SCIENTIFIC PAPERS

SERIES B. HORTICULTURE

Volume LIX, 2015

UNIVERSITY OF AGRONOMIC SCIENCES
AND VETERINARY MEDICINE OF BUCHAREST
FACULTY OF HORTICULTURE

SCIENTIFIC PAPERS
SERIES B. HORTICULTURE

VOLUME LIX

2015
BUCHAREST

PUBLISHERS:

University of Agronomic Sciences and Veterinary Medicine of Bucharest - Faculty of Horticulture

Address: 59 Marasti, District 1, 011464 Bucharest, Romania

E-mail: journal@horticultura-bucuresti.ro, Webpage: www.horticultura-bucuresti.ro

CERES Publishing House

Address: 1 Piața Presei Libere, District l, Zip code 013701, Bucharest, Romania

Phone: + 40 21 317 90 23, E-mail: edituraceres@yahoo.com, Webpage: www.editura-ceres.ro

To be cited: Scientific Papers. Series B. Horticulture, Vol. LIX, 2015

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They represent the authors' point of view.

Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

International Database Indexing: INDEX COPERNICUS (5,17), CABI, CNCSIS B+,
ULRICH'S PERIODICALS DIRECTORY, PROQUEST, GOOGLE SCHOLAR.

SUMMARY

FRUIT GROWING

VITICULTURE AND OENOLOGY

VEGETABLE GROWING

FLORICULTURE, ORNAMENTAL PLANTS, DESIGN AND LANDSCAPE ARHITECTURE

MISCELLANEOUS

FRUIT
GROWING

EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE IMPORTANCE OF FINANCIAL SUPPORT FROM EUROPEAN COMMUNITY IN ROMANIAN FRUIT PRODUCTION

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Abstract

Fruit growing in Romania has passed through different phases in the past time. The fact that Romania is EU member since 2007 brought a number benefits regarding the funds for development in different domains. First of all the economic development of all EU members is the main objective, that's why in the National Program of Rural Development for 2014-2020 the focus is distributed to fruit growing. The studies made on the development of this section of agriculture brought positive conclusions regarding the investments in this sector, with respect to the eco-climatic conditions in Romania. The main objective is focusing on building new crops, investment in equipment, rehabilitation of nurseries, appearance of new and competitive products and last but not least investment in research studies in the field of fruit growing. All these together are the motor of economic competiveness growth of the fruit crops that can bring a number of financial benefits for all the implicated factors. The EU initiative of offering financial support for the fruit crops is necessary, welcome and in the same time certifies the development of Romania in this sector that has an excellent perspective.

Key words: *development, European Union, financial support, fruit production, Romania.*

INTRODUCTION

Fruit growing sector has been in a steady decline over the past 23 years, with negative consequences for the economic development of rural areas (Cojocaru, 2000; FAO Statistics; PNDR 2014). The surface covered with orchards, during 1990-2013, decreased by about 50% (from 313,400 ha in 1990 to 158,600 ha in 2013). In the last five years deforestation rate was faster than the establishment of new ones, in 2008-2012 only were cleared 5722 ha and 3007 ha established (FAO Statistics; Isac, 2002; PNDR 2014). Most orchards are aging, older than 25 years; from the total area of orchards, 73.8% (117, 000 ha) are plantations older than 25 years, 18.7% (29,700 ha) are plantations aged 10-25 years and only 7.5% (11,800 ha) are plantations aged 1-10 years (FAO Statistics; Merce, 2010; Mitre, 2002; Pânzaru, 2007; PNDR 2014). 83,000 ha of plantations are declining (52.4% of the total area), about 67,000 ha are fruit plantations (42.2% of total area) and 8540 ha are young plantations (5.4% of total surface). 108,500 ha plantations (68.4%) are cultivated in an extensively system, 47,200 ha plantation (29.7%) cultivated intensively and 2,930 ha (1.9%) are plantations super intensive (FAO Statistics; PNDR 2014; Ra i, 2001). The area cultivated organically increased from 211 ha in 2006 to 6,083 ha in 2012. Of the 6,083 hectares approximately 86% are under conversion and only 14% are certified (FAO Statistics; PNDR 2014). In Table 1, are given data regarding the orchards in Cluj County by species and ages.

Table 1. The centralized orchards by species and age, in Cluj County

Nr.	Basin orchards	Species	Area (ha)	Ages			Category			Cultural system		
				>25 years	10-25 years	1-10 years	In decline	In production	Young	Extensive	Intensive	Super intensive
				(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)
1	DEJ	Apples	616	607		9	448	159	9	188	428	
		Pears	21	21			10	11			21	
		Plums	147	147			147				147	
		Cherries	10	10			10				10	
		Sour cherries	5	5			5				5	
		Nuts	2			2			2		2	
		Black currant	1			1			1		1	
TOTAL AREA DEJ			**802**	**790**		**12**	**620**	**170**	**12**	**188**	**614**	
2	APAHIDA	Apples	752	749		3	729	20	3	109	643	
		Plums	116	116			116				116	
		Cherries	7	7			7				7	
		Sour cherries	2	2			2				2	
		Seabuckthorn	15.03			15.03			15.03		15.03	
		Nuts	4.5			4.5			4.5		4.5	
TOTAL AREA APAHIDA			**896.53**	**874**	**0**	**22.53**	**854**	**20**	**22.53**	**109**	**787.53**	
3	TAGA	Apples	242	217		25	217		25	217	25	
		Plums	46	46			46			24	22	
		Seabuckthorn	24.24			24.24			24.24		24.24	
TOTAL AREA TAGA			**312.24**	**263**		**49.24**	**263**		**49.24**	**241**	**71.24**	
4	CLUJ	Apples	868	858		10	858		10	109	759	
		Pears	15	15			15			15		
		Plums	574	574			574			44	530	
		Cherries	20	20			20				20	
		Sour cherries	8	8			8				8	
		Huckleberry	3.6			3.6			3.6		3.6	
		Black currant	2			2		2			2	
		Experimental collection	20									
TOTAL AREA CLUJ			**1490.6**	**1475**		**15.6**	**1475**	**2**	**13.6**	**168**	**1322.6**	
5	BACIU	Apples	274	269		5	269		5	120	154	
		Plums	359	359			359			2	357	
		Raspberry	1			1			1		1	
		Huckleberry	2.5			2.5			2.5		2.5	
TOTAL AREA BACIU			**636.5**	**628**		**8.5**	**628**	**0**	**8.5**	**122**	**514.5**	
6	TURDA	Apples	307.54	295		12.54	295	10.04	2.5	295	12.54	
		Pears	5	5			5			5		
		Plums	12.46	10		2.46	10	2.46		10	2.46	
		Cherries	29	29			29			29		
		Sour cherries	27	27			27			27		
		Nuts	3.23			3.23			3.23		3.23	
TOTAL AREA TURDA			**384.23**	**366**	**0**	**18.23**	**366**	**12.5**	**5.73**	**366**	**18.23**	**0**
TOTAL			**4522.1**	**4396**	**0**	**126.1**	**4206**	**204.5**	**111.6**	**1194**	**3328.1**	**0**

MATERIALS AND METHODS

The main objective is focusing on building new crops, investment in equipment, rehabilitation of nurseries, appearance of new and competitive products and last but not least investment in research studies in the field of fruit growing.
The data, collected from Ministry of Agriculture and Rural Development, and from the National Program of Rural Development.

RESULTS AND DISCUSSIONS

A major factor that led to the decline of the sector is excessive fragmentation of land, especially in hilly favourable fruit crops, average surface area owned tree farm is 0,38 ha in 2010, much less than the minimum area required for a holding fruit to become viable (minimum 0,3 - 5 ha). According to the General Agricultural Census (GAC) 2010, the largest average size occurs when plantations of peaches and nectarines and lowest for pears, 0,64 ha, 0,16 ha respectively. The main species grown (by area) are plum (43,8%), apple (42,4%) (Figure 1.) (FAO Statistics).

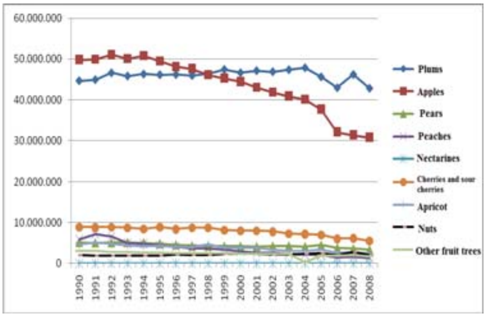

Figure 1. Evolution of the number of trees by species during 1990-2008 (Statistical Yearbook of Romania; FAO STATISTICS)

In terms of ownership structure, 88% of holdings are individual properties and only 10% are held by associations or societies (Figure 2.).

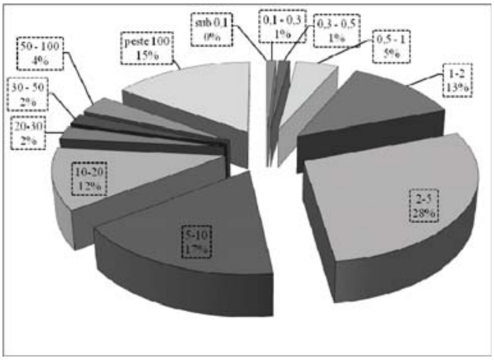

Figure 2. Distribution orchards on every farm size in 2007 (Statistical Yearbook of Romania; FAO STATISTICS)

The share of the fruit production on farm types in 2008 is presented in Table 2.

Table 2. The share of fruit production on farm types in 2008 (Statistical Yearbook of Romania)

	Companies and associations	Individual farms	Other holdings
Pomiculture	10%	88%	1%
Apples	16%	83%	2%
Pears	1%	98%	0%
Plums	3%	97%	1%
Peaches, nectarines	18%	75%	7%
Cherries, sour cherries	10%	89%	1%
Other fruits	7%	93%	1%
Expenses for fruit plantations	52%	43%	5%
Seedlings for plantation establishment	92%	2%	6%

CONCLUSIONS

A main objective is the establishment of new fruit tree plantations, of all kinds, depending on the specific area of orchards and market demands (super-intensive farms, intensive, extensive, green); investment in rejuvenation/conversion fruit crops; investment in modernization of farms and orchards and economic competitiveness and environmental thereof; supporting investments in equipment, machinery and facilities for performance, storage, processing, packaging, transport and to increase the quality and quantity of fruit production (including investments in more efficient irrigation systems or creating new and good water management infrastructure) support the setting up of young farmers; support for small farms; rehabilitation nurseries and research stations capable of meeting market needs to produce high quality seedlings, adapted to the specific soil; development of processes/innovative products to increase competitiveness of the sector; supporting investment in research and innovation for endangered tree species to maintain and improve genetic resources and for making efficient tree varieties adapted to specific local conditions.

ACKNOWLEDGEMENTS

This paper was published under the frame of European Social Fund, Human Resources Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/132765.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

PRELIMINARY RESULTS OF SOME EARLY RIPENING SWEET CHERRY CULTIVARS ON SOME HUNGARIAN BRED MAHALEB ROOTSTOCKS

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Abstract

Evaluation of ten cherry rootstocks ('Bogdány', Cerasus mahaleb 'Cemany' (control), 'Egervár', 'Érdi V', 'Korponay', 'Magyar', 'SM 11/4', 'Vadcseresznye C. 2493', 'GiSelA 6', 'INRA SL 64') combined with early ripening sweet cherry cultivars ('Petrus℗', 'Vera℗', 'Carmen℗') has been studied among non-irrigated conditions in Hungary. Trials were set up at Research Station of Érd of Fruitculture Research Institute of National Agricultural Research and Innovation Centre. Aim of our study was to find suitable rootstock for novel bred Hungarian sweet cherry varieties. It can be stated after seven years investigation that 'Petrus' was the most vigorous varieties, which is followed by 'Vera' and 'Carmen'. The 'GiSelA 6' rootstock had low vigor among examined rootstocks and 'INRA SL 64' was the most vigorous one in our trial. 'Petrus' produced the biggest yield and the smallest fruit size among observed cherry varieties. Yield of 'Carmen' grafted on 'Érdi V', 'Egervár', and 'GiSelA 6' was the highest but only 'Érdi V' had a positive effect on fruit size because more than 40% of examined fruits were larger than 28,1 mm in diameter. 'Vera' yielded well on 'Érdi V' and 'Egervár', the best fruit size was produced by 'Érdi V'. On the basis of value –yield index, which was calculated by actual market price per fruit size category, 'Carmen' produced the highest income per tree on 'Egervár' and 'GiSelA 6' and 'Vera' was the most valuable on other rootstocks.

Key words: *fruit size, sweet cherry, rootstocks, rootstock-scion interactions.*

INTRODUCTION

A lot of cherry rootstocks have been released around the world over the last two or three decades therefore there are wide range cherry rootstocks available for growers. Other factor is, that there are 26 state approved sweet cherry cultivars in the Hungarian assortment therefore it is still not easy for the growers to choose the best rootstock-scion combinations. Based on previous studies the different rootstock-scion interactions can make more difficult the growers' rootstock choice.
There are two different trends in Europe. In a wider sense north half of Europe low or medium vigor rootstocks are preferred because of mild and more humid climate conditions. The climate is drier in the South Europe therefore the cherry rootstock usage still focuses on medium or strong vigorous rootstocks mostly (Bujdosó and Kállayné, 2004).

Growers prefer planting on vegetative-propagated rootstocks in order to achieve medium vigorous and homogenous tree population in the orchard. However, the Hungarian growers still use generative-propagated Mahaleb rootstocks (Hrotkó et al., 2006) because of its drought and lime tolerance. The new, vegetative-propagated Mahaleb rootstocks (Hrotkó and Magyar, 2004) should be evaluated with the newly bred Hungarian cultivars (Apostol, 2008).

MATERIALS AND METHODS

Three early sweet cherry varieties were tested in the trial: 'Petrus℗′, 'Carmen℗', and 'Vera℗′ on different Mahaleb stocks selected at Department of Fruit Growing of Corvinus University of Budapest ('Bogdány', 'Egervár', 'Magyar', 'SM 11/4', 'Korponay') and at Research Institute for Fruit Growing and Ornamentals ('Erdi V'). Cerasus avium

‘C 2493’, ‘INRA SL 64’ and ‘GiSelA 6’ were also involved in the trial. Control of the trial was ‘Cemany‘ Mahaleb rootstock, which is about 10 % less vigorous compared to F 12/1. Number of rootstocks was different by each scion varieties because of available plant material.

Based on literate data ‘Cemany’ and Cerasus avium ‘C. 2493’ are very vigorous, the growth of ‘Bogdány’, ‘Kornopay’ and ‘SL 64’ is vigorous. Furthermore, ‘Magyar’ and ‘Egervár’ have moderate vigor and ‘GiSelA 6’ has low vigor (Franken-Bembenek, 1995, Hrotkó, 1999, 2003, Hrotkó and Magyar, 2004, Hrotkó et al., 2009).

The trial was planted in spring of 2004 at Experimental Fields of the Research Institute on chernozem soil with high lime content (K_A=40, pH=8, total lime content in the top 60 cm layer 5%, humus content 2,3-2,5 %). Site conditions are the following: average yearly sunshine hours: 1981; average yearly temperature: 10,7°C; average yearly temperature in the vegetation period: 16,6°C; average yearly precipitation: 515 mm. Canopy was trained to spindle, the orchard is non irrigated.

Our data base contains data on trunk diameter, estimated yield, fruit diameter by size fraction from 2008. Trunk diameter was measured 20 cm above graft union in every November. Yield data were estimated after measuring 1 kg full ripen cherries. Sixteen fruits per rootstock-scion combinations were picked randomly to determine the fruit diameter of the combinations. Unfortunately, there was no crop on rootstock-scion combinations in 2012 because of late spring frosts. The cumulated yield efficiency index was calculated as cumulated yield between 2008 and 2014 / trunk cross sectional area of 2013.

Value equivalent Yield Efficiency (average fruit weight of the cultivars x No. of fruit by size fraction x yield x price of size fraction in EUR/kg) was also calculated. Average fruit weight of ‘Petrus℗’ was 5 g, of ‘Vera℗’ 8 g, of ‘Carmen℗’ 11 g.

Following farmer prices of different fruit size fractions were taken into consideration: up to 23,9 mm in diameter 0,6 EUR/kg, 24,0 to 25,9 mm in diameter 0,75 EUR/kg, 26,0 to 27,9 mm in diameter 1,1 EUR/kg, 28,0 to 29,9 EUR/kg 1,5 EUR/kg, more than 30,0 mm in diameter 2 EUR/kg.

Statistical evaluation was made by PSAW 18 program’s Duncan’s homogeneity evaluation of ANOVA analysis for one factor. There aren’t any significant differences in the data marked by same letters.

RESULTS AND DISCUSSIONS

The vigorous variety was ‘Petrus℗’ grafted on different rootstocks, followed by ‘Vera℗’ and ‘Carmen℗’. The largest vigor was produced by trees grafted on ‘SL 64’ and trees on ‘GiSelA 6’ were the lowest. ‘Petrus℗’ grafted on control showed significant difference to those trees grafted on ‘Magyar’, ’C. 2493’, ‘Egervar’, ‘GiSelA 6’. There was no significant difference in growth of ‘Carmen℗’ except trees on ‘GiSelA 6’. Growth of ‘Vera℗’ grafted on ‘Cemany’ was significant vigorous than those grafted on ’Egervar’, ‘Korponay’ and ‘GiSelA 6’ (Figures 1., 2., 3.).

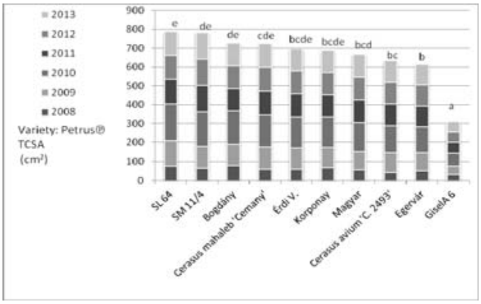

Figure 1. Effect of different rootstocks on trunk cross sectional area of 'Petrus℗' (Érd-Elvira major, 2008-2013)

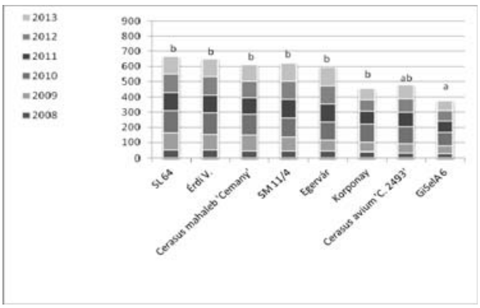

Figure 2. Effect of different rootstocks on trunk cross sectional area of 'Vera℗' (Érd-Elvira major, 2008-2013)

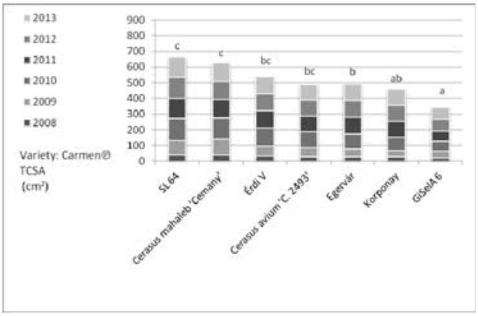

Figure 3. Effect of different rootstocks on trunk cross sectional area of 'Carmen®' (Érd-Elvira major, 2008-2013)

Suckers haven't been appeared in the trial yet. The highest cumulated yield was produced by 'Petrus®', followed by 'Vera®' and 'Carmen®'. 'Petrus®' on 'Magyar', 'Cemany' and 'Bogdany' rootstocks produced the highest yield (Figure 4).

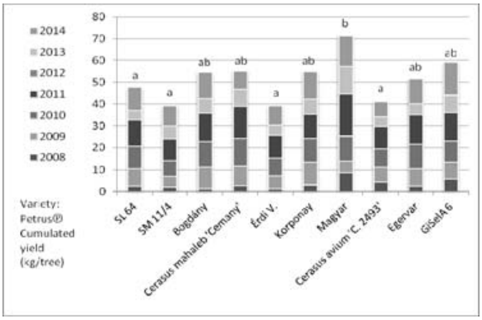

Figure 4. Effect of different rootstocks on cumulated yield of 'Petrus®' (Érd-Elvira major, 2008-2014)

There was small difference in cumulated yield of 'Vera®', the largest yield was produced on 'Erdi V' and 'Egervar' rootstocks (Figure 5.).

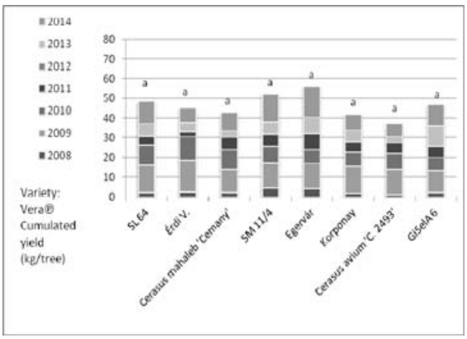

Figure 5. Effect of different rootstocks on cumulated yield of 'Vera®' (Érd-Elvira major, 2008-2014)

'Carmen®' grafted on 'GiSelA 6' was the most productive followed by 'Egervár' and 'Cemany' (Figure 6).

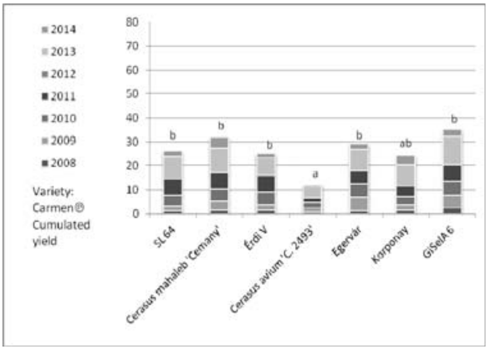

Figure 6. Effect of different rootstocks on cumulated yield of 'Carmen®' (Érd-Elvira major, 2008-2014)

'Petrus®' grafted on 'GiSelA 6' rootstock produced the best fruit size; 60 % of fruits reached 22 mm in diameter (Figure 7.).

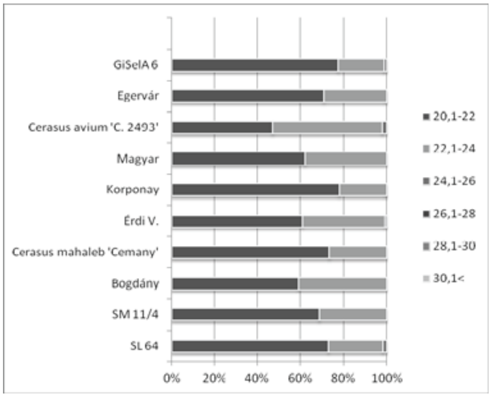

Figure 7. Effect of different rootstocks on fruit size of 'Petrus®' (Érd-Elvira major, 2010-2014)

Vera®' fruits were significant larger compared to 'Petrus®'. 50 % of 'Vera®' fruits picked from trees on 'Erdi V' and 'SM 11/4' reached 26 mm in diameter (Figure 8).

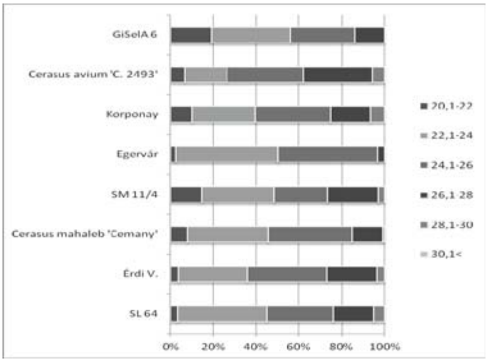

Figure 8. Effect of different rootstocks on fruit size of 'Vera®' (Érd-Elvira major, 2010-2014)

‘Carmen®’ trees grafted on ‘Erdi V’ produced the best fruit size because 60 % of picked fruit were equal or larger than 28 mm in diameter (Figure 9.).

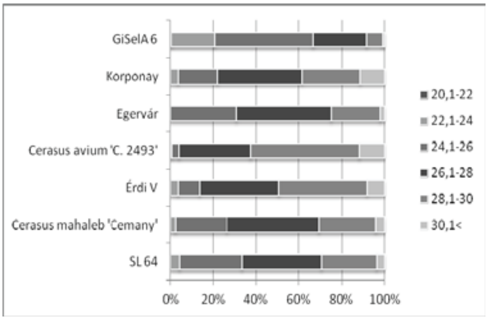

Figure 9. Effect of different rootstocks on fruit quality of 'Carmen®' (Érd-Elvira major, 2010-2014)

The best cumulated yield efficiency index was produced by scions grafted on ‘GiSelA 6’ followed by trees grafted on ‘Egervár’ and ‘Korponay’ (Figures 10, 11, 12).

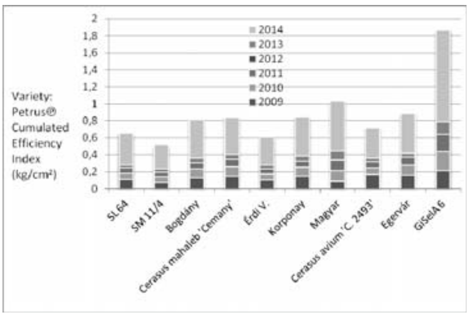

Figure 10. Cumulated yield efficiency index of ‘Petrus®’ grafted on different rootstocks (Érd-Elvira major, 2009-2014)

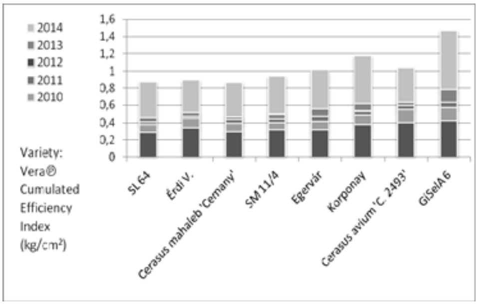

Figure 11. Cumulated yield efficiency index of ‘Vera®’ grafted on different rootstocks (Érd-Elvira major, 2010-2014)

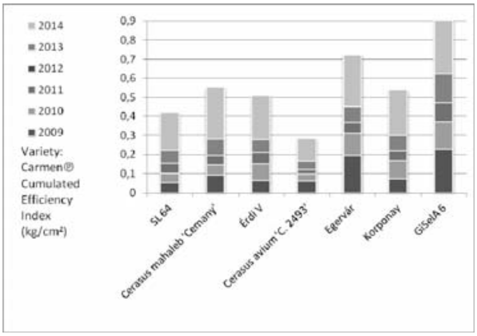

Figure.12. Cumulated yield efficiency index of ‘Carmen®’ grafted on different rootstocks (Érd-Elvira major, 2010-2014)

Based on value equivalent yield efficiency there was a lot of big difference in rootstock-scion combination studied in the trial. ‘Petrus®’ performed the lowest value equivalent yield efficiency followed by ‘Vera®’ and ‘Carmen®’ (Figure 13.).

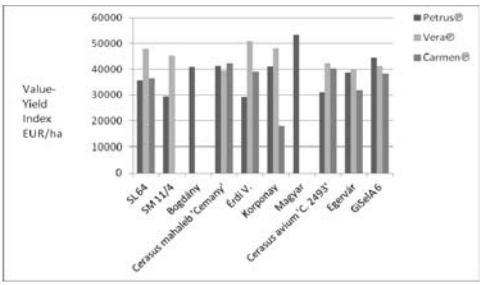

Figure 13. Value equivalent Yield Efficiency of different rootstock/scion combinations (Érd-Elvira major, 2008-2013)

CONCLUSIONS

Rootstocks tested in our trial can be categorized by vigor as follows:

- vigorous rootstocks: ’INRA SL 64’, ’Cemany’, ’Érdi V’, ’SM 11/4’ and ’Bogdány’,
- moderate vigorous rootstocks: Korponay’ seedling, ’Magyar’ and ’Egervár’,
- semi dwarfing rootstock ’GiSelA 6’.

‘Petrus℗’ is a self fertile cultivar; therefore this variety produced the highest yield. ‘Vera℗’ and ‘Carmen℗’ are self sterile varieties so their yields depend - among others - on the weather conditions under blooming time (Apostol, 2008).

‘Petrus℗’ produced small fruit size and rootstocks did not affect its fruit size. Fruit size of ‘Vera℗’ and ‘Carmen℗’ was excellent and the chosen rootstocks didn’t have any negative effect on their fruit size. ‘Carmen℗’ produced the largest fruit size in the tested cherry assortment.

Since ‘Vera℗’ produced higher yield than ‘Carmen℗’, ‘Vera℗’ reached the best value equivalent yield efficiency. The larger fruit size of ‘Carmen℗’ couldn’t compensate the difference in yield.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDIES REGARDING THE INFLUENCE OF APPLE SORTING UPON THE QUALITY AND EFFICIENCY OF SELLING PROCESS

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Abstract

Very often, the fruit tree growing exploitations sell their gross production directly from the farm immediately after harvesting, without sorting and storing it. The present paper aims at printing out the economic differences in apple within the fruit tree-growing area of Voinesti –Dambovita County, comparing the en-gross selling of the fruits and the selling after sorting by quality category. The higher economic efficiency, calculated for the 'Rubinola' and 'Sirius' varieties in comparison with 'Jonathan' and 'Golden Delicious' varieties is also due to the fact that for the first two varieties the production costs were lower, thanks to the smaller number of phytosanitary treatments, since these have genetic endurance to the apple scab disease. The additional profit per hectare might vary between 280 lei ('Golden Delicious') and 2900 lei ('Rubinola'), which means an increase in the profit of 9,5 -43,5 %, compared with the en-gross selling.

Key words: *genetically resistant varieties, quality variation index, average quality coefficient.*

INTRODUCTION

In Romania, agricultural exploitations are more and more market-oriented, becoming increasingly commercial.
In the traditionally fruit tree, grapevine and vegetable growing areas, the commercial feature is even more obvious, as production always exceeds consumption and the surplus is destined to market.
Nevertheless, the economic results of the production activities are influenced by several factors such as: the exploitation size, average productions, product quality, available financial resources, the exploitation manager's experience, pedoclimatic factors, etc.
Production commercialisation also plays an important role (Pană et al., 1983). Very often, the orchard exploitations sell their gross production directly from the unit immediately after harvesting, without storing it.
This commercialisation method is determined by various factors, among which: insufficient or improper storage space; the need to obtain immediate financial resources for starting the production cycle again; difficulties in the retail selling system (particularly the reduced time budget of the producer – the only of the producer – the only or the main working force of the exploitation, additional expenses resulting from going to the market, etc).
Much more, this commercialisation method may derive an important share of the producer profit which is transferred to the commercial link (Chira A et al., 2012).
Fruit quality influences the valorization price directly. The large fruit supply compared with the reduced demand results is unique price selling, neglecting the advantages of previous merchandise classification according to quality.

The present paper aims printing out the economic differences in apple within the fruit tree growing area of Voineşti – Dâmbovița county, comparing the gross selling for a unique price per kilogram with the retail selling of the quality – classified harvest.

MATERIALS AND METHODS

The data resulted from the actual results of apple production in a family exploitation located in the fruit tree growing area of Voineşti – Dâmbovița County. The varieties grown were 'Jonathan', 'Golden Delicious', 'Rubinola' and 'Sirius'. The data analysis was performed by calculating some technical and economic indicators (income, expenses, profit), while the variety quality assessment was made by determining the quality variation indices and the average quality coefficient of the variety and the group of varieties.

RESULTS AND DISCUSSIONS

For this purpose, the production results refer to the average production per hectare in the four varieties, out of which two ('Rubinola' and 'Sirius') are genetically resistant to scab and medium resistant to powdery mildew, while the others are considered the standard for the winter storage varieties.
The fruit quality classification was based on the standard diameter: 65 mm – Extra quality, 60 mm – first quality, 55 mm – second quality; the fruit has fallen prematurely from the trees improper for consumption were used for distillation. The prices of the area in 2014 were different, according to quality class: 2.5 lei/kg – Extra quality; 2.0lei/kg – first quality; 1.5lei/kg second quality; 0.6 lei/kg for industrial processing. For the gross selling, the price in the area was 1.5 lei/kg. Table 1 contain the production results obtained and the income from the two commercialisation methods.

The average production per hectare and its structure according to quality classes were different from one variety to another, according to the variety potential and the weather conditions of the year. The production selling according to quality classes may result in an income increase varying according to variety from 1970 lei/ha to 5440 lei/ha, which corresponds to an increase of 12.6 % - 28.5 %, compared with the en-gross commercialisation. The share of the various quality classes in the variety structure indicates that the first and second quality class fruit exceed the Extra quality and industrial processing fruits.
The production expenses were higher in the 'Jonathan' and 'Golden Delicious' varieties, compared with the 'Rubinola' and 'Sirius', as the latter recorded less expense for phytosanitary protection due to their strong genetic resistance to scab and medium resistance to powdery mildew (Table 2).
Moreover, when production is targeted for commercialisation according to the quality class, the production unit cost increases by 0.2 lei/kg as a result of fruit classification.
The profit was calculated as difference between the selling income and the total expenses, and varied from one variety to another. The analysis of the profit obtained from the two commercialisation methods pointed out to the following:

- The producer would be more economically advantaged if selling occurred according to quality criteria;
- The additional profit per hectare might vary between 280 lei ('Golden Delicious') and 2900 lei ('Rubinola'), which means an increase in the profit of 9.5 -43.5 %, compared with the gross selling;
- The additional profits per hectare were almost from 2 - 4 times higher in the genetically resistant varieties, compared with the standard ones ('Jonathan', 'Golden' etc).

Table 1. Production and income obtained from engross and quality – Class selling

Variety	Average production t/ha	Production according to quality class		Price Lei/t	Income from selling according to quality class		Income from en-gross selling Lei/ha	Selling income difference according to quality class	
		tons	%		Lei	%		Lei	%
‘Jonathan’	10,4	E 1,20	11,5	2500	3000	17,2	15600	+1970	+12,6
		I 4,15	39,9	2000	8300	47,2			
		II 3,60	34,6	1500	5400	30,7			
		Ind 1,45	14,0	600	870	4,9			
	Total	10,40	100	(1689)	17570	100	13800	+2120	+15,3
‘Golden delicious’	9,2	E 1,60	17,4	2500	4000	25,2			
		I 3,20	35,2	2000	6400	40,2			
		II 3,20	34,8	1500	4800	30,1			
		Ind 1,2	12,6	600	720	4,5			
	Total	9,2	100	(1624)	15920	100	19050	+5440	+28,5
‘Rubinola’	12,7	E 3,30	25,6	2500	8250	31,5			
		I 5,90	46,5	2000	11800	49,3			
		II 2,60	20,5	1500	3900	18,1			
		Ind 0,90	7,4	600	540	1,1			
	Total	12,7	100	(1928)	24490	100	17700	+5060	+28,6
‘Sirius’	11,8	E 2,80	23,8	2500	7000	29,4			
		I 5,60	47,4	2000	11200	51,3			
		II 2,80	23,7	1500	4200	17,6			
		Ind 0,60	5,1	600	360	1,7			
	Total	11,8	100	(1929)	22760	100			

Table 2. Profit from engross and quality – class selling

Variety	Gross selling			Quality – class selling			Profit difference	
	Income lei /ha	Production expenses lei/ha	Profit lei /ha	Income lei/ha	Production expenses lei/ha	Profit lei/ha	lei /ha	%
‘Jonathan’	15600	11150	4450	E 3000	1521,4	1478,6	890	20,0
				I 8300	5278,8	3021,2		
				II 5400	4577,6	822,4		
				Ind 870	1852,2	-982,2		
Total	15600	11150	4450	17570	13230	5340		
‘Golden Delicious’	13800	10850	2950	E 4000	2208,1	1791,9	280	9,5
				I 6400	4466,9	1933,1		
				II 4800	4416,1	383,9		
				Ind 720	1598,9	-878,9		
Total	13800	10850	2950	15920	12690	3230		
Rubinola	19050	7250	11800	E 8250	2506,2	5743,8	2900	43,5
				I 11800	4552,3	7247,7		
				II 3900	2007,0	1893,0		
				Ind 540	724,5	-184,5		
Total	19050	7250	11800	24490	9790,0	14700		
‘Sirius’	17700	6450	11250	E 7000	2096,8	7024,1	2700	42,6
				I 11200	4175,9	7024,1		
				II 4200	2088,0	2112		
				Ind 360	449,3	-89,3		
Total	17700	6450	11250	22760	8810	13950		

The following emphases the influence of fruit quality in the two groups – standard and genetically resistant upon the economic results obtained from commercialisation according the quality class.
The I_q variation index of quality according to variety groups was calculated by the formula:

$$I_q = \frac{Q_1}{Q_0}$$

where Q_1 = average production of genetically – resistant varieties according to quality class
Q_0 = average production of standard varieties according to quality class.

The values obtained were I_q Extra = 1.25; Iq I-st quality = 1.56; Iq II quality = 0.8; Iq ind = 0.6.
Calculated for variety groups, the same index was Iq = 1, 25. The values of the variation index show that, in both variety groups, the Extra and first quality fruit number was higher than the second – quality and industrial processing. The production of genetically resistant varieties was higher than standard varieties because of rainy season on 2014 which determine a strong attack of apple scab. Also the fruits achieve higher quality compared with the standard group, particularly as a result in the increase in the Extra and first quality categories.

CONCLUSIONS

The current practice of production selling through engross system is economically disadvantageous for the fruit producers;
This results in profit loss which can reach more than 40 % of the total;
It is necessary for the producers to become familiar with the advantages, and to turn them to better account;
The establishment of some associative forms of commercialisation (cooperatives) would facilitate quality – class selling;
The apple varieties which are genetically resistant to some diseases have superior productions of average quality compared with the standard varieties, and their commercialisation according to quality class can increase profits for the producers.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

CONTRIBUTION TO KNOWLEDGE OF THE GALL INSECTS AND MITES ASSOCIATED WITH PLANTS IN SOUTHERN ROMANIA

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Abstract

Many phytophagous insect and mite species induce galls to plant leaves, either by lying eggs or feeding activity. Some of them attack forest and fruit trees in different environments, and can became serious pests where heavy infestation occurred. The paper presents the results regarding on the presence of galls and gall insects and mites detected in 2013 on various plant species in different sites from northern part of Bucharest city (the South part of Romania). A total of 15 species of insects and 3 species of mites causing gall on plants were evaluated according to their galls type and host plant information. The gall insects belonged to Aphididae, Psyllidae, Cecidomyiidae, Cynipidae families and gall mites belonged to Eriophyidae family. The galls were encountered on the buds, leaves and twigs of plants, as ornamental oak and elm trees, walnut, apple, pear and plum fruit trees and dog-rose, raspberry and goji plants. The damages caused were of aesthetic or economic importance, depending on the purpose for which the investigated plants were used.

Key words: *galls, gall insects and eriophyd mites.*

INTRODUCTION

Organisms producing plant galls are an important group of pests on which numerous research studies have been directed worldwide. The galls are described as abnormal growths of plant tissues caused by increase of some plant growth hormones (auxins, cytokinins, gibberellins, etc.) under the influence of parasite organism species (Neacşu, 2006). Egg laying and feeding activity of numerous phytophagous insects and mites as well as infections of bacteria, fungi or nematodes are among the factors that can induce the galls formation. Many parts of plants (buds, flowers, leaves, stems, twigs or roots) can be affected by galls. Aphids, midges, psyllids and eriophyid mites are among the common arthropod species with abilities to produce different types of galls to a wide range of plant species.
The researches devoted on this subject have been achieved in Romania still in the earliest times by Borcea (1912) and Borza et al. (1938), who brought the first important contributions to the knowledge of the galls in Romanian fauna, which remained applicable nowadays, too.
The extended presence in high density of galls and gall inflicting organisms to a great range of plants and areas in Romania, stimulate many researches and an increased numbers of published studies and new records have occurred recently (Ianovici et al., 2010; Gutue et. al., 2012). From one area to another, the gall types and gall-making organism species are different depending on composition of the host plant species and local climatic conditions, as well as invasion of alien species in new environmental conditions.
In this paper we described the results of investigation on the presence of the galls, and insects and mites associated with them, found on different plant species in sites from various habitats in green spaces, orchards and private gardens located in the Northern part of Bucharest city in 2013. This area has experienced a rapid and profound development in terms of building of people houses and company offices, with promotion of large green areas that become a very complex environment with various vegetation structures and reach flora and fauna diversity.

MATERIALS AND METHODS

The investigation was undertaken in 2013 in sites from the Northern part of Bucharest city, which is located in the Romanian Plain, the South part of Romania. This part of the city benefits from areas with large green spaces including different categories of urban and spontaneous vegetation which created very favourable conditions for the pests and diseases development. For our research purposes, the samples of plants together with their galls and associated arthropods were collected in the field and processed in laboratory conditions. The species of plants and associated gall types and arthropod fauna inside galls were determined based on the descriptions available in relevant publications. The pictures were achieved by photographic techniques.

RESULTS AND DISCUSSIONS

During this research, we recorded various types of galls on plants caused by 15 insect and 3 mite species, belonging to the families Aphididae, Psyllidae, Cecidomyiidae, Cynipidae and Eriophyidae from Hymenoptera, Diptera, Homoptera and Acari orders. The gall arthropods associated with the galls on plant species in Northern part of the Bucharest city detected in 2013 are listed in Table 1.

Table 1. The gall arthropods associated with plant species in Northern part of Bucharest city, 2013

Order	Family	Species	Common name	Host plant of galls
Hemiptera	Aphididae	*Dysaphis devecta*	Apple rosy leaf-curling aphid	*Malus domestica* (Rosaceae)
		Myzus varians	Peach leaf-roll aphid	*Prunus persica* (Rosaceae)
		Tetraneura ulmi	Elm sack gall aphid	*Ulmus sp.* (Ulmaceae)
		Eriosoma lanuginosum	Elm balloon-gall aphid	*Ulmus sp.* (Ulmaceae)
	Psyllidae	*Cacopsylla pyrisuga*	Great pear sucker psyllid	*Pyrus communis* (Rosaceae)
Diptera	Cecidomyiidae	*Dasineura pyri*	Pear leaf midge	*Pyrus communis* (Rosaceae)
		Dryomyia circinans	Oak gall midge	*Quercus sp.* (Fagaceae)
		Asphondylia pruniperda	Gall midge of plum buds	*Prunus domestica* (Rosaceae)
		Lasioptera rubi	Raspberry stem gall midge	*Rubus sp.* (Rosaceae)
Hymenoptera	Cynipidae	*Aphelonyx cerricola*	Oak bud gall wasp	*Quercus sp.* (Fagaceae)
		Andricus kollari	Oak marble gall wasp	*Quercus sp.* (Fagaceae)
		Andricus hungaricus	Oak bud gall wasp	*Quercus sp.* (Fagaceae)
		Andricus quercustozae	Oak bud gall wasp	*Quercus sp.* (Fagaceae)
		Cynips quercusfolii	Oak leaf gall wasp	*Quercus sp.* (Fagaceae)
		Diplolepis rosae	Mossy rose gall wasp	*Rosa canina* (Rosaceae)
Acari	Eriophyidae	*Aceria tristriata*	Walnut gall mite	*Juglans regia* (Juglandaceae)
		A. erinea	Walnut leaf blister mite	*Juglans regia* (Juglandaceae)
		A. kuko	Goji gall mite	*Lycium barbarum* (Solanaceae)

The galls were encountered on buds, leaves, and on shoots having various shapes, colour and consistence.

The galls on oak species were the most commonly found. Four important gall maker insects were found associated with fruit trees, apple, pear, peach and plum species, and 2 gall mites on walnut trees. The elm trees were affected by two species of gall aphids.

The insect and mite species causing galls on plants and the type of galls are presented as follows:

***Dysaphis devecta* Walker 1849 (Hemiptera: Aphididae) - the apple rosy leaf-curling aphid** This aphid is widespread on apple trees in Europe, and it is considered an important pest producing galls on leaves of *Malus* species. Damage caused by *D. devecta* appeared in many localities in Romania (Feraru, 2004; Trandafirescu et al., 2004; Ianovici et al., 2010). In this research, it was found feeding on apple trees in orchards and in house backyards from early spring to summer. Characteristic symptoms of rosy aphid infestation are the downward curl of the margins of apple leaves, which gradually transform into galls of shiny red colour (Figure 1). These types of galls are called pseudogalls. The leaf rolling and red colour of galls are caused by a toxin present in the saliva of aphids, which is injected into leaf tissues during their feeding from phloem. Large colonies of aphid develop several generations inside galls, sucking sap under protection of curled leaves. Aphid damages include loss of sap, decrease of the foliage surface of apple trees by coating with honeydew on which the fungal diseases develop.

Figure 1. Red galls of rosy leaf curling aphid

***Myzus varians* Davidson 1912 (Hemiptera: Aphididae) - the peach leaf-roll aphid** This is spread in Europe, Minor Asia and North America, and is considered a sever pest for peach in Italy (Manachini et al., 2004). Aphid damage on peach was reported in the Southern part of Romania (Chireceanu 2006; Sivu, 2011). The biological cycle of *M. varians* occurs on peach *Prunus persica* (primary host) and on species of *Clematis* (secondary host). Under the influence of the *M. varians* attack, the peach leaves roll backwards along the midrib, the galls being of cigar shapes (Figure 2). Additional to direct damage, *M. varians* is an efficient vector of the Plum Pox Virus, causing significant losses in peach crop, on which the aphid can transmit from infected *Clematis* plants to peach trees (Manachini et al., 2004). In 2013, ooccasional attacks of *M. varians*, visible through the curled young leaves of the annual shoots were notated on peach trees in orchards and house backyards.

Figure 2. Peach leaves rolled caused by *M. varians*

***Tetraneura ulmi* L. 1758 (Hemiptera: Aphididae) – the elm sack gall aphid** It is a cosmopolitan species found in Europe, Asia and North America and Romania as well. This aphid galls (Figure 3) have a bean shape with peduncle and are smooth and shiny, of reddish, green or yellow colour. They are produced on the leaves of elm tree species (*Ulmus spp.*). The winged aphids emerge from elm galls in June-July and colonize the grasses roots from the *Poaceae* family. In autumn, they return to elm. The galls of *T. ulmi* were collected from the leaves of massively attacked elm trees in June in a private garden.

Figure 3. Elm leaf galls of *Tetraneura ulmi*

***Eriosoma lanuginosum* Hartig 1839 (Hemiptera: Aphididae) - the elm balloon-gall aphid** The galls form on elm branches (Figure 4). They are bag-shaped and have variable sizes. The abandoned galls are hard and dry with various numbers of holes, where the aphids exited. The abandoned galls may host various organisms as caterpillars. Samples of balloon-galls were sampled from one elm tree in a street alignment in autumn.

Figure 4. *Eriosoma lanuginosum* galls

***Cacopsylla pyrisuga* Foerster 1848 (Hemiptera: Psyllidae) – the great pear sucker psyllid** It is a phloem feeding insect important pest of pear in Europe, where is widely distributed. *C. pyrisuga* develops only a single generation per year from March to May (Chireceanu, 2001). The damage to pear trees is produced by deposition of a great number of eggs along the midrib on the upper surface of leaves. The attack results in the rolling up of leaves (Figure 5), stunting of shoots and covering of the trees foliage with sooty mould that develop on the honeydew secreted by the nymphs. Usually, *C. pyrisuga* is present together with *C. pyri*, *C. pyricola* or *C. bidens* which compose the pear psyllids group. In addition, this species, similar to others psyllids is vectors for phytoplasmas causing the *pear decline* disease (Lethmayer et al., 2011).

Figure 5. The rolling up of pear leaves under *C. pyrisuga* egg lying action

***Asphondylia pruniperda* Rondani 1867 (Diptera: Cecidomyiidae) – the gall midge of plum buds** This species is widely spread in Europe (Gagné and Jaschhof, 2014). It is regarded as a potential pest for the plum trees in Serbia, Italy and Moldova (Simova-Tošić et al., 2000; Timuş et al., 2014). In Romania, the pest damage is not yet estimated. Only the species of *Prunus domestica* and *P. spinosa* are attacked. *A. pruniperda* has a single generation each year. Adults appear in June and July and females insert the eggs into young buds where the larvae develop onwards. A single larva occurs inside a gall and the pupation completes in the next year (Skuhravá et al., 2007). We found galls midges of plum buds (Figure 6) in a private garden in a residential area. The wasp attack was sporadic.

Figure 6. Galls midge of plum buds

***Dasineura pyri* Bouché 1847 (Diptera: Cecidomyiidae) – the pear leaf midge** *D. pyri* is a European species, present in Europe and North America (Skuhravá and Skuhravý, 2010). In Romania it is present in most pear growing regions. This causes galls exclusively on the leaves of trees in *Pyrus* genus. Females emerged in May and lay their eggs on the leaves growing in the top of annual shoots. By feeding on leaves, the larvae cause galls by rolling upwards and inwards of the margins along the main vine. They develop inside the galls, sucking sap. Two generations are developed annually, May-June and July-May. The infested leaves gradually blacken, dry and early fall from the tree. Great infestations of the gall midge can cause important damage to pear young nurseries. The galls of pear leaf midge were found on young leaves of vegetative shoots tip, during the summer months, in the house gardens and orchards of some research institutions. The pest attack was limited to 2-10 gall shoots per tree.

Dryomyia circinans **Giraud 1861 (Diptera: Cecidomyiidae) - the oak gall midge** The species is a forest gall midge developing on trees of genera *Quercus* (Fagaceae), frequently on *Q. cerris*. It is present all over the territory of Romania (Fodor et al., 2011). The larvae cause circular galls affecting both leaf sides of the oak trees (Figure 7): the pubescent discs on the lower side (Figure 7a, b) correspond with round openings on the upper side of the leaf (Figure 7c). The insect has one generation per year; adults fly from April to May; larvae overwinter in the soil after leaving the galls (in the Mediterranean regions) or remain in galls where they pupate. *D. circinans* has economic importance especially in the forest areas.

In the study area, we observed a large number of characteristic galls induced by *D. circinans* on the leaves of *Quercus sp.* trees planted in street alignaments and in private gardens in residential sites. The significance of *D. circinans* attack was relevant for hardly attacked *Quercus* trees used in ornamental purposes. The gall midge attack created an unpleasant aspect for the people and the ornamental value of the trees was reduced.

Figure 7. *Dryomyia circinans* galls on oak leaves:
a) heavily attacked and deformed summer leaves; b) lower leaf side; c) upper leaf side of autumn leaf

From the galls that affected the oak leaves, adults of *D. circinans* (Figure 8) and other wasps (Figure 9) have resulted in laboratory conditions. On the basis of morphological characters of the wasps, compared with the descriptions found in the relevant literature (Graham and Gijswijt, 1998; Stojanova et al., 2012), they may be a natural enemy of the oak gal midge from the genus *Torymus* (Hymenoptera: Torymidae).

Figure 8. *Dryomya circinans* adults

Figure 9. Wasp parasites emerged from galls

Lasioptera rubi **Schrank 1803 (Diptera: Cecidomyiidae) - the raspberry gall midge,** represents a major pest, mainly for untreated and ungroomed raspberry plantations (Milenković and Tanasković, 2008), widely distributed in Europe and Romania as well. It has one generation per year. In April-May, at temperatures over 14°C, first adults emerge (Teodorescu, 1999). Females lay groups of 8-15 eggs at the base of flowering buds. White larvae penetrate the raspberry stem forming small bumps under epidermis, which later become galls where the larvae overwinter. The stem galls are asymmetric, globulous or elongated, of 3-4 cm long/1.5-2 cm wide (Anonymous 2007), with cracked and rough appearance (Neacsu, 2006). In our field observations, we collected numerous raspberry canes with galls of *L. rubi* (Figure 8) occurred in a private house garden during spring and summer.

Figure 10. Raspberry gall midge

***Aphelonyx cerricola* Giraud 1859 (Hymenoptera: Cynipidae) – the oak bud gall wasp** The gall wasp is native to countries from Central and Southern Europe, including Romania (Ionescu, 1973) and a recently established species in Britain (Schönrogge et al., 2011). It causes bud galls on *Quercus cerris*. It has a single generation in a year. The galls are round (1.5 - 1.8 cm), strung along the branch and pressed together, surrounding the branch partially or completely (Figure 11a), fixed with a short peduncle resulted from the laid egg of females. The mature galls are brown, glabrous and hard with one or two internal galls (Figure 11b) of oval shape and a thin wall. A high density of wasp galls was noted on many shoots of *Quercus* trees from street alignments and house gardens. White larvae of the gall wasp (Figure 11c) in various larval instars were found inside the galls in the autumn period.

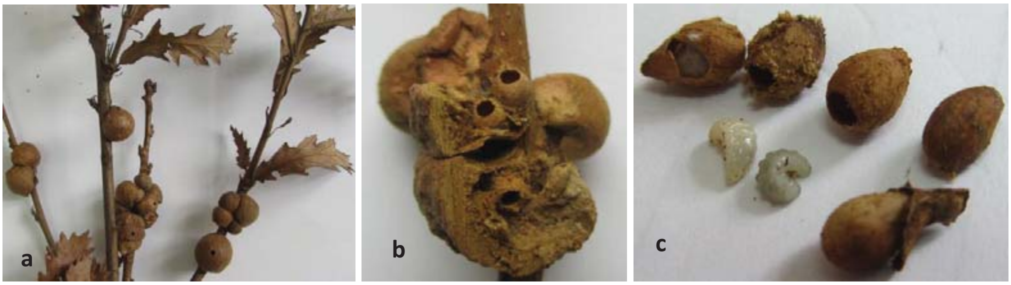

Figure 11. *Aphelonyx cerricola* oak bud galls: a) mature bud galls on shoots; b) section through the galls; c) internal galls and white larvae of oak gall-wasps

***Andricus kollari* Hartig 1843 (Hymenoptera: Cynipidae) – the oak marble gall wasp** The marble gall has alternating sexual and asexual generations. The galls form on terminal or lateral buds of host plants of *Quercus* genus. They are lignicolous, spherical in shape, of 3 cm in diameter (Figure 12). Sometimes they can be a little deformed, especially when commensal organisms develop inside. The galls are more frequent on young bushy trees. They are usually 2-3 together, rarely isolated. Inside the gall, there is the larval chamber, thin and slightly elongated. Galls of *A. kollari* were found during the summer and autumn on oak trees in street alignaments.

Figure 12. *Andricus kollari* oak marble galls

***Andricus hungaricus* Hartig 1843 (Hymenoptera: Cynipidae) – the oak bud gall wasp** It is common in Europe and Romania also, causing galls to oak trees of *Quercus robur* and *Q. pubescens*. The galls form in buds. Females deposit eggs inside the buds, afterwards the galls develop during spring and summer. They fall on the ground in autumn. A gall is large and spherical (20-25 mm) (Figure 13), being one of the greatest in the Western Palaearctic (Stone et al., 2008). It's hard, woody, brown, with angular swells on its surface, sharper or blunt. The gall wall is thick and spongy, containing about 11% tannin (Hac et al., 2013). Inside the gall, there is a large empty chamber with an oval and small internal gall in which the insects develop. Samples of galls were collected from the branches of oak trees during autumn.

Figure 13. *Andricus hungaricus* galls and larva inside the internal chamber

***Andricus quercustozae* Bosc 1792 (Hymenoptera: Cynipidae) - the oak bud gall wasp** The galls of this wasp appear on the oak trees of *Quercus spp.* They are spherical, slightly elongated. The top is bulged and has a small nodule in the middle (Figure 13). The gall is hard, woody, and yellow-brownish and on top it has a crown of nodules surrounding the gall. The gall's external wall is thick, spongy and hard. Inside the gall there is a horizontal cavity, where the internal gall is situated. The internal gall has an ellipsoidal shape situated horizontally and a very thin wall.

Figure 14. Oak bud gall of *Andricus quercustozae*

***Cynips quercusfolii* L. 1758 (Hymenoptera: Cynipidae) - the oak leaf gall wasp** It's a very common and widespread oak bud gall wasp. The galls are induced on *Quercus* oak trees. They are usually developed in groups on the same leaf, rarely isolated, more often on the leaves from the upper part of the oak canopy (Giertych et al., 2013). The medium height oak trees are more affected. They have a spherical shape and a diameter from 1-2 to 3 cm, and are attached in one spot on the main or secondary ribs on the down leaf face. The galls are smooth, glabrous and shiny. The gall's wall is soft, juicy, spongy and white-green in colour, later becoming brown. In the centre is found the larval chamber which is also spherical with a thin wall. Like many other types of oak galls, the *C. quercusfolii* galls (Figure 15) were sampled in almost all the oak trees.

Figure 15. The oak leaf gall of *Cynips quercusfolii*

***Diplolepis rosae* L. 1758 (Hymenoptera: Cynipidae) - the rose gall wasp** This is frequently found in Europe on species of *Rosa spp.*, mainly *R. canina*. Females lay their eggs into plant buds during spring and galls are fully developed in the late summer. Larvae feed upon the leaf bud tissue inside the galls and the pupae remain inside till next year in the spring. The galls have a complex internal structure, with one or many chambers, depending on the clutch sizes of wasps (László and Tóthmérész, 2008). A multi-chambers gall consists of smaller galls which are spherical and tightly stuck together, having different sizes and each containing a larval chamber. Each gall is fully covered with dense, smooth and filamentous extensions, of greenish, yellowish or reddish colour, up to brown at the completed development in autumn (Ionescu, 1973). The galls are formed on branches, leaves and fruits as well. The galls sampling of rose gall wasp were done from dog-rose bushes in a neglected field between buildings. The galls (Figure 16a, b) were formed on branches and on fruits of the dog-rose plants. From two to seven mature galls per dog-rose bush were encountered in the autumn.

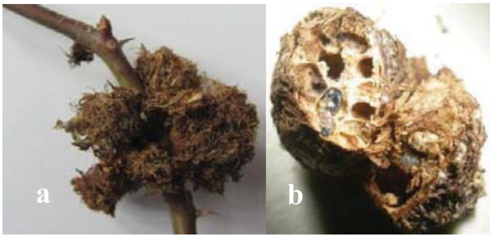

Figure 16a. Mature bud gall on dog-rose
Figure 16b. Dissection of a multi-chambers gall

Aceria tristriata **Nalepa 1890 (Diptera: Eriophydae) - the walnut gall mite**

Aceria erinea **Nalepa 1891 (Diptera: Eriophydae) - the walnut leaf blister mite**

Both gall midge species induce galls on the leaf of *Juglans regia* and are considered among the most important worldwide pests for the common walnut (Stojanovic et al., 2001). The two gall mites are originating from Asia, and have large world distribution. In our research, the high infestations of these gall pests on walnut trees were found in residential house gardens. The galls of *A. tristriata* have a round shape with 2 mm in diameter, brown colour, placed on the upper leaves surface of walnut trees (Figure 17). The galls of *A. erinea* form on the lower side of leaves inducing a characteristic discoloured blister like a swollen formation on the upper side of leaves (Figure 18). Later on, the blister zones turn brown (Neacşu 2006). The damage caused on walnut is mainly related to the aesthetic aspect of affected trees. Severe infestations may result from the malformations of young fruits.

Figure 17. *Aceria tristriata* galls on *Junglas* sp. leaves: a. upper leaf side; b. lower leaf side; c. opened gall

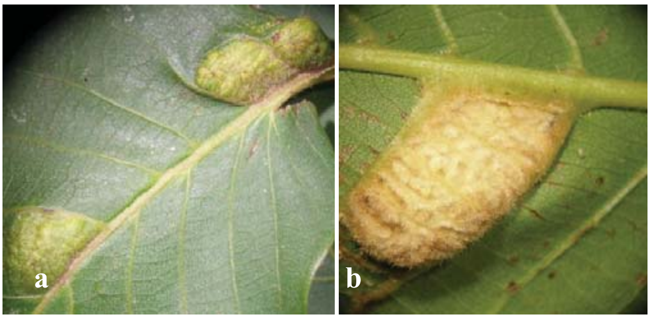

Figure 18. Galls on the leaves of *Junglas* sp. caused by the gall midge *Aceria erinea*,
a. upper leaf side; b. lower leaf side

***Aceria kuko* Kishida 1927 (Acari: Eriophyidae) – the goji gall mite** *A. kuko* mite is native from the south-eastern Asia (Ostojá-Starzewski, 2009). It has recently been reported in some European countries, United Kingdom and Netherlands (EPPO 2008), Germany (EPPO 2011), Greece and Slovenia (European Commission, 2012) on planting material of *Lycium spp.* imported from China and other parts outside Europe. The mite develops on *L. chinense* and *L. barbarum*, the weed *Solanum nigrum* and *Capsicum anuum* (Anderson and Starzewski, 2010). Within our research, the presence of *A. kuko* was detected on plants of *Lycium barbarum L.* planted for research purposes in an experimental field. It was probably introduced with the infested plant material brought from China. The affected plants showed a strong attack of the mite. There were galls on buds, both the upper and lower surfaces of leaves (Figure 19). *L. barbarum* (Solanaceae) is a perennial ornamental plant, cultivated for its ornamental or commercial value in the West and South parts of Romania in the last years. At present, there is a commercial production of 'goji berries' in the country. The presence of *Lycium* plants in open field crops can acts as a primary reservoir for the mite, and that could be a threat to the cultures of economic interest from the Solanaceae family (e.g. pepper, tomato, potato, eggplant) cultivated in their vicinity. The weed *Solanum nigrum*, a common weed widely spread around the crops, could also be a potential source for the pest infection (EPPO, 2008).

Figure 19. Leaf galls of *Aceria kuko* on *Lycium sp.*

CONCLUSIONS

As a result of our investigation, a number of 18 types of galls have been collected and described on the plant species from the Northern area of Bucharest city (the South part of Romania) in 2013. Galls were induced on buds, leaves and stems, having various shapes, colour and consistence, on oak and elm trees, walnut, apple, pear and plum fruit trees and dog-rose, raspberry and goji plants.

Presence of 15 insect and 3 mite gall-making arthropod species belonging to 14 genera, 5 families and 4 orders have been recorded to be associated with collected galls.

Warming climatic conditions characteristic of the Bucharest region and environmental diversity in terms of wide range of plant species created a favorable context for presence of a considerable number of plant gall inducing arthropod species in this area just one year, possibly in the absence of adequated control measures.

Information gathered from our results show the importance of an intensive field survey concerning the galls and the galling species presence and identifying them based on their description and host plant information.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EFFECT OF TREE GIRDLING ON SOME VARIETIES OF CHINESE DATE (*ZIZIPHUS JUJUBA* MILL.)

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Abstract

Special production practices can be used to enhance yield and overall fruit quality. Trunk and branch girdling are known among those practices applicable to some wooden fruit species. For Chinese date (Ziziphus jujuba Mill.*) girdling was a common practice in traditional orchards with the aim to increase the fruit set. Short and deep wounds were usually made with an ax in the tree bark and phloem around the trunk. The paper presents the effect of girdling applied at the beginning of the flowering season on tree trunk and lateral branches. The girdled jujube trees increased their yield by improving fruit set, enlarged fruit size and advanced fruit maturity. Girdling effect was notable for some genotypes: larger fruit size by 3 to 5 mm in diameter, earlier harvest by 3 up to 10 days and reduced number of pickings at harvests. Varietal response to this practice, however, was quite variable. Preliminary results showed that the varieties response to girdling was substantial in some and almost unnoticeable in others.*

***Key words**: trunk, branch, cambium, fruit yield.*

INTRODUCTION

The changing trends from agrochemical based production to green farming have made farmers to seek for practices that are less harmful to the environment and leave less or no chemical residue in fruit. Fruit producers are always looking for methods to reduce farm operation costs while maintaining high fruit quality.
An important cultural practice responsible for improving fruit setting, yield as well as physical and chemical properties of fruits is girdling.
Girdling is a manipulation practice for stimulating fruit trees into more productive usage, usually carried out by cutting through the phloem only as deep as the cambium layer and removing a strip of tissue. By girdling it stops or reduce the flow of sap via the phloem to the lower parts of the tree and to the roots and teoretically and practically carbohydrates are accumulated above the girdle.
A wide variety of fruit species are girdled to increase their yields, improve set, enlarge fruit size and advance maturity. Stem girdling has been widely used in apples, grapes, olives, oranges, grapefruits, peaches and has responded in at least one but not necessarily all of these areas (LaRue and Johnson, 1989; Goren et al., 2004). Girdling is a common practice in yellow flesh kiwifruit (*Actinidia chinensis*) to increase fruit size (Minchin et al., 2003, Woolley et al., 2005).
The best-known effects of girdling are presumably brought about by accumulation of assimilates above the girdle (Chun et al., 2003). Reported data showes that the ringing of trees can bring an increase in the size and sugar content of fruits and cause them to mature a few days to a week earlier (Onguso *et al.,* 2004; Hossain *et al.,* 2007; Hossain & Boyce, 2009). Rivas et al. (2008) reported that girdling few weeks before flowering reduced fruitlet abscission, increased leaf chlorophyll content and chlorophyll fluorescence.
The aim of the present study was to check the effects of girdling on inflorescence development, fruit set, yield and fruit quality of Chinese date under field conditions.

MATERIALS AND METHODS

Plant material and experimental site. The research was conducted at the University of Agronomic Sciences and Veterinary Medicine of Bucharest in the Experimental Field of the Horticulture Faculty. Eight Chinese date trees (*Ziziphus jujuba* Mill.) from different varieties were used in the experiment. Each tree was approximately twenty years old.

Girdling. At the beginning of flowering season, girdling was performed for three genotypes: R1P8, R2P5 and R3P5 by removing a circular bark strip from around the trunk with a girdling knife (Figure 1).

Figure 1. Girdled trunk of jujube trees

The ring cut on the trunk was 2 cm wide at the deep of the cambium layer till the xylem, at 25 cm above ground. We used the same number of similar varieties/trees as controls.

Girdling was performed for five other genotypes: R2P10, R2P11, R3P9, R3P6 and R2P5 by removing a bark strip of 5 mm wide from lateral fruiting branches. The same number of similar ungirdled branches was used as control (Figure 2).

Figure 2. A) Control; B) Girdled branch

Observation and measurement of bio-physical parameters. Field observations were made each seven days interval. Inflorescence development of the branches was carefully monitorised. The growth of the trees was monitored by measuring lengths of selected terminal shoots per tree for the one year and respectively, four years old branches to girdled and non-girdled trees. Trunk and branch diameter for girdled and non-girdled variants was measured.

Fruit set (%) from the tagged branches on the experimental trees was calculated by reporting the number of fruit at seven days after anthesis and the number of fruit before harvesting.

Fruit length and diameter was measured using a Vernier digital calliper. At harvesting, final fruit diameter, fruit number and weight were recorded.

RESULTS AND DISCUSSIONS

Inflorescence development and fruit set. Girdling significantly reduced the time needed for inflorescence emergence and the duration of flowering. Results showed that the flowering duration was 9 days for R3P6 in girdled variant, whilst it took 14 days in control.

The same behavior after girdling was shown by R2P5 genotype with 15 days of flowering in comparison with 19 days of flowering in control treatment (Table 1).

Girdling treatment had a significant effect on tree fruit set capacity.

All the girdling treatments determined higher fruit set values compared to the control. In the case for R3P6, the highest fruit set percentage per branch was of 65%, while the lowest was of 37% (Table 1).

Average fruit weight (g). The data on fruit weight showed significant positive results after girdling. The increase in weight was nearly with one gram per fruit. Fruit weight of 19,01 g was registered for R2P10 in girdled variant and 18,20 g in the control. Lowest average fruit weight of 5,73 g produced by R2P5 genotype in girdled variant and 4,90 g was found in control (Table 1).

Fruit size (length & diameter). Promising results related to girdling effect on the fruit size expressed in fruit length and diameter, were obtained when compared with the untreated control branches. The fruit diameter increased from 3 mm for R2P11 to up to 5 mm for R3P9 genotype on girdled branch compared with control.

As can be seen in the Table 1, average fruit size (length and diameter) was significantly influenced by girdling compared to control.

Table 1. Effects of girdling on fruit set and fruit characteristics at Chinese date (*Ziziphus jujuba*) (*Control -non girdled)

Genotypes	Inflorescence development (days)	Fruit set (%)	Fruit weight (g)	Fruit lenght (cm)	Fruit diameter (cm)
R2P5	15	48	5.73	2.90	1.67
R2P5*	19	37	4.90	2.50	1.45
R2P10	13	61	19.01	3.85	2.78
R2P10*	17	52	18.20	3.30	2.28
R2P11	11	58	18.81	3.94	2.65
R2P11*	16	42	17.90	3.62	2.35
R3P6	9	65	12.70	2.60	1.94
R3P6*	14	37	11.89	2.24	1.54
R3P9	12	59	10.80	3.80	1.76
R3P9*	17	48	9.78	3.10	1.24

Number of fruits. In this study we observe during a monitored period of 7, 14 respectively 21 days after treatment, that girdling had significant effects on the number of fruits on girdled branches compared with the control. From the results we found out that fruits of the different girdled branches produced more total number of fruits (Figure 3).

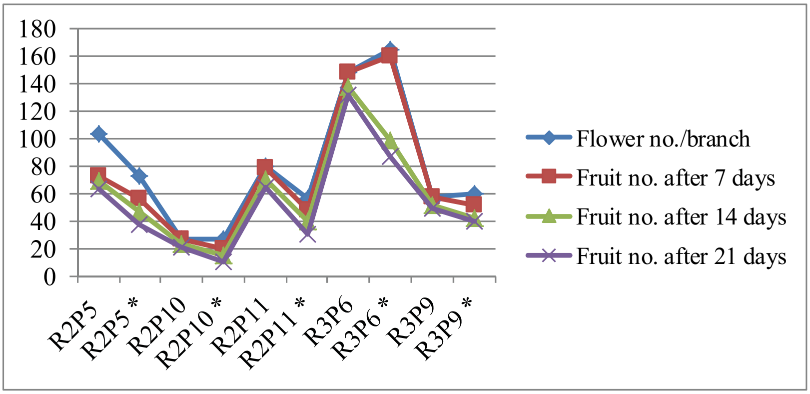

Figure 3. Total number of flowers per branches and total number of fruits per branches as affected by girdling after 7, 14 and 21 days after treatment (*Control - non girdled)

Tree growth. Monitoring the vegetative growth after girdling we noticed that the shoot length of the girdled trees, particularly for the one year branches, increased, being slightly higher than the control (Figure 5). That can indicate that young shoots were particularly active under girdling treatment, assimilates were delivered to the tissues and engaged in shoot elongation (Table 2).

All the girdled branches developed thick callus above the girdle (Figure 4), but there were no significantly differences in branch diameter growth for girdled branches compared with control.

Figure 4. Callus formation above the girdle area after two months from girdling

Total fruit production. The most encouraging results related to the fruit yield was in case of the girdled trees which showed a total fruit production increase with more than 50% over the non-girdled (control) trees. The total fruit production of girdled tree in R1P8 genotype was 16.31 kg per tree comparing with the control - 7.24 kg per tree. Yield increase expressed as percentage for all girdled trees was substantial: 51.40% for R1P8, 46.57% R2P5 and 58.00% for R3P5 (Table 3).

Table 2. Effects of girdling on shoot length and branch diameter of Chinese date (*Ziziphus jujuba* Mill.) (*Control - non girdled) (Ø1 - below the girdle, Ø2 - above the girdle)

Treatment	Genotype	Diameter Ø1 (cm)	Diameter Ø2 (cm)	Shooth length (cm)			
				1 year old branch	2 year old branch	3 year old branch	4 year old branch
Girdled	R2P5	1.50	1.55	23.53	24.00	19.93	9.16
	R2P10	0.75	0.90	29.11	23.00	51.00	36.50
	R2P11	1.10	1.25	20.33	22.85	23.00	10.50
	R3P6	2.70	2.75	18.18	9.50	20.80	-
	R3P9	1.10	1.75	23.00	21.50	20.00	-
Non-Girdled	R2P5*	1.45	-	17.75	13.75	18.00	-
	R2P10*	0.90	-	19.52	28.5	13.60	36.23
	R2P11*	1.00	-	31.25	16.00	-	-
	R3P6*	2.57	-	16.72	12.37	21.50	47.12
	R3P9*	1.00	-	22.80	18.00	19.00	-

Table 3. Effect of girdling on yield and harvesting date of some Chinese date (*Ziziphus jujuba* Mill.) genotypes

Treatment	Genotype	Fruits harvesting date					
		3.10	**8.10**	**13.10**	**17.10**	**22.10**	**Yield (kg/tree)**
Girdled	**R1P8**	10.71	-	5.60	-	-	16.31
Non-girdled		3.60	3.64	-	-	-	7.24
Girdled	**R2P5**	-	7.57	-	2.27	2.57	12.41
Non-girdled		-	-	-	1.17	4.61	5.78
Girdled	**R3P5**	8.00	4.00	-	0.69	-	12.00
Non-girdled		4.91	2.05	-	-	-	6.96

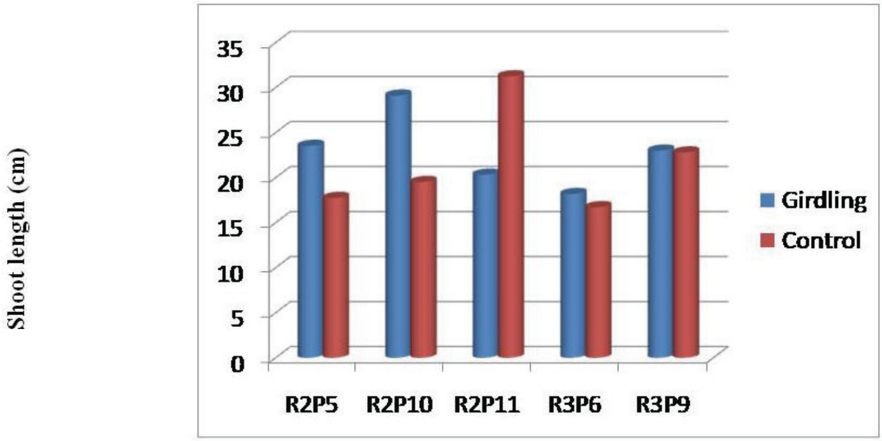

Figure 5. The girdling effect on the shoot length, particularly on one year old branches

CONCLUSIONS

From our preliminary results it has been showed that girdling treatments significantly reduced the flowering time and enhanced inflorescence development for the studied Chinese date genotypes. Similar observations have been reported by Khandaker et al. (2011) in wax apple and Arakawa et al. (1997) in apple.

The fruit weight on girdled branches was slightly higher than on control ones. Girdling can be an effective technique for improving fruit weight.

The girdling improved substantially some fruit characteristics (size and weight) beside fruit set percentage and ripening period.

Girdling determined a fruit diameter increase by 3 to 5 mm, earlier harvest by 3 up to 10 days.

and a reduced number of pickings because of a more synchronized fruit maturation.

The results related to the effect on the total yield was the most encouraging: an increase in fruit production of more than 50% was registered on girdled trees.

Varietal response to this practice, however, was quite variable. Preliminary results showed that almost all varieties showed some response: substantial in some and almost unnoticeable in others.

ACKNOWLEDGEMENTS

Part of this work was supported by POS DRU/159/1.5/S/132765, project financed from the European Social Fund through the Sectoral Operational Programme for Human Resources Development 2007-2013.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE INFLUENCE OF BIO-FERTILIZATION UPON PRODUCTION LEVEL OF SOME HARVESTED APPLE CULTURES (*Vf*) IN AN INTENSIVE SYSTEM IN THE SOUTH-EAST OF ROMANIA

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Abstract

Knowing the relationship between orchards and bio-fertilization practices is needed to develop new production systems which bring known benefits and those of economic nature. Bio-fertilization systems applied to varieties of apple (Malus domestica Borkh.*) Vf type are recommended in order to maximize profitability in the apple culture. The purposeof this study (2012-2013) was to calculate bio-fertilization influence on yield (t/ha) of apple varieties with genetic resistance to scab (Vf): 'Topaz', 'Redix', 'Rubinola', 'Goldrush' and economic indicators in the climate conditions of the Ilfov county. Experimental module was arranged by trifactorial type using the subdivided parcels method in three repetitions. At the base of the economical study the technological files of apple culture/ha was used, determining the following indicators: production costs (lei/ha), net profit (lei/ha) and net profit ratio(%). Significant increases ineconomic indicators between 10 and 20% resulted in the experimental variant Naturamin 7,5kg/ha.*

***Key words**: biofertilization, apple varieties, economical indicators, yield.*

INTRODUCTION

In Romania, the apple (*Malus domestica* Borkh.) has among other tree cultures, a leading position in terms of production and harvested areas. Because of the economical and nutritional importance the apple culture will maintain an important continuous place in the tree sector of our country. The results of research in tree domain was performed with a duration of a couple of years, this has shown the decisive influence of pedoclimatical conditions and culture technologies upon the apple production and implicitly economical efficiency. Regarding obtaining a economically profitable culture, rigours zoning must be impided on new apple varieties of *Vf* type according to the type of soil, climatic resources and their genetic needs.

In the areas with precipitation the evident efficiency of released production is shown and once with the increase in the mechanized grade and fertilization, economical spendings rise as well.

Numerous researches have shown a positive relation between genetic quality of the varieties used and technological works applied, all of these increasing the chance of growth in productivity and implicitly the economical efficiency (Țiu J.V. and colab., 2014).

Establishing the plane for technical economical activity supposed the early establishing of a specific document among which the technological file holds an important role (Merce and colab., 2000).

MATERIALS AND METHODS

The experiences had the purpose of determining the productivity of varieties taken in study with conditions of biofertilization and establishing economical efficiency for the apple culture of *Vf* type. To establish optimal technologically growth of profit, variant realized spendings were calculated for entire culture and released profit, on different hydric regime and numerous varieties *Vf* type. Observations and determinations were performed in 2012-2013 at Didactical Farm Station Belciugatele, didactical farm Moara Domneasca, with the following experimental factors: A - irrigation: a1 - unirrigated, a2 -

irrigated 2 l/h, a3 - irrigated 4 l/h; B - biofertilization: b1 – unfertilized, b2 – fertilized Naturamin 3,75 kg/ha, b3 – fertilized Naturamin 7,5 kg/ha; C - variety: c1 – Topaz, c2 – Rubinola, c3 – Goldrush.

The period of irrigation application was established by following a hydric graphic in the period of maximal requirement for plants and according to the active humidity index (AHI). The fertilizers were applied 4 times: immediately after blossom and every 3 weeks after. The biofertilizant Naturamin is a latest generation fertilizer with 80% free aminoacids with the role for biostimulation of growth and plant development in all phases, compatible with most fertilizers and pesticides and contributing to the growth and quality of production. The experimental module was of trifactorial type, arranged after the subdivide parcels method in three repetitions. Specific data of economical efficiency were calculated: cost production, income and profit rate.

RESULTS AND DISCUSSIONS

Analizing the index of economical efficiency in 2012 for the apple culture, every factor was took into the study, income was higher than the expenses related in the cultures maintenance.

As such the data from table 1 shows, that the variants less profitable from an economical point of view were irrigated variant 4l/h + unfertilized (a3b1) for Topaz *Vf* and Rubinola *Vf* and unirrigated + unfertilized variant (a1b1) for Goldrush *Vf* (Table 1).

With the highest procent of profit rate was obtained in the fertilizer with Naturamin 7,5 kg/ha + irrigated 2 l/h (a2b3) for all variants took into study, recording percentage of 59,3% of Topaz *Vf*, 56,81% of Goldrush *Vf* and 57,23% of Rubinola *Vf* varieties. Of irrigated 4 l/h+ biofertilized with Naturamin 7,5 kg/ha variant (a3b3), satisfactory percentages were released between 44,94% (Rubinola *Vf*), 49,57% (Topaz *Vf*) and 56,64% (Goldrush *Vf*) (Table 1).

Table 1. Economic efficiency of apples productions in 2012

Hydric regime	Fertilizer level	Production (kg/ha)	Production value (lei/ha)	Costs (lei/ha)	Profit (lei/ha)	Profit rate (%)
Topaz *Vf*						
a1(unirrigated)	b1	10.986,00	13.183,20	5.874,00	7.309,20	55,44
	b2	12.144,00	14.572,80	6.286,00	8.286,80	56,86
	b3	13.564,00	16.276,80	6.866,00	9.410,80	57,82
a2 (irrigated 2l/h)	b1	11.867,00	14.240,40	5.862,00	8.378,40	58,84
	b2	13.144,00	15.772,80	7.341,00	8.431,80	53,46
	b3	16.235,00	19.482,00	7.930,00	11.552,00	59,30
a3(irrigated 4l/h)	b1	12.130,00	14.556,00	8.188,00	6.368,00	43,75
	b2	13.950,00	16.740,00	8.477,00	8.263,00	49,36
	b3	14.864,00	17.836,80	8.995,00	8.841,80	49,57
Goldrush *Vf*						
a1(unirrigated)	b1	10.762,00	12.914,40	5.860,00	7.054,40	54,62
	b2	13.350,00	16.020,00	6.840,00	9.180,00	57,30
	b3	13.782,00	16.538,40	7.290,00	9.248,40	55,92
a2 (irrigated 2l/h)	b1	11.998,00	14.397,60	6.220,00	8.177,60	56,80
	b2	14.016,00	16.819,20	7.532,00	9.287,20	55,22
	b3	15.840,00	19.008,00	8.210,00	10.798,00	56,81
a3(irrigated 4l/h)	b1	15.120,00	18.144,00	7.998,00	10.146,00	55,92
	b2	14.872,00	17.846,40	7.990,00	9.856,40	55,23
	b3	15.980,00	19.176,00	8.315,00	10.861,00	56,64
Rubinola *Vf*						
a1(unirrigated)	b1	10.097,00	12.116,40	5.887,00	6.229,40	51,41
	b2	11.363,00	13.635,60	6.670,00	6.965,60	51,08
	b3	12.674,00	15.208,80	6.950,00	8.258,80	54,30
a2 (irrigated 2l/h)	b1	11.876,00	14.251,20	7.120,00	7.131,20	50,04
	b2	12.849,00	15.418,80	7.440,00	7.978,80	51,75
	b3	15.433,00	18.519,60	7.920,00	10.599,60	57,23
a3(irrigated 4l/h)	b1	11.870,00	14.244,00	7.995,00	6.249,00	43,87
	b2	12.863,00	15.435,60	8.380,00	7.055,60	45,71
	b3	13.562,00	16.274,40	8.960,00	7.314,40	44,94

In 2013 at the apple culture in all the variants studied, income was higher than expenses related in culture maintenance.

The table 2 shows that the least profitable variants were the once from irrigation 4 litri/h + unfertilized variant (a3b1) at Topaz *Vf* (43,46%) and Rubinola *Vf* (43,87%) and Goldrush *Vf* from irrigated 4 l/h + fertilized with Naturamin 3,75 kg/ha variant (55,37%) (a3b2).

The highest procentage of profitability rate (%) were obtained in the irrigated 2 l/h + fertilized with Naturamin 7,5 kg/ha variant (a2b3) for all varieties studied and performed values of 59,23% of Topaz *Vf*, 55,52% of Rubinola *Vf*, respectively 57,76 % of Goldrush *Vf*. At the same experimental variants was achieved satisfactory income (lei/ha) between 9760 and 12088 lei/ha (Table 2).

Table 2. Economic efficiency of apples productions in 2012

Hydric regime	Fertilizer level	Production (kg/ha)	Production value (lei/ha)	Costs (lei/ha)	Profit (lei/ha)	Profit rate (%)
Topaz *Vf*						
a1 (unirrigated)	b1	10.468,00	12.561,60	5.645,00	6.916,60	55,06
	b2	11.744,00	14.092,80	6.229,00	7.863,80	55,80
	b3	12.564,00	15.076,80	6.997,00	8.079,80	53,59
a2 (irrigated 2l/h)	b1	11.167,00	13.400,40	5.839,00	7.561,40	56,43
	b2	13.144,00	15.772,80	7.210,00	8.562,80	54,29
	b3	16.120,00	19.344,00	7.886,00	11.458,00	59,23
a3 (irrigated 4l/h)	b1	12.130,00	14.556,00	8.230,00	6.326,00	43,46
	b2	13.950,00	16.740,00	8.554,00	8.186,00	48,90
	b3	14.864,00	17.836,80	8.875,00	8.961,80	50,24
Goldrush *Vf*						
a1 (unirrigated)	b1	11.890,00	14.268,00	6.210,00	8.058,00	56,48
	b2	13.350,00	16.020,00	6.834,00	9.186,00	57,34
	b3	13.934,00	16.720,80	7.218,00	9.502,80	56,83
a2 (irrigated 2l/h)	b1	11.998,00	14.397,60	6.322,00	8.075,60	56,09
	b2	14.016,00	16.819,20	7.464,00	9.355,20	55,62
	b3	17.440,00	20.928,00	8.840,00	12.088,00	57,76
a3 (irrigated 4l/h)	b1	15.120,00	18.144,00	7.886,00	10.258,00	56,54
	b2	14.872,00	17.846,40	7.964,00	9.882,40	55,37
	b3	15.980,00	19.176,00	8.170,00	11.006,00	57,39
Rubinola *Vf*						
a1 (unirrigated)	b1	11.737,00	14.084,40	6.272,00	7.812,40	55,47
	b2	11.363,00	13.635,60	6.430,00	7.205,60	52,84
	b3	11.774,00	14.128,80	6.860,00	7.268,80	51,45
a2 (irrigated 2l/h)	b1	11.876,00	14.251,20	6.990,00	7.261,20	50,95
	b2	12.849,00	15.418,80	7.410,00	8.008,80	51,94
	b3	14.650,00	17.580,00	7.820,00	9.760,00	55,52
a3(irrigated 4l/h)	b1	11.870,00	14.244,00	7.995,00	6.249,00	43,87
	b2	12.863,00	15.435,60	8.268,00	7.167,60	46,44
	b3	13.562,00	16.274,40	8.797,00	7.477,40	45,95

Analizing the profit rate for the applied experimental factors it has concluted that in both studied years, the Topaz *Vf* and for the Rubiola *Vf* varieties, the lowest profit was irrigated 4 l/h + unfertilized (a3b1) and máximum profit was recorded in all three varieties for irrigated 2l/h + fertilized 7,5 kg/ha variant (a2b3) as well as the experimental variant.

The minimal profit for Goldrush variety was unirrigated + unfertilized (a1b1) in 2012a nd irrigated 4 l/h + fertilized 3,5 kg/ha in 2013 year. It can be concluded that values between the minimal and maximal profit between the years, the smallest differences were situated between 54,62% (2012 – a1b1) and 57,76% (2013 - a2b3) (Figure1).

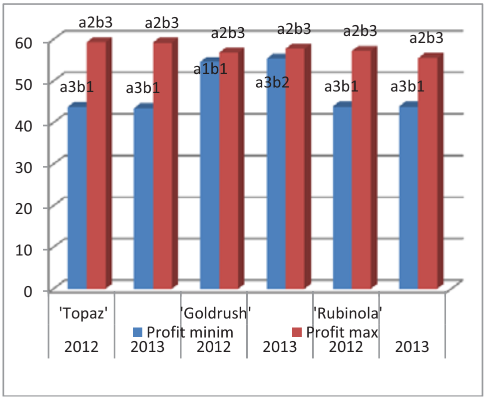

Figure 1. Experimental variants with minimal and maximal profit

CONCLUSIONS

❖ In the unfavourable climatic conditions specific for the 2012 year, technology for the apple culture regarding studied variants depended on the application of punctual irrigation at the trees root and application of four treatments with Naturamin biofertlizant products in doses of 3.75 kg/ha, respectively 7.5 kg/ha, respecting the phenophases of wetting application shown in the wetting graphic.

❖ In normal climatic conditions similar to 2013, technology for the apple culture regarding studied variants depended on the wetting application in critical phenophases and application of biofertilizing products.

❖ The high economical results were recorded due to a high level of production as a following of the influence of favourable climatical condition of 2013 in the technological links used.

❖ Maximum profit was recorded in all three studied varieties in the irrigated 2 l/h + fertilized with Naturamin 7.5 kg/ha variants (a2b3) and minimum profit for the irrigation 4l/h + unfertilized variants (a3b1).

ACKNOWLEDGEMENTS

This paper was published under the frame of European Social Fund, Human Resources Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/132765.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

FIRST RESULTS OF TESTING GOJI BERRY (*LYCIUM BARBARUM* L.) IN PLOVDIV REGION, BULGARIA

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Abstract

The study was conducted during the period 2013 - 2014 at the experimental field of the Department of Fruit Growing at Agricultural University – Plovdiv, Bulgaria. In vitro propagated plants of two Bulgarian cultivars ('JB 1' and 'JB 2') were planted in 20 June 2013 at distances of 3 x 2 m. The plants were grown under drip irrigation. The plants were formed as trees with 40 cm trunk height. Despite of late planting in the permanent place the plants of both cultivars started to bloom and bear fruits (although single fruits) in the same year. During the second vegetation flowering of tested cultivars started in the beginning of June and finished in the end of November. Better productivity was recorded in cultivar 'JB 1' with 0,56 kg/tree and theoretical yield per decare – 93,52 kg whereas the yield of cultivar 'JB 2' was 0,31 kg/tree and 51,77 kg respectively. The cultivar 'JB 2' was more susceptible to powdery mildew than 'JB 1'.

Key words: *cultivar, fruit bearing, growth, Lycium barbarum* L.

INTRODUCTION

An increasing interest to growing untraditional crops especially those with high nutritional value has been observed recently. *Lycium barbarum* L. is a frutescent plant which belongs to *Solanaceae.* The fruits of this plant are also known as goji berry and together with other parts of the plant have been used for a long time in traditional chinese medicine (Institute of Chinese Materia Medica, 1997). The place of origin of *L. barbarum* is not definitively determined. Probably it can be found in the Mediterranean Basin (Genaust, 1996). The plant is widely distributed in the Mediterranean area, Southwest and Central Asia. It is also cultivated in North America and Australia (Hänsel et al., 1993). Niculescu M. et al. (2011) reported presence of *Lycium barbarum* L. (*L. halimifolium* Miller.) in the Bistrita - Varatic Valley and Jiu Valley.

Fruits with optimum quality can be obtained in hot summer conditions. Rains during ripening cause cracking of the fruit. There is relationship between the environmental conditions and the yield.

Liu Jing et al. (2004) reported that for good growth and fruit bearing effective temperature of 3450^0 C and light for 1640 h are required. Other factors such altitude, temperature and sunshine are important for the quality of the fruits. As a result of a study Lin et al. (2013) defined the most suitable regions for growing goji berry in their province.

Nutritionists describe goji berry as "exotic super food" because of its high content of polysaccharides, vitamins and carotenoids. Cultivation of goji berry plants recently increases due to high demand of fresh or dried organic fruits. In the past new plantations have been established using seedlings whereas nowadays vegetative propagated plants of certain cultivars are mostly used.

In Ningxia-China goji berry plants were formed as a shrub or a small tree and were planted at density 1,5 x 1m (Hummer et al., 2012).

Diploid and triploid cultivars were studied in China. The authors reported that triploid cultivars were more vigorous and there were differences in terms of beginning and finish of certain phenophases (Ann et al., 1998).

Wang et al. (2011) had compared the cultivar Ningqi 6 with the standard Ningqi 1. The authors pointed out cultivar Ningqi 6 as more vigorous, better feathered and higher productive. The fruit of this cultivar were bigger, with smaller seeds and higher quality than the standard.

In different study the cultivar Ningqi 1 were compared with two new cultivars of *Lycium barbarum* L. - Ningqi 6 and Ningqi 8. It was found out that the new cultivars have thicker leaves, which explains their vigorous vegetative growth and large size of the fruits (Yan et al., 2014).
Different cultivars were studied at arid and semi arid conditions of Gansu and Ningxia province in China. It was established that cultivars Ningqi 5, Mengqi 1 and Bianguogouqi were the most vigorous during first few years after planning. Therefore, the authors define them as most suitable for growing under such conditions (Zhang et al., 2013).
Five new goji berry strains were studied in three regions of Ningxia province, China. As a result it was established that the environmental conditions influence the growth of different strains (An et al., 2009). Investigating the possibilities for growing goji berry is done in other countries in Asia. The suitability of growing goji berry in typical steppe in Inner Mongolia was investigated and it was reported that *Lycium barbarum* L. can be successfuly grown under such conditions (Liu, 1999).
Two cultivars of *Lycium barbarum* L. were studied near by North Bucharest, Romania (Mencinicopschi et al., 2012). It was established that the cultivars are suitable for growing in this region. The authors reported the differences concerning vegetative and reproductive characteristics of the studied cultivars. Mencinicopschi and Balan (2013) established differences between two cultivars goji berry in terms of beginning of phenophases and pointed out the importance of weather conditions for the beginning of phenophases flowering and fruit bearing. The authors inform that one of the cultivars was more vigorous and less productive but its fruits were of higher quality.
Till now in the available scientific literature we have not found data concerning testing goji berry plants grown on the field in Bulgaria. The aim of the study was to evaluate some of the growth and reproductive characteristics of two bulgarian goji berry cultivars under conditions of Plovdiv region, Southern Bulgaria.

MATERIALS AND METHODS

The study was conducted during the period 2013 - 2014 at the experimental field of the Department of Fruit growing at Agricultural University–Plovdiv, Bulgaria. For that purpose in vitro propagated plants of two Bulgarian cultivars (JB 1 and JB 2) were planted in 20 June 2013 at distance 3 x 2 m. The thickness at the root neck was 2-3 mm and the plant height was 20-30 cm. The plants were formed as trees with 40 cm trunk height, supporting sticks were used and drip irrigation was applied. The experiment was set up in a randomized block design. Six replications and one plant per plot were included in each variant. The data were statistically processed by the method of analysis of variance. The following parameters were evaluated: height of the plants, total growth, trunk thickness, crown diameter and crown volume and yield per tree. Phenological observations concerning the beginning and end of phenophases flowering and fruit bearing also were determinated.
The climate in Plovdiv region is typical of temperate climate zone. The average year active temperature sum is 3900^{o} C, mean annual rainfall is 515 mm and pH of the soil is 7,2 – 7,4 (Angelov, 2006).

RESULTS AND DISCUSSIONS

Growth characteristics of tested cultivars are presented in (Table 1). The differences between the two studied cultivars concerning height of the plants in the year of planting (2013) are insignificant. In the end of the second vegetation the plants of cultivar JB 2 are significantly higher than these of JB1. Other authors (Zhang et al., 2013; Mencinicopschi and Balan, 2013; Wang et al., 2011) also reported for differences in terms of vigor of tested cultivars.
For the period 2013 – 2014 the differences between tested cultivars in terms of vegetative growth are significant and the cultivar JB 2 surpasses JB 1.

Table 1. Growth characteristics of two goji berry cultivars.

Cultivar	Height of the plants, cm		Total growth, cm		
	2013	2014	2013	2014	∑ 2013-2014
JB 1	42.0	103.50	86.00	761.50	847.50
JB 2	48.50	238.67	130.00	1061.17	1191.17
LSD 5%	19.92	56.51	69.69	202.63	184.81

Data about other parameters concerning the growth characteristics of the tested goji berry cultivars at the end of the second vegetation (2014) are presented in Table 2. Concerning the trunk thickness there is no significant difference between tested cultivars. In terms of crown diameter and crown volume cultivar JB 2 surpasses JB 1.

Table 2. Other parameters characterizing the growth characteristics of two cultivars goji berry at the end of the second vegetation (2014).

Cultivar	Trunk thickness, mm	Crown diameter, cm	Crown volume, m^3
JB 1	8.99	66.25	0.09
JB 2	8.91	110.00	0.63
LSD 5%	2.14	13.04	0.20

Despite of relatively late planting (20 June) the plants started to bloom and bear fruits in the same vegetation - the cultivar JB 1 produced approximately 16 fruits per plant as long as the cultivar JB 2 produced 1-2 fruits per plant.

In the second year after planting the flowering of the cultivars began in the beginning of June. Start of flowering was recorded in JB 1 cultivar as well as JB 2 cultivar started flowering 2-3 days later. End of flowering for both cultivars was recorded in the end of November. Mencinicopschi and Balan (2013) reported for long period of flowering of the tested goji berry cultivars in Romania.

In the second vegetation fruit bearing of JB 1 cultivar was higher in comparison with JB 2 cultivar (Table 3). Other authors (Wang et al., 2011; Mencinicopschi and Balan, 2013) also reported about differences concerning the obtained yield in different tested cultivars.

Table 3. Reproductive characteristics of two goji berry cultivars in second vegetation (2014).

Cultivar	Yield, kg/tree	Theoretical yield, kg/decare
JB 1	0.56	93.52
JB 2	0.31	51.77
LSD 5%	0.28	45.32

In 2014 the first harvest of both cultivars was conducted in late August and the last in mid-November.

In another study in Bulgaria, Stoykov (2012) in laboratory analysis of samples of *Lycium barbarum* L. was discovered the causative agent of powdery mildew on goji berry plants. The author defined it as *Arthrocladiella mougeotii* (Lev.) Vassilkov. Monitoring for attack by pests and diseases was conducted in our experimental plantation. The results confirmed the presence of powdery mildew. Among the two cultivars JB 2 is visibly more susceptible to this disease than JB 1.

CONCLUSIONS

The first results (till the end of the second vegetation) of testing two goji berry cultivars allow the following conclusions:

1. The Bulgarian goji berry cultivars JB 1 and JB 2 can be successfully grown under environmental conditions of Plovdiv region (Southern Bulgaria).
2. Cultivar JB 2 is more vigorous in terms of height of plants, diameter and volume of the crown than JB 1 cultivar.
3. When planting in the permanent place the plants of both cultivars started to bloom and bear fruits (although single fruits) in the same year. During the second vegetation flowering of tested cultivars started in the beginning of June and finished in the end of November. Better productivity was recorded in cultivar JB 1 with 0,56 kg/tree and theoretical yield per decare – 93,52 kg whereas the yield of cultivar JB 2 was 0,31 kg/tree and 51,77 kg respectively.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EVALUATION OF SOME AUTOCHTHONOUS PEACH AND NECTARINE CULTIVARS AT RESEARCH STATION FOR FRUIT GROWING CONSTANŢA

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Abstract

The peach is one of the species for which runs a very active worldwide genetic improvement programme, both in public and in private. At Research Station for Fruit Growing Constanta (RSFG Constanta) an efforts have been made to identify, collect and preserve a rich germplasm found of this species. Currently, the national collection of peach, rejuvenated in the period 2011-2014 has a total of 505 genotypes of peaches and nectarines, of which 14 are old, native varieties. This paper describes these varieties in terms of morphological, biochemical, pathological by grouping according to their biological characteristics, in order to choose the initial material for hybridization schemes, the knowledge of the existing gene sources and promotes valuable varieties.

Key words: *Prunus persica, varieties, blooming, yields.*

INTRODUCTION

Collection, conservation and rational use of germplasm fund (Cociu V. and Oprea S., 1989) is an essential condition for the creation of new peach varieties with better qualities (Cepoiu N. and Manolache C., 2006) regarding productivity, diseases resistances, superior quality of the fruit and destination (Monet R., 1992). At Research Station for Fruit Growing (RSFG) Constanta peach germoplasm preservation was started in 1977 (Cociu V., 1993, 1999).

At RSFG Constanta the main objectives in peach breeding are the following:

- Creation of peach and nectarine varieties with superior quality, with early ripening (18-25 of June) and late ripening (25 September-5 Octomber), for a longer fresh fruit assortment consumption;
- Creation of peach and nectarine varieties with pest and diseases resistance;
- Obtaining of varieties with longer winter latency period and resistance to the return frosts and late hoar-frosts;
- Diversification of fruits in size, shape, color, firmness;
- Obtaining of peach and nectarine with reduced habit (full dwarf and semidwarf) (Dumitru, 2003);
- Obtaining of peach varieties for canning (clingstone);
- Creation of some oranamental varieties (red leaf and abundant flowers)

Currently, the national collection of peach, rejuvenated in the period 2011-2014 has a total of 505 genotypes of peaches and nectarines, of which 14 are old, native varieties that could be used as genitors for creation of new peach varieties.

MATERIALS AND METHODS

RSFG Constanta is located in the south-eastern part of Romania, in the area between the Danube River and the Black Sea, and has specific steppe climatic conditions, with a semi-arid character. Frosts return is a quite often phenomena in spring and affect fruit trees with early blooming as nectarine. Absolute temperature beyond the limits of resistance of peach and nectarine species, e.g. -25°C or above +40°C is rare (1/20 or 1/30 years). Rainfall is deficient to the requirements of the trees; the average amount of rainfall is around 400 mm, with unequal time distribution in the active growing season (April 1 to September 30). Chernozem soil type is deep, well supplied with humus, showing proper conditions for water circulation.

The trees were observed from the phenological point of view.

There were made biometrical measurements on fruits and trees and physico-chemical analyses on fruit. The crown form was the improved vase. The orchard density was 833 trees/ha (4/3 m).

Phenological observations and measurements, and physical and chemical analyses on plants were done.

The trees and fruit characteristics were evaluated according to the Methodology for trying new varieties of fruit trees, shrubs and rootstock in order to approve the homologation and International Union for the Protection of New Varieties of Plants (UPOV) guidelines.

The peach yield was appreciated by weighing the tree crop (kg/tree) and reporting per hectare the average yield recorded in the years of study.

RESULTS AND DISCUSSIONS

All studied varieties have proved a superior quality and are suitable both for fresh consumption and for processing. Most of the peach varieties have medium vigor, except De Cândeşti variety that has high vigor (table 1).

The ripening time started with Nectarine superintensiv variety (5-20.07) and finished with Excelsior (20.09-5.10). Regarding the fruit ripening time one of the variety is early, two are medium, five are late and one extralate. The fruit shape is spherical, simetrical or slightly asymmetric; Băneasa 1 turtite genotype has flat fruit.

The fruit are attractive, colored, with white flesh (De Voineşti, Superbă de toamnă, De Cândeşti, Băneasa 1 turtite).

The average weight of the fruit (table 2) is between 70 g (Băneasa 1 turtite) and 180 g (Flacăra clon 1). Dry matter ranged between 9% (De Cândeşti) and 14% (Nectarin superintensiv). Acidity was between 0.41 mg % (Mioriţa) and 0.83 mg % (Nectarin superintensiv).

Table 2. Quality test of some genotypes of peach and nectarine (multiannual data) at the Research Station of Fruit Growing Constanta, Romania

No	Variety	Average weight of a fruit (g)	% of kernel	Dry matter (%)	Acidity (mg%)	Yield	
						kg/tree	t/ha**
1.	De Voineşti	105	9,2	11	0.6	37	23
2.	Superbă de toamnă	175	8,7	10	0.53	22	14
3.	Flacăra clon 1	180	7,2	11.5	0.53	27	17
4.	Nectarin superintensiv	80	7,7	14	0.83	25	15,7
5.	Mioriţa	130	8,5	11	0.41	30	18,8
6.	Cluj 1112	145	8,3	10	0.56		
7.	Băneasa 1 turtite	80	7,8	10	0.51	23,5	15,0
8.	De Cândeşti	100	9,1	9	0.54	30	18,75
9.	Superbă de vară	120	9,3	10	0.47	25	15,6

*Acidity: mg malic acid / 100 g flesh fruit

Table 1. Charactersitics of some autohtenous peach varieties from National Peach Collection of RSFG Constanta

No.	Variety/group	Vigour	Ripening time	Pollination	Fruit shape	Fruit skin and flesh colour	Use
1.	De Voineşti / peach	medium	late (10.08-23.08)	autofertile	Spherical, asymmetrical,	White greenish, white-cream flesh	Fresh consumption and proccesing
2.	Superbă de toamnă / peach	medium	late (25.08-15.09)	autofertile	Spherical, asymmetrical, slightly elongated	White greenish, white flesh	Fresh consumption and proccesing
3.	Flacăra clon 1 / peach	medium	late (01.09-20.09)	autofertile	Spherical, slightly asymmetric	Orange, red streaked on 10% of fruit; yellow	Fresh consumption and proccesing
4.	Nectarin superintensiv / nectarine	medium	early (5.07-20.07)	autofertile	Spherical, slightly asymmetric	Orange, yellow-orange flesh	Fresh consumption and proccesing
5.	Miorița / peach	medium	medium (12.07-27.07)	autofertile	Spherical, slightly asymmetric	Yellow -green, red streaked on 10% of fruit; white-cream flesh	Fresh consumption and proccesing
6.	Cluj 1112 / peach	medium	late (20.08-20.09)	autofertile	Spherical, slightly asymmetric	Yellow, red 30 % of the surface; yellow flesh	Fresh consumption and proccesing
7.	Băneasa 1 turtite / flat peach	medium	late (10.08-30.08)	autofertile	Flattened	Greenish white, pink streaked; greenish-white flesh	Fresh consumption and proccesing
8.	De Cândeşti / peach	high	late (01.08-20.08)	autofertile	Spherical, slightly asymmetric	Greenish white , pink streaked 5% of the fruit; greenish-white flesh	Fresh consumption and proccesing
9.	Superba de vară / peach	medium	medium (25.07-10.08)	autofertile	Spherical, slightly elongated	Yellow, red streaked 30% of the fruit; yellow	Fresh consumption and proccesing

CONCLUSIONS

The studied varieties, can be used in breeding programmes due to their qualities such as: rusticity, precocity of fruiting, annual high and constant productivity, superior fruit taste and flavour.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESEARCH AND STUDIES REGARDING THE BEHAVIOR OF CERTAIN RASPBERRY VARIETIES WITHIN BUCHAREST REGION

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Abstract

The experiment was conducted within the teaching field of the Horticulture Faculty during 2012-2014, with 5 genotypes of raspberry: 'Heritage', 'Opal', 'Gustar', 'Elite 89' and 'Malling Promise', out of which the first four with biannual fructification, planted at a distance of 2.2 m between rows, with a plant management system in the shape of lane, with espalier with two rows of double wire. The culture technology applied was specific for the raspberry plantations. The analyzed varieties had a different behaviour from the point of view of the vegetative growth, production capacity and fruit quality. The 'Gustar' variety had the highest capacity to produce root shoots; 'Elite 89' had the highest number of inflorescences per strain, while 'Malling promise' had the highest number of fruit per inflorescences. From the quality point of view, the 'Heritage' and 'Elite 89' varieties recorded higher content in dry substance; 'Opal' recorded the highest content in vitamin C, while 'Gustar' and 'Malling Promise' recorded higher content in carbohydrates.

***Key words**: raspberry, production, quality.*

INTRODUCTION

The raspberry (*Rubus idaeus* L.) is a rustic species that grows spontaneously in the mountain region and in clearings in forests, but also one that is cultivated both within individual gardens and within commercial plantations (Hoza, 2000). The fruit obtained from an organic culture have a higher antioxidant capacity than the ones from a conventional culture (Jin et al., 2012). It represents a species of a major food and sanogeneous importance, the fruit have a complex biochemical composition, and its antioxidant components contribute to the protection of cells against serious diseases. The biochemical composition of fruit (soluble dry substance, acidity, phenol and antioxidant content) is influences by the cultivar variety (Zhang et al. 2010, Mazur et al., 2014). The raspberry based extracts have a neuroprotective role by inhibiting the peroxynitrite that determines the effects on the DNA (peroxynitrite-induced DNA damage) (Chen W. and al., 2012). Raspberry is a species that bearly deals with the soluble salts from the soil and especially with chlorine (Neocleous D., and Vasilakakis M., 2007); the soils with secondary salinization must be avoided. It is one of the species with high capacity to produce root shoots and with an anti-erosion protection role (Chira, 2000).

MATERIALS AND METHODS

The objective of this study was to evaluate the behavior of several Romanian varieties ('Opal', 'Gustar' and 'Elite 89-15-3') compared to the varieties 'Heritage' and 'Malling Promise', in the pedo-climatic conditions from the Bucharest area, a region with temperate-continental climate, with temperatures low during winter and high during spring and an amplitude of more than 50°C. The soil from the plantation is reddish brown, with a moderate degree of mineral supply and a weakly acid pH. The experiment was conducted within the teaching field of the Faculty of Horticulture Bucharest, during 2013-2014, within a four-year-old raspberry culture, with a distance between rows of 2.5 m and a width of 40 cm for the band along the row. Five raspberry varieties were analyzed: 'Heritage', 'Opal', 'Gustar', 'Malling Promise' and 'Elite 89-15-3', out of which only the variety Promise. The length of the fruit growing strains was limited to 120 cm through pruning.

The study method used was in field stationary and several biometric parameters were determined, while for the laboratory measurements related to quality the HPLC system was used HPLC (Agilent Technologies). The measurements evaluated the growth and fructification of the five genotypes in terms of: capacity to produce root shoots, capacity to form fertile shoots, number of flowers per inflorescence, fruit size, production and quality.

RESULTS AND DISCUSSIONS

The capacity to produce root shoots was influenced by the variety, number of root shoots per linear meter of band was between 14.3 shoots/linear meter for the variety 'Malling Promise' and 45.1 shoots/linear meter for 'Gustar', compared to an average of the varieties of 32.12 shoots/linear meter (Figure 1). Three varieties, 'Heritage', 'Opal' and 'Gustar', had a higher capacity to produce root shoots, above average (32.12 shoots/linear meter), while two varieties, 'Malling Promise' and 'Elite 89-15-3', had a weak capacity, less than 26 shoots/linear meter.

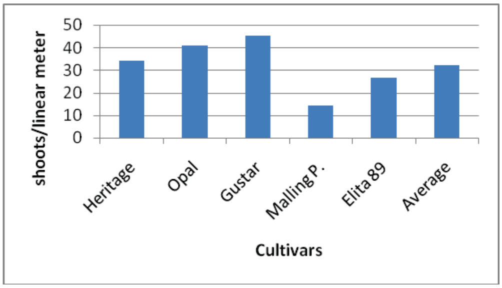

Figure 1. The capacity to produce root shoots for several raspberry varieties

The number of fertile shoots per strain was influenced by the variety, being higher for the varieties 'Gustar', 14.7 fertile shoots/strain, and 'Malling Promise', 11.3 fertile shoots/strain. Comparing the capacity of the varieties to produce fertile shoots to the average, three varieties, 'Gustar', 'Heritage' and 'Elite 89-15-3', had higher values, while 'Opal' and 'Malling Promise' had lower values (Figure 2).
The number of flowers per inflorescence varied among the studied varieties, with values from 7.15 flowers for 'Opal' and 10.56 flowers for 'Elite 89-15-3', compared to the average of 8,68 flowers (Figure 3).

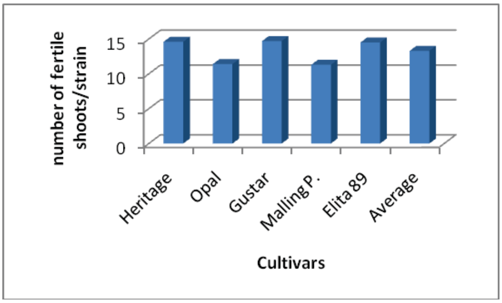

Figure 2. Capacity to form fertile shoots for several raspberry varieties

It was interesting that for these varieties, a strong positive correlation was highlighted between the number of fertile shoots and the number of flowers per inflorescence, expressed through r^2 = 0.683 (Figure 4), which showed that these two characteristics are dependent on the variety and biologically controlled.

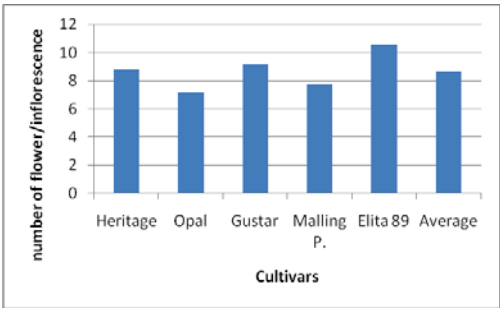

Figure 3. Number of flower per inflorescence for several raspberry varieties

It was interesting that for these varieties, a strong positive correlation was highlighted between the number of fertile shoots and the number of flowers per inflorescence, expressed through r^2 = 0.683 (Figure 4), which showed that these two characteristics are dependent on the variety and biologically controlled.
The production capacity was variable and recorded values between 1.45 kg/l.m. (linear meter of fruit growing band) for the variety Opal, a variety with smaller fruits, and 3.15 kg/l.m. for 'Gustar', as maximum value. The average of the experiment was 2.3 kg/l.m.; the varieties 'Gustar', 'Elite 89-15-3' and 'Heritage' had values higher than the control, while the varieties 'Opal' and 'Malling Promise' recorded lower values (Figure 5).

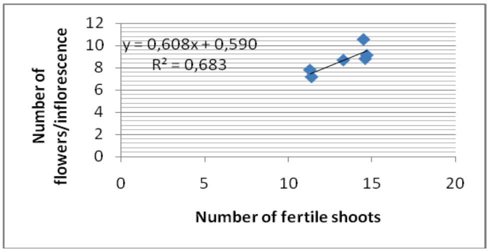

Figure 4. Correlation between the number of fertile shoots and the number of flowers per inflorescence

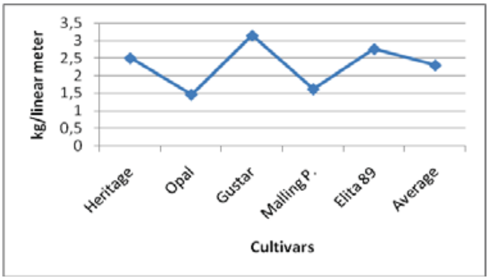

Figure 5. Production capacity for several raspberry varieties (kg/l.m.)

Fruit quality is important for capitalization, but also for the consumer. Differences were recorded among the varieties related to the content in soluble dry substance (SDS), content in vitamin C and carbohydrates (table 1). From the point of view of the content in dry substance, a higher content was recorded for the varieties ‘Heritage’ and ‘Elite 89-15-3’, 14.2 respectively 13.7%, the differences being statistically ensured by the variance analysis as very significant, while a lower content was recorded for the varieties ‘Gustar’ and ‘Malling Promise’, with very significant negative differences compared to the average. The content in vitamin C was higher for the varieties ‘Gustar’ (28.4 mg/100 g p.p.), the difference being very significant positive, and for ‘Opal’ (24.1 mg/100 g p.p.) with a significant positive difference from the control, compare to the other varieties (Table 1). The carbohydrate content varied according to the variety.

Table 1. Biochemical characteristics of the fruit for several raspberry varieties

Variety	S.U.S. (%)	Vitamin C (mg/100 g p.p.)	Fructose (mg/100 g p.p.)	Glucose (mg/100 g p.p.)	Sucrose (mg/100 g p.p.)
‘Heritage’	14.2***	17.7^{oo}	3.7	3.0	1.2
‘Opal’	12.1 N	24.1**	4.0	2.7	1.2
‘Gustar’	10.7^{ooo}	28.4***	4.0	3.0	1.6
‘Malling promise’	11.2^{ooo}	18.5^{oo}	3.7	2.9	1.8
‘Elite 89-15-3’	13.6***	19.9^{o}	3.63	3.12	1.3
Average	12.36 Control	21.72	3.80	2.94	1.42
DL 5%	0.32%	1.31 mg/100 g p.p.			
DL 1%	0.54%	2.17 mg/100 g p.p.			
DL0.1%	1.01%	4.07 mg/100 g p.p.			

CONCLUSIONS

From the present study, the following conclusions can be drawn:

The analyzed varieties had a good behaviour in the specific conditions of Bucharest area; they can be recommended for industrial cultures or cultivating them as a hobby

The capacity to produce root shoots was different and dependent on the variety; the varieties ‘Opal’ and ‘Gustar’ had a high capacity, over 40 root shoots per linear meter of band, while the rest of the varieties recorded lower values.

The number of fertile shoots per strain was higher for the varieties ‘Heritage’, ‘Gustar’ and Elite 89-15-3’, over 14 shoots per strain, while lower numbers were recorded for ‘Opal’ and ‘Malling Promise’.

The production capacity was higher for the varieties ‘Gustar’, ‘Elite 89-15-3’ and ‘Heritage’, with more than 2,5 kg per linear meter of band, while the varieties ‘Opal’ and ‘Malling Promise’ recorded smaller productions.

Fruit quality depended on the variety. The varieties ‘Opal’ and ‘Gustar’ had higher values for the content in vitamin C.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

GROWTH DYNAMICS OF SHOOTS RELATED TO CULTIVAR AND SHAPE OF THE NECTARINE TREE CROWN

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Abstract

The nectarine tree is pretentious as far as light is concerned, which is why the differentiation of the fruiting buds on annual branches is directly linked to the ensuring of sufficient light. A study was organised to establish both the optimal density of trees per hectare as well as the adequate shape of the trees crown in order to ensure a good lighting of the crown; also, the maintenance works and the harvesting have become mechanised. The research was carried out between 2008 and 2011 at R.S.F.G. Constanța and was focused on four nectarine tree cultivars ('Cora', 'Delta', 'Romamer 2' and 'Crimsongold') and four shapes of the crown and planting distances considered together: Tatura, planting distance 6/2 m= = 833 trees/ha; Vertical strap, planting distance 4/1.5 m= 1,666 trees/ha; Veronese vase, planting distance 4/3 m= 833 trees/ha; Improved vase, planting distance 4/3.5 = 714 trees/ha. The carried out determinations were focused on: a) The vegetative phenophases development – the vegetative buds burst, the beginning of shoot growth, the ending of shoot growth and b) The growth dynamics of shoots per cultivar and shape of the crown. The study revealed that, at all nectarine tree cultivars studied between 2008 and 2011 the vegetative buds burst occurred between March 5th and April 1st. The ending of shoot growth occurred at different moments according to the cultivar, the climatic year and the shape of the crown. The dynamics of shoot growth registered the lowest values at the 'Delta' cultivar (6.87 cm) and the shoots grew more in length in 2010 as compared to the other years of study.

Key words: *buds burst, cultivars, growths.*

INTRODUCTION

The nectarine tree is a very valuable species from an alimentary point of view. It can successfully adjust to different environmental conditions, it starts fruiting very quickly and it is very stable as far as the fructification is concerned. The nectarine tree is an important source of income for the countries which cultivate it (the USA, Italy, France, Spain, and Greece), its culture being among the first if one takes into account its profitability (Cociu, 1981). In France, the nectarines have been known ever since the Middle Ages under the name "brugnons", being the object of a small local trade (Debeunne and Thiault, 1969 apud Cociu, 1971). In modern fruit-growing, the shape of the crown of the tree holds a significant role in ensuring the bioconversion of the solar energy as well as in the production level and fruit quality. In Eastern Europe the most utilised shapes of the crown are the palmette with oblique branches, the bush spindle, the crown with a central axe, and the slim spindle, spread after 1980 especially in Poland, Hungary and the Czech Republic (Fideghelli C. Et al., 1987, apud Sumedrea D., et al., 2003). During the last decade, research has become more extensive in the USA and Canada regarding the shapes of the crown specific to intensive orchards: slim spindle, vertical axe, short spindle (the axe is cut during the first two years), tall spindle (the axe is not cut), shapes which are realised by means of highly simplified cuts and which ensure an efficient use of light (Baritt B. H. et al., 1997; Hampson C. R. Et al., 1997; Robinson T.L., 1997, apud Sumedrea D., et al., 2003). In Australia researchers considered creating shapes of the crown with horizontal or oblique branches (Tatura trellis, Lincoln) which would allow for the mechanisation of cuts in intensive orchards (Mckenzie D. W. et al., 1978, Sumedrea D., et al., 2003). The number of varieties planted in recent years has practically doubled (Fideghelli et al., 1998), the peaches representing 58%, the nectarines, 38% and the clingstones only 16% of all these varieties. Within this context, the choice of the combination cultivar - parent stock, of the appropriate shapes of the crown, of the planting distances, of the technology for maintaining and fertilising the soil and the trees, of the applied phytosanitary treatments should represent a major preoccupation for every fruit-grower (Lespinasse et al., 1998). Also, within the context of the new market demands (Fideghelli, 2002), where the horticultural production is becoming reoriented from quantity to quality, R.S.F.G. Constanța has attempted during the past several years to adopt a modern orientation in creating new cultivars. Among those which were preoccupied with the technology of peach tree and nectarine tree cultures were the following: Ivașcu (2002; 2005); Spita (2002); Cociu (1971; 1981). The purpose of this paper is to determine the development of the main vegetative phases, as well as the growth dynamics of shoots per cultivar and shape of the crown in the conditions of the fruit-growing area Valu lui Traian.

MATERIALS AND METHODS

A bi-factorial experiment was organised at R.S.F.G. Constanța in the spring of 2002: Factor A = the cultivar, a1 = Cora, a2= Delta, a3= Romamer2, a4= Crimsongold and Factor B = the shape of the crown and the planting distance considered together, b1 = Tatura, planting distance 6/2 m= = 833 trees/ha; b2 = Vertical strap, planting distance 4/1.5 m= 1,666 trees/ha; b3 = Veronese vase, planting distance 4/3 m= 833 trees/ha; b4 = Improved vase, planting distance 4/3.5 = 714 trees/ha. The research was carried out between 2008 and 2011.

The planted material was produced in the nursery garden of R.S.F.G. Constanta, all the cultivars being grafted on the same parent stock, T16. As far as the technology applied to the nectarine tree culture is concerned, there were no differences; for all the cultivars, shapes of the crown and planting distances the technology was applied in an identical manner. Regarding the soil on which the experiment is situated, it is a calcareous chernozem (CZka), with a claylike texture and low alkaline pH (8.2) in its entire profile. Also, the climatic conditions in this area are very favourable to culture of nectarine trees. As far as precipitations are concerned, although the area is considered to be droughty, the nectarine trees are constantly irrigated, which solves the issue of the necessary quantity of water.

During the studied period (2008-2011), the average monthly temperature had a value of 12.4 °C, being higher than the normal value for the region by 1.7 °C; the value recorded during the vegetative period was of 19.1 °C, again higher than the normal value for the region by 1.7 °C. The average annual quantity of precipitations had a value of 590.7mm, from which 304.6 mm were recorded during the vegetative period, which proves that the area lacks in precipitations.

The average multi-annual quantity of precipitations per 25 years is of 421.0mm, from which 240.7mm were recorded during the vegetative period.

In order to determine the development of the main vegetative phases in the conditions of the fruit-growing area Valu lui Traian, phenological observations of the trees were carried out, both in the resting period as well as in the vegetative one, as follows:

a) Vegetative phenophases – The beginning of the buds burst, when the bud literally cracks and one can observe the tips of the leaves; the beginning of shoot growth, after the appearance of the first 5 leaves, takes place most years in the month of May; the ending of shoot growth, which was determined by means of the growth dynamics of shoots upon the appearance of the terminal bud and

b) The growth dynamics of shoots per cultivar and shape of the crown. The measurements were carried out on 10 shoots per tree for each cultivar, shape of the crown and planting distance, respectively. The shoots were labelled (in three different points of the tree) at the beginning of the measuring and every 7 days they mere measured and their length was recorded for the calculation of the dynamics. Based on the obtained data we were able to determine both the average length of the annual shoots as well as the average growth dynamics.

RESULTS ANS DISCUSSIONS

At the nectarine tree in the studied years 2008-2011 the cracking of the vegetative buds occurred between March 5th and 30th for the 'Cora' and 'Delta' cultivars, when the sum of active temperatures (over 6.5^{o}C) reached a value ranging between 121^{o}C and 156^{o}C and between March 7th and April 1st for the 'Romamer 2' and 'Crimsongold' cultivars (Table 1), when the sum of active temperatures (over 6.5^{o}C) reached a value ranging between 121^{o}C and 162^{o}C, 2008 being the earliest year for all the studied cultivars.

The triggering of the beginning of shoot growth phenophase is important because it is a critical moment for the ensuring of the plant's nutrition (the applying of nitrogen) and the protection against insects which attack the leaves (treatment warning).

The beginning of shoot growth occurred between April 5th and May 14th in the studied years 2008-2011 for the 'Cora' and 'Delta' cultivars, when the sum of active temperatures had a value ranging between 309^{o}C and 640^{o}C, between April 7th and May 16th for the 'Romamer 2' cultivar (sum of active temperatures ranging between 328^{o}C and 698^{o}C) and between April 5th and May 16th for the 'Crimsongold' cultivar (sum of active temperatures ranging between 309^{o}C and 669^{o}C)

Table 1. The main vegetative stages in the period 2008-2011

No.	Cultivar	Year	Beginning of the swelling		Beginning of shoots growth		Ending of shoots growth	
			Date	∑ active temp. ^{o}C	Date	∑ active temp. ^{o}C	Date	∑ active temp. ^{o}C (>6,5 ^{o}C)
1	CORA	2008	5.03	121	5.04	309	8.08	2966
2		2009	10.03	156	5.05	557	23.08	3125
3		2010	15.03	106	5.05	640	23.08	3107
4		2011	30.03	138	14.05	581	11.08	3135
	Average		5.03-30.03	131	5.04-14.05	522	8.08-23.08	3083
5	DELTA	2008	5.03	121	5.04	309	8.08	2966
6		2009	10.03	156	5.05	557	23.08	3125
7		2010	15.03	109	5.05	640	23.08	3107
8		2011	30.03	138	14.05	581	11.08	3135
	Average		5.03-30.03	131	5.04-14.05	522	8-23.08	3083
9	ROMAMER 2	2008	8.03	130	7.04	328	8.08	2966
10		2009	12.03	162	9.05	616	27.08	3209
11		2010	17.03	109	9.05	698	27.08	3203
12		2011	01.04	156	16.05	617	15.08	3230
	Average		8.03-01.04	142	7.04-16.05	565	8-27.08	3152
13	CRIMSONGOLD	2008	7.03	121	5.04	309	8.08	2966
14		2009	8.03	139	7.05	586	25.08	3167
15		2010	15.03	109	7.05	669	25.08	3154
16		2011	01.04	156	16.05	617	18.08	3303
	Average		7.03-01.04	131	5.04-16.05	545	8-25.08	3147

The ending of shoot growth occurred at different dates: on August 8th for all the studied cultivars in 2008, between August 23rd and 27th in the years 2009 and 2010 and in 2011 on August 11th for the 'Cora' and 'Delta' cultivars, August 15th for the 'Romamer 2' cultivar and August 18th for the 'Crimsongold' cultivar. The highest value of the sum of active temperatures was of 2966^{o}C, while the lowest was of 3209^{o}C.

The dynamics of shoot growth was calculated in order to establish the periods with the highest shoot growth, period when, from a vegetative point of view, the largest quantities of nutrients and water are consumed per surface unit.

At the nectarine tree in 2008 the growth of the shoots was triggered at the beginning of the month of May; 12 biometric weekly measurements were performed on the shoots between May 7th and July 30th. For each cultivar and shape of the crown 10 shoots per tree were measured every week.

In 2008 (Table 2) the shoot growths were modest for all the analysed cultivars. The average growth rhythm of the shoots at the 'Cora' cultivar recorded values ranging between 4.58 cm (Tatura shape of the crown, which recorded the lowest growth dynamics overall) and 5.8 cm (Improved vase, which recorded the highest growth dynamics overall). At the 'Delta' cultivar the average growth rhythm of shoots recorded values ranging between 5.25 cm (Veronese vase) and 5.66 cm (Improved vase). At the 'Crimsongold' cultivar, the values ranged from 4.41 cm (Tatura) to 5.52 cm (Improved vase). As average per cultivar of the average growth rhythm, the lowest values were recorded by the 'Crimsongold' cultivar (4.74 cm), while the highest were recorded by the 'Romamer 2' cultivar (5.68 cm). The dynamics of shoot growth, as well as the number, thickness and length of the shoots is directly correlated with the age of the trees, the quantity of fruit per tree, the applied agrotechnique (cuts, works on the soil, fertilizers, irrigation) and the vegetative behaviour of each cultivar.

In 2009 the beginning of shoot growth was triggered in the first half of the month of May; 14 biometric measurements were performed weekly on the shoots between May 12th and August 11th, when the growth of the shoots reached its end (Table 3). 10 shoots per tree were measured weekly for each cultivar and shape of the crown. At the 'Cora' cultivar the average growth rhythm of the shoots recorded values ranging between 5.28 cm (Vertical strap, which recorded the lowest growth dynamics overall) and 5.92 cm (Veronese vase, which recorded the highest growth dynamics overall). At the 'Delta' cultivar the values ranged from 6.21 cm (Vertical strap) and 7.00 cm (Veronese vase), while at the Romamer2 cultivar the values ranged between 6.14 cm (Veronese vase) and 6.91 cm (Vertical strap). At the 'Crimsongold' cultivar the values ranged from 5.92 cm (Vertical strap) and 6.14 cm (Tatura). As average per cultivar of the average growth rhythm in 2009, the lowest values were recorded by the 'Cora' cultivar (5.62 cm), while the highest values were recorded by the 'Delta' cultivar (6.62 cm).

In 2010 the beginning of shoot growth was triggered in the first half of the month of May; 14 biometric measurements were performed weekly on the shoots between May 11th and August 10th, when the growth of the shoots reached its end (Table 4). 10 shoots per tree were measured weekly for each cultivar and shape of the crown and the average per cultivar can be seen in the table. At the 'Cora' cultivar the average growth rhythm of the shoots recorded values ranging between 6.28 cm (Improved vase) and 7.00 cm (both Tatura and Vertical strap). At the 'Delta' cultivar the values ranged from 6.21 cm (Vertical strap) and 7.57 cm (Improved vase), while at the Romamer2 cultivar the values ranged between 6.42 cm (Veronese vase) and 6.78 cm (Improved vase), the differences being very small among the shapes of the crown for this cultivar. At the Crimsongold '' cultivar the values ranged from 6.21 cm (Vertical strap) and 6.57 cm (Veronese vase). As average per cultivar of the average growth rhythm in 2010, the lowest values were recorded by the 'Crimsongold' cultivar (6.37 cm), while the highest values were recorded by the 'Delta' cultivar (6.87 cm). In 2010 the average growth rhythm of the shoots (cm) was higher compared to the other studied years due to the fact that 2010 was richer in precipitations (rain) and the trees benefitted from more water in some critical moments, there being no need for irrigations.

In 2011 the beginning of shoot growth was triggered in the first half of the month of May; 16 biometric measurements were performed weekly on the shoots between May 5th and August 10th, when the growth of the shoots ended (Table 5). 10 shoots per tree were measured weekly for each cultivar and shape of the crown and the average per cultivar can be seen in the table. At the 'Cora' cultivar the average growth rhythm of the shoots recorded values ranging between 5.00 cm (Tatura) and 6.5 cm (Improved vase). At the 'Delta' cultivar the values ranged from 4.87 cm (Tatura) and 5.68 cm (Improved vase), while at the 'Romamer 2' cultivar the values ranged between 4.75 cm (Veronese vase) and 6.18 cm (Improved vase), the differences being very small among the shapes of the crown for this cultivar. At the ‘Crimsongold’ cultivar the values ranged from 5.31 cm (Vertical strap) and 6.18 cm (Improved vase). The ending of shoot growth also depends on the evolution of climatic conditions, especially the maximum temperatures during summer and on the agrotechnical conditions (irrigation, pruning) and the nutritive substances in the soil. Analysing this phenophase (the ending of shoot growth) at 4 nectarine tree cultivars, planted at different distances and having different shapes of the crown, but grafted on the same parent stock (T16), we were able to determine that there are differences between cultivars but also differences between one year and the next at the same cultivar. Moreover, there are differences between the shapes of the crown concerning the date when the shoots stop growing.

Shoot length in the studied years (2008-2011)

Following the statistical analysis of the length of the shoots carried out in 2008 the obtained results were significantly positive at the ‘Romamer 2’ cultivar, Improved vase shape of the crown and distinctly significantly positive at the ‘Cora’ cultivar, Improved vase. The ‘Crimsongold’ cultivar, Tatura and Veronese vase shapes of the crown displayed significantly negative results (Table 6).

Similarly, in 2009 the results were significantly positive at the ‘Delta’ cultivar (Improved vase) and distinctly significantly positive at the same cultivar (Veronese vase); the results were very significantly negative at the ‘Cora’ cultivar, Tatura and Vertical strap shapes of the crown.

In 2010, the significance was positive at the Delta cultivar, Veronese vase shape and distinctly significantly positive at the ‘Cora’ cultivar, Tatura shape and the ‘Delta’ cultivar, Veronese vase shape of the crown. The results were distinctly significantly negative at the ‘Delta’ cultivar, Vertical strap shape and the ‘Crimsongold’ cultivar, again Vertical strap shape.

In 2011 the significance was positive at the ‘Cora’ cultivar, Improved vase shape of the crown and the ‘Crimsongold’ cultivar, again Improved vase shape and very significantly negative at the ‘Romamer 2’ cultivar, Veronese vase shape.

As average per shape of the crown for the 4 studied years, the Improved vase shape of the crown was distinctly significantly positive.

CONCLUSIONS

At the nectarine tree during 2008 and 2011 the cracking of the vegetative buds occurred between March 5th and 30th at the ‘Cora’ and ‘Delta’ cultivars and between March 7th and April 1st at the ‘Romamer 2’ and ‘Crimsongold’ cultivars, 2008 being the earliest year for all the studied cultivars. The beginning of shoot growth takes place in most of the studied in April or May (2008-2011), there being differences from one year to another. Also worth noting is the fact that at Valu lui Traian the potential negative temperatures which may occur until mid-May do not affect the vegetative phenophases of the nectarine tree. The vegetative buds are highly resistant to negative temperature during this phenophase.

The growth dynamics of shoots recorded the highest values at the delta cultivar (6.87 cm). The shoots grew more in length in 2010 as compared to the other studied years because 2010 was rich in precipitations.

The ending of shoot growth occurred at different moments according to the cultivar, the climatic year and the shape of the crown.

The length of the shoots in the studied years 2008-2011 was greater at the ‘Cora’ cultivar, Improved vase, the ‘Delta’ cultivar, Improved vase and the ‘Romamer 2’ cultivar, Tatura and Improved vase.

As average per shape of the crown, during the four studied years the Improved vase was better from this point of view.

Table 2. The growth dynamics of shoots at the nectarine tree in 2008

Cultivar	Shape of the crown	Length of the shoots at different moments (cm)												
		May				June				July				Average growth rhythm (cm)
		07.05	14.05	21.05	28.05	04.06	11.06	18.06	25.06	02.07	09.07	16.07	30.07	
Cora	Tatura	9	13	19	23	29	36	44	49	55	58	62	64	4.58
	Vertical strap	12	17	20	25	31	35	48	55	62	65	69	73	5.08
	Veronese vase	6	11	15	18	27	33	42	49	54	57	62	65	4.91
	Improved vase	8	18	26	29	34	39	47	57	66	72	76	78	5.8
Average/cultivar														5.09
Delta	Tatura	7	18	24	28	35	41	49	56	59	63	67	71	5.33
	Vertical strap	5	13	21	27	33	38	45	52	56	69	71	73	5.66
	Veronese vase	9	16	19	23	29	36	44	49	56	64	69	72	5.25
	Improved vase	8	14	18	25	31	33	47	58	63	70	73	75	5.58
Average/cultivar														5.45
Romamer 2	Tatura	9	12	17	22	29	36	48	53	61	68	72	75	5.5
	Vertical strap	6	11	18	24	31	38	49	56	60	66	70	74	5.66
	Veronese vase	9	16	22	27	36	41	47	55	62	67	72	74	5.41
	Improved vase	11	16	19	23	29	36	44	59	67	75	81	85	6.16
Average/cultivar														5.68
Crimson-gold	Tatura	6	11	14	19	23	30	35	41	47	51	57	59	4.41
	Vertical strap	8	13	17	22	30	35	48	52	56	60	62	65	4.75
	Veronese vase	6	10	13	15	22	30	36	41	48	54	58	61	4.58
	Improved vase	8	14	21	29	34	39	45	51	59	64	68	71	5.25
Average/cultivar														4.74

Table 3. The growth dynamics of shoots at the nectarine tree in 2009

Cultivar	Shape of the crown	Length of the shoots at different moments (cm)														Average growth rhythm (cm)
		May			June					July				August		
		12.05	19.05	26.05	02.06	09.06	16.06	23.06	30.06	07.07	14.07	21.07	28.07	04.08	11.08	
Cora	Tatura	7	13	17	24	31	39	47	55	67	75	80	84	85	86	5.64
	Vertical strap	9	14	19	22	30	37	44	53	61	69	75	78	80	83	5.28
	Veronese vase	11	16	18	23	29	33	41	53	65	71	82	89	91	94	5.92
	Improved vase	13	14	21	26	33	42	51	64	72	79	86	89	91	92	5.64
Average/cultivar																5.62
Delta	Tatura	9	14	19	26	29	36	47	50	63	75	87	95	100	102	6.64
	Vertical strap	12	15	22	27	33	39	48	55	71	80	87	93	98	99	6.21
	Veronese vase	7	13	17	21	27	36	49	62	77	84	97	101	103	105	7.0
	Improved vase	11	18	23	29	38	47	56	69	78	88	94	99	101	104	6.64
Average/cultivar																6.62
Romamer 2	Tatura	11	16	19	21	29	37	44	56	68	75	89	95	98	100	6.35
	Vertical strap	14	19	24	27	37	49	55	64	69	77	84	91	95	97	6.91
	Veronese vase	12	17	22	26	32	41	53	64	73	79	84	89	94	98	6.14
	Improved vase	9	15	18	25	37	45	56	64	76	83	89	94	98	101	6.57
Average/cultivar																6.49
Crimson-gold	Tatura	13	14	21	26	33	42	51	64	71	79	87	92	98	99	6.14
	Vertical strap	9	14	19	22	30	37	45	53	62	74	79	83	89	92	5.92
	Veronese vase	10	16	18	23	29	33	41	53	59	67	74	80	86	94	6.00
	Improved vase	6	10	14	21	29	37	44	52	61	72	79	85	88	91	6.07
Average/cultivar																6.03

Table 4. The growth dynamics of shoots at the nectarine tree in 2010

Cultivar	Shape of the crown	Length of the shoots at different moments (cm)														
		May			June					July				August		Average growth rhythm (cm)
		11.05	18.05	25.05	01.06	08.06	15.06	22.06	29.06	06.07	13.07	20.07	27.07	03.08	10.08	
Cora	Tatura	10	19	26	36	41	56	70	79	87	93	97	99	104	108	7.0
	Vertical strap	7	15	20	31	46	54	65	71	78	85	91	96	101	105	7.0
	Veronese vase	6	11	16	24	37	42	52	67	76	84	89	93	96	98	6.57
	Improved vase	13	15	21	30	44	51	68	76	85	89	92	96	98	101	6.28
Average/cultivar																6.71
Delta	Tatura	8	16	23	31	40	51	63	72	79	86	90	94	97	100	6.57
	Vertical strap	9	15	22	31	42	57	64	75	78	86	92	95	96	96	6.21
	Veronese vase	8	14	22	32	49	55	69	88	77	94	98	103	106	108	7.14
	Improved vase	6	13	25	32	46	57	69	78	85	90	99	104	107	112	7.57
Average/cultivar																6.87
Romamer 2	Tatura	12	17	25	31	36	43	58	67	73	85	91	100	103	104	6.57
	Vertical strap	10	18	29	34	58	64	77	85	91	97	100	102	103	103	6.64
	Veronese vase	9	16	26	35	47	56	64	71	78	85	89	93	96	99	6.42
	Improved vase	8	18	27	35	46	52	69	78	85	90	96	100	102	103	6.78
Average/cultivar																6.60
Crimson-gold	Tatura	9	15	22	31	42	57	64	75	78	86	92	95	97	98	6.35
	Vertical strap	10	19	26	36	41	56	69	77	84	89	95	96	97	97	6.21
	Veronese vase	8	14	22	32	49	55	69	78	87	92	98	99	100	100	6.57
	Improved vase	9	13	25	32	46	57	69	78	85	90	94	97	98	98	6.35
Average/cultivar																6.37

Table 5. The growth dynamics of shoots at the nectarine tree in 2011

Cultivar	Shape of the crown	Length of the shoots at different moments (cm)																Average growth rhythm (cm)
		May			June					July				August				
		5.05	12.05	19.05	26.05	02.06	09.06	16.06	23.06	30.06	07.07	14.07	21.07	28.07	04.08	11.08	18.08	
Cora	Tatura	10	12	19	26	33	41	54	63	71	77	82	85	88	89	90	90	5.00
	Vertical strap	9	10	14	22	35	44	52	67	73	78	85	87	89	91	92	92	5.18
	Veronese vase	7	11	16	21	30	39	51	62	69	75	79	85	88	92	95	97	5.62
	Improved vase	6	9	16	25	34	46	59	69	82	91	98	103	105	108	109	110	6.5
Average/cultivar																		5.57
Delta	Tatura	6	11	22	34	45	53	61	65	72	78	80	81	82	83	83	84	4.87
	Vertical strap	8	14	19	27	38	49	57	69	75	79	81	83	84	85	86	87	4.93
	Veronese vase	7	12	20	31	37	48	58	66	73	77	79	81	83	85	87	88	5.06
	Improved vase	6	10	14	22	33	44	53	64	72	78	83	87	91	93	95	97	5.68
Average/cultivar																		5.13
Romamer 2	Tatura	10	16	21	29	37	49	58	69	78	87	91	94	97	100	103	105	6.12
	Vertical strap	9	13	19	27	36	45	56	72	81	87	92	94	96	97	98	99	5.62
	Veronese vase	7	12	17	25	33	42	51	64	71	77	78	79	80	81	82	83	4.75
	Improved vase	8	14	20	28	39	47	59	68	79	87	91	95	98	101	104	107	6.18
Average/cultivar																		5.66
Crimson-gold	Tatura	6	9	17	29	38	49	54	65	71	77	83	86	88	91	92	92	5.37
	Vertical strap	10	12	20	31	39	48	57	68	76	81	85	89	93	94	95	95	5.31
	Veronese vase	6	11	16	27	36	41	52	61	69	75	79	83	88	90	92	93	5.43
	Improved vase	9	14	21	33	39	48	59	67	76	83	89	94	99	104	106	108	6.18
Average/cultivar																		5.57

Table 6. The length of the shoots in the years of study (2008-2011)

Vari ant	Shape of the crown	2008			2009			2010			2011			Average		
		Shoot length (cm)	Diff. comp. to the average	Signif.	Shoot length (cm)	Diff. comp. to the average	Signif.	Shoot length (cm)	Diff. comp. to the average	Signif.	Shoot length (cm)	Diff. comp. to the average	Signif.	Shoot length (cm)	Diff. comp. to the average	Signif.
CULTIVAR																
a1. CORA																
a1b1	b1.Tatura	64	-6.9	oo	86	-10.0	ooo	108	+6.2	**	90	-5.4	-	87.0	-4.0	o
a1b2	b2.Vertical strap	73	+2.1	-	83	-13.0	ooo	105	+3.2	-	92	-3.4	-	88.2	-2.8	-
a1b3	b3.Veronese vase	65	-5.9	o	94	-2.0	-	98	-3.8	o	97	+1.6	-	88.5	-2.5	-
a1b4	b4.Improved vase	78	+7.1	**	92	-4.0	-	101	-0.8	-	110	+14.6	***	95.2	+4.2	**
	Average	**70.0**	**-0.9**	**-**	**88.7**	**-7.3**	**oo**	**103.0**	**+1.2**	**-**	**97.2**	**+1.8**	**-**	**89.7**	**-1.3**	**-**
a2. DELTA																
a1b1	b1.Tatura	71	+0.1	-	102	+6.0	*	100	-1.8	-	84	-11.4	oo	89.2	-1.8	-
a1b2	b2.Vertical strap	73	+2.1	-	99	+3.0	-	96	-5.8	oo	87	-8.4	o	88.7	-2.3	-
a1b3	b3.Veronese vase	72	+1.1	-	105	+9.0	***	108	+6.2	**	88	-7.4	o	93.2	+2.2	-
a1b4	b4.Improved vase	75	+4.1	-	104	+8.0	**	112	+10.2	***	97	+1.6	-	97.0	+6.0	**
	Average	**72.7**	**+1.8**	**-**	**102.5**	**+6.5**	******	**104.0**	**+2.2**	**-**	**89.0**	**-6.4**	**o**	**92.0**	**+1.0**	**-**
a3. ROMAMER 2																
a1b1	b1.Tatura	75	+4.1	-	100	+4.0	-	104	+2.2	-	105	+9.6	**	96.0	5.0	**
a1b2	b2.Vertical strap	74	+3.1	-	97	+1.0	-	103	+1.2	-	99	+3.6	-	93.2	+2.2	-
a1b3	b3.Veronese vase	74	+3.1	-	98	+2.0	-	99	-2.8	-	83	-12.4	ooo	88.5	-2.5	-
a1b4	b4.Improved vase	85	+14.1	***	101	+5.0	*	103	+1.2	-	107	+11.6	**	99.0	+8.0	**
	Average	**77.0**	**+6.1**	*****	**99.0**	**+3.0**	**-**	**102.2**	**+0.4**	**-**	**98.5**	**+3.1**	**-**	**94.1**	**+3.1**	*****
a4. CRIMSONGOLD																
a1b1	b1.Tatura	59	-11.9	ooo	99	+3.0	-	98	-3.8	o	92	-3.4	-	87.0	-4.0	o
a1b2	b2.Vertical strap	65	-5.9	o	92	-4.0	-	97	-4.8	oo	95	-0.4	-	87.2	-3.8	o
a1b3	b3.Veronese vase	61	-9.9	ooo	94	-2.0	-	100	-1.8	-	93	-2.4	-	87.0	-4.0	o
a1b4	b4.Improved vase	71	+0.1	-	91	-5.0	-	98	-3.8	o	108	+12.6	***	92.0	+1.0	-
	Average	**64.0**	**-6.9**	**o**	**94.0**	**-2.0**	**o**	**98.2**	**-3.6**	**o**	**97.0**	**+1.6**	**-**	**88.3**	**-2.7**	**-**
SHAPE OF THE CROWN																
b1	b1.Tatura	67.2	-3.7	-	96.7	+0.7	-	102.5	+0.7	-	92.7	-2.7	-	89.8	-1.2	-
b2	b2.Vertical strap	71.2	+0.3	-	92.7	-3.3	-	100.2	-1.6	-	93.2	-2.2	-	89.3	-1.7	-
b3	b3.Veronese vase	68.0	-2.9	-	97.7	+1.7	-	101.2	-0.6	-	90.2	-5.2	-	89.3	-1.7	-
b4	b4.Improved vase	77.2	+6.3	*	97.0	+1.0	-	103.5	+1.7	-	105.5	+10.1	**	95.8	+4.8	**
		X=70.9 DL 5% =5.0 DL1% =6.9 DL0.1% =9.6			X=96.0 DL 5% =4.4 DL1% =6.1 DL0.1% =8.5			X=101.8 DL 5% =3.4 DL1% =4.7 DL0.1% =6.5			X=95.4 DL 5% =6.3 DL1% =8.8 DL0.1% =12.2			X=91.0 DL 5% =3.0 DL1% =4.2 DL0.1% =5.8		

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

APPLYING SUMMER PRUNING TO THE APRICOT TREE CULTIVARS FROM THE R.S.F.G. CONSTANŢA

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Abstract

Based on the study of favourable factors to the apricot tree culture, Dobrogea was outlined as an area which is highly favourable to the cultivation of this species. The apricot tree is a species which reacts very well to the applying of pruning during the vegetative stage, these cuts being a technological measure which has as goal the diminishing of the risk of losing the yield in the years when late frosts occur in spring. The research carried out at R.S.F.G. Constanța on three apricot tree cultivars, 'Augustin', 'Orizont' and 'Elmar', had the purpose of establishing the best time for performing summer pruning by carrying out in a differentiated manner, according to the type of fructification. The three cultivars reacted well to the variant which included summer pruning carried out in the middle of the month of June, which recommends this moment as being the best for this type of cuts. The 'Orizont' and 'Elmar' cultivars respond well to summer pruning carried out by shortening the annual growths by 20 cm in order to generate the forming of anticipated shoots. The fruit buds formed on these shoots are later differentiated and enter in the vegetative stage 5-6 days later, which ensures that the danger of hoarfrosts and late frosts is overcome.

Key words: *anticipated shoots, growths, summer pruning.*

INTRODUCTION

The qualitative and technological characteristics of the fruit result in the apricot tree being among the fruit-growing species which are highly appreciated by consumers. The apricot tree culture is widespread in Europe, Asia, America and Oceania; almost 40% of the global production of 3,473,710 tons obtained in 2008 was produced in Europe, followed by Asia with 32%. The largest producer in the world is Turkey (528,000 tons), other large producers being Spain (159,000 tons), the USA (81,000 tons), Italy (212,000 tons), France (180,000 tons), Greece (68,500 tons) and so on. In Romania the apricot tree production in 2008 was of 32,100 tons (Stanica F. et al., 2011). The summer pruning of the apricot trees are based upon this species' characteristic of displaying two or three growth waves in favourable pedo-climatic conditions. Thus, on the anticipated shoots which are usually formed on the superior part of the annual growths, the flowering buds are later differentiated, which means that they can escape the negative effects of hoarfrosts and late spring frosts. The biological characteristic of the apricot tree of issuing anticipated shoots is very useful in case of climatic accidents, the latter being able to partly or even totally compromise the production because of the loss of the flowering buds. On the anticipated shoots which are usually formed on the superior part of the annual growths, the flowering buds are differentiated later, which means that they can resist hoarfrosts and late spring frosts (Cociu, 1993). Previous research has shown that the impact of the climatic changes upon the fruit-growing species is already visible. For example, by the end of the nineteen nineties, the blossoming of the trees in Germany was prolonged by a couple of days (Chmielewschi et al., 2004 şi 2005). The vegetative season in Europe has also prolonged during the past ten years (Chmielewschi and Rotzer, 2002).

MATERIAL AND METHODS

The research carried out at R.S.F.G. Constanța on three apricot tree cultivars aimed to determine the best moment for applying the summer pruning by means of performing it in a differentiated manner. The experiment was organised within the research allotment of R.S.F.G. Constanta, situated in Valu lui Traian on a flat terrain with calcareous chernozem (CZKa), with a claylike texture and a low alkaline pH (8.2) in its entire profile. The research was carried out between 2008 and 2011 on the contest crop cultivated in the spring of 2003, at a distance of 4 metres between rows and 4 metres between the trees on each row (625 trees/ha). The shape of the head was that of a vase. The climatic conditions in the area are favourable to the apricot tree culture as far as the temperature and the precipitations are concerned. Taking the latter into account, although the area is considered to be droughty, the apricot trees are constantly irrigated, which solves the issue of the necessary quantity of water. The studied cultivars are indigenous, created at R.S.F.G. Constanta: ‘Augustin’ (Synonym: VT 34/72), ‘Orizont’ (Synonym: V.T. 30/103) and ‘Elmar’ (Synonym: VT 92.01.10*),* grafted on the parent stock Constanța 14 and being part of the apricot tree assortment cultivated in the area. The cultivars are of medium vigour, with a globular head and solid skeleton branches, well filled with leaves. The fructification usually occurs on May bouquets and on one year old branches.

The three cultivars underwent summer cuts during the period of intense growth of the shoots, 5 trees per each cultivar and consisted of shortening all the annual growths which surpassed the length of 40 cm in three variants, as follows: V1 = the shortening of the annual shoots to a length of 20 cm (5 trees), V2 = the shortening of the annual shoots to a length of 40 cm (5 trees) and V3 = the witness (5 trees which did not undergo summer cuts) (Table 1, Figure 1 and Figure 2). After the harvesting, but no later than August 10^{th}, maintenance and fruiting cuts were applied to the variant considered as witness, while for the variants which had already underwent summer cuts, correction cuts were applied, consisting of removing the stubs and lessening the anticipated shoots. The number of formed anticipated shoots, their average length, the degree of occurrence and the number of formed shoots per 100 shortened shoots were calculated following measurements in the field at the end of the vegetative season.

Table 1. Experimental variants

Cultivar	Cutting variant (5 trees)	Development stage of the annual shoots / calendar period
Elmar	V1= Shortening of the growths to 20 cm	Intense growth (June 10^{th} – 20^{th})
	V2= Shortening of the growths to 40 cm	Intense growth (June 10^{th} – 20^{th})
	V3= Witness (no summer cuts)	-
Orizont	V1= Shortening of the growths to 20 cm	Intense growth (June 10^{th} – 20^{th})
	V2= Shortening of the growths to 40 cm	Intense growth (June 10^{th} – 20^{th})
	V3= Witness (no summer cuts)	-
Augustin	V1= Shortening of the growths to 20 cm	Intense growth (June 10^{th} – 20^{th})
	V2= Shortening of the growths to 40 cm	Intense growth (June 10^{th} – 20^{th})
	V3= Witness (no summer cuts)	-

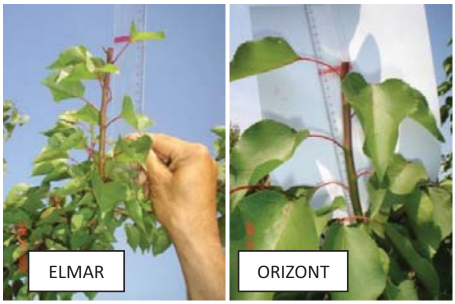

Figure 1. Shortening of the annual growths to 20 cm


Figure 2. Shortening of the annual growths at the Augustin cultivar to 20 cm (left) and 40 cm (right)

RESULTS AND DISCUSSIONS

The applying of summer cuts generated the forming of anticipated shoots in different manners, according to the moment when the cuts were performed and the shortening of the annual shoots which surpassed the length of 40 cm. Thus, following the cuts performed on the ‘Orizont’ cultivar (during the period of intense growth of the shoots between June 10th and 20th), 76% of the shoots shortened to 20 cm issued anticipated shoots. The figures are different for the other two cultivars: 69% for the ‘Elmar’ cultivar and 61% at the ‘Augustin’ cultivar (Table 2).

Following the shortening of the shoots to 40 cm at the ‘Orizont’ cultivar, 72% of them issued anticipated shoots, while for the other two cultivars the figures are again different: 61% for the ‘Elmar’ cultivar and 48% for the ‘Augustin’ cultivar.

As for the variant which did not undergo summer cuts (witness), the ‘Orizont’ cultivar formed the fewest anticipated shoots (38%), while ‘Elmar’ formed 48% and ‘Augustin’, 51%.

Table 2. The impact of summer cuts upon the forming of anticipated shoots (average values for the period 2008-2011)

Cultivar	Variant	Average length of annual growths (cm)	Capacity of shortened shoots of issuing anticipated shoots (%)					Shoots which issued anticipated shoots (%)	Total number of anticipated shoots per 100 shortened shoots
			Number of issued anticipated shoots						
			0	1	2	3	4		
Elmar	V1 = Shortening of the growths to 20 cm	73	31	19	24	19	5	69	73
	V2 = Shortening of the growths to 40 cm	67	39	12	23	21	5	61	65
	V3 = Witness (no summer cuts)	55	52	21	19	8	-	48	56
Orizont	V1 = Shortening of the growths to 20 cm (5 trees)	94	24	32	29	11	4	76	83
	V2 = Shortening of the growths to 40 cm	78	28	16	21	27	8	72	72
	V3 = Witness (no summer cuts)	68	62	13	19	6	-	38	61
Augustin	V1 = Shortening of the growths to 20 cm (5 trees)	73	39	19	29	11	2	61	71
	V2 = Shortening of the growths to 40 cm	77	41	29	20	7	3	59	61
	V3 = Witness (no summer cuts)	75	49	33	12	6	-	51	58

Considering the studied cultivars, we notice that the ‘Orizont’ cultivar, a vigorous cultivar with numerous vegetative growths formed more anticipated shoots on the shoots shortened to 20 cm and 40 cm. the number of anticipated shoots varied from 1 to 4 and the data recorded in the field allowed for the calculation in percentages of the degree of occurrence. Also, the percentage of shortened shoots which did not form anticipated shoots ranged between 24% and 62%. The shortened shoots within the three variants (to 20 cm, to 40 cm and without cuts) which issued only one anticipated shoot registered values ranging between 12% and 33%, followed by the shoots which produced two anticipated shoots (values ranging between 12% and 29%).

The shortened shoots within the three variants (to 20 cm, to 40 cm and without cuts) which issued three anticipated shoots registered values ranging from 6% to 27%, followed by the shoots which produced 4 anticipated shoots (low values, ranging from 2% to 8%).

The data concerning the total number of anticipated shoots per 100 shortened shoots reveal the fact that the cuts applied during the period of intense growth (June 10th – 20th) recorded values ranging between 71 and 83 (for the shoots shortened to 20 cm) and between 61 and 72 (for the shoots shortened to 40 cm).

Taking into account the cultivar, the 'Orizont' cultivar generated the largest number of anticipated shoots when the shoots were shortened to 20 cm (83 anticipated shoots); there 72 anticipated shoots when the shoots were shortened to 40 cm and 61 anticipated shoots when there were no summer cuts performed. The average length of the shoots varied between 55 cm (the 'Elmar' cultivar – the witness variant) and 94 cm (the 'Orizont' cultivar – V1).

CONCLUSIONS

The studied apricot tree cultivars react well to summer cuts, the best moment for carrying out these cuts being the phenophase of intense growth of the shoots which generally occurs at the middle of the month of June.

The shortening of the growths to 20 cm at the 'Orizont' cultivar generated the forming of anticipated shoots (83%), which differentiated the fruiting buds. These cuts favour the appearance of anticipated shoots and May bouquets (the future fruit formations) from mature buds on the middle third of the shortened shoots (buds with a high potential of becoming fruit formations). The fruit is kept close to the base of the tree, avoiding the fruiting alternation.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESEARCH ON THE USE OF SOME APPLE GENITORS IN THE BREEDING PROCESS FOR GENETIC RESISTANCE TO DISEASE AND FRUIT QUALITY

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Abstract

Research conducted at the Research and Development Station for Fruit Growing Voineşti in the period 2012 - 2014, took into account the increase of genetic variability through the use of hybrid combinations that involved commercially valuable genotypes or selected elite in order to obtain desired characteristics: genetic resistance to disease, low vigor, constant production, firm pulp and good storage capacity. In apple breeding for genetic resistance at RDSG Voineşti were used as genitors, apple elites and recently created cultivars with genetic resistance to disease, which have embedded complex resistance genes: Iris, Inedit, Goldrush, Ariwa, Topaz, Golden Lasa or genotypes created in Voineşti: H1/22, H5/20, H2/75, H1/27, H1/7, H4/37 etc. Apple seedlings hybrids obtained in jiffy 7 in greenhouse were transplanted in the fortification field, after a previous mass selection, depending on objectives. After the selection of forms derived from hybrid seedlings planted in the fortification field, it resulted 40.3% to 96.2% seedlings resistant to scab, the following combinations: Inedit x Topaz (83.3%), Topaz x H1/27 (93.1%), Inedit x Ariwa (93.7%), Goldrush x H1/3 (96.2%) etc. Creating apple varieties with genetic resistance to disease is an ongoing process that must be done by annually hybrid combinations using high economic value genitors which enclose complex genetic resistance genes.

Key words*: genetic resistance to disease, genitors, apple hybrid seedlings.*

INTRODUCTION

Apple breeding is a long time process and has a special complexity regardless the research method used. In the programme dedicated for obtaining apple varieties with genetic resistance to disease, at RDSFG Voinesti annually were made various hybrid combinations using maternal and paternal material chose according to the purpose.

In order to create autochthonous apple cultivars, the basic work such as inter and intraspecific hybridizations remains together with the selection of the promising hybrids obtained from early juvenile stage or obtained in previous years (Cociu V. et all, 1999).

Increasing genetic variability is achieved in particular at hybrids combinations where genitors as apple elites or varieties with genetic resistance to disease recently created are used, hybrids which have embedded complex resistance genes (Petre V. and Petre Gh., 2014). In creating the apple varieties with genetic resistance at RDSFG Voinesti, it was used in crosses, resistant apple varieties, with high commercial value or apple elite with genetic resistance to disease, from the latest generation.

MATERIALS AND METHODS

Research conducted at Voineşti between 2012 - 2014 for obtaining apple varieties with genetic resistance to diseases were related to sexual hybridization or selection inside the promising hybrids of biological material obtained from juvenile phase. In hybridizations it was used paternal and maternal material such as new elite and varieties with genetic resistance to disease.

In the process of sexual hybridization, it were followed all steps specific for hybridization

process: choosing the parents, marking trees, flowers emasculation, harvesting and conditioning pollen, pollination, inventory pollinated flowers on combinations. From the hybrid fruits, the seeds were extracted and conditioned.
The specific duration of apple seeds post maturation is 90 days, so the layering of those was done in the last decade of January. The hybrid seeds were mixed with sterile sand well misted after fungicide disinfestations.
When the apple seeds begin to root in the stratification slot, these were sown in jiffy pots no 7 into the greenhouse. The apple hybrids at the 10-15 cm height and 8-10 leaves stage were moved out in the fortification field. All the hybrids with scab symptoms were eliminated before planting outside.
All the pollinated flowers were counted, fruits and obtained seeds the same. Meanwhile, in the fortification field it was evaluated the hybrids resistance to *Venturia inaequalis.*
Selected genotypes from the previous hybrid series which presented genetic resistance to diseases and fruits with high quality traits were grafted in the nursery. With these ones it was established in 2009 a trial micro-culture. It were made observations and determinations regarding the growth vigour of trees, ripening time of the fruits, productivity and the fruits quality in terms of size (weight) and soluble dry content (SDC).

RESULTS AND DISCUSSIONS

Aiming to a good performance in the fruit growing production, it has to promote cultivars with a genetic base that could assure an increase of yield potential and fruit quality, an improved resistance to diseases and pests in order to protect the environment and a good adaptation to economical and performing technology.
One important thing is to manage the cultural technology for keeping the production capacity and quality unaffected. In this way, the cultivars performance is emphasized.
Apple breeding is a long time process and has a special complexity regardless the research method used.

Apple genitors used for crossing
In the programme dedicated for obtaining apple varieties with genetic resistance to disease, at RDSFG Voinesti annually it were made various hybrid combinations using genitors chose according to several goals such as: scab resistance, low vigour, constant yielding, firm pulp of the fruits, a long shelf life.
Choosing the genitors is highly important for obtaining descents with economical and commercial value, good appearance of fruits and special tasting quality. When we use genitors with small fruits, the negative trait is dominant and is hard to attain a good size and tasting quality. Sometimes entire hybrid combinations could be removed due to the low biological value of the biological material. Therefore, a good decision is to use resistant cultivars with high economic value.
In order to gain faster disease resistance and in the same time productivity and quality traits, is necessary to cross maternal and also the paternal genitors that present resistance and proved excellence in the field.
For enlarging the apple variability at RDPS Voinesti it were used as genitors elites and new bred cultivars with genetic resistance: Iris, Inedit, Goldrush, Ariwa, Topaz, Florina, Golden Lasa or genotypes created in the Research Station: H 1/22, H 5/20, H 2/75, H 1/27, H 1/7, H 4/37, etc. All the genitors have the Vf gene.
Knowing the combinative value of the cultivars used in crossing process is a great concern of the breeder.
Breeding method
For creating autochthonous apple cultivars, the main method remains intra and interspecific hybridization followed by selection in the descendent biological material since the juvenile stage. After the genitors selection and setting the crossing combinations step, the hybridization start with emasculation of the maternal genitor, procedure which allow to not protecting the flowers by bags. This recommendation was made by Prof. J.R. Hough from the Rutgers University (USA) starting to 1970.
After crossing procedure, consequent operations are realised. First is related to obtaining hybrid fruits, extraction and post

maturation of the seeds. Next step is to saw the hybrid seeds in jiffy pots no 7. A special phase is about the artificial infection of the seedlings followed by selection of the resistant ones. The selected hybrid seedlings are plant in the fortification field. For quality test they are moved after in the selection field (test 1). Promoting the elites in the test 2 (DSO) and 3 (VAT) and registering to the ISTIS organization.

The results obtained in the period 2012-2014 are presented in the paper.

In 2012 were made 15 crossings, being emasculated and pollinated 2.531 flowers. It results 557 fruits set at 10.06.2012 representing 22% of the pollinated flowers (Table 1.).

The percentage of sett fruits at first inventory was between 0% at Florina x H1/22, Florina x Ariwa, Topaz x H 5/20, Topaz x H 2/75 and 69,5% at combination Goldrush x H 1/7. The low share of fruit set in 2012 was determinate by the climatic conditions in the blossoming time. Temperatures of 28 – 30^{0}C and a low humidity of the air (22 – 24%) conducted to the stigma dehydration.

At harvest time, 491 fruits were collected and 2.743 hybrid seed were extracted. From these, after stratification, only 1.449 post maturated seed were retained. In 2013, these hybrid seed were sown in jiffy pots (no 7) and have been obtained 1.066 hybrid seedlings. It was actually transplanted in the fortification field 73.5 % of the seeds.

Table 1. Apple hybrid seedlings obtained from crossings made at RDSFG Voinesti in 2012

No	Crossing	Pollinated flowers	Fruits		Hybrid Seeds	Sown seeds	Seedlings	
			No	%			No	%
1	Florina x H 1/22	222	0	0	0	0	0	0
2	Florina x Ariwa	195	0	0	0	0	0	0
3	Topaz x H 1/22	122	4	3,2	28	20	15	75,0
4	Topaz x H 5/20	224	0	0	0	0	0	0
5	Topaz x H 2/75	156	0	0	0	0	0	0
6	Topaz x H 1/27	128	7	5,4	38	43	29	67,4
7	Inedit x Topaz	161	2	1,2	12	9	6	66,6
8	Inedit x Ariwa	106	10	9,4	63	55	32	58,1
9	Goldrush x Golden Lasa	268	85	31,7	488	162	121	74,7
10	Goldrush x H 1/13	243	86	35,4	518	190	132	69,4
11	Goldrush x H 4/37	173	90	52,0	526	280	202	72,1
12	Goldrush x Inedit	256	78	30,4	413	275	208	75,6
13	Goldrush x Iris	102	23	22,5	98	90	60	66,6
14	Goldrush x H 5/20	93	49	52,6	261	160	128	80,0
15	Goldrush x H 1/7	82	57	69,5	298	165	133	80,6
	TOTAL	2531	491	19,4	2743	1449	1066	73,5

In 2013 were realised 22 hybrid combinations and a number of 4.008 flowers were emasculated and pollinated. Only 113 hybrid fruits were obtained (determination at 15.06.2013). This is only 3.5% of the total pollinated flowers (Table 2.).

The percentage was ranking from 0% at combinations Dalinbel x Inedit, Dalinbel x Generos, Dalinbel x H 3/123, Dalinet x H 4/131, Red Topaz x H 3/123, Rosana x Inedit, Opal x H 4/17 to 45% at Goldrush x H 4/40.

Similar to year 2012, the percentage of fruit set was extremely reduced by the climate conditions registered in the flowering period. Temperatures of 27 – 29^{0}C in the full blossom correlated to the low relative humidity of the air at noon (25 – 33%) produced a dehydration of the pollen and stigma.

Only 113 hybrid fruits were picked being extracted 496 seeeds. From the 453 post maturated and sown seeds resulted 351 seedlings (77.4%) which were planted in the fortification field.

Table 2. Apple hybrid seedlings obtained from crossings made at RDSFG Voinesti in 2013

No	Crossing	Pollinated flowers	Fruits		Hybrid Seeds	Sown seeds	Seedlings	
			No	%			No	%
1	Dalinbel x Inedit	120	0	0	0	0	0	0
2	Dalinbel x Generos	122	0	0	0	0	0	0
3	Dalinbel x H – 3/123	130	0	0	0	0	0	0
4	Dalinet x Inedit	106	2	1,8	7	6	4	66,6
5	Dalinet x Generos	341	10	2,9	61	58	45	77,5
6	Dalinet x H – 3/123	291	2	0,7	12	10	8	80,0
7	Dalinet x H - 4/131	185	0	0	0	0	0	0
8	Dalinred x H – 4/131	351	2	0,5	13	13	8	61,5
9	Dalinred x Inedit	210	0	0	0	0	0	0
10	Dalinred x H – 3/123	144	4	2,7	18	16	13	81,2
11	Dalinred x Generos	224	4	1,8	21	21	15	71,4
12	Goldrush x Crimson	120	23	19,2	98	94	68	72,3
13	Goldrush x H – 4/40	122	43	35,2	171	152	123	80,9
14	Luna x Inedit	175	9	5,1	19	4	9	81,8
15	Luna x H – 4/47	168	7	4,1	39	36	29	80,5
16	Red Topaz x H – 4/131	206	1	0,5	4	4	3	75,0
17	Red Topaz x H – 3/123	307	0	0	0	0	0	0,
18	Rosana x Inedit	157	0	0	0	0	0	0
19	Opal x H – 4/17	147	0	0	0	0	0	0
20	Opal x H – 4/47	124	1	0,8	6	6	6	100,0
21	Inedit x H – 1/132	83	2	2,4	8	7	6	85,7
22	Inedit x Generos	175	3	1,7	19	19	14	73,6
	T O T A L :	4.008	113	2,8	496	453	351	77,4

In 2014, as genitors were selected as follows: Inedit, Florina, Enterprise, H 1/46 and H 4/50, which present valuable traits especially a good storage capacity (Table 3).

Table 3. Hybrid combinations realised in 2014 at RDSFG Voinesti

No	Hybrid combination	Pollinated flowers	Hybrid fruits		Hybrid seeds	
			No	%	No	Average no/fruit
1	Florina x Inedit	126	114	90,4	463	4,06
2	Inedit x Enterprise	520	110	21,1	352	3,20
3	H 1/46 x H 4/50	370	36	9,7	105	2,92
	TOTAL	1016	260	25,6	920	3,54

From the three hybrid combinations 1016 flowers were pollinated and results 260 fruits picked up on 1.10.2014, representing 25.6% of total pollinated flowers.

The share of hybrid fruits different from 9.7% at combination H 1/46 x H 4/50 and 90.4% at Florina x Inedit cross.

From the 260 hybrid fruits were extracted 920 seeds with an average number of 3.54 seeds/fruit. It is notable the Florina x Inedit combination which record a percent of 90,4% harvested fruits. The average number of seeds/fruit is 4.06, bigger than previous combinations.

The evaluation of hybrids resistance to diseases in the fortification field

In the case of 2012 hybrids series, from 1.066 apple hybrids (Table 4) resulted by 11 hybrid combinations (genitors with Vf) it shows field scab resistance1.012 trees representing 95.8% from the total hybrids in the fortification field. The percent of scab resistant hybrids varied from 80% at Topaz x H 1/22 combination and 96.2% at Goldrush x H 1/13.

Table 4. Evaluation of the scab resistance hybrids in the field (series 2012)

No	Hybrid combination	Analysed hybrids	Scab resistant hybrids	
			Number	%
1	Topaz x H 1/22	15	12	80,0
2	Topaz x H 1/27	29	27	93,1
3	Inedit x Topaz	6	5	83,3
4	Inedit x Ariwa	32	30	93,7
5	Goldrush x Golden Lasa	121	114	94,2
6	Goldrush x H 1/13	132	127	96,2
7	Goldrush x H 4/37	202	191	94,5
8	Goldrush x Inedit	208	200	96,1
9	Goldrush x Iris	60	57	95,0
10	Goldrush x H 5/20	128	123	96,0
11	Goldrush x H 1/7	133	126	94,7
	TOTAL	1066	1012	95,8

The apple genotypes behaviour in the trial field

From the previous hybrids series, it were selected a couple of apple genotypes with genetic resistance to diseases, high quality and good appearance of fruits. These were grafted in the nursery on M9 rootstock and consist of a new micro culture trial in 2009. The traits monitored were: growth vigour, ripening time, productivity and fruit quality.

The trees vigour registered by the 20 apple genotypes/M9 from micro culture trial emphasized by the trunk diameter and growth increase shows that in the 6th leaf of the trees, the diameter of the trunk varied from 35.5 mm at H1/78 to 53.9 at H1/7 (Table 5). The annual growth increase was ranged between 4.1 mm (H 1/21, H 3/80) to 9.1mm (H 1/7).

Ripening time of the apple hybrids in the years 2012-2014 was from September 3rd to October 5th. Most of them are autumn-winter maturation. From the group of September maturation were remarked H 1/16, H 9/27, H 8/86, H 3/80. End of September – first decade of October group are represented by H 1/11, H 1/22, H 1/112, H 1/7, H 1/27, H 2/125, H 4/131, H 8/88, H 1/46.

The fruit production obtained in the 4th year varied from 0-3.5 kg/tree. With high yield are noted H-8/86, H-8/88, H-1/46, H-9/27, H-1/99, genotypes where was registered over 3.5 kg/tree. In the climatic conditions of the 2013 year, 18 from 20 studied genotypes was bearing fruits.

In the 5th leaf, production ranged from 0-5.5 kg/tree, high productivity shows H 1/16; H 8/86; H 1/78; H 8/88; H 1/63, where it was weighted more than 5 kg/tree.

Table 5. Growth vigour, ripening time, productivity and fruit quality of the apple genotypes in the micro culture trial (2012-2014)

No	Genotype	Trees vigour in the 6th year (2014)		Ripening date	Yield in the 6th leaf (kg/tree)	Average weight of the fruits (g) (2012 -2014)	Dry substance content (%) average of 2012 - 2014
		Ø trunk (mm)	Annual growth increase				
1	H 1/11	40,5	6,4	25-28.09	4,5	200	13,6
2	H 1/22	37,5	5,6	25-28.09	8,5	175	15,1
3	H 1/112	40,1	6,1	24-25.09	7,0	170	16,0
4	H 3/80	36,8	5,6	09-10.09	4,0	170	14,1
5	H 2/75	44,5	8,3	14-15.09	6,5	173	14,0
6	H 1/102	43,7	7,2	10-12.09	5,5	175	13,2
7	H 1/7	53,9	9,1	27-30.09	5,0	160	14,1
8	H 4/130	38,8	6,5	15-20.09	6,0	165	13,7
9	H 1/78	35,5	6,9	01-05.10	10,5	190	14,0
10	H 9/27	40,2	6,4	05-10.09	7,0	172	14,2
11	H 8/86	38,1	6,8	05-10.09	11,5	155	14,8

No	Genotype	Trees vigour in the 6th year (2014)		Ripening date	Yield in the 6th leaf (kg/tree)	Average weight of the fruits (g) (2012 -2014)	Dry substance content (%) average of 2012 - 2014
		Ø trunk (mm)	Annual growth increase				
12	H 1/16	38,6	6,3	03-05.09	9,5	160	13,0
13	H 1/27	36,6	5,7	20-25.09	8,0	160	14,4
14	H 1/99	43,1	6,3	10-15.09	12,0	150	14,0
15	H 2/125	46,3	8,2	20-25.09	8,0	180	15,1
16	H 1/63	38,5	5,7	10-11.09	9,0	200	14,4
17	H 4/131	45,9	8,3	20-27.09	5,0	197	14,8
18	H 8/88	44,5	8,4	01-05.10	8,0	155	14,0
19	H 1/46	35,7	5,6	25-29.09	7,5	182	15,5
20	H 1/21	40,2	6,0	15-20.09	11,0	145	14,6

The fruit production in the 6^{th} year at all 20 studied genotypes (in the climatic conditions of 2014) ranged from 4 kg/tree (H 3/80) to 12 kg/tree (H 1/99). Most productive genotypes were H 1/99, H 8/86, H 1/16, H 2/125, H 1/21, H 1/78, H 1/63, H 8/88, H 1/27, H 1/22 with more than 8 kg/tree (22 t/ha), in a orchard density of 2.857 trees/ha.
The fruits quality was assessed taking into account the average wight of the fruits and the dry substance content (2012 – 2014). Concerning the fruits size, the weight ranged by 145 g (H 1/21) to 200 g (H 1/ 11, H 1/63). Most of the apple genotypes exceeded 170g. The dry substance content has the limits between 13% (H 1/16) and 16% (H 1/112), 17 from 20 apple genotypes recorded more than 14% DSC, as average value (2012 – 2014).
The best genotypes remarked by productivity and fruits quality were submitted to ISTIS for testing and obtaining the patent protection (H 1/16 and H 1/78).

CONCLUSIONS

The breeding programme developed at RDSFG Voinesti use as genitors only cultivars or elites with genetic resistance to scab (*Venturia inaequalis*).
Crossings made in the last three years conducted to a different number of seedlings according to the climate conditions specific in each year of hybridization.
The evaluation of 20 genotypes from the micro culture trial shows a variable vigour of the trees (trunk diameter 35.5-53.9 mm and annual growth increase of 4.1-9 mm).
Most of apple hybrid genotypes are autumn-winter type and has the ripening period in September of first days in October.
The highest productivity obtained in the 4^{th} year was 4.8 kg/tree, in the 5^{th} year 5.5 kg/tree and in the 6^{th} year 12 kg/tree. The most productive apple genotypes were: H 1/99, H 8/86, H 1/16, H 2/125, H 1/21, H 1/78, H 1/63, H 8/88, H 1/27, H 1/22.
The fruits size is very good for most of the genotypes (over 170 g/fruit) and the dry substance content bigger than 14%.
The best genotypes H1/16 and H 1/78 were submitted for testing and patent obtaining at ISTIS.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

DETERMINATION OF SOME PHYSICAL AND CHEMICAL PROPERTIES OF WALNUT (*JUGLANS REGIA L.*) GENOTYPES GROWN IN THE CENTRAL DISTRICT OF BITLIS/TURKEY

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Abstract

This research was carried out to determine the superior walnut genotypes grown within seedling population between 2009-2012 years in the Central District of Bitlis. For this purpose, fruit samples were taken from 120 walnut genotypes. It was found that 17 walnut genotypes were determined as promising with regard to fruit characteristics. The quantity of fruit weight, kernel weight and kernel ratio were determined as 10.42-14.25 g, 4.52-7.44 g, 42.38-54.07 % respectively for the promising genotypes. The contents of protein (12.45 - 20.04 %), fat (58.44 - 67.14%) and ash (1.44 - 2.14 %) were determined as the quantity in the selected genotypes. The quantity of K, Ca, Mg, Cu and Zn contents in kernels of the selected genotypes were analyzed. The following results were found for K contents changing from 408.37 to 569.48 mg/100g, for Ca contents 194.79 to 267.85 mg/100g, for Mg contents 241 to 426 mg/100g, for Cu contents 0.72 to 1.43 mg/100g and while Zn contents were determined as 1.93-3.47 mg/100g in kernels. In conclusion, some of these selected genotypes can be recommended for the farmers in the region.

Key words: *walnut, genotypes, breeding, pomology, selection, Bitlis, Turkey.*

INTRODUCTION

Starting from the south of the Carpathian Mountains, Eastern Europe and Turkey, Iraq, Iran and the Himalayan Mountains to the east beyond the remaining countries well into the area of walnut having a very broad habitat. Although 18 species are known where on earth *Juglans regia* L. is cultivated in Turkey.
Walnut production in Turkey where inside of orchards and grown in garden borders scattered with walnut trees grown from seed are common practices (Şen, 1980). However, in the last few years there have been positive developments in the cultivation of walnuts. In recent years, walnut orchards established with the grafted nursery plants in the form of the closure is seen that production started to spread (Akça, 2001; Çiftçi, 2004).
It has been emphasized that primary importance of fruit quality criteria in selection breeding of walnut are fruit weight, fruit length, kernel weight, internal rate, shell thickness, shell and interior color, ash content, protein and fat ratio (Germain, 1997; Mitroviç et. al., 1988; Akça, 2005; Yarılgaç, 1997; Muradoğlu, 2005).
In this research, within very dense population of the walnut trees grown from seed in Bitlis district is intended to reveal the superior quality of genotypes. Therefore, it was aimed to determine some physical and chemical properties of walnut (*Juglans regia L.*) genotypes grown in the central district of Bitlis/Turkey.

MATERIALS AND METHODS

This work was carried out in the center of the province of Bitlis between the years 2009-2012. In this study, 120 walnut genotypes were determined and used as plant material on 3 consecutive years. The samples were taken from the fruit of these trees. Measurements and weighing were taken randomly 30-60 fruit from the trees.
Fruits physical measurements were made after drying in the shade. Features such as shelled fruit weight, kernel weight, kernel ratio, shell thickness, fruit length, fruit width, fruit height were determined (Şen, 1980). While weighing 0.001 g was performed with sensitive precision

scales, measuring was made with 0.01 mm precision digital caliper.

Walnut kernels were grinded and moisture determination were made before chemical analysis. Protein ratio with Khejdal method (Flagged, 1987) and fat content of kernels with Soxholet method (Akyuz and Kumar, 1992) was determined. In the determination of ash content, grinded kernels were analyzed after the furnacing at the 100, 200, 600 °C kept until the gray-white colors (Şen, 1980).

In walnut kernels, in order to determine content of potassium, iron, copper, calcium, sodium, manganese, magnesium and zinc, 0.5 g samples were taken and these samples were burned at 200 °C for 2 hours, 6 hours at 500 °C. For cooling the samples, 5 ml of 3 N HCL and 10 ml of pure water was added after 5 min. After the filtration with Whatman 42 filter paper the samples was completed to 50 ml with distilled water in the 50 ml round-bottomed flask. 0.5 g kernels filtrates obtained by dry combustion of the spectrophotometer phosphorus, potassium readings were performed and results were reported in ppm.

RESULTS AND DISCUSSIONS

In terms of fruit properties, evaluated as superior 17 genotypes were identified as promising compared to other genotypes. Some physical and chemical properties of the promising 17 genotypes were determined and are presented in Table 1, 2 and 3.

Table 1. Some physical properties of walnut genotypes

Genotypes	Fruit weight (g)	Kernel weight (g)	Kernel ratio (%)	Shell thickness (mm)	Fruit width (mm)	Fruit height (mm)	Fruit length (mm)
13 BİT 01	11.25	5.24	46.58	1.20	32.46	30.47	40.25
13 BİT 02	13.76	7.44	54.07	1.35	32.68	31.41	36.70
13 BİT 03	13.92	6.32	45.40	1.45	33.86	31.64	37.48
13 BİT 04	11.85	5.73	48.35	1.15	32.85	31.14	41.48
13 BİT 05	10.42	4.52	43.38	1.76	31.45	30.64	37.17
13 BİT 06	12.62	5.80	45.96	1.62	28.67	25.02	32.97
13 BİT 07	11.74	6.21	52.90	1.42	29.24	26.79	34.14
13 BİT 08	14.24	6.56	46.07	1.54	32.76	29.48	37.24
13 BİT 09	11.42	4.84	42.38	1.80	31.98	30.12	37.17
13 BİT 10	12.69	5.80	45.71	1.32	30.45	28.42	35.56
13 BİT 11	12.45	5.97	47.95	1.47	33.48	30.87	39.35
13 BİT 12	11.48	5.84	50.87	1.34	32.76	31.29	38.15
13 BİT 13	13.26	5.98	45.10	1.57	29.70	26.22	34.08
13 BİT 14	14.25	6.54	45.89	1.48	30.06	28.43	35.37
13 BİT 15	12.74	6.07	47.65	1.36	32.76	31.04	43.24
13 BİT 16	11.66	5.87	50.34	1.27	32.47	30.14	37.43
13 BİT 17	12.98	6.05	46.61	1.74	31.07	29.04	36.18

The lowest nut weight 10.42g (13 BIT 05) and the highest 14.25g (13 BIT 14) were identified in the selected genotypes. The lowest kernel weight 4.52g (13 BIT 05) and the highest kernel weight 7.44g (13 BIT 02) were determined, whereas the lowest % 42.38 (13 ICT 09) and the highest kernel ratio 54.07% (13 BIT 02) were identified. Muradoğlu and Balta (2010) carried out a survey in Ahlat region and reported 9.91-15.22g fruit weight, 5.00-6.24g kernel weight, 40.9-52.3 % kernel ratio for 15 genotypes as promising. In the same survey, the shell thicknesses were determined between 1:22 to 2:05 mm. In our study, as the thin shell thickness 1.20 mm (13 BIT 01) was determined as the highest shell thickness was for 13 ICT 09 genotype (1.80 mm). In the study carried out in the region of Kastamonu, a selection of promising genotypes was identified as 9:04-14.13g fruit weight, kernel weight 5.79-8.58g and the kernel rate of 53-65.38% (Abdis, 2010).

This study revealed that, the 13 bit 03 genotype had widest fruits (33.86 mm), the narrowest fruits (28.67 mm) were obtained from 13 bit 06 genotype. Fruit height changed between 25.2 mm (13 BIT 06) - 31.64 mm (13 BIT 03). Fruit length was found between 32.97 mm (13 BIT 06) - 41.48 mm (13 BIT

04). Şimşek (2010), found that selecting types of walnut fruit length 33.1-42.5 mm, fruit width 28.9-35.4 mm, 27.7-34.9 mm for the height of the fruit obtained in Diyarbakir region. The values found in similar studies conducted in our country (Oğuz and Aşkın, 2007; Şimşek and Osmanoğlu, 2010; Karadeniz, 2011; Çelik et. al., 2011) are in line with the values in our study

The protein, fat, moisture and ash contents of the promising walnut genotypes are given in Table 2.

Table 2. Some chemical properties of walnut genotypes

Genotypes	Protein (%)	Fat (%)	Humidity (%)	Ash (%)
13 BİT 01	12.48	64.84	2.82	1.75
13 BİT 02	13.65	62.14	3.24	2.01
13 BİT 03	14.98	65.47	3.84	1.65
13 BİT 04	18.35	66.79	2.14	1.44
13 BİT 05	20.04	67.41	2.48	1.87
13 BİT 06	17.54	62.78	2.44	1.82
13 BİT 07	16.76	63.96	3.07	1.61
13 BİT 08	12.45	58.44	3.98	1.44
13 BİT 09	14.29	67.14	2.85	1.52
13 BİT 10	13.25	64.72	2.19	1.79
13 BİT 11	17.98	66.78	2.99	1.82
13 BİT 12	16.84	65.80	2.44	1.76
13 BİT 13	12.47	59.42	2.75	1.63
13 BİT 14	15.14	65.48	3.14	1.25
13 BİT 15	15.48	67.11	3.04	2.14
13 BİT 16	18.93	67.09	2.46	1.95
13 BİT 17	19.47	64.48	2.17	1.47

These genotypes protein ratio were detected between 12.45% (13 Bit 08) and 20.4% (13 Bit 05). Most low-fat ratio were identified as 58.44% (13 BIT 08) and the highest fat content as 67.14% (13 BIT 09). It was found that moisture ratio was between 14.2 (13 bit 04)-3.98 (13 bit 08) % and the ash ratio 1.44 (13 BIT 04)-14.2% (13 bit 15) in the selected genotypes. Northeast Anatolia and Eastern Black Sea region selection made in the study of fat and protein content of 70-80% were reported to vary between 20-52% (Sen, 1980). In a research conducted in Hakkari district and Ahlat region, protein ratio was found between 13.9-23.3%, whereas oil 51.3-59.9%, ash 1.01-2.51 and humidity 1.0-4.2%.

In other study conducted in Ermenek region, the protein contents were determined as 12.11-20.75%, oil ratio 54.08-67.63%, moisture ratio 2.70-3.79%, ash 1.00-2.22% (Oğuz, 1998). In another study conducted in the region of Gevaş, fat, protein and ash were determined as 54.89-68.20%, 12.11 to 23.43% and 1.62-3.21% respectively (Yarılgaç, 1997). With the findings obtained in other studies are consistent with the findings in this study.

Some mineral contents in walnut kernels are given in Table 3.

Table 3. Kernels mineral elements content of walnut genotypes

Genotypes	K (mg)	Ca (mg)	Mg (mg)	Fe (mg)	Mn (mg)	Cu (mg)	Zn (mg)
13 BİT 01	428.98	254.21	328	2.45	2.78	1.12	2.14
13 BİT 02	552.16	241.48	345	3.26	2.84	0.84	3.14
13 BİT 03	435.48	194.79	367	2.47	3.48	0.99	2.98
13 BİT 04	478.87	267.85	287	3.36	2.12	0.65	2.26
13 BİT 05	524.76	246.24	248	2.35	3.56	1.16	3.02
13 BİT 06	489.32	213.68	259	1.78	3.24	0.72	2.48
13 BİT 07	492.47	224.78	332	2.84	2.84	0.90	2.90
13 BİT 08	472.42	216.98	314	2.44	2.63	0.78	2.00
13 BİT 09	408.37	284.40	278	2.58	2.55	1.43	2.04
13 BİT 10	569.48	224.75	256	3.98	1.24	1.26	2.14
13 BİT 11	524.82	253.13	241	1.15	1.04	0.84	2.12
13 BİT 12	423.96	264.77	426	1.08	3.62	0.76	2.07
13 BİT 13	487.42	279.82	241	2.57	1.42	1.20	1.93
13 BİT 14	499.04	212.34	349	2.63	1.03	1.05	1.98
13 BİT 15	514.74	234.42	264	2.98	1.09	0.78	2.68
13 BİT 16	529.45	248.75	289	1.02	2.00	0.87	3.47
13 BİT 17	489.34	203.20	277	3.36	1.09	0.84	2.88

The examined genotypes potassium ratio was found between 408.37 mg (13 BIT 09) and 569.48 mg (13 BIT 10) according to analyzes results of the 100 g samples. The amount of calcium was changed between 194.79 mg (13 BIT 03) and 267.85 mg (13-bit 04). In the promising genotypes were determined as the content of magnesium 241 mg (13 bits 13) and 426 mg (13 bit 12). The amount of iron in the selected genotypes were determined as 1.02 mg (13 BIT 14) and 3.98 mg (13 bit 10) and manganese content 2.55 mg (13 BIT 09) and 3,24 mg (13 bit 06). The amount of copper was between 0.72 -1.43 mg (13 BIT 06) and the zinc content was determined as 1.93 (13 BIT 13) and 3.47 mg (13 ICT 16). High amounts of potassium (390-700 mg/100g), phosphorus (310 to 510 mg/100g) and magnesia (90 -140 mg/100g) and lower amounts sodium content (1-15 mg/100g) were reported in walnut kernels (Ravai, 1992; Payne, 1985; Feinberg et. al., 1987; Klepping et. al., 1989; Souci et. al., 1994).

Muradoğlu et. al., (2011) in Bingol region reported in a study that the amounts of calcium changed between 60.34 and 278.76 mg and average amount of calcium was determined as 148.76 mg in 100 g kernels. The average amount of Mg in the promising genotypes were reported to be 166.75 mg. The same researchers reported as average content of iron, manganese, copper and zinc 3.41, 1.93, 1.27 and 2.01 mg/100g respecttively in the kernels of selected genotypes. (Muradoğlu et al., 2011).

In the other study conducted at Bahçesaray districts and Van region the values of Mg (1020 -1680 mg/kg), Ca (640 -1180 mg / kg), Mn (18.80 -50.60 mg / kg), Zn (19.6 -43.60 mg/kg), Fe (28.0 -139.8 mg/kg) and Cu (10 - 27.20 mg/kg) were determined for the macro and micro nutrients in selected walnut genotypes (Koyuncu et. al., 2002). The results obtained in this study were consistent with the values reported by other researchers.

CONCLUSIONS

In this study, the promising walnuts grown from seed at the center of Bitlis some physical and chemical properties were investigated. The results showed that our selected qualified walnut genotypes compete with the selected genotypes in other studies. In addition, our selected genotypes under better care conditions are thought to give better results. With the future adaptation studies in the same environmental conditions, our selected genotypes, domestic varieties and some walnut cultivars, yield, fruit quality and flowering properties should be investigated in terms of determination of true capacity. After this stage, statistical analyses are needed to identify those genotype/genotypes with the best qualities which can be recommended for the farmers in the region

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESEARCH ON OBTAINING SEA BUCKTHORN ORGANIC BERRIES IN REPUBLIC OF MOLDOVA

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Abstract

According to the results obtained from the study of sea buckthorn varieties, during the years 2010, 2013, 2014, the accumulation of dry substances in the variety 'Trofimovskaia' achieved the highest average values -9.35%, while the lowest were achieved in the variety 'Otradnaia' -8.4%. The accumulated amount of sugars reached average values in the variety 'Nivelina' -7.77% and lowest ones in the variety 'Otradnaia' -2.58%. The average values of the fruits acidity were reached by the variety 'Botaniceskaia' -3.88% , while the variety 'Otradnaia' reached 1.86%. The average accumulation of vitamin C in fruit is found in the variety 'Otradnaia'-117.96 mg% and in the variety 'Botaniceskaia' -79.97 mg%. The average value of sugar/acidity coefficient is expressed to the variety 'Otradnaia' through -4.51 and to the variety 'Botaniceskaia' -0.55.

Key words: *varieties, sea buckthorn, phenological phases, harvest, nutrient substances, Republic of Moldova.*

INTRODUCTION

Sea buckthorn is a shrub introduced into culture in our country, valuable in its many uses: like food, forestry, animal husbandry, pharmacology, as anti erosion and ornamental plant. It's fruits contain numerous bioactive substances, valuable, with an important role in the treatment of numerous diseases (high tension, avitaminoses, radiation disease etc.) (Gradinaru, Istrate, 2009).

The sea buckthorn fruits contain two times more vitamin C than the rose hip and ten times more than the citrus fruits. Other vitamins present in the fruit composition are A, B1, B2, B6, B9, E, K, P, F and we can find cellulose, beta-carotene (in a significantly much higher percentage than in carrot pulp), microelements as phosphor, calcium, potassium, magnesium, iron and sodium, complex oils. Sea buckthorn is a unisexual dioeciously shrub, 1.5-3.5 m high, forming a dense bush with many branches equipped with many strong thorns or without, adaptable to different climatic conditions and to any type of soil. The sea buckthorn yields starting its 3rd year after planting and it can produce 10-15 t/ha, with a lifespan of 18-20 years (Gatin, 1963).

This shrub has a great ecological plasticity, growing in dry plateau areas, as well as in foothill and mountain areas. Regarding the temperature it is less demanding, with a tolerance to low temperatures up to – -35 ºC, -40 ºC. It manifests also a strong resistance to sun strokes on the ground over +45 ºC. Sea buckthorn demands lots of light and produces very large fruit in areas exposed to direct sunlight. In shading conditions the young plants perish and lose their leaves.

Regarding the humidity sea buckthorn adapts easily, resisting from the worst drought in temperate area until the temporary water redundancy.

The sea buckthorn is totally indifferent to the nature of the soil. It grows on dry land lacking humus layer, on sandy soils or gravel, clay, salty, which other fruit species fail (Chira, 2000).

MATERIALS AND METHODS

Sea buckthorns experimental sector was established in 1999 on the experimental territory of the Technological - Experimental Station "Codru" on an area of 0.20 ha with a planting scheme of 3.0 x 2.0 m, on medium loamy chernozem soil type, in irrigated. As study object served the following varieties: Nivelina, Botaniceskaia, Padaroc sadu, Trofimovskaia and Otradnaia. Researches regarding the studies of the sea buckthorn varieties were performed according to accepted methods for small fruits.

RESULTS AND DISCUSSIONS

Sea buckthorn is distinguished by growth form, fruits size, color, nutrients and yield. Fruit, in great number, are false drupe, small (0.26-0.50g), ovoid to globular shape and even flattened. Their predominant color is orange, passing in yellow and more rarely red fruits. Research has revealed that sea buckthorn berries contain a number of valuable biologically active substances with important role in regulating human metabolism. The fruit processing producing highly valued: juice, syrup, nectar, jam, jelly, liquor etc.

Table 1. Phenological phases and biometric measurements to varieties of sea buckthorn, year 2014

Name of the Variety	Duration of flowering and % flowers	Leaf length, cm	Sprouts length, cm	Thorn presence	Crown shape	Harvest t/ha
Padaroc sadu 2013 2014	80% 70%	7-8	10-13	few	Middle Compact	14.5
Nivelina 2013 2014	80% 70%	5.6	10-15	few	Middle Compact Umbrella	16.0
Otradnaia 2013 2014	60% -	6-5	10-14	many	Pyramid Branched	15.0
Trofimovskaia 2013 2014	50% 30%	6-7	11-20	few	Compact Umbrella	9.0- 13.0
Botaniceskaia 2013 2014	50% -	5-6,5	11-14	few	Pyramid	20.0

Sea buckthorn every year confirms high productivity through good growth of shoots which are formed for next year's harvest. Each year, the floral buds differentiation, favoring increase the proportion of the large fruits formation depending on natural climatic requirements and the characteristics special for variety. Submission of the sea buckthorn fruit bud occurs in the period between 15.X-30.XII. Many annual cycle of growth and fruiting in ecological conditions of the sea buckthorn is influenced by the variety. Research conducted to study this fruits varieties allowed us to obtain results on the influence of environmental factors. The varieties Podaroc sadu, Nivelina and Trofimovschaia are more resistant to low temperatures during winters than the varieties Botaniceschia and Otradnaia.

Figure 1. Variety Botanicescaia

Figure 2. Variety Nivelina

Figure 3. Female plants with small buds

Figure 4. Male plants with large buds

On which negatively influenced temperatures -20 °C, -18 °C in January and February of 2014. Conducted research to study the varieties of sea buckthorn allowed to obtain results on the accumulation of nutrients in fruits as solids, sugars, vitamin C, tannins and dyestuffs, acidity, and the results are shown in Table 2. During the researches in various climatic conditions, with continued plant growth, fruit quality was influenced by variety.

Table 2. Biochemical analysis of some buckthorn varieties fruits

Varieties	Dry substances, %	Sugar, %	Acidity, %	Tanning, color substances,mg%	Vitamine C, mg %	Coefficient sugar/acid
Nivelina 2010	8.13	7.16	4.52	37.41	81.90	1,58
2013	8.27	2.99	3.06	83.14	99.40	0,97
2014	8.8	6.58	2.59	54.04	99.88	2,54
mean	**8.4**	**5.58**	**3.39**	**58.20**	**93.73**	**1,70**
Botaniceskaia 2010	7.87	4.60	3.92	37.40	69.52	1,17
2013	10.07	2.14	3.84	74.83	90.42	0,55
2014	-	-	-	-	-	-
mean	**8.97**	**3.37**	**3.88**	**56.11**	**79.97**	**0,86**
Podaroc sadu 2010	8.06	2.50	4.46	54.04	85.80	1,80
2013	9.00	3.18	2.46	83.14	110.00	3,65
2014	9.67	5.46	3.50	41.57	89.96	1.56
mean	**8.91**	**3.71**	**3.47**	**59.58**	**95.25**	**2,34**
Trofimovskaia 2010	8.06	3.48	2.97	29.10	124.96	2,71
2013	9.80	3.31	2.58	83.14	114.40	3,79
2014	10.20	6,30	3.20	54.04	80.16	1,96
mean	**9.35**	**4.36**	**2.92**	**56.12**	**106.51**	**2,82**
Otradnaia 2010	-	-	-	-	-	-
2013	8.4	2.58	1.86	62.36	117.96	4,51
2014	-	-	-	-	-	-
mean	**8.4**	**2.58**	**1.86**	**62.36**	**117.96**	**4,51**
Limite of variation	**8.4-9.35**	**2.58-5.58**	**1.86-3.88**	**55.2-62.36**	**79.97-117.96**	**0,86-4, 51**

In 2013 for all studied varieties were obtained higher values of dry substances accumulated, which ranged from 8.27 to 10.07%. The amount of sugars that has accumulated in smaller quantities was in the variety Botanicescaya in 2013, and the highest accumulated in the variety Nivelina in 2010.

Gained acidity in this fruit ranged between 1.86% in variety Otradnaia in 2013 and 4.52% in variety Nivelina in 2010, and according to the literature, the given values ranges between 2.0 - 3.5 % (Bukştinov, Trofimov et all., 1978). Tanning and dyestuff substances accumulation ranged from 29.10 mg% in variety Trofimovskaia in 2010 and 83.14 mg% in 2013, compared to other geographical regions where ranged differently between 48-55 mg% (Bukştinov, Trofimov, et all., 1978).

The amount of vitamin C gained in studied berry varieties in 2010 ranged between 69.52 mg% in variety Botaniceskaia and 124.96% mg in variety Trofimovskaia in 2010. Sea buckthorn fruit varieties grown in the European part of Russia, the quantity of vitamin C accumulated ranged between 30-70% (Bukştinov, Trofimov et all., 1978). Coefficient sugar / acid, in 2013 compared to previous years research has achieved higher values in Trofimovscaia and Otradnaia varieties corresponding to 3.79 and 4.51, which certifies the highest quality fruit taste.

CONCLUSIONS

According to the results obtained in the varieties study of sea buckthorn during the years of research it was found that: accumulation of dry substances reached higher average values in the variety Trofimovskaia - 9.35% and lower average values in the variety Otradnaia – 8.4%.

Sugars accumulated amount has reached the maximum average values in Nivelina variety - 7.77% and minimum averege values in the variety Otradnaia - 2.58%. Medium to high fruit acidity values were set in Botaniceskaia variety at 3.88% and lower values in the variety Otradnaia - 1.86%.

Accumulation of average amount of vitamin C in fruit stands in the variety Otradnaia - 117.96 mg% and -79.97 mg% in variety Botaniceskaia.

Averege value of the coefficient sugar / acidity is expressed by 4.51 in variety Otradnaia and in the variety Botaniceskaia - 0.55.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

ACHIEVEMENTS AND PROSPECTS IN THE DEVELOPMENT OF BERRY CULTURES IN REPUBLIC OF MOLDOVA

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Abstract

This paper presents a detailed analysis of the berry crop growth in the Republic of Moldova in the period 2010-2013, the benefits of berry production, cultivated areas, fruit production, cultivated assortment, achievements and perspectives.

Key words: *berry crops, fruit production, achievements and prospects, Republic of Moldova.*

INTRODUCTION

Berry culture unlike other fruit cultures is distinguished by an early bearing; it achieves high and stable yields. Berry fruits are valued due to their phytotherapeutic and curative qualities, they have a wide use while fresh, processed and frozen (Chira L., 2000).

Secular traditions and favorable natural conditions allow cultivation of strawberries and fruit shrubs, the production of berries and products derived from them with special qualities, obtaining higher yields, although investment is considerable, revenues are substantial and are of major economic importance in the development of agriculture in the Republic of Moldova (Sava, 2000; 2003).

Maintenance of small fruit plantations and is simple and most of the work can be mechanized (planting, soil care, harvesting, fight against weeds, pests and diseases), these species are highly valued as a melliferous crop.

Basic characteristic features of a new type of berry plantations are: implementing the required performance varieties on the market, the use of high biological quality planting material, increased plant density to the unit area, early bearing, increased productivity and high quality fruit competitiveness on the internal and external market (Mladin, 2011).

Although in recent years, scientists have created highly productive varieties with big and qualitative fruits, we must not forget that they are created for a specific climate and soil, and no one can guarantee that they will manifest the same qualities to the conditions of our country. For this reason it is necessary to conduct research on small areas in order to establish their degree of adaptability to new conditions for cultivation.

MATERIALS AND METHODS

A study on the current state of berry cultures development in Moldova was conducted during the years 2010-2013 and it was based on scientific, practical and specialized literature data within the IP IŞPHTA - strawberry trees and shrubs laboratory, in collaboration with the Ministry of Agriculture and Food Industry, the direction of Services Horticultural Products, the Association of Berry Producers « Bacifera ». and relying on statistical data of the National Bureau of Statistics of the Republic of Moldova.

RESULTS AND DISCUSSIONS

Establishment of new strawberry and berry plantations, implementation of technologies and new varieties, installation of water tanks and irrigation systems, maintenance purchases, construction of refrigerators, storage rooms and packaging involves large investments which can be obtained through advantageous loans and require a concrete plan and reliable recovery of these costs.

Many public associations get involved to support agricultural producers, for example: "FNAM, AGRO, FNFM, UniAgroProtect (UAPA), ACSA, the Association of Producers and Exporters of fruits - Moldova Fruct, Grape Producers and Exporters Association of Moldova, the Association of Berry Producers « Bacifera »", etc.

The National Rural Development Agency is organizing trainings, theoretical and practical seminars for berry producers involving laboratory and strawberry fruit tree specialists and awards grants in projects including the establishment of berry plantations.

In February 2010, the Association of Berry Producers « Bacifera » (AO APP Bacifera) is created in order to promote the interests of producers of berries, to provide consultative support in economical activities, to represent its members in the network of public organizations, State bodies, public administration organizations, in order to promote the policy of berries production, to participate in the creation and promotion of laws, to create economic development programs, to solve problems related to the production, including the purchase of planting material, marketing, organize and attend seminars, exhibitions, fairs etc., « Bacifera » is successfully operating today.

In this chain that supports the berry producers the most important link is the Public Institution "Practical Scientific Institute of Horticulture and Food Technology" (IP ISPHTA) with its specialists, who create, update and implement cultivation technologies for berry cultures, introduce, study and recommend productive and qualitative varieties, support the producers in this field, provides advise both in the premises of the institute, as well as on the field, organizes theoretical and practical seminars, publishes articles, prepare technological recommendations to studied cultures, specialized literature, and, publishes them within financial possibilities etc.

Certainly an important role is played by the State Agrarian University of Moldova that trains specialists for agriculture and research institutions in the field.

To facilitate the initiation of strawberry and berry plantations State aid comes to the reimbursement of a part of the costs invested by the berry producers. Ministry of Agriculture through the AIPA (Payments and Intervention Agency for Agriculture) provides grants to berry producers since 2010. Subsidizing of berry producers is very welcomed, namely attributable to these measures taken by the State to actively reinvigorate and develop this sector, although the mechanism of grants still needs some improvement and simplification.

Only by working intensively together we can create better conditions for agricultural development, especially for the cultivation of strawberry segment and fruit shrubs, which are high-value crops, with high productivity and profitability and which are able to favor the increase of capital in our country.

The interest of producers is manifested through the establishment of new plantations, and the statistical data are presented in Table 1.

Table 1. The current state of berry cultures in Moldova

Specification	Unit of measure	Years					
		2010	2011	2012	2012 in % as against 2011	2013	2013 in % as against 2012
Total area, of which:	thousand ha	0.96	0.93	0.76	82	0.78	103
Fruit plantations growth	thousand ha	0.87	0.84	0.67	80	0.68	101
Global harvest	thousand tons	1.80	1.48	0.96	65	1.09	114
Average yield	tons/ha	20.20	17.20	14.00	81	1.57	112
Export and Re-export	tons	8.47	5.81	7.73	133	5.42	70
Export/re-export Value	mil USD	14.18	10.02	11.48	115	7.50	65
Import	tons	10.56	8.17	10.11	124	8.29	82
Import value	mil USD	14.98	12.07	11.89	99	9.77	82
The planting	ha	5.00	48.00	101.0	210	152.60	242
Deforestation	ha	3.00	0	600.0	0	50.00	556

According to statistics presented in Table 1 it is noticeable that since 2010 the surface of newly created berry culture plantings increased from 5 ha to 48 ha in 2011 and reaches 101 ha in 2012.

In Figures 1; 2 and 3 are presented the data relating to area, global harvest and productivity of the most widespread berry crops cultivated in the country.

The largest areas are planted with raspberries, they occupy 0.28 thousand ha, other areas: strawberry – 0. 27 thousand ha, blueberry – 0.19 thousand ha, and gooseberries which began to attract the attention of producers and it has reached 0.04 thousand /ha. The largest global harvest is obtained from strawberry– 0,6 thousand tons with the average yield of 2.23 t/ha, followed by raspberry with a production of 0.420 tones and average yield of 1.72 t/ha, blueberry with 0.070 thousand tons and average yield of 0.45 t/ha and gooseberry with a production of 0.003 thousand tons and average yield of 0.07 t/ha.

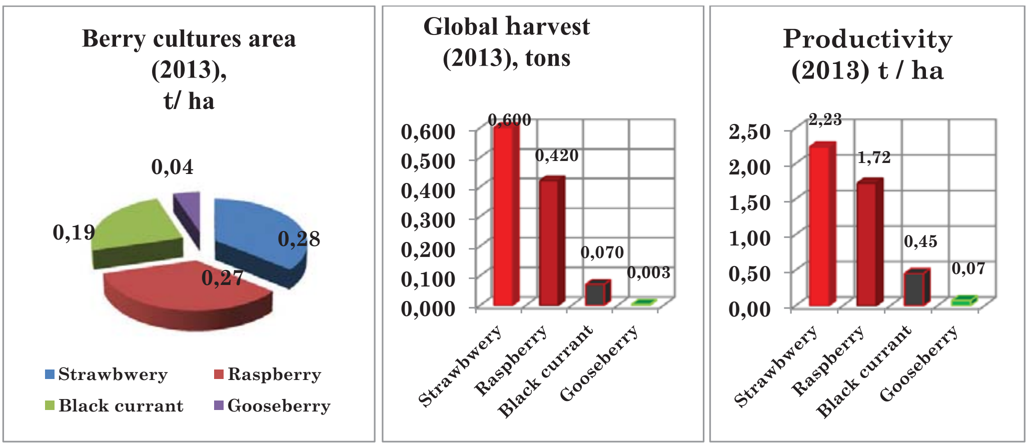

Figure 1. Statistic data of area cultures, global harvest and productivity of berries in Moldova

Due to lack of funding we do not have local varieties of strawberry and berry plantations created for pedoclimatic conditions of our country. Specialists of ISPHTA IP Institute, study, select and propose the most productive and qualitative from the introduced varieties to be tested at the State Commission for Variety Testing, with their further proposal for record them in the catalog of Plant Varieties of Moldova, that can be cultivated under the conditions of our country. The species of berry varieties registered in the catalog of Plant Varieties of Moldova and approved for cultivation in the agri-food sector are: raspberry (Rubus idaeus L.) - Barnaulskaia, Skromnitsa; black currant (Ribes nigrum L.) -Belarusskaia sladcaia, Minai Smiriov, Titania; red currant (Ribes rubrum L.) - Red Netherlands; gooseberries (Ribes L. grossularia) - Donetskii crupnoplodnai, Donetskii pervenets; strawberry (Fragaria ananassa Duch.) - Gorella, Red Gauntlet, Senga Sengana; blackberry (Rubus fruticosus L.) - Thornfree Cl.

Varieties temporarily admitted for testing under production conditions: strawberry - Betty, Cireine, Charlotte, Elsanta, Honeoye, Marmolada, Polka, Selva; Black rowan (Aronia melanocarpa L.) - Aronia divi.

The varieties cultivated on small areas in the Republic of Moldova to obtain strawberries fruits are Koroleva Elizaveta II, Elsinore, Elsanta, Honeoye, Marmolada, Polka, Victoria, Gigantella Symphony, Tristar, Elvira, Charlotte etc.;

Raspberry: Polana, Crepis, Automne Bliss, Pathfinder, The Latham, Delbard Magnificent, Gheracle, Pathfinder, Automne Bliss, Cuzimina Novosti, Liulin, Scromnița;

Black currant: Titania, Kentavr, Ben Alder, Dubrovskaia, Golubca, Zagadca, Ciornoglazaia, Minai Smiriov, Belorusskaia sladcaia.

Gooseberries: Coloboc, Smena, Donetskii krupnoplodnai, Donetskii pervenets, Rozovai, Ruskii, Captivator.

Some of the big farms with strawberry and berry plantations have rented the land as for small and medium-sized farms, they are privately owned. Plantations producing small berries structures are comprised mostly of two to three berry cultures of most widespread species like strawberry, raspberry, blueberry, gooseberry, blackberry while in the big farms monoculture prevails or other shrub species are cultivated on the small surfaces.

The size of areas cultivated with strawberry by the producers varies between 0.01ha - 8.0 ha, gooseberry between 0.01ha - 53.0 ha, raspberry between 0.01ha - 20.0 ha, gooseberries between 0.01ha - 10 ha, ha blackberry 0.4 - 7.0 ha. Optimal surfaces of strawberry and berry plantations set up to achieve cost-effective production are 1-5 ha, where can be applied to maximum mechanization of maintenance, which reduces the cost of obtained production, for small farms - 0.5 ha.

Strawberry and berry plantations are carried out mainly intensively for a more efficient use of land. The life of strawberry plantations is 4 years including 3 years of fructification, raspberry plantations 10-12 years, 12-15 years blackberry, currant and gooseberries up to 15 years, and its duration depends on several factors, particularly on the way of taking care of the plantations. The planting distances that is used to establish plantations of strawberries (0.7-0.9 x 0.25 m), raspberry (1.6 to 3.0 x 0.5 m), gooseberry (1.6 to 3.0 x 0.5-1.0) and blackberry (3.5-4.0 x 1.5-2.0 m). The life of strawberry plantations is 4 years including 3 years of fructification, raspberry plantations 10-12 years, 12-15 years blackberry, currant and gooseberries up to 15 years, and its duration depends on several factors, particularly on the way of taking care of the plantations. The planting distance that is average age of existing strawberry plantations is 2-3 years, 3-7 years of raspberry plantations, blueberry 3-10-15 years, of gooseberries - 3-7 years, 3-4 years blackberry. Aging berry plantations, exhausted, each parcel are gradually replaced with new ones that have a high productive potential and fruit quality.

Atmospheric precipitations in Republic of Moldova fall in the amount of 300-600 mm, which are unevenly distributed during the year and more often dry periods prevail. Available water reserves are limited; therefore irrigation is a very important factor in cultivating of berries. In the climatic conditions of our country, without irrigation, strawberry is not likely to be cultivated. Strawberry is grown in open field and in protected field - greenhouses, tunnels, in which they apply extensively polyethylene film mulching, agrilia, straw and sawdust. Blueberry, raspberry and blackberry species are more resistant to drought than strawberries, but harvest and quality suffer more in case of severe water insufficiency, the irrigation is therefore a welcome thing.

The most drought-resistant crops among berries are gooseberries whose roots penetrate deep into the soil up to 2.0-2.5 m. Therefore when planting, gooseberries can be placed even on top of the slope, where a dry place, but can also be used as contraerozionala culture. For maintaining soil fertility (based on analyses) organic or mineral fertilizers (macro or trace elements) are applied in soil, irrigation water or foliage.

Labor force is an important factor in maintaining and developing berries producing farms. It is available in regions with more developed enterprises, where the arms are engaged on permanent and well-paid, and it is available in regions with more developed enterprises, where the workforce are employed on permanent and well-paid job. Certain persons employed permanently, being well trained, become qualified and for works that do not require qualification temporary workers are being hired. To solve the problem of insufficiency of the labor force it is required a mechanization of all possible processes of the maintenance of the culture; including harvesting. Large berries producing farms employ permanent workers in about 15-50 persons, seasonal and 35-120 persons. Small farms employ permanent workers about 3-8 people, and seasonal 5-30 people, or hire no one, only family members are working.

The productivity of strawberry and shrubs plantations depends on the compliance of all the technological elements, plantation age etc. Harvest per hectare on strawberries plantation varies between 5-15-20 t/ha in dependence of technology used, cultivated variety and quality of planting material. The selling price of the fruit is 25-35 lei/kg. The obtained harvest from blueberry plantation varies between 6-8 t/ha, from raspberry 8-10 t/ha, from blackberry 10-12 t/ha, from gooseberries 15 to 20 t/ha. The selling price of a kilogram of fruit is in average 15-25 lei/kg.

The local market of berries is not yet saturated. Berry production intended for export is an insignificant quantity; the import of fresh berry production takes place in the period when we do not have fresh fruit, in the months from November to April. Medium and large enterprises sell fruit production to legal entities at shops, schools, kindergartens, restaurants, bakeries, factories for processing or freezing and operate with payment by transfer, but small producers-individuals, with payment in cash.

Getting very high strawberry harvest of aproximatively 50 t/ha, blueberry, raspberry, gooseberry, blackberry 15-30 t/ha involves implementation of new super intensive technologies, fertilizer application in large quantities, performant varieties, but not always guarantees high harvests and high quality and organic fruits.

Harvesting requires cold room for temporary storage of berries directly on the field or nearby. For strawberry, raspberry and blackberry fruit storage facilities are not necessary for a long time, because production is easily perishable and is intended to be sold as soon as possible.

Blueberry and gooseberries harvested production can be sold directly from the field or it can be harvested in stages, selectively as the fruit reaches maturation period or may be kept in storage rooms only for 1-2 days, while in refrigerated rooms with controlled atmosphere the storage period can go up to 14-15 days for blackcurrants, gooseberries up to 20 days, and for some varieties this period may be extended up to 50 days. As for the white and red currants their preservation period can reach up to 40-45 days. Mechanically harvested berries, packed in polyethylene bags can be stored in the refrigerator for 50-60 days. To extend their period of use, berries can be frozen and can be used at the right time for another 6-8 months (Sava et all. 2012, Crivorot, 2004).

Currently there is a need for temporary storage refrigerator or for refrigerating berries, for the construction of which considerable investments are needed; in their absence we seek access to existing ones. Establishing partnership links, conclusion of mutually beneficial contracts between canning factories for processing fruits would promote the development berry production. Using a qualitative packaging in harvesting berry increases the trading success. Most commonly are being used containers, sometimes baskets made out from paper, plastic or wood with a capacity of 0.25; 0.5; 1.0 kg, which are placed in cardboard boxes.
The fruits for processing are harvested directly into wooden boxes or cardboard with 3-4 kg capacity. Harvesting period for strawberries, raspberry and blackberry is long (30-60 days). Harvesting is carried out as the fruit matures after 1-2 days. Sorting the strawberries, raspberries and blackberries is made directly during harvest because they are very sensitive and does not support being molded from one container to another.
Most of the strawberry production is used fresh. Part of it is processed for juice and used in the food industry. Raspberry and blackberry production is mostly intended for processing or freezing and is used partly for dessert. Black currant production goes to processing, gooseberry, red and white currant are mostly for dessert, although they are also good for processing and freezing. For the berry production destined for sale it is necessary to receive a certificate of quality, "hygiene certificate", attesting to the high quality of the fruit, which is confirmed by the results of laboratory analysis for toxic residues

CONCLUSIONS

The berry production sector is one of perspective that can cope with internal and external market and it is a strong point in agricultural development in Moldova.
The areas occupied by the berry cultures in Moldova are: raspberry – 0.28 thousand ha, on strawberries – 0.27 thousand ha, black currant – 0.19 thousand ha, gooseberries – 0.04 thousand ha. Global harvest obtained from strawberry is 0.6 thousand tons and average harvest - 2.23 t/ha, at raspberry corresponding – 0.42 thousand tons, 1.72 t/ha, at black currant – 0.07 thousand tons and 0.45 t/ha, to gooseberries – 0.003 thousand tons and 0.07 t/ha.
Attracting specialists in the field of berry cultures with the aim to establish modern plantations can be achieved with the use of quality planting material produced by a certified company and complying with all the technological elements of maintenance.
Cooperation of State institutions, associations in the field and producers, will create conditions for agricultural development and especially of the generation of berry cultures that have a high productivity and profitability.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

ESTIMATING ROOT ACTIVITY OF A DRIP-IRRIGATED PEACH ORCHARD UNDER THE SOIL AND CLIMATE CONDITIONS OF A SEMI-ARID REGION

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Abstract

Irrigation is a very important link in fruit growing of semi-arid regions. Dynamics of soil water content was studied in such a region, Dobrogea, Romania, during more irrigation cycles. The biological material studied was peach, 'Cardinal' variety, grafted on franc rootstock in a 4 x 3 m layout, with a trained spindle bush canopy shape. Soil management system was represented by clean cultivation both between tree rows and in the row. It was found that the main root activity of the peach orchard occurred in the 0-80 cm soil layer, and this finding could be used for both irrigation planning and scheduling.

Key words: *soil water content, root activity, matric potential, depletion cycle, Prunus persica.*

INTRODUCTION

For the last decades, the competition for water has increased mainly due to global changes and population growth, but due to the large crop land area worldwide the pressure upon water resources has mainly occurred in agriculture. Crop transpiration and evaporation are, alongside soil internal drainage and surface runoff, the principal components of the crop water consumption in the field. All these processes consistently influence the dynamics of soil water content (SWC), either in fully irrigated orchards or in water stressed plantations.

Many soil and plant parameters, e.g. physical soil properties, SWC dynamics, plant rooting depth and density or root activity, are important to establish fruit tree plantations and irrigation methods in order to use more efficiently irrigation water in orchards.

Dynamics of SWC in orchards is caused by a complex interaction between climatic factors (reference evapotranspiration ETo and, implicitly, crop evapotranspiration ETc and precipitation), technological factors (e.g. irrigation technological parameters, soil management) and plant characteristics (root thickness, volume and density, and leaf area index), etc.

Cockroft and Wallbrink (1966) were among the first scientists reporting root distribution of peach orchard trees in the soil and said that roots growth was as close to the actual ground surface as was allowed by such factors as cultivation depth, competition, and soil temperature.

More recently, Olsson and Rose (1988) studied the patterns of water withdrawal beneath an irrigated peach orchard on a red-brown earth where the hydraulic properties varied with depth. They found that when drying, water uptake by roots was well correlated with root concentration over the profile but, over time, water uptake was redistributed over the root system.

Mata et al. (1999) studied SWC variation in daily drip irrigated peach orchard on a sandy-loam soil lysimeter in USA and reported a relatively shallow SWC change depth (76 cm). Schwankl et al. (1999) also investigated the pattern of soil wetting-drying cycle in an almond tree grafted on peach rootstock orchard irrigated as surface drip, subsurface drip and microsprinklers and found various soil wetted volumes as a function of irrigation method used.

Girona *et al.* (2002) have reported that in monitoring the available soil water content for irrigation timing in high frequency irrigation methods, more than one plant and soil property is particularly important, e.g.: variable tree responses, wetting patterns, soil depth and root exploration. In the same context, Mounzer et al. (2008) reported comparative data on the soil water content distribution in two irrigation treatments and its effect on the physiological response of young peach trees during growing season, while Abrisqueta et al. (2008) studied the Root dynamics of peach trees submitted to partial rootzone drying and continuous deficit irrigation.

Rooting depth of fruit trees were previously reported in the study region for mature peach trees grown in fertile soils by Indreias (1997), who found values of 60-80 cm, but there is no more information with regard to the root spatial distribution within the soil in the region.

Data on daily SWC dynamics during depletion cycles showing daylight versus night and morning versus afternoon in an irrigated peach orchard under various soil water regimes has been recently reported by Paltineanu et al. (2013). However, little has been done with regard to SWC dynamics over the entire soil profile in drip irrigated peach orchards under the specific soil and climate conditions of Black Sea coastal area in Romania.

The purpose of this paper is to find out the SWC pattern during water infiltration and depletion cycles within soil layers from a chernozem in a young peach orchard, when applying usual water depths by drippers under a fully irrigated regime in order to use in irrigation design and scheduling; another objective is to emphasize the depth of normal activity of the tree roots.

MATERIALS AND METHODS

The experiment was performed in the summer of 2013, at the Research Station for Fruit Growing Constanta, Agigea Farm, in the village of Agigea located on the Black Sea coastal area in the eastern part of Dobrogea region, Romania, at the latitude of 44º 05' North and longitude of 28º 37' East. The average altitude of the field is 30 m.

Climate and soil conditions

The temperate climate of the experimentation site has a continental character with mild Black Sea influence. The climate conditions are characterized by mean annual values of temperature and precipitation of 10.7 °C and 409 mm, respectively, and precipitation is not uniformly distributed across the year, with about 60% during the growing season; for the whole year the reference evapotranspiration ETo is 778 mm, with an average of 122, 133 and 118 mm month^{-1} during summer months: June, July and August, respectively (Paltineanu et al., 2007).

For the site of experiment and period of study, the climatic data were recorded by an automatic weather station (Watch Dog Weather Station 2000, Spectrum Technologies, Aurora, Illinois, USA) possessing mowed sod as reference cover. The data consisted of solar radiation (Rs), air temperature (T), relative air humidity (RH), wind speed at the height of 2 m (U) and precipitation (P) were recorded by a 30-min step and averaged for 1-h intervals. These data were periodically transferred by wire to a laptop and processed as diurnal means and used in calculations. ETo was calculated using the combined equation of Penman-Monteith (Allen et al., 1998) based on daily climate data and grass reference.

For the period of study (May 10 through July 14, 2013, i.e. day of year, DoY, 130 to 195) and the whole agronomic year before these months, the climatic elements are presented in Table 1. One can note the fact that the mean temperature was positive along the winter, and total precipitation till July (303.1 mm) were much lower than total ETo (695.8 mm), resulting in a real need to irrigate. During the experiment, the rainfall recorded a total of 107 mm in more than one event, as further shown in graphs.

The soil is a Calcaro-Calcic Chernozem (Sistemul Român de Taxonomie a Solurilor, Florea and Munteanu, 2012; World Reference Base for Soil Resources, 2006) or Entic Haplustolls (Soil Survey Staff, 1999) with a loamy texture and alkaline pH in topsoil, which has a proper soil structure and fertility. Land slope is between 2.0 and 2.5%.

There is the following sequence of soil layers within the soil profile: Am, about 45 cm deep with two sub-horizons, then an A/C layer ca. 18 cm deep, after which a C/A of 23 cm, and there are more horizons (Cca symbol) deeper containing lots of calcium carbonate (more than 12%) down to 1.2 m.

Table 1. The monthly means of the climatic conditions of Agigea Farm for the 2012-2013 agronomic year (period October - July)

Monthly Values	Temperature (ºC)			RH	Solar rad.	Wind speed	Rain	ETo
	Mean	Max.	Min.	%	(W/m^2)	(km/h)	(mm)	(mm)
October	15.5	20.7	10.1	76.0	123.9	4.2	28.9	47.7
November	8.9	13.0	5.0	85.8	71.4	4.3	17.2	19.8
December	2.1	6.4	-2.2	81.3	49.5	6.2	62.1	9.3
January	1.2	4.9	-2.5	83.2	57.1	5.8	29.6	12.4
February	3.6	7.2	-0.1	84.2	62.5	5.8	12.1	16.8
March	5.4	9.4	1.3	72.4	124.7	6.5	9.5	46.5
April	11.3	16.5	6.1	72.5	265.5	6.9	11.9	102.0
May	18.3	23.7	12.8	76.4	306.8	4.2	34.9	139.5
June	20.7	27.0	14.2	70.8	316.6	3.5	66.7	153.0
July	22.1	27.6	16.5	66.9	301.5	3.1	30.2	148.8

Sum of rainfall = 303.1 mm, sum of ETo = 695.8 mm

The main SWC indexes — permanent wilting point (WP), field capacity (FC), management allowed deficit (MAD) and total soil water capacity (TC) on the soil entire profile down to 1.2 m depth — were previously determined for the studied site and shown in the following graphs, as either mean values for the entire soil profiles or for each soil layer. A specific characteristic of the soils is that there is a large range between FC and TC where water can infiltrate without waterlogging or air deficits.

Experimental design and irrigation application

One of the most representative fruit tree for the region is peach tree (*Prunus persica* (L) Batsch). The 5-year old orchard consisting of Cardinal variety grafted on generative franc rootstock was established in the autumn of 2008 in a 4 m x 3 m layout. The canopy shape was trained as a spindle bush with a height of about 2.5 m, and the soil management system was clean cultivation (bare soil) both between tree rows and in the row. The canopies were flattened in the row to enhance technological traffic, and fruit tree volumes occupied all the space in the row as a fence, with a mean canopy tree diameter of ca. 2.7 – 3.0 m. The studied field parcel comprised three adjacent fruit tree rows in a 50 m long plot, with the central row containing two trees for measurements, while the other trees were guard trees.

For this region, irrigation usually completes the lack of precipitation, and scheduling is based on both water balance method and soil water sensing devices. Five irrigation applications were carried out during the experiment in DoYs: 134, 156, 163, 177 and 187. The 200 m^3/ha water of each irrigation application was usually carried out when SWC had values around MAD (half of the available soil water holding capacity), i.e. there was a fully irrigation regime until harvest and a rain-fed regime afterwards. The time of each application was 24 h. The 2-l/h discharge drippers were located 0.6 m apart on the single lateral line along the tree rows. After irrigation application the fruit tree rows showed a wetted bulb about 1 m wide at the soil surface, and the water depth was considered to be equivalent to 800 m^3/ha for the tree rows, because only one fourth of the orchard area received irrigation water.

Soil water content measurements

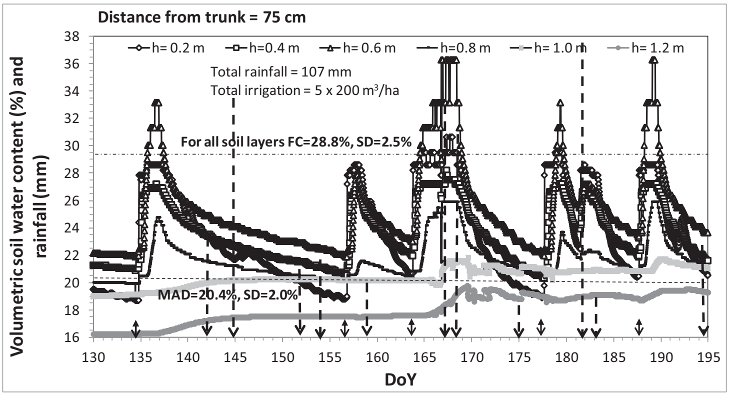
More than one infiltration and depletion cycles were investigated after irrigation application and rainfall events in the reference plots to notice the SWC variation, i.e. crop evapotranspiration, redistribution and deep percolation combined, in order to emphasize the pattern of soil wetting and drying in the orchard.

Soil water matric potential was measured continuously with Watermark resistance blocks (6450 Watermark Soil Moisture Sensor, Spectrum Technologies) installed in two replicates for each of two representative fruit trees at six depths: 20, 40, 60, 80, 100 and 120 cm, and for two distances from the tree trunk: 75 cm and 150 cm (1/4 and 1/2 of distance between fruit trees on the row), respectively. These data were recorded by WatchDog dataloggers (WatchDog Model 1650 Data Logger, Spectrum Technologies) and downloaded periodically by a laptop. The relationships between soil water matric potential measured with the Watermark sensors and SWC measured gravimetrically were previously determined from field data (Paltineanu et al., 2011); these relationships were then used to transform soil water matric potential readings into SWC values during the experiment.

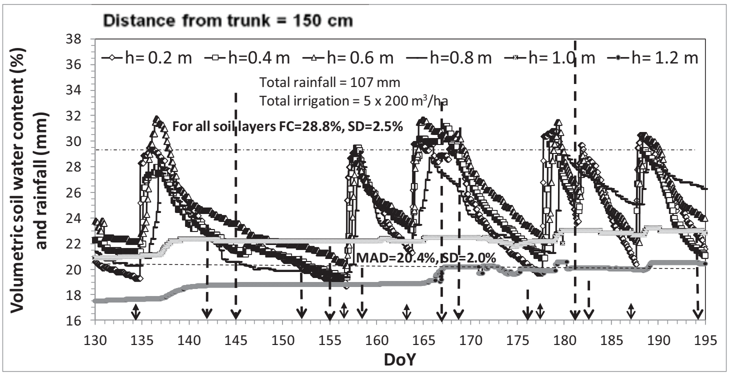
RESULTS AND DISCUSSIONS

Dynamics of soil water content

For the five irrigation / rainfall events, SWC dynamics of six soil layers: 0.2; 0.4; 0.6; 0.8; 1.0 and 1.2 m depth during the 130 – 195 days of year (DoY) is depicted in figure 1. This variation is shown for both distances from the tree trunk: 75 and 150 cm, respectively, and these places are between two consecutive drippers. In the graph, there are also shown the moments of irrigation application and rainfall amounts.



a)



b)

Figure 1. Dynamics of soil water content on six soil layers: 0.2; 0.4; 0.6; 0.8; 1.0 and 1.2 m depth during the irrigation period, days of year (DoY) 130 – 195, Agigea, for two distances from the tree trunk: a) 75 and b) 150 cm respectively; equal small-sized double arrows represent the moment of irrigation application and the other up-down arrows represent rainfall at the scale; each point in the graph is the result of two replicates.

Field capacity (FC) and MAD as average values for the soil layers over the soil profile are also shown. One can note that the first four soil layers mainly show an intense SWC dynamics by participating to wetting – drying cycles between FC and MAD. The other two soil layers, i.e. at 1.0 and 1.2 m depth, which show lower SWC values, near MAD due to a particularly droughty year, show a different shape, generally increasing with time. This is true even if the irrigation and rainfall water has reached their depths, because these layers have been slightly wetted, and SWC has not shown a real decrease afterwards. This means that SWC has been mainly up-taken by the fruit tree roots found in the first 80 cm of soil, and the possible existing roots were not active.

Mean variation of SWC

The mean variation of SWC between the moments of irrigation application and 2-3 days after internal drainage and redistribution on the six soil layers studied during the irrigation period is illustrated in figure 2 for both trunk distances studied.

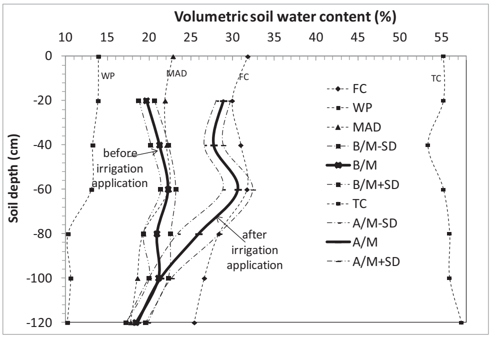


Figure 2. Mean variation of SWC between the moment of irrigation application and 2-3 days after water redistribution on the six soil layers studied during the irrigation period; symbols used: FC, MAD, WP and TC are explained in the text, M = mean, SD = standard deviation, A and B are the situations after and before irrigation application, respectively

For all irrigation – rainfall events, SWC has been averaged in time for all soil layers studied both just before (B) water application and after (A) its redistribution in order to emphasize SWC range during the most active root water uptake (RWU) period, the summer time.

As a rule, it can be noted that the highest SWC variation has occurred within the first 60 cm soil depth, and this fact can be explained by the existence of the biggest root mass and volume there, as previously reported by Indreias (1997). However, there has also been a SWC variation deeper in the soil. Thus, as this figure shows, the intersection between these two curves (and their accompanying standard deviation curves) occurs at a soil depth of 80-100 cm, showing this way the most intense root activity depth in such fertile deep soils where fruit tree roots of this kind of generative rootstock can easily penetrate.

Irrigation applications and soil water stored

Figure 3 shows the five irrigation applications and soil water stored in the first 80 cm depth for both distances analyzed here, i.e. 75 cm and 150 cm from the tree trunk, respectively, after internal drainage and redistribution; otherwise this can be seen as being actually irrigation efficiency for this depth.

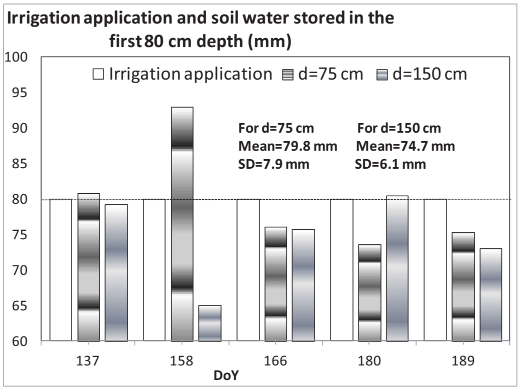


Figure 3. The five irrigation applications and soil water stored in the first 80 cm depth for both distances analyzed, 75 cm and 150 cm from the tree trunk, respectively, after 2-3 days of internal drainage and redistribution; SWC stored mean and standard deviations are specified in the figure for the five occasions (DoY 137-189)

For the soil surface layer the water stored in soil was estimated according to the 20 cm depth Watermark sensor. SWC stored and standard deviations specified in the figure for the five occasions during DoYs 137 and 189 show that most of the irrigation water, i.e. 75

– 80 mm, was retained homogeneously within the first 80 cm soil depth, with a SD of 6 – 8 mm. Even if this calculation has not the accuracy of a weighing lysimeter and has used some SWC estimated values (at 0 cm depth), the results indicate a proper way of wetting-drying cycle for drip irrigation in young peach orchards.

Discussions

The pattern of wetting-drying cycles from above took into consideration the soil layers and root system of the peach tree rows between two consecutive drippers, for two distances from the tree trunk. The distance of 75 cm characterizes the vicinity of plant, whereas the distance of 150 cm is specific for the mid-interval between two consecutive trees. Hence, the root system as well as the canopy projection over the soil surface is covered by these two-distance determinations. Consequently, it is different from the pattern of other irrigation methods ,like sprinkler or furrow irrigation, where water is spread over almost all area.

Working in a daily drip irrigated peach orchard on a sandy-loam soil lysimeter, Mata et al. (1999) found a 76-cm root activity depth shown by SWC change; they considered that shallow extraction of water as being induced mainly by the high frequency irrigation application regime. The results obtained in our experiment showed a bigger SWC change depth, about 80 to 100 cm, due to both low frequency irrigation application regime and finer soil texture. The authors also reported that, since there had been presumably denser rooting closer to the tree trunks, soil water in that area would have been extracted at a greater rate than in the vicinity of soil water monitoring instruments, which had been located some distance from the trunks. This assumption was also probably true in our case, but the results were not significantly different for the two trunk distances used.

On the other hand, experimenting on course-textured soils with low water-holding capacity Schwankl et al. (1999) studied the pattern of soil wetting-drying cycle in an almond tree grafted on peach rootstock irrigated orchard as surface drip, subsurface drip and microsprinklers, with the drip systems operated daily and the microsprinklers about once every 3 days. The climate of the region was similar concerning the precipitation amount (375 mm annually). The authors found a SWC change depth of about 90-120 cm. According to these authors, the trees initially withdrew soil water from zones close to the tree, especially at shallow depths, and as that soil moisture was depleted, the trees withdrew water from zones farther away from the tree and from deeper depths.

More recently, Mounzer et al. (2008), studied drip irrigation scheduling of peach trees by continuous measurement of soil water status on calcareous, rocky and shallow clay-loam texture and low organic matter soils with about 90 mm m^{-1} available SWC. The climate conditions were more arid there than in our experiment, with about 1100 mm of Penman-Monteith reference evapotranspiration and 440 mm of annual precipitation. However, the authors monitored soil moisture only down to 50 cm where they found SWC changes and intense root activity.

CONCLUSIONS

It has been found that the first four soil layers mainly show an intense soil water content dynamics by participating to wetting – drying cycles between field capacity and management allowed deficit, meaning that the soil water has been mainly up-taken by the fruit tree roots found in the first 80 cm of soil, and the possible existing roots were not active.

This fact can be explained by the existence of the biggest root mass and volume there, and most of the irrigation water was retained homogeneously within the first 80 cm soil depth.

More instruments should be installed at more distances from the trunk in order to find more accurate conclusions for SWC change and root activity in peach orchards. This is particularly true because the high spatial variability of the root distribution in such soil.

The results obtained in this study on fertile and medium-textured chernozems can be used by irrigation designers and planners, as well as in irrigation scheduling, to improve water management and conservation in semiarid regions with similar environmental conditions, by taking into account the architecture of root system and the intense fruit trees activity that should be considered when calculating irrigation depth and timing, as well as dripper discharge and density.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

OPTIMIZATION OF LIGHT INTERCEPCION IN INTENSIVE SWEET CHERRY ORCHARD

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Abstract

In high density sweet cherry orchards the crop canopy is fragmented, arranged in linear lanes. In between the tree lanes the alleyway provides the space for technology measures and machinery. The area rate of orchard covered by canopy considerably influences the PAR (photosynthetic active radiation) absorption potential of the orchard. Our first step in Hungary towards intensification of cherry orchard was the "modified Brunner Spindle" in spacing 6x4 to 5x3 m, introduced in the 80-es of last century. The canopy covered rate of the orchard area increased from 0.4-0.5 to 0.6-0.7 with decreasing spacing. The denser "Hungarian Cherry Spindle" with spacing of 4x2m slightly increased the rate of canopy covered orchard area (0.6-0.8) but in this system the leaf and shoot population is more and more crowded in a reduced space. This situation may provide both advantages and disadvantages considering environmental physiology and technology aspects. The total leaf area of trees and the leaf area index (LAI) is considerably influenced by the cultivar and rootstocks. The LAI and so the PAR absorption capacity of orchard shows typical course during the season, influenced by the applied pruning too. On dwarfing rootstock GiSelA 5 or 6 the LAI values of trees reach a maximum of 2 to 3, while the LAI of tree on vigorous rootstocks can achieve 7 to 8. At the stage of LAI_{max} the canopy walls of trees intercept 60-90% of PAR, which means 40-75% PAR absorption calculated for the whole orchard area. Environmental factors considerably influence the performance of net CO_2 assimilation of leaves in daily and seasonal course as well. Our investigation confirmed the role of water supply and temperature of leaves affecting the stomatal conductance. The stomatal conductance of leaves on different rootstocks at appropriate water supply showed daily maximum in the T_{leaf} range of 30 – 40 °C, while in the T_{leaf} range of 40 – 45 °C the conductance rapidly decreased. This down regulation on dwarfing rootstock is faster, while on vigorous rootstocks slower. Since the water supply of leaves on dwarfing rootstocks due to their hydraulic system is more vulnerable, and the exposition of leaves to solar radiation is higher due to the scarse canopy, the leaves get faster into the critical T_{leaf} range. In contrary trees on vigorous rootstocks with higher LAI, which is linked with higher shading, may show more efficient PAR utilization. The research was supported by TÁMOP-4-2.1.B-09/1/KMR- 2010-0005 project and by Hungarian Scientific Research Funds OTKA 109361project.

***Key words**: PAR absorption, orchard systems, rootstocks, stomatal conductance, CO_2 fixation.*

INTRODUCTION

The assimilating leaf canopy of trees convert the light energy into assimilates and finally produces marketable fruits in cherry orchards. Several authors in apple orchards showed linear correlation between yield and light interception (Robinson et al., 2005), which suggest increasing the light interception towards maximum.

Several factors influence the light interception in modern orchard systems (Jackson, 2003). Modern orchard systems are characterized by more or less fragmented canopy, the alleyway is needed for machinery. Further on several factors influence the light interception of the orchard, such as tree architecture, canopy covered area vs. alleyway rate, LAI (leaf area index), leaf density, and shading.

On the other hand the further factors influence the PAR (photosynthetic active radiation) use efficiency of leaves, like leaf exposition to solar radiation, leaf turgor, stomatal conductance and leaf temperature.

In our overview we discuss the above factors based on our investigations and literature data.

CANOPY COVERED RATE OF ORCHARD SURFACE

In traditional sweet cherry orchards on high trunks with spherical canopy or modified central leader, the machinery and labor craft was moving under the canopy, the orchard surface was covered by leaf canopy around 70-90%. Compared to those in modern orchard systems the leaf canopy is more fragmented, larger alleyway rate is required for machinery, or more and more narrowed leaf walls (in hedge forms) are established. Table 1 gives a comparison of canopy covered rate of some recently tested orchard systems in Hungary.

Table 1. Comparison of canopy covered rate (canopy area/orchard space allotted for one tree) of different orchard systems

Growth vigor of rootstock	Traditional mod. central leader 8x7 m	Modified Brunner Sp. 6x4 m	Modified Brunner Sp. 5x3 m	HU Cherry Spindle I. 4x2 m	HU Cherry Spindle II. 4x2 m	Super spindle 3x0.6 m
Vigorous	0.7 – 0.9	0.47	0.70	0.76	0.69	
Moderate vigorous	-	0.38	0.61	0.60	0.62	
Low vigor	-	-	-	0.43	0.51	0.2 – 0.25

Our first step in Hungary towards intensification of cherry orchard was the “modified Brunner Spindle” in spacing 6x4 m to 5x3 m, introduced in the 80-es of last century. The canopy covered rate of the orchard area increased from 0.4-0.5 to 0.6-0.7 with decreasing spacing. The denser “Hungarian Cherry Spindle” with spacing of 4x2m slightly increased the rate of canopy covered orchard area (0.6-0.8) but in this system the leaf and shoot population is more and more crowded in a reduced space. This situation may provide both advantages and disadvantages considering environmental physiology and technology aspects.

PERFORMANCE OF LEAF AREA, LAI (LEAF AREA INDEX)

Rootstock and cultivars considerably influence the size of single leaves and so the LAI of the orchard (Gyeviki et al., 2012).

Table 2. The single leaf area (SLA) of ‘Petrus’ and ‘Rita’ sweet cherry trees on different rootstocks, 2008-2009 (Gyeviki et al., 2012)

	2008				2009			
Rootstock	Extension shoots (cm^2)		Spurs (cm^2)		Extension shoots (cm^2)		Spurs (cm^2)	
’Petrus’								
’Prob’	45.45	a	34.12	a	43.30	a	34.67	a
’Gisela 6’	57.50	b	37.41	a	47.10	a	37.13	ab
’Magyar’	66.02	c	48.15	b	65.26	b	51.55	b
’Bogdány’	72.07	d	53.65	c	73.19	b	56.15	c
Average SLA	60.26	y	43.33	x	57.21	Y	44.88	X
’Rita’								
’Gisela 6’	42.81	a	30.95	a	46.41	a	31.95	a
Mazzard	61.17	c	45.61	c	54.33	a	38.14	ab
‘Korponay’	55.28	b	36.18	ab	57.12	a	39.31	ab
Prunus mah. sdlg.	67.22	c	39.84	bc	67.11	b	43.39	b
Average SLA	56.62	y	38.15	x	56.24	Y	38.20	X

Note: Means in columns are separated by Duncan’s multiple range test, values marked with different letters differ at p=0.05. Average SLA is separated by T-test of paired samples.

The leaf area related to crop load considerable influences the fruit size of cherry orchards.

Accepting the data of Cittadini et al. (2006), production of 1 kg cherry in good size (mean

fruit weight 10 g) requires around 1.25 m² leaf area. Continuing this calculation along, the production of 20 t/ha cherry in 10 g MFW requires around 30-35 000 m² leaf surface (LAI 3-3.5).
The total leaf area of trees and the leaf area index (LAI) is considerably influenced by the cultivar and rootstocks. The LAI and so the PAR absorption capacity of orchard shows typical course during the season, influenced by the applied pruning too. On dwarfing rootstock GiSelA 5 or 6 the LAI values of trees reach a maximum of 2 to 3, while the LAI of tree on vigorous rootstocks can achieve 7 to 8.

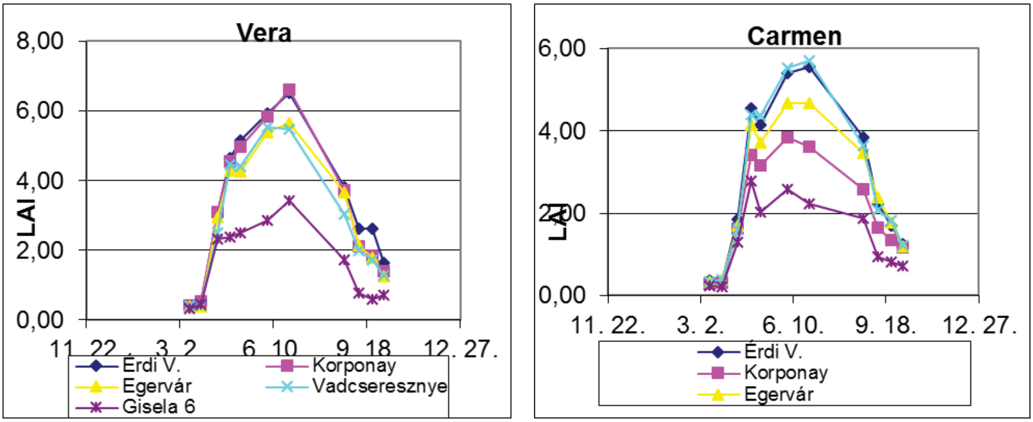

Figure 1. Performance of LAI of ‘Vera’ and ‘Carmen’ on different rootstocks related to canopy area

Considering that the canopy covered area rate is smaller, the orchard surface related LAI calculation is showed in the Table 3 and 4 in 2014 for ‘Vera’ and ‘Carmen’ cultivars.

Table 3. Canopy parameters and calculated LAI for the orchard surface of ’Vera’ on different rootstocks at spacing 4x2 m.

Rootstock	Canopy area (m²)	Canopy diameter (m)	crop covered rate	LAI (Orchard)
Mah Sdlg	5.32	2.60	0.65	4.34
Mazzard	5.93	2.75	0.69	4.23
Egervár	5.32	2.60	0.65	3.76
Korponay	5.78	2.71	0.68	2.61
Gisela 6	3.52	2.12	0.53	1.50

Table 4. Canopy parameters and calculated LAI for the orchard surface of ’Carmen’ on different rootstocks at spacing 4x2 m.

Rootstock	Canopy area (m²)	Canopy diameter (m)	crop covered rate	LAI (Orchard)
Mah Sdlg	5.94	2.75	0.69	4.11
Mazzard	5.88	2.74	0.68	4.19
Egervár	4.88	2.49	0.62	2.86
Korponay	5.26	2.59	0.65	2.37
Gisela 6	3.64	2.15	0.54	1.02

Related to the total orchard surface in our test orchards planted in light sandy soil on the Hungarian flatland, only moderate vigorous and vigorous rootstocks can produce LAI meeting the target orchard LAI of 3 – 3.5.

By our measurements at the stage of LAI_{max} the canopy walls of trees intercept 60-90% of PAR, which means 40-75% PAR absorption calculated for the whole orchard area.

PHOTOSYNTHETIC ACTIVITY, PAR USE EFFICIENCY

Environmental factors considerably influence the performance of net CO_2 assimilation of leaves in daily and seasonal course as well. Our investigation confirmed the role of water supply and temperature of leaves affecting the stomatal conductance. The stomatal conductance of leaves on different rootstocks at appropriate water supply showed daily maximum in the T_{leaf} range of 30 – 40 °C, while in the T_{leaf} range of 40 – 45 °C the conductance rapidly decreased. This down-regulation on dwarfing rootstock is faster, while on vigorous rootstocks slower. Since the water supply of leaves on dwarfing rootstocks due to their hydraulic system is more vulnerable, and the exposition of leaves to solar radiation is higher due to the sparse canopy, the leaves get faster into the critical T_{leaf} range.

In contrary trees on vigorous rootstocks with higher LAI, which is linked with higher shading, may show more efficient PAR utilization. Results of Centritto et al. (2000) and Beppu and Kataoka (2005) suggest that even with appropriate irrigation the shading of trees by net may decrease the evaporative demand of ambient air and overheating of leaves. As the frequency of such days is much larger in continental climate or in high density orchards on low vigor rootstocks, this practice may create optimal conditions for PAR utilization.

CONCLUSIONS

Summarizing the literature data, our results and experiences, we can confirm that light interception is one element only in the „puzzle" named orchard system. At optimizing of light interception the site factor (solar radiation intensity, weather characteristics), cultivar, rootstock, tree architecture and pruning protocol should be considered. As our preliminary results suggest, the light penetration in an average dense canopy could be sufficient in a depth of 70-80 cm, this radius of the conical canopies can be considered as optimum. However, further research is needed to get further information on the interactions between the above elements and light interception.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

SPECIES COMPOSITION OF PLANT PARASITIC NEMATODES *PRATYLENCHUS* SPP. IN CONVENTIONAL AND ORGANIC PRODUCTION OF RASPBERRIES

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Abstract

The sustainable organic production involves a lot of difficulties in pest control. Plant-parasitic nematodes of the genera Pratylenchus cause significant economic damage to raspberry production. To study the species composition of root-lesion nematodes of Pratylenchus spp., observations were carried out of raspberry plants in conventional and organic cultivation systems. The species composition of the established nematodes by different farming technologies was similar. In the conventional production, the species composition of nematodes was relatively homogeneous, as the number of established Pratylenchus species was 4, while, in the organic production, the species composition of nematodes is characterized by variety, but their number was 6. The number of individuals of the Pratylenchus species in conventional cultivation was significantly higher.

Key words: *root-lesion nematode Pratylenchus spp., raspberry, organic production.*

INTRODUCTION

Raspberry-growing is currently occupying an important place in the fruit production in many European countries, which creates new jobs in the agriculture sector and delivers food products and raw materials for the food industry. Maintaining a healthy and productive raspberry plantations for years creates significant difficulties and efforts are directed to a preliminary assessment of the overall process. The economic damage is considerable in the infested soil with plant-pathogenic nematodes. The yield can be completely lost in heavily infested fields, and the presence of certain species of Nematoda restricts the growing of a range of crops in the contaminated areas (Nicol et al., 2011).

The worldwide damage caused by root lesion nematodes of the genus *Pratylenchus* (Filipjev, 1936) increased, and thus the interest in them. In the most regions, the root lesion nematode *Pratylenchus penetrans* continues to be a major limiting factor in the production of raspberries. This species is endoparasitic, destroyes the root tissue, reduces the flow of water from the soil into the roots and the transport of nutrients. In many cases in the field, there are mixed populations of plant- parasitic nematodes, rather than individually occurring species.

This study of the species composition of plant parasitic nematodes in conventional and organic systems of production of raspberries based on a comparative assessment will be achieved not only to determine the effectiveness of the methods and means of plant protection and will ensure the plant health and the growth potential.

The aim of this work was to investigate the qualitative and quantitative structure of root lesion nematodes in the genus *Pratylenchus* in different growing technologies.

MATERIALS AND METHODS

Characteristics of experimental fields

The study was conducted in two raspberry plantations near the town of Kostinbrod (GPS: 42°49'5.80"N; 23°13'30.54"E). The plants are planted at a distance of 2.50 x 0.50 m or 88 plants/ha. Two growing systems were tested conventional growing and organic growing. The test plot was 25 m^2, four replications of sequences of time.

Sampling methods

The plant health condition of the fields has been satisfactory; there were zones of reduced plant growth and plant damage.

According to the meteorological data, abiotic factors, which could cause these symptoms, are excluded. The period of sampling of plant and soil samples was consistent with that recommended by Knuth et al. (2003). In order to determine the increase or decrease of density of the populations, the samples were taken depending on the season, during no-vegetation and vegetation period. The soil samples were taken randomly from 15 – 25 cm depths and then transferred in plastic bags to the laboratory.

Extraction of the nematodes

The methods for the extraction of the nematodes from the soil and roots and their subsequent mounting on permanent slides for identification are according to the Baermann pan method described by Townshend (1963). Species characterization and identification were based on morphology of various life stages (Loof, 1978; Bongers, 1988; Handoo and Golden 1989).

Statistical analysis

The statistical analysis was carried out using Statistica 99 Edition statistical package.

RESULTS AND DISCUSSIONS

The established species of the genus *Pratylenchus* in different cultivars and variations of fertilization are shown in Tables 1 and 2.

Besides the most commonly found species of *P. crenatus*, *P. neglectus* and *P. pratensis*, two species of this genus: *P. thornei* and *P. sonvallariae* were isolated in organic growing. Although the species of *P. penetrans* was established, its presence in both fields was sporadic.

During the first year of investigations (2011), symptoms of plant damage and the increased density of nematodes of this genus were not observed.

But in 2012, the density of species of the genus *Pratylenchus* was increased during fruiting seasons in the conventional growing systems compared to the organic growing.

During the investigation of the samples (soil and plant), a total number of individual nematodes of the genus *Pratylenchus* was 620; 384 individuals in the conventional framing of the genus *Pratylenchus* and 236 individuals in the organic growing.

The highest density was recorded in September 2012- 74 individuals in conventional growing, and lowest in the organic growing in August 2012-9 individuals. Throughout the research period in 2012, the total number of isolated nematodes of the genus *Pratylenchus* did not confirm the increase of their density in the organic growing.

It should be noted that the number of species of the genus *Pratylenchus* is difficult to predict, since they are located at a specific moment in the soil and the roots.

Figure 1 and 2 present the percentage of the number of species and their density in the conventional and the organic growing during the study.

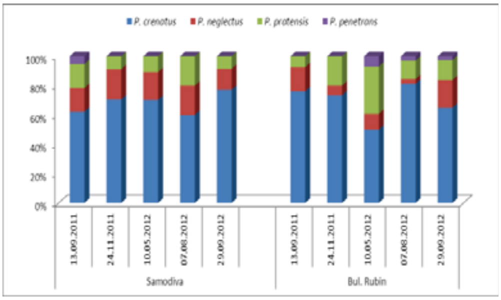

Figure 1. Percentage of species of the genus *Pratylenchus*, extracted from soil and plant samples in conventional growing of raspberry

Throughout the study period from the total number of samples infected with *Pratylenchus* spp., these species were isolated: in the conventional growing: the species *P. crenatus* was 69.7%, *P. neglectus*- 13.4% and *P. pratensis*- 14.7%; in the organic growing: *P. crenatus* was found 48.7%, *P. neglectus*- 29.3%, *P. pratensis* 14.5%, *P. thornei* 3.4% and *P. sonvallariae* 2.5% (Figure 1 and 2).

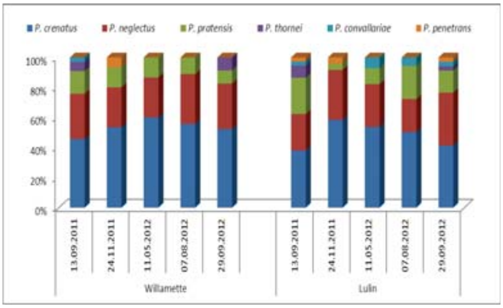

Figure 2. Percentage of species of the genus *Pratylenchus*, extracted from soil and plant samples in organinc growing of raspberry

Postive significant correlations (R=0.15; P <0.05) between the different variants of fertilisation and the density of nematodes were found in the conventional growing. Correlation between nematodes of the genus *Pratylenchus* and variants of fertilization (R=-0.06; P>0.05) was not demonstrated in the organic growing.

The population density of *Pratylenchus* spp. was negatively correlated with the total density of the migratory root nematodes (R=-0.26; P <0.01).

The sum of the number of individuals of the species *P. crenatus* was 38 individuals, which is indication of the most common species in the organic growing. *P. neglectus*, especially in the autumn of 2012, was 1.5 times more common species than other species of the genus *Pratylenchus*.

Table 1. Species of root lesion nematodes of the genus *Pratylenchus*, extracted from fields with conventional growing of raspberry

sampling time/cultivar	*P. crenatus*	*P. neglectus*	*P. pratensis*	*P. penetrans*	undetermined species
			13.09.2011		
Samodiva	*V2-9 V3-14	V0-1 V1-1 V2-2 V3-3	V0-2 V3-4	V1	V3-1
Bul. Rubin	V0-12 V1-13 V2-10 V3-26	V0-2 V1-4 V2 - 5	V0-2 V2-1 V3-2		
			24.11. 2011		
Samodiva	V0-1 V1-2 V2-10 V3-11	V0-2 V2-1 V3-4	V0-1 V3-3		V0 -1
Bul. Rubin	V0-11 V3-11	V3-2	V0-1 V2-1 V3-4		V1 -1
			10.05.2012		
Samodiva	V0-4 V1-9 V3-13	V0-1 V2-3 V3-3	V0-1 V1-1 V3-2		
Bul. Rubin	V0-1 V1-4 V2-2 V3-7	V1-1 V2-1 V3-1	V0-2 V2-4 V3-3	V3-3	
			07.08.2012		
Samodiva	V0-2 V1-0 V3-4	V2-1 V3-1	V2-1 V3-1		V3-1
Bul. Rubin	V1-1 V2-13 V3-12	V3-1	V0-2 V2-1 V3-1		
			29.09.2012		
Samodiva	V0-1 V1-4 V2-10 V3-12	V0-1 V1-1 V2-1 V3-2	V0-1 V1-1 V3-1		
Bul. Rubin	V0-10 V1-14 V3-24	V0-3 V1-1 V3-7	V0-1 V1-2 V2-2 V3-5	V0-2	V2 -1

*V- variants of experiment (various fertilization) and number of established nematode species

Table 2. Species of root lesion nematodes of the genus *Pratylenchus*, extracted from fields with organic growing of raspberry

sampling time/cultivar	*P. crenatus*	*P. neglectus*	*P. pratensis*	*P. thornei*	*P. convallariae*	*P. penetrans*	undetermined species
			13.09.20111				
Willamette	*V0-5 V1-3 V2-2 V3-5	V3-10	V1-1 V2-1 V3-3	V0-2	V2-1		
Lulin	V0-7 V1-2 V3-5	V2-2 V3-5	V1-2 V2-3 V3-4	V0-3	V3-1	V3-1	
			24.11.2011				
Willamette	V2-4 V3-4	V2-1 V3-3	V2-1 V3-1			V3-1	V3-1
Lulin	V0-4 V1-2 V2-2 V3-6	V2-5 V3-3	V2-1			V0-1	
			11.05.2012				
Willamette	V0-3 V1-4 V3-4	V0-2 V1-2 V3-5	V2-1 V3-1				V3-1
Lulin	V1-3 V2-5 V3-7	V0-4 V2-2 V3-2	V0-2 V1-1		V0-1 V1-1		V2-1 V3-1
			07.08.2012				
Willamette	V1-2 V2-1 V3-2	V0-3	V0-1				
Lulin	V0-1 V1-2 V2-3 V3-3	V0-1 V1-2 V3-1	V0-1 V1-3		V3-1		
			29.09.2012				
Willamette	V0-4 V1-3 V3-5	V0-2 V1-2 V2-2 V3-1	V3-2	V3-2	V3-2		
Lulin	V0-1 V1-2 V2-6 V3-5	V0-2 V1-4 V2-2 V3-3	V3-5	V0-1	V0-1	V3-1	

*V- variants of experiment (various fertilization) and number of established nematode species

Many authors reported that the species *P. thornei* and *P. convallariae* were isolated from heavy soils (Whish et al., 2014).

Despite their differences in preferences for the type of soil (Sturhan, 2014), the species *P. crenatus* and *P. neglectus* were found in joint populations in both growing technologies. The frequent occurrence of these two together is reported by Kleynhans et al. (1996) Kruse (2006), Söğüt et al. (2014) and Esteves et al. (2015) in various agricultural ecosystems.

As regards the reaction of the soil it has been found that the population density of *P. crenatus* and *P. neglectus* was significant different. The species *P. crenatus* prevailed in the soil with slightly alkaline reaction, pH ± 8. This species was present 1.5-2.5 times more than in the soil with a neutral to slightly acid, pH 7.5–6.0 (organic growing). The species *P. neglectus* was detected in significantly less samples of the organic growing soil with low pH values.

Larvae of genus *Pratylenchus* were isolated more frequently from the samples, thus so that making it difficult to determine or its determination could not be carried out. The prevalence of *Pratylenchus* spp. is higher in regions with extensive agriculture (Vrain and Dupré, 1982; Vrain and Rousselle, 1980). Kimpinski (1985), Bélair (1991), Zasada and Moore (2010) demonstrate that the significant increase in population density of *Pratylenchus* spp. requires soil treatment in raspberry fields with nematicides.

The root lesion nematode, *Pratylenchus penetrans*, is a production-limiting pest in red raspberry, *Rubus idaeus*. Nowadays authors continue searching for genetic resistance, as a tool to manage *P. penetrans* in raspberries. This would reduce the impact of this nematode on raspberry productivity as well as reduce the plant chemical treatments to keep populations in control (Zasada and Moore, 2014).

These results indicate that more research is needed to learn about the relationship between fertilization, cultivars and root lesion nematodes of genus *Pratylenchus* in different growing technologies.

Given that the culture practices within each field remained almost unchanged for 10 years, this study provides a current representation of the distribution of nematode populations of small areas in the conventional and the organic production of raspberries.

It should be noted that a redistribution of certain species of plant-parasitic nematodes stays possible.

CONCLUSIONS

The species of the genus *Pratylenchus* were dominant in both of growing technologies, as *P. crenatus* and *P. neglectus* are occurred most often.

The number of identified species of the genus *Pratylenchus* in the conventional growing was 4 and 6 in the organic growing.

Although the number of established species of the genus *Pratylenchus* in the conventional production was smaller, the number of individuals of each species was significantly higher.

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VITICULTURE AND OENOLOGY

EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE INFLUENCE OF THE VINE CULTIVATION TECHNOLOGY ON THE PHENOLIC COMPOSITION OF RED GRAPES

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Abstract

The biosynthesis of phenolic compounds and their accumulation during the grape berry ripening is influenced by various factors such as the genotype, climatic conditions and agricultural practices. The phenolic maturity desired at harvest time refers not only to the total phenolic compound concentration, but also to their quality, which is related to their structure and extractability during the winemaking process. The goal of this work was to improve the total concentration of phenolic compounds of the black cultivars Feteasca neagra and Cabernet Sauvignon by applying various viticultural practices such as organic and conventional growing, no cluster thinning and 30% cluster thinning during summer, before veraison. The work was performed during the period of 2013-2014 and the phenolic compounds were evaluated by the standard Glories method, which provided results for total anthocyanins (ApH 1), extractable anthocyanins (ApH 3,2), the percentage of the extractable anthocyanins (%AE), maturity of the seeds (MS) and total phenols (PT). The statistical analysis of the results showed that the main factor that influences the phenolic composition of the grapes and their extractability is the grape variety, but for the same cultivar the cluster thinning and the agrotechnical practices also induced certain significant differences.

Key words: *phenolic composition, organic, cluster thinning.*

INTRODUCTION

Phenolic compounds are the most important group of chemical substances in grapes, after sugars and acids. They have an important contribution in defining visual, olfactory and gustative sensory characteristics of grapes and wines (Antoce, 2007; Gil-Munoz *et al*., 2009).

Phenolic compounds (anthocyanins, tannins, etc.) accumulates in the solid parts of the grape skin, seeds, rachis; their content is variable, depending on the variety, the maturation degree of grapes, the climatic conditions of the area, farming practices and last but not least the applied winemaking technology (Jackson *et al*., 1993; Downey *et al.,* 2006). Agricultural practices that influence the expression of phenolic composition during ripening process of grapes, reported in various journals are: the system of trunk formation (Zoeckelein *et al.,* 2008), row spacing, pruning, thinning grapes, removing buds and leaves, irrigation management and fertilization (Gonzales-Neves *et al*., 2002; Delgado *et al*., 2004; Poni *et al*., 2007; Antoce, 2007) and so on.

Phenolic compounds in grapes are secondary metabolites, which constitute a category of natural bioactive compounds which show remarkable health benefits for the body (Del Rio *et al*., 2013), due to their antioxidant or rather due to redox signalling actions.

Of these the most important are anthocyanins, the colored pigments of grapes, and tannins from skin and seeds, that are responsible for the red wine astringency and bitterness (Cheynier *et al.,* 2006). The assessment of the phenolic maturity of the grapes may be useful for their classification at the time of winemaking in accordance with the quality level, even for choosing optimal method based on the extractive phenolic compounds (Zamora, 2002).

The (poly)phenolic compounds of grapes have a variable "extractibility", depending on the conditions during ripening and biological potential of varieties. The extractability of anthocyanins depends also on the state of maturity that controls the decomposition of the grape skins. Although high concentrations of anthocyanins in the skin is necessary to obtain an intensely colored wine, this is not sufficient for the color extraction and color stability. In order to make these molecules easily to extract, cell walls must be decomposed mildly but sufficiently, by non-aggressive technological methods. Upon reaching phenolic maturity, grapes have both an increased pigmentation potential and the ability to release these substances in wine. The grape skin and seeds are considered key factors in the process of red wines vinification because they represent the main source of phenolic compounds, extracted during the process of fermentation and maceration. Anthocyanins, the molecules responsible for the color of wine, gradually accumulate in grapes during grape maturation (Canals *et al.,* 2008). The anthocyanins are not always easy to extract from the skin grapes, the low level of extraction causing light colored wines, even if the concentration of anthocyanins in grapes is sufficient. The anthocyanin extractability is one of the main factors affecting their concentration of the final product (Glories *et al*., 1993). In recent years there have been proposed and developed several methods for measuring the phenolic maturity (Segade *et al.,* 2008), direct measurement of the color absorption of extracts from the grape skins (Celotti *et al.,* 2007) and even multispectral high resolution image analysis (Lamb *et al.,* 2004). These methods, however, remain experimental and are not routinely used in winemaking. The methods usually applied are based on obtaining grape extracts by maceration in different solvents (Iland *et al.,* 2004). Among them, Glories method (Glories, 1984) and ITV method (*http://www.vignevin-sudouest.com*) are the most commonly used. Although is more laborious, Glories method used in this paper provides comprehensive information not only about the content of anthocyanins and polyphenols in grape, but also about the anthocyanins extractability and the maturity of seeds.

MATERIALS AND METHODS

The aim of this paper consisted of improving the polyphenolic potential of Feteasca Neagra and Cabernet Sauvignon grapes varieties, applying different vineyard practices such as organic and conventional culture system with and without additional works to reduce grapes on the vine by 30%, in the climatic conditions of the 2013 and 2014 years. The study was conducted in the viticultural center Murfatlar at the Research Center for Viticulture and Enology Murfatlar and the experimental design regarding the studied plots and variants are presented in Table 1.

Table 1. The characteristics of the studied plots

The system of culture	Variety	Variant	Year of planting	Planting distance	Density vine/ha	Exposi-tion	Slope
Organic	Feteasca neagra	Mt (control)	2007	2.2×1.1	4132	N-S	3-5%
		R30% (30% cluster thinning)					
	Cabernet Sauvignon	Mt (control)	2009	2.2×1.1	4132	N-S	3-5%
		R30% (30% cluster thinning)					
Conventional	Feteasca neagra	Mt (control)	2001	2.4×1.2	3472	E-V	1-2%
		R30% (30% cluster thinning)					
	Cabernet Sauvignon	Mt (control)	2001	2.4×1.2	3472	E-V	1-2%
		R30% (30% cluster thinning)					

For each of the eight variants about 200 berries/ three repetitions were collected, then packed and labeled in plastic bags and carefully transported to the laboratory to avoid crushing. Analyses were performed on the same day of sampling.

The polyphenolic potential of grapes has been evaluated by the Glories method, which consists in extracting anthocyanins from the grape skin, first under mild conditions and then under severe conditions necessary for facilitating the diffusion conditions. Acid medium, used as a facilitator factor of extraction, ruptures the proteo-phospholipid membrane, destroys the protein binding and releases the content of vacuoles. Two different aqueous solutions are used: a solution of pH 1 (0.1 n HCl solution prepared with 8.33 ml of 37% HCl in 1000 ml distilled water) and a solution of pH 3.2 (prepared by dissolving 5 g of tartaric acid in 800 ml of distilled water, adding 22.2 ml NaOH 1n and water up to 1000 ml in a volumetric flask). The method involves extraction of 50 g mashed grape skin with 50 ml of pH 1, while another 50 g of the mashed grape skin is subjected to extraction with pH3.2 solution. Both samples were manually stirred and allowed to rest for 4 hours at the room temperature. Samples are then filtered, resulting 2 solutions identified as "pH 1" and "pH3.2". Analysis of anthocyanins is performed for both solutions, using the differential pH method (Ribereau-Gayon, 1976), the determinations being performed in 1 cm optical path length glass cuvettes, by using a Helios Alpha UV-VIS spectro-photometer, produced by ThermoScientific, USA. The total content of phenols is determined only for the second solution, the pH3.2 at 280 nm, the determinations being spectrophotometrically performed by using 1 cm path length quartz cuvettes. These results allow for simple analysis of the potential total anthocyanins (A_{pH1}) potential extractable anthocyanins ($A_{pH3.2}$), the extractability index of anthocyanins expressed by the equation: $E(\%) = [(A_{pH1}-A_{pH3.2})/A_{pH1}] \times 100$; seed maturity index: $MP (\%) = [(280\text{-dpell})/280] \times 100$, skin grape tannin content, $dpell = (A_{pH3,2}x40)/ 1000$, the tannin content of seeds dTpep = A280-dpell and the content of total polyphenols PT (A280). Statistical calculation was performed using SPSS Statistics 17.0, by applying Duncan test for SD 5%.

RESULTS AND DISCUSSIONS

The synthesis of phenolic compounds in grapes was influenced by the different climate conditions of the two years studied; both years are considered as favorable, with for proper maturation conditions in July, August and September, although the average temperature of the air was with 2,7-4,7 ^{0}C higher than the average calculated over the last 20 years, and the precipitation were quantitatively significantly above the multi-annual average for Murfatlar vineyard ecosystem (Fig 1).

It is found that the significant amount of precipitations and the increase of the average air temperature have contributed to the inhibition of phenolic compound synthesis in 2014, while higher anthocyanin values were recorded in 2013, this phenomenon being consistant with the findings of other authors (Mori *et al.,* 2007; Cohen *et al.,* 2008).

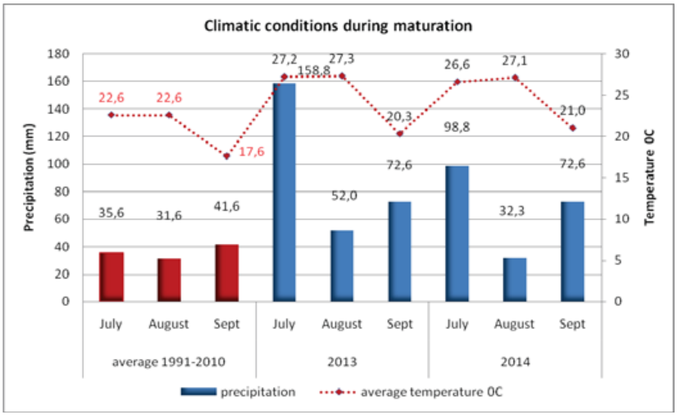

Fig. 1. The precipitation and the average temperatures during grape maturation in 2013 and 2014 years as compared to the averages of 1990-2010

The potential total anthocyanins (ApH1), and the potential extractable anthocyanins (ApH3,2) presented in Fig 2 (a and b) were influenced both by climatic conditions that led to a decrease in 2014 as compared to 2013, but also by the viticultural practices applied (organic and conventional culture system and special pruning techniques by suppression of the clusters) that led to a significant increase in anthocyanins. In the case of Feteasca Neagra variety the accumulation of total anthocyanins decreased in 2014 as compared to 2013, the recorded values for the ecological and conventional system being 27.4% and 11.2%, respectively. For Cabernet Sauvignon the decreasing trend is maintained for the 2014, with reduction of 26.4% for ecological and 31.1% for the conventional system. In case of the grapes thinning, this green harvest operation leads to an increase in the total anthocyanin content in the case of ecological system as compared to conventional one, regardless the year of harvest. The same trend is kept for extractable anthocyanins, the differences being significant between years and the applied viticultural practices.

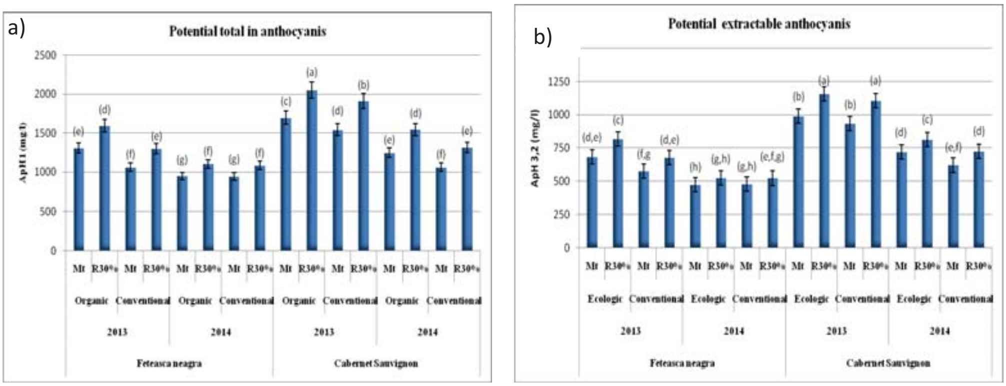

Fig. 2. The influence of climate and viticultural practices on potential total anthocyanins (a) and potential extractable anthocyanins (b). Mean values ± standard deviation (n = 3), letters represent difference of significance at $p < 0.05$ between variants.

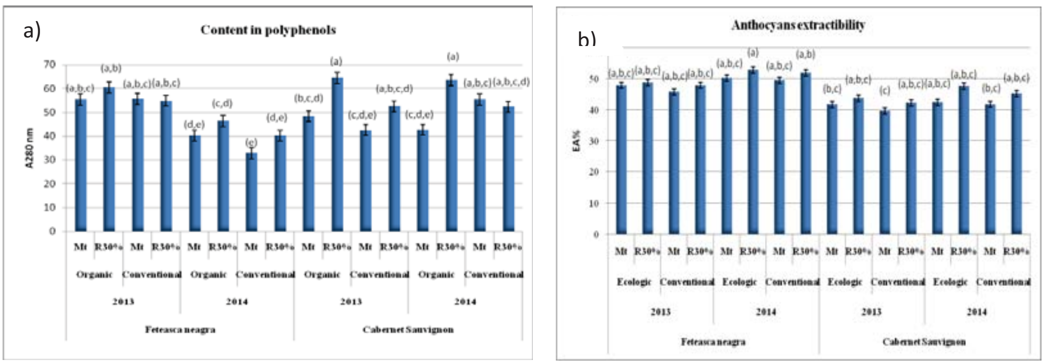

Fig. 3. The influence of climate and viticultural practices on the content of polyphenols (a) and anthocyanins extractability (b). Mean values ± standard deviation (n = 3), letters represent difference of significance at $p < 0.05$ between variants.

In the case of Feteasca Neagra the content in polyphenols (Fig. 3a) was significantly influenced by climatic conditions only, while the influence of thinning of the clusters and of the type of culture system was insignificant. For Cabernet Sauvignon, polyphenol content (Fig. 3a) was significantly influenced by the thinning of the clusters only in the case of ecological system, for both studied years. The percentage of extractability of anthocyanins (% EA) was not statistically influenced by any of the factors presented in this paper, higher values of this index being found for Cabernet Sauvignon variety, showing that extraction is more difficult in this case as compared to Feteasca Neagra. Skin grapes tannin content (dpell), shown in Table 2 was significantly influenced in the case of Feteasca Neagra variety only by the climatic conditions, but not by the viticultural practices applied. For Cabernet Sauvignon, skin grape tannin content showed higher values than Feteasca Neagra, being influenced by the applied viticulture practices (ecological and conventional and thinning of the clusters). Tannin content of seeds (dTpep) values were lower in 2014 as compared to 2013 for both varieties studied. The operation of clusters thinning and the organic and conventional culture system showed significant influences in this index. Maturity seeds showed significant differences in accordance to the variety and insignificant differences due to the climatic conditions and applied viti-cultural practices.

Table 2. Tannin content in the skin and seeds of grapes

Variety	Culture system and year	Variant	Skin tannin content (dpell)	Tannin content of seeds (dTpep)	Maturity seeds (Mp %)
FETEASCA NEAGRA	Organic 2013	Mt	28.9±3.4 (cde)	26.5±3.4 (ab)	47.8±4.5 (abc)
		R30%	34.3±4.8 (bcd)	26.1±3.9 (ab)	43.2±5.8 (bcde)
	Conventional 2013	Mt	26.1±5.1 (def)	27.5±2.6 (a)	49.5±4.3 (ab)
		R30%	30.6±3.1 (cde)	24.2±1.8 (abc)	44.2±3.6 (bcd)
	Organic 2014	Mt	20.3±4.7 (fg)	19.9±2.2 (bcd)	49.5±4.7 (ab)
		R30%	25.9±3.5 (ef)	20.4±2.6 (bcde)	44.1±3.8 (bcd)
	Conventional 2014	Mt	14.7±2.9 (g)	18.1±3.0 (cde)	55.2±4.2 (a)
		R30%	20.2±3.3 (fg)	20.0±2.6 (bcde)	49.8±5.1 (ab)
CABERNET SAUVIGNON	Organic 2013	Mt	31.8±4.3 (cde)	16.6±3.5 (de)	34.3±6.2 (efg)
		R30%	43.6±5.1 (a)	20.8±4.8 (bcde)	32.3±5.8 (fg)
	Conventional 2013	Mt	26.9±4.5 (def)	15.6±5.1 (e)	36.7±4.6 (defg)
		R30%	37.1±5.6 (abc)	15.4±3.6 (e)	29.3±5.2 (g)
	Organic 2014	Mt	24.6±4.4 (ef)	18.1±3.2 (cde)	42.4±4.6 (bcde)
		R30%	40.3±6.2 (ab)	23.1±4.0 (abcd)	36.5±4.8 (defg)
	Conventional 2014	Mt	29.2±3.1 (cde)	26.2±3.9 (ab)	47.3±5.4 (abc)
		R30%	32.1±3.8 (cde)	20.2±4.3 (bcde)	38.6±5.8 (cdef)
	SD%		0.052-0.145	0.053-1.000	0.055-0.174

Mean values ± standard deviation (n = 3), letters represent difference of significance at p <0.05 between variants. Different letters indicate the existence of statistically significant differences.

Tannin content in the skin and seeds with ApH1, ApH3,2,% EA, come to complete the information that technologist needs to know in order to adapt extraction technique for a sepcific vintage depending on the type of wine that wants to produce and the organo-leptic characteristics that wants to express in the wine. Based on the information obtained from the calculated indices regarding the po-lyphenolic potential the enologist can adjust the maceration-fermentation time adjustment, oxygenation, treatment with enzyme extrac-tion, temperature control, apply special me-thods of crushing and technological opera-tions (pumping, agitation etc.). In this way, the technologist is better equiped to make decisions for the production of high quality wines able to satisfy consumer preferences and needs of all of red wines lovers.

CONCLUSIONS

Based on the statistical analysis of the results it was concluded that the polyphenolic potential of the grapes is significantly influenced primarily by variety, followed by the climatic conditions of the two years studied, by the thinning cluster technique and last, but not least, by the culture system applied (organic and conventional).

All of the parameters obtained by the method Glories (total anthocyanins potential, potential extractable anthocyanins, the anthocyanin extractability index, index of maturity of seeds, skin tannin content, tannin content and seed polyphenol content) provide useful information necessary for the technologist to adapt winemaking techniques to improve the extraction of anthocyanins and tannins, in order to obtain quality wines, with intense color, but also balanced in taste and with distinctive typical varietal aroma, not covered by the agresivity of tannins. Adopting new vineyard practices such as cluster thinning for the ecological cultivation system may lead to an increase of the quality of grapes, especially as regards the polyphenolic compounds attracting in this way more consumers to the ecologically cultivated grapes and ecological wines.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

GLUTATHIONE AS A POSSIBLE REPLACEMENT OF SULFUR DIOXIDE IN WINEMAKING TECHNOLOGIES: A REVIEW

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Abstract

The paper presents a literature review regarding the role of glutathione as a natural antioxidant and its usage in various fields, with a special emphasis on aspects relevant to winemaking. Recent studies demonstrated the beneficial influence of the addition of glutathione in the white wine production technology, especially for the preservation of the varietal character of the wines obtained from aromatic grapes. Considering that in all living cells it has a similar role of antioxidant protection, it is a logical assumption that glutathione can contribute to the reduction of the dosage of sulfur dioxide used for wine protection and, in the future, it might be a good candidate for the replacement of sulphur dioxide.

Key words*: Glutathione, sulphur dioxide, white wine oxidation, varietal character preservation.*

1. INTRODUCTION

Glutathione (GSH, γ-L-Glutamyl-L-Cysteinyl Glycine), the most established antioxidant of endogenous origin, produced in both animal and vegetal cells, has as its main role the elimination of free radicals and protection of reactive compounds, which otherwise would rapidly interact with oxygen, ensuring as well the protection against various toxins and detrimental heavy metal actions, which interfere in the processes of cellular aging. Pompella *et al*. (2003) defined glutathione (GSH) as "an important antioxidant in plants, animals, fungi, and some bacteria and archaea, preventing damage to important cellular components caused by reactive oxygen species such as free radicals and peroxides". In fact, glutathione (Fig. 1) is a tripeptide with a gamma peptide bond between the carboxyl group of the glutamate side-chain and the amine group of cysteine (which is attached by normal peptide bond to a glycine). Due to its chemical structure, glutathione may protect against oxidation.

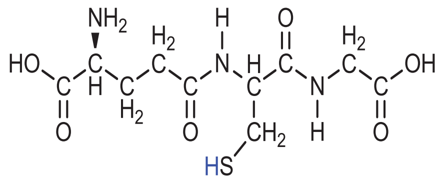

Figure 1. Glutathione (γ-L-Glutamyl-L-Cysteinyl Glycine, GSH)

A simple mechanism of protection is the one by which glutathione in its reduced form (GSH) is oxidized to its dimer form, thereby releasing protons and electrons (H^{+}+e^{-}) used in coupled reactions for the protection of other molecules against oxidation (Antoce, 2007).

Glutathione exists in both reduced (GSH) and oxidized (GSSG) forms. In the reduced state, the thiol group of cysteine is able to donate a reducing equivalent (H^{+}+ e^{-}) to other unstable molecules, such as reactive oxygen species. By donating an electron, glutathione itself becomes highly reactive, therefore readily reacting with another reactive glutathione to form GSSG (Fig. 2).

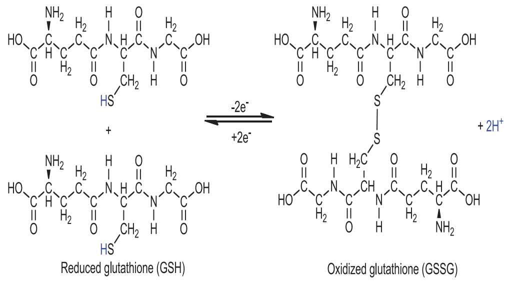

Figure 2. The oxidation reaction of GSH to GSSH

2. GLUTATHIONE AND ITS ROLE IN PREVENTING HUMAN DISEASES

Studies about glutathione appeared as early as the 1980's, but it was only after the year 2000 that an abundance of research results with relevance especially for the medical field was published. Investigations carried out on this tripeptide, which is synthesized by all the cells of the organism, revealed its valuable antioxidant, anti-inflammatory and detoxifying traits. This, in turn, made the researchers to consider it as a possible solution for the prevention and treatment of various immunitary, degenerative and metabolic diseases, including cancer. The fact that this tripeptide can be naturally found in all cells and qualities conferred by its antioxidant capacity, the cellular immune stimulation and detoxification encouraged researchers to consider glutathione a solution to fight incurable diseases such as different cancer types, neurodegenerative diseases such as sclerosis, Parkinson's disease and Alzheimer's disease, autism, Down syndrome, chronic fatigue, heart disease, chronic infections, autoimmune diseases, diabetes, arthritis, asthma, kidney problems, liver disease and more. Glutathione is the most spread intracellular thiolic antioxidant, being essential for redox defense mechanisms activated against oxidative stress. Glutathione metabolism is extremely accurate and is involved in redox signaling and protection against harmful actions of many environmental oxidants. Changes in the ratio of its reduced form and the disulfide form (GSH / GSSG) can destabilize the pathways that cause a wide range of physiological responses of the body, starting from cell proliferation to autophagy and apoptosis, due to the expression of genes involving H_2O_2 as a second messenger (Biswas *et al.*, 2009). The signalling mechanism involved is quite simple: reduced glutathione bonds to cysteine of another reduced glutathione, by serving as an electron donor used by the cells to detoxify ROS (reactive oxygen species), the glutathione being in this way converted to its oxidized form. Once oxidized, the dimer GSSG can be reduced back to GSH through a reverse process controlled by glutathione reductase, by using nicotinamide adenine dinucleotide phosphate as an electron donor (Couto *et al.*, 2013). A wealth of recent studies have concluded that ROS cause the development and evolution of tumors by inducing DNA mutations, genomic instability and aberrant pro-tumorigenic signalling. On the other hand, a high level of ROS may be toxic as well to cancer cells and can lead to their death, some treatment schemes relying on this very effect. To equilibrate the state of intracellular oxidative stress, cancer cells intensify their antioxidant protection mechanisms based on glutathione, which leads to the conclusion that high ROS levels can indeed block the tumors development (Glasauer *et al.*, 2014). An imbalance in the oxidant/antioxidant intracellular ratio and additional ROS generated by environmental factors have been demonstrated to have an important role in the development of respiratory diseases such as asthma, acute respiratory distress syndrome, chronic obstructive pulmonary disease, idiopathic pulmonary fibrosis and so on (Biswas *et al.*, 2008). Obvious deterioration of GSH homeostasis has been proven by Fitzpatrick and his team (2009) in the case of children with severe asthma refractory to the usual treatment. Decreased GSH, increased GSSG and higher oxidation levels were measured in their epithelial lining fluid. According to Livingstone and Davis (2007), "Glutathione is a central marker of oxidative stress and the most abundant, predominantly intracellular, antioxidant in the central nervous system". Previous studies (Cruz *et al.*, 2003) have suggested that maintaining glutathione balance is imperative for antioxidant protection mechanisms, synaptic plasticity, memory function and learning processes, the huge importance of glutathione for the proper functioning of the nervous system being underlined. Recent studies made by Michels and his co-workers (2014) demonstrated that, as compared to the case of non-PTSD participants, in PTSD (posttraumatic stress disorder) patients the levels of γ-amino butyric acid (a primary inhibitory neurotransmitter) and glutathione (a marker for neuronal oxidative stress) are found in significantly higher concentrations, strongly suggesting an abnormal oxidative stress. A deficiency in the glutathione metabolism was also identified in autism, a syndrome of specific mental pathology of children characterized by severe communication difficulties, repetitive behaviours and impairment in the ability to socially interact. Until now it was not clear whether the cause of the GSH deficiency in the cerebellum tissues of autistic subjects lay in the decreased synthesis, increased consumption and/or deficient regeneration mechanisms, but recent researches (Gu *et al.*, 2013) have reported that out of various enzymes involved in GSH metabolism, the glutamate cysteine ligase (GCL), catalyzing both GSH regeneration and synthesis, has an insufficient activity, most likely due to a decreased protein expression of GCL catalytic and modulatory subunits. A protective effect of glutathione was demonstrated in acute poisoning with omethoate, an organophosphorous insecticide, which may lead to hepatocellular edema and fatty degeneration of the liver. Lu and his team (2010) showed that exogenous reduced glutathione (GSH) prevents liver damage, by restoring the activity of acetylcholinesterase (AChE), which is significantly inhibited by the insecticide, and by also mitigating the stress response of the cells, by attenuating the increase in the activity of aspartate aminotransferase (AST), alanine aminotransferase (ALT), Tumor Necrosis Factor-alpha (TNF-α) and in nitric oxide (NO) production. As expected, the total concentration of glutathione in the cells and the balance in the GSH/GSSG forms is genetically determined. By studiying mono-and dizygotic twin pairs, Van ‘t Erve and his co-workers (2013) have demonstrated that the concentration of glutathione in human erythrocytes is an inheritable trait. They have also anticipated that this holds true for other types of cells too. As the couple GSH/GSSG is a marker of oxidative status in the cells, future research can focus on determining the contributions of both genes and environment to the antioxidant protection each individual can naturally achieve, so that personalized preventive or treatment strategies be applied. In this sense, up-regulation of glutathione-related genes (Schuliga *et al.*, 2002), modulating glutathione-related defenses, as well as modulating glutathione-related enzyme activities, may be a new approach in various therapeutic strategies. Knowing that GSH cannot be directly administered *per se* with any clinical consequence (Chen *et al.*, 1998a), various precursors (Chen *et al.*, 1998b; Olney *et al.* 1990; Ortolani *et al.*, 2000) or similar products with chemically modified formula (Yamamoto *et al.*, 1993; Burg *et al.*, 2002; Hamilton *et al.*, 2004; Kals *et al.*, 2008) were developed in order to simulate the physiological or pharmacological effects of glutathione, some of them used to intensify the anti-oxidant activity (Shibata *et al.*, 1995; Wang *et al.*, 1996; Ehrlich *et al.*, 2007), while others to target the enzymes involved in GSH metabolism (Batist *et al.*, 1986; Kunze *et al.*, 2000; Gate *et al.*, 2001; Ruscoe *et al.*, 2001;Wu *et al.*, 2010). The two approaches have shown significant therapeutic potential and a lot of new molecules are now in clinical tests and development (Green *et al.*, 2012). Modulation of glutathione, both by increasing it or by reducing it, has a huge potential and clinical significance in a wide range of human diseases (Wu and Batist, 2013).

3. GLUTATHIONE AND ITS ROLE IN PLANTS

The glutathione, as in all living cells, plays an indispensable role in plant cells, being involved in the antioxidant system, sulfur metabolism and the detoxification of xenobiotics (Noctor and Foyer, 1998). Glutathione is found in all plant cells, being synthesized either in the cytosol or in the chloroplast. As in human/animal cells, it has an antioxidant role, being associated with plant responses to various stress factors, participating in neutralizing free radicals and hydrogen peroxide produced by large temperature differences, lack of water, pesticides, air pollution (Alscher, 1989). Glutathione has vital importance for plants, because it fulfills certain essential functions in their metabolism. GSH participates in some biosynthesis processes and cell detoxification. It is involved in photorespiratory and respiratory metabolism control, phytohormones modulation and in redox mechanism against damaging actions of ROS (Noctor *et al.*, 2012). In some plants glutathione is found together with his homologues, molecules which have in their structure other amino acids in C-terminal position than the glycine (Rennenberg, 1980; Klapheck, 1988; Klapheck *et al*., 1992), such as alanine or serine. Homoglutathione (γ-Glutamyl-Cysteinyl-β-Alanine) is found mainly in legumes (MacNicol, 1987; Klapheck 1988), while in cereals, another GSH analogous, hydroxymethyl GSH (γ-Glutamyl-Cysteinyl-Serine), is predominant. Some researchers concluded that these analogues are not formed by specific synthesis, but rather by glutathione molecule modification (Klapheck, *et al*. 1992; Okumura *et al.*, 2003; Skipsey *et al.*, 2005). As in animal cells, disulfide forms of glutathione and its homologues are reduced to GSH through reactions catalyzed by GSH reductases (Klapheck 1988; Klapheck *et al*., 1992). Glutathione fulfills other important functions in plants, being involved in sulfur assimilation and inhibition of sulfate absorption (Herschbach and Rennenberg, 1994; Lappartient *et al*., 1999; Vauclare *et al*., 2002; Buchner *et al*., 2004), pollen germination and pollen tube growth (Zechmann *et al*., 2011) and cell division and meristem development (Vernoux *et al*., 2000; Cairns *et al*., 2006; Reichheld *et al*., 2007; Frottin *et al*., 2009; Bashandy *et al*., 2010). GSH is part of the mechanism to fight against infections caused by molds, such as *Botrytis cinerea* (Chassot *et al*., 2008). Oxidants are produced in plants following the metabolic processes of photosynthesis, photorespiration and respiration (Foyer and Noctor, 2003), but they are also generated by unfavourable weather conditions (cold, heat, drought, heavy rainfall), soil and air pollution and various pathogen agents, all affecting the GSH redox state in plants leaves (Sen Gupta *et al.*, 1991; Vanacker *et al*., 2000; Bick *et al*., 2001; Gomez *et al*., 2004). Interestingly, the content of GSH or its homologues in leaves is not very much influenced by the variation of light intensity during the day/night alternance. The ratio GSH/GSH homologues is constant in plants leaves, for example almost all soybean leaves with the exception of those damaged by age, contain similar total amounts and similar GSH/GSH homologues ratios. However, important gradients were measured between young and aged poplar tree leaves (Arisi *et al*., 1997). Toxic metals and metalloids determine an excessive production of ROS responsible for the oxidative stress, plants being among the most sensitive organisms to metal toxicity. GSH controls directly or indirectly the defense mechanisms against ROS, thus being involved in plants protection against oxidative stress generated by toxic metals and metalloids (Anjum *et al*., 2012). The anti-oxidant mechanism of glutathione observed in living cells is also valid in food products containing reduced-glutathione or their precursors. Their presence contributes to a better protection against the aggression of oxygen and to a longer shelf life of these products. Among foods, one that can benefit the most from anti-oxidant protection is the wine, therefore, from ancient times men was in pursuit of powerful (and healthy) anti-oxidant molecules to be added to protect the aroma and colour. It is therefore no surprise that the naturally-occurring GSH attracted recently a lot of attention, especially for the white wine anti-oxidant protection. Glutathione has crucial roles in winemaking, from the preservation of important varietal aroma compounds originating in grapes, to the limitation of browning and of atypical ageing off-flavours development in wines. The simplest protection mechanism against oxidation is the oxidation of reduced form of glutathione to its disulfide form. Another mechanism is based on the fact that, due to its end cysteine residue, the GSH reacts with quinones and forms colorless complex molecules, more resistant to further oxidation (Antoce, 2007).

4. OXIDATION MECHANISMS OCCURING IN WHITE WINES

Oxygen control, especially during white winemaking process, plays an extremely important role for the quality of wine. The lack of proper management of oxygen can promote oxidation reactions of certain phenolic compounds responsible for maintaining varietal character and typicity of the wine. Oxidative transformations of grape must start during the harvest process and transportion of grapes to the cellar, due to the exposure to air of the must leaking from the broken berries. Protection against oxidation should be taken into consideration particularly in pre-fermentation phases, the only cases in which positive effects of oxygen are apparent being during the first stages of wine fermentation and during maturation (Antoce, 2007). In the presence of oxygen, the very well known polyphenol oxidation processes are rapidly occurring and are followed by changes in the must/wine chemistry, with negative effects on the white wine quality, mostly expressed by wine browning and fruity aroma loss. However, oxygen supplementation is desired in some cases, going even as far as the hyper-oxygenation of the must. Winemaking by hyper-oxygenation technology is only recommended for non-aromatic varieties, in order to obtain neutral wines to serve as a base for sparkling wines or to obtain wines with enhanced fermentation aroma. Loss of aromatic compounds, browning and phenol precipitate formation are specific incidents associated with oxidation of white wines (Kilmartin, 2010). Oxidation of phenolic compounds in wine takes place by uptaking the oxygen dissolved in wine, either by chemical or by enzymatic pathways, both oxidation mechanisms occurring simultaneously. The oxidation of polyphenols from must occurs very rapidly under the catalysis of various polyphenoloxidases (PPOs). The tyrosinase enzymes catalyze the oxidation of cinnamic acid and its esters with tartaric acid (caftaric acid and cutaric acid) causing the formation of quinones, which are involved in various metabolic reactions of oxidation and oxidative polymerization. Laccases, another polyphenoloxidase found only in musts from grapes attacked by the fungus *Botrytis cinerea*, catalyze the quick oxidation of various substrates and is very hard to control (Antoce, 2007). On the other hand, it is believed that the non-enzymatic absorption of oxygen in the wine leads to similar products and further chemical processes as in the case of the enzymatic oxidation in the presence of PPO, except that the formation of hydrogen peroxide is only linked with the non-enzymatic oxidation (Singleton, 1987). Non-enzymatic oxidation of *ortho*-catechins leads to the formation of *ortho*-diquinones, with elimination in must of a molecule of H_2O_2, which is also very reactive and can oxidise other substances in wine, such as alcohols, producing more volatile aldehydes. One of the common oxidation reactions that occurs immediately following the chemical transformation of *ortho*-diphenols is the transformation of the ethanol into acetaldehyde (Antoce, 2007). The oxidation of *ortho*-diphenolic compounds allows for some further reactions resulting in the formation of quinones, by means of a semi-quinone radical intermediate. In this case oxygen is initially reduced to hydrogen peroxide, by a coupled transformation reaction of iron(II) into iron(III) (Waterhouse and Laurie, 2006). The resulted quinones have electrophilic properties, which prompts them to react with the nearby nucleophilic molecules, so that the catechol radical is converted back to a reduced phenolic form, although with a substituted group attached. The semi-quinones radicals are able to react with other radical species, including hydrogen atoms, regenerating in this way the *ortho*-diphenol structure. The chemical transformation of ethanol into acetaldehyde occurs in a significant proportion only when coupled with the oxidation of readily-oxidisable polyphenols, such as caffeic acid, a hydroxycinnamic acid typical for white wine (Wildenradt and Singleton, 1974). As such, these *ortho*-diphenolic compounds are oxidation propagators. In the absence of polyphenols, considered the main initial substrates for oxidation of wine, ethanol and tartaric acid are very stable against oxidation.

4.1. OXIDATIVE BROWNING OF WHITE WINES

The reaction of browning of white wines normally starts with a lag time, followed by a low speed phase, before reaching an accelerated phase, which leads to the conclusion that this phenomenon is rather an autocatalytic process, in which the easiest oxidizable polyphenol oligomeric products are involved. The browning of the white wines was rather correlated to the total flavonoid content than to the total phenols content or to the concentration of hydroxycinnamic acids (Singleton, 1987). The browning of the white wines is due to the oxidation of oxidisable polyphenols and is associated with the loss of varietal aroma compounds that give wine varietal typicity. Chemical analyses show that white wines have lower concentrations of total polyphenols (typically 200–500 mg/L), with a predominance of hydroxycinnamic acids. White wines contain low concentrations of flavonoids (quercetin glycosides or catechins), but even so, their presence is important in the context of wine browning. Higher concentrations of these compounds were found in musts with a longer time of contact with the skin and harder pressing (Maggu *et al.*, 2007), which make these particular musts more susceptible to browning. The mechanism by which the polyphenoloxidases (PPO) catalyze the oxidation reactions of the very easily oxidisable compounds in the presence of oxygen and in the absence of any protection with sulfur dioxide is very well known (Singleton, 1987). PPO enzymes determine the formation of reactive quinones, which can react further with other polyphenols, with glutathione or different varietal thiols, such as 3-sulfanylhexanol, in all cases resulting brown coloured products (Cheynier *et al.*, 1989a, 1993; Nikolantonaki *et al.*, 2014). Studies have shown that the preferred substrate of PPO is not the catechin, but the caftaric acid (caffeoyl tartaric acid) and the quinones resulted from the oxidation of caffeic acid have a higher affinity to bond with catechin, rather than with another caffeic acid, leading to catechin quinones, which in turn form condensation compounds (Cheynier *et al.*, 1989a). However, the PPO enzymes are playing this role in the white wine browning processes, only under certain conditions, such as the lack of SO_2 and only for a limited period of time (Traverso-Rueda and Singleton, 1973). Moreover, Lutter *et al.* (2007) showed in a model wine solution that in the presence of an Fe(II) catalyst the oxidation of caffeic acid leads to dihydroxy-benzaldehyde. When the dihydroxy-benzaldehyde reacted with catechin, not brown, but various colourless and yellow/red compounds were produced, including bridged-catechin dimmers (Cheynier *et al.*, 1989b; Schneider, 1998; Ho *et al.*, 2000). For the instability of varietal aromatic compounds (i.e. 3-sulfanylhexan-1-ol and for the wine browning reactions occuring during maturation) again the polyphenols are responsible, especially the flavonoids (i.e. flavan-3-ols and their condensation products, proanthocyanidins), which are readily oxidisable compounds (Blanchard *et al.*, 2004; Fernandez-Zurbano *et al.*, 1995; Nikolantonaki *et al.*, 2012; Rossi and Singleton, 1966). All the compounds responsible for the browning reaction of white wine were difficult to determine, but some studies have indicated some possible other directions and methods. George *et al.* (2006) have demonstrated that the glyoxylic acid, resulted from the oxidation of tartaric acid, binds with two catechin molecules trough a reaction catalysed by metalic ions (iron, copper) and form yellow coloured xanthylium pigments. The xanthylium cation pigments originating formed from epicatechin proved to be two times more intensely colored than those forming from solutions containing catechins (Labrouche *et al.*, 2005). The same pigments were generated in reactions between catechin and dihydroxfumaric acid, resulted from tartaric acid oxidation by hydroxyl radicals (Clark, 2008). The researches made by Merida *et al.* (2006) have demonstrated that in the presence of yeasts, a lower quantity of coloured products have been produced in the reaction between catechin and glyoxylic acid, this phenomen being explained by the fact that yeasts consumed the oxygen and that they are also capable to absorb the brown products. On the other hand, to prevent the browing of the finished wine, the hyperoxidation of musts can be used to eliminate the excessive easily oxidisable phenolic compounds, which are in this way oxidized and precipitated (Cheynier *et al.*, 1989b; Schneider, 1998; Ho *et al.*, 2000). As a consequence, wines with very low concentrations of polyphenols and with lower browning potential are produced. The aroma of these wines may achieve a high intensity if it is enhanced by freeze-concentration or the grapes are late harvested (i.e.: the icewines cases) (Kilmartin *et al.*, 2007)

4.2. OXIDATION OF AROMA COMPOUNDS

Another important general effect of wine oxidation is directly seen upon wine aroma (du Toit *et al.*, 2006), ranging from the benefic elimination of reductive smells generated by sulfur-containing compounds, to the detrimental aroma losses, through their oxidative degradation and the production of new 'oxidised' aromas. Moreover, many sulfur-containing compounds may produce unwanted aromas in wines (Mestres *et al.*, 2000), which must be removed later through oxygenation operations, racking or copper fining. However, some sulfur-containing compounds have positive effects to wine aromas (i.e: the dimethyl sulfide is enhancing the berry fruit note of the wines and varietal thiols, such as 3 mercaptohexanol (3MH), determine the grapefruit/ passionfruit aromas of Sauvignon blanc and other wines (Tominaga *et al.*, 1998)). Such compounds have to be protected against oxidation (Segurel *et al.*, 2004; Escudero *et al.*, 2007). A lot of studies have been made to understand how aroma compounds oxidation occurs in wines. As we saw previously, the polyphenols oxidation products are the quinones, which are easily reacting with the sulfides. Direct oxidation of thiols (mercaptans) to disulfide forms can also occur and is detrimental for the wine quality as these products are not anymore removable by copper fining (Rauhut *et al.*, 1996; Mestres *et al.*, 2000). Fedrizzi and his team (2007) found that in older wines, higher concentrations of dimethyl disulfide and diethyl disulfide, coupled with lower concentrations of ethyl mercaptan and 2-mercaptoethanol, indicate the occurance of oxidation processes. Marais (1979) reported as well increases in dimethyl sulfide with aging, due to the degradation of S-methyl methionine. In the case of the thiol group-containing amino acid cysteine, a very fast oxidation reaction occurs in the presence of O_2, Fe(II) and Cu(II), as the oxidation of thiols is catalysed by metals (Danilewicz *et al.*, 2008). The disulfides have the capacity to convert back to thiols due to the reducing ability of sulfites in wine, which has been demonstrated in model solution studies by Bobet *et al.* (1990). During wine ageing thiol compounds with lower sensorial thresholds than the disulfides they originate from are being released. During bottle storage mercaptans release from the hydrolysis of thioacetic esters has also been described by Rauhut and co-workers (1996). During wine-ageing, aldehydes are important intermediates in the redox processes occuring, leading to color and flavor changes. If the off-flavors resulted from wine oxidation remain at low concentrations they can contribute to the complexity of a wine, but when their proportion is increasing, the wine quality is affected (Oliveira *et al.*, 2011). Unsolved questions and issues remain regarding the way in which the behaviour of the aroma compounds can be controlled and modulated to obtain a better aromatic profile of the wines. Studies aiming to improve the aromatic profile of wines are continuously performed, a multitude of products with antioxidant properties and antioxidant protection technologies being proposed for various stages of the wine evolution, from grape harvesting and pre-fermentation phases, to wine stabilization, aging in bottles and final consumption.

4.3. ANTIOXIDANT PROPERTIES OF DIFFERENT ADDITIVES IN WHITE WINE

White wines resistance to oxidation is an imperious condition for the preservation of quality and extension of their shelf life. Winemakers can choose among a multitude of available choices for anti-oxygen protection, taking into account the rate and extent of oxygen exposure at various stages in winemaking. Among the most used methods for the management of unwanted sulfur compounds formed by oxidation it is the addition of antioxidant molecules such as SO_2, glutathione (GSH) and ascorbic acid, independently or in combinations. Another very well known technique is to maintain the wine on yeast lees during ageing, in order to harness lees ability for oxygen consumption. The use of various fining agents, especially before bottling, is another way to preserve wine quality, used to remove the substrates prone to oxidation, such as polyphenols and sulfur-containing compounds. As the metals act as catalysts for oxidation reactions, procedures to decrease the wine's metal content (especially iron and copper) or the use of chelating agents to block these metals and reduce their catalytic oxidative effect became available. Another direction is to use different antioxidant agents, in order to consume the dissolved oxygen or to reverse the oxidative processes from the wine, as antioxidants can act in a multitude of directions in achieving their antioxidant effect. One of the most used antioxidant compounds is sulfur dioxide (SO_2) widely applied in a lot of operations and with a multitude of techniques. Attempts to protect selected aroma compounds in a model wine solution containing isoamyl acetate, ethyl hexanoate and linalool were made by Roussis and Sergianitis (2008) by using as antioxidants SO_2 and mixtures of glutathione with either caffeic acid or gallic acid at concentrations similar to those found in wine. Polyphenolic compounds such as caffeic acid and gallic acid were used to provide protection against the loss of certain aroma compounds, by exploiting their preferential affinity for oxygen, as compared to other oxidisable substrates. In this case, the phenolic compounds proved to have completely different effect from the one shown in browning reactions (Kilmartin, 2010). Preservatives like SO_2, ascorbic acid, glutathione, having the ability to act as quinones reductants and/or scavengers are decisive factors for managing the wine resistance to oxidative aging and varietal thiol stability (Brajkovich *et al.*, 2005; Lavigne Cruège *et al.*, 2003; Ugliano *et al.*, 2011). The use of sulfur dioxide and ascorbic acid combined in different proportions determined the inhibition of polyphenol oxidation in wines to various extents (Oliveira *et al.*, 2002). However, as Barril *et al.* (2009) underlined, ascorbic acid is a highly unpredictable molecule and the usage brings some risks, because in the presence of catechin its degradation products can eventually react farther and lead to yellow coloured xanthylium pigments. Pons *et al.* (2010) emphasized that the ascorbic acid has a big potential to compromise the wine flavour, considering the fact that it stays at the origin of sotolon in dry white wines. As it is known, sulfur dioxide does not have the ability to capture oxidative degradation products of ascorbic acid, which means it is possible that SO_2 could not reduce the degradation of ascorbic acid (Barril *et al.*, 2012). Apart from SO_2 and ascorbic acid, the other native antioxidant compound found in grapes, the tripeptide glutathione (GSH), was studied in the last years and at present it is occasionally employed in winemaking, as the product is under evaluation by the OIV for the addition in must and wine (OIV resolutions OENO-TECHNO 10-445 and OENO-TECHNO 10-446, stage 5 in 2015) up to a concentration of 20 mg/l. Previous researches have demonstrated that the glutathione, combined with small quantities of SO_2, inhibit the loss of desirable aromatic compounds like mono-terpenes and esters, and delay the browning reactions in wines, especially the yellow coloured xanthylium cation pigments formation (Bouzanquet *et al.*, 2012; Roussis *et al.*,2007; Sonni *et al.*, 2011a). Lavigne and Dubourdieu (2002) were the first who have observed that reduced glutathione confers direct protection of the volatile thiols during the oxidative processes or aging in barrels, while Ugliano *et al.* (2011), confirmed the same protective effect by measuring the loss of volatile thiols in samples of Sauvignon Blanc with 20 mg/L of GSH added at bottling, finding that after 6 months of aging in bottles the loss of thiolic compounds was highly reduced. Vaimakis and his co-workers (1996) have measured in the white wine a higher un-oxidised phenol content after the addition of another thiolic compound, the amino acid cysteine. Other researchers (Nikolantonaki *et al.*, 2014) assessed with modern techniques the protective effect of antioxidant agents in wine, including SO_2, GSH, ascorbic acid and tannins. In spite of the intensifying research regarding the glutathione in wines, the present knowledge about the GSH antioxidant role and its complementary activity with the most common wine preservatives such as sulfur dioxide and ascorbic acid need to be further studied, as these combinations seem to be very promising for the wine oxidation control (Kritzinger *et al.*, 2012).

4.4. THE SULFUR DIOXIDE AS ANTIOXIDANT IN WINE

The most common antioxidant and preservative agent used in winemaking is the sulfur dioxide, as it has both oxidation preventing activity and antimicrobial role. An important proportion of SO_2 in wine is bound to carbonyl compounds, such as acetaldehyde and the free SO_2 is found mostly in the bisulfite ion (HSO_3^-) form, only a small proportion being identified as molecular SO_2 (Abramovicˇ*et al.*, 2014). This leads us to the conclusion that bigger quantities of free sulfur dioxide in wine, although not welcomed by the health-concerned consumers, determine higher molecular SO_2 levels and a better wine quality, as the amounts of hydrogen peroxide, o-quinones and carbonyl compounds are smaller (Webber *et al*., 2014). The sulfur dioxide is used in winemaking to limit the detrimental impact of oxygen intake into the wine, as its principal ability is to scavenge the above mentioned hydrogen peroxide, ortho-quinones and carbonyl compounds (Adachi *et al.*, 1979; Danilewicz and Wallbridge, 2010). The sulfur dioxide was seen first as an inhibitor of PPO activity (Singleton *et al.*, 1985). Later, SO_2 has been proven to be a fast scavenging agent of hydrogen peroxide, but not by directly reacting with oxygen. SO_2 can be oxidised by O_2 in model wine solutions only in the presence of catalytic metals (such as Fe and Cu) which are increasing the oxidation of ethanol to acetaldehyde, followed by an acetaldehyde-bound SO_2 accumulation (Danilewicz, 2003, 2007; Danilewicz *et al.*, 2008). Vivas and his co-workers (1997) have proposed an inhibitory role of sulfur dioxide for the polyphenols auto-oxidation reaction, as in their experiments the oxidation of catechol-containing polyphenols occurred much faster, with a bigger SO_2 consumption, but with minimal ethanol oxidation. The researchers have concluded that SO_2, at the concentrations typically found in wine, did not act as a superoxide ion scavenger, while superoxide was actually effectively removed by ascorbic acid and polyphenols (Vivas *et al.*, 1997). Sulfur dioxide has also an important role in the rapid reduction of oxidized polyphenols (Cheynier *et al.*, 1989a, 1993), which has also been demonstrated by Saucier and Waterhouse (1999) in the synergistic activity of SO_2 and catechin. Both tests applied (Folin–Ciocalteu and Randox (ABTS) total antioxidant assays) have indicated a minimal response with SO_2 alone, but a significant increasing response in the case of catechin and SO_2, demonstrating the ability of SO_2 to bring back the catechin quinone oxidation products in the form of reduced catechin, allowing it to start the reaction over again. In accordance to Lambropoulos and Roussis (2006), in model wine studies, the sulfur dioxide increases the ability of caffeic acid and gallic acid to protect from oxidation several esters and terpenes. Although any carcinogenic or genetic mutations caused by sulfur dioxide have not been demonstrated, it is agreed that the sulfur dioxide may adversely affect human health because of its potential allergenicity (Walker, 1985; Garde-Cerdán and Ancín-Azpilicueta, 2007). As a consequence, because SO_2 is actually used not only for wine production and preservation, but also as an additive in a multitude of food products, the amount ingested being cumulative, reducing its utilization had to become a priority for food and beverages industry. Even if at present producing wine without SO_2 addition is not acceptable for many oenologists, in the view of its multiple protection abilities to prevent the enzymatic oxidation of musts and to inhibit the growth of unwanted microorganisms (Garde-Cerdán and Ancín-Azpilicueta, 2007), for the sake of the consumers' health, finding other suitable replacement products or new compounds with similar or better preservative actions, has to be a priority for the wine researchers.

4.5. GLUTATHIONE AND ITS ROLE IN PREVENTING THE MUST AND WINE OXIDATION

One of the most promising molecules with abilities to at least replace the sulfur dioxide in its antioxidants actions is the glutathione. As mentioned before, glutathione (GSH) is a natural antioxidant contained in grapes, that plays key roles in winemaking, from the preservation of important varietal aroma compounds, to the limitation of browning and of atypical ageing off-flavours development in wines. The GSH content found in the various varieties of *Vitis vinifera* is extremely variable, depending on the genetic component, the level of grapes ripening, nutrition or environmental stresses. Grape juices contain different concentrations of GSH, from traces to more than 100 mg/L, the content being influenced by oxygen exposure, polyphenoloxidases activities, crushing operations, grape skin contact period and pressing conditions (Cheynier *et al.*, 1989c; Park *et al.*, 2000a; du Toit *et al.*, 2007; Maggu *et al.*, 2007; Patel *et al.*, 2010). Lower concentrations of GSH were found in a more oxidative must treatment, compared to a reductive one. In the pressed grape juice researchers measured lower concentrations of

GSH in the absence of added SO_2 and ascorbic acid, but the GSH content found during frozen storage, was quite stable (du Toit *et al.*, 2007). To assure the antioxidant protection of musts, high concentrations (50–100 mg/L) of free glutathione in crushed grapes are needed (Singleton *et al.*, 1985). Even during the alcoholic fermentation a possible variation of GSH content can be observed, related to the yeast activity (Mezzetti and de Vero, 2014). In finished wines, the GSH concentration may considerably vary (Kritzinger *et al.*, 2013; Park *et al.*, 2000a) due to several technological conditions. Starting from the grapes, GSH production is directly correlated with both total nitrogen and assimilable amino acid content of grape juice, therefore, even from the beginnig, the raw materials differ significantly. Afterwards, the fermentation yeast may also influence the GSH concentration in the medium, and the lees contact can have an even greater influence. To establish the GSH positive influence to the wine quality, intending specifically to limit the browning reactions and losses of aroma compounds, some researchers analyzed its antioxidant status in the presence of various oenological factors, such as yeast strain choice, extended lees contact and the manipulation of juice assimilable nitrogen content (Kritzinger *et al.*, 2013). The GSH concentration during the alcoholic fermentation was measured too within various experimental studies. Irregular levels of GSH during the alcoholic fermentation were found, some researchers reporting higher levels (Park *et al.* 2000a, b; Fracassetti, 2010; Andújar-Ortiz *et al.*, 2012), other lower levels (du Toit *et al.*, 2007; Patel *et al.*, 2010; Coetzee, 2011) as compared to GSH initial amount. Lavigne and his collaborators (2007) established that the glutathione concentration after alcoholic fermentation completion is directly influenced by the yeast strain, as they measured different GSH concentrations in the same Sauvignon Blanc juice inoculated with different yeast strains. Working with other yeasts, other researchers did not confirmed these results. Results obtained by Fracassetti (2010) lead to the conclusion that the influence of yeast strain on the GSH wine concentration is insignificant. Kritzinger and his team (2013) studied too the influence of some commercial wine yeast strains, lees contact and assimilable nitrogen content on glutathione concentration in wine. Decreased contents of glutathione were reported by many researchers during wine ageing (Penna *et al.*, 2001; Ugliano *et al.*, 2011). However, the GSH concentration remaining in wine is indeed affected by the wine yeasts, as it was observed that the lees prevents the consumption of the glutathione content (Lavigne *et al.*, 2007). Kritzinger *et al.* (2012) demonstrated that the use of GSH-enriched inactive dry yeast preparations also have influence on the GSH concentration in the wine, fact also supported by other researchers (Lavigne *et al.* 2007), who showed that keeping the wines on the lees could contribute to maintaining of a good level of glutathione in the aging wine. Some yeasts are at present specifically selected to impact on the total content of GSH and resolutions are under debate at the OIV, regarding the approval of inactivated yeasts rich in glutathione containing at least 8 mg/g of reduced glutathione (resolutions OENO-TECHNO 13-532 and OENO-TECHNO 13-533, Stage 5 in 2015).

As suggested by Kritzinger (2012), the final concentration of GSH in wine may be influenced by the *Saccharomyces cerevisiae* metabolism during alcoholic fermentation. As GSH is an intracellular compound, it is released during the process of yeast autolysis, and can be absorbed as well from the extracellular environment by the yeast cells. Kritzinger and his co-workers (2013) concluded that the yeast strains could alter the GSH content in wines, by either utilising or secreting glutathione during fermentation, leading in this way to a variable wine GSH content. In supporting this theory, several research teams have identified and described in *S. cerevisiae* transporters for both the absorbtion and secretion of GSH (Miyake *et al.*, 1998; Bourbouloux *et al.*, 2000; Dhaoui *et al.*, 2011). Because GSH can be transported to the vacuoles of yeast cells, Jaspers and his collaborators (1985) have shown that GSH may be degraded by the enzymes form vacuolar membrane, such as c-glutamyltranspeptidase (c-GT) and L-cysteinylglycine dipeptidase. Kumar *et al.* (2003) described an alternative pathway of GSH degradation in *Saccharomyces cerevisiae*, independent of the enzyme c-GT, mediated by a novel protein complex encoded by three new genes (Ganguli *et al.*, 2007). GSH plays a crucial role during the oxidation of white must and wine, being involved even in some oxidation reactions of phenolic compounds, as it is the case of caftaric acid quinones, with which it forms 2-S-glutathionyl caftaric acid, the so called Grape Reaction Product (GRP) (Singleton *et al.*, 1985; Cheynier *et al.*, 1986; Antoce, 2007; Sonni *et al.*, 2011a,b). These reactions usually occur during the operation of grapes crushing, when most of the phenolic compounds come in contact with oxygen and in the presence of PPO are rapidly oxidized, but these reactions can also occur later, without enzymes, when there only is chemical oxidation (Sonni *et al.*, 2011a, Ugliano *et al.*, 2011). GSH can also operate indirectly as a cofactor for several antioxidant enzymes, such as GSH peroxidase, GSH reductase, glutaredoxins and GSH S-transferases (Grant, 2001). This is the way in which GSH inhibits the browning reactions in wine, by blocking the *ortho*-quinones in uncoloured polymers (Singleton *et al.*, 1985; Antoce, 2007), making the ratio of glutathione to caftaric acid important for the browning susceptibility of a wine (Cheynier and van Hulst, 1988). Singleton suggested in 1987 to calculate an index of the enzymatic oxidation to which a must was exposed, as the ratio of caftaric acid to the GRP. Although it is thought that during alcoholic fermentation and storage of wine no significant changes of caftaric acid or S-glutathionyl caftaric acid (GRP) content occur, in further studies performed on bottled red wines kept for 170 days at 20°C, Giovanelli and Brenna (2007) found an increase of GRP concentration. The increase in GRP may be explained by a reaction of glutathione with caftaric acid quinones resulted from the chemical oxidation that can still occur in wine during aging in bottle. A similar evolution has been proven by Bassil *et al.* (2005), who obtained S-cysteinecaffeic acid by adding only the amino acid cysteine to caffeic acid oxidised by using sodium periodate as oxidant agent. To balance the dual effect of glutathione, which can protect from oxidation and contribute to oxidation as well, Vaimakis and Roussis (1996) have proposed a combination of white must oxidation and glutathione addition. It has been already demonstrated that glutathione is useful for the protection of different varietal aroma compounds during the aging of wines, as it is the case of 3-mercaptohexanol or other polyphenols (Dubourdieu *et al.*, 2000), volatile thiols (Lavigne-Cruège and Dubourdieu, 2002; Dubourdieu and Lavigne, 2004; Ugliano *et al.* 2011), esters and terpenes (Papadopoulou and Roussis, 2001, 2008; Roussis *et al.*, 2009). GSH appears to have an inhibitory effect on the formation of sotolon and 2-aminoacetophenone, which contribute to the development of atypical ageing characters (Dubourdieu and Lavigne, 2004). Other studies were not able to show any significant correlation between browning and GSH content. The statistical analyses of physicochemical parameters of thirteen Lebanese 2 years old Chardonnay dry wines of the same vintage studied by El Hosry and his team (2009) have lead to the conclusion that the main contributors to the wine browning are the pH, total phenols and total SO_2, but not the glutathione. Previously similar results were reported by Fernandez-Zurbano and co-workers (1995). In these cases, rapid oxidation of glutathione might explain the lack of correlation between GSH and browning predisposition of wine. By adding GSH, the aromatic characteristics of wines are primarily improved (du Toit *et al.*, 2006), as the first step of wine oxidation affects the aroma compounds, while browning is a later step (Singleton, 1987). The wines produced from oxygenated musts to which GSH has been added registered a considerable improvement of quality, without signs of specific oxidation flavour (Vaimakis and Roussis, 1996). In order to determine the doses of exogenous GSH which should be added to wine to obtain antioxidant protection and improved wine aromatic profile, different variants were studied. The protection against the loss of α-terpineol and linalool has been ensured by the addition of 20 mg/L of glutathione in Muscat wines kept in contact with the air at 20°C for 3 days (Papadopoulou and Roussis, 2001). The results were also confirmed in 2008 by the same authors during the storage of Debina white wines added with 20 mg/L of GSH. Lavigne-Cruege and Dubourdieu (2002) have showed that the addition of only 10 mg/L of GSH prevented the apparition of yellow shading of wine, ageing defects and the loss of the varietal aroma. Du Toit *et al.* (2006) have found that during 8 days of accelerated oxidation (55°C), a concentration of 10-20 mg/l added GSH lead to a maximum total phenol content, while in the samples with 30 mg/L a moderate diminution of the total content of phenol occurred. The control samples, without any addition of GSH registered the lowest total phenol content. A clear improvement in total phenol content was initially observed (on day 0) for all wine samples with added GSH in comparison with control sample (with no added GSH). After 8 days of oxidation, irrespective of the glutathione addition, the GSH concentration in all the studied samples, ranged from 4.79 to 5.11 mg/L. Because a similar GSH concentration of 5.1 mg/L was found in white Palomino wine from Davis USA (Park *et al.*, 2000a) some researchers (Du Toit *et al.*, 2006) drew the conclusion that the value of about 5 mg/L of GSH is a steady-state value for the white wines. Webber and his collaborators (2014) have evaluated the effect of glutathione (GSH) addition on secondary aromas and on the phenolic compounds of sparkling wine elaborated by traditional method. When 10-20 mg/l GSH were added to the base must, lower levels of total phenolic compounds, hydroxycinnamic acids, ethyl decanoate, octanoic and decanoic acids were recorded, along with higher levels of 2-phenylethanol, 3-methyl-1-butanol and diethyl succinate. The GSH addition has a better effect for the sparkling wine quality when it is performed in the base must and not in the base wine. The highest level of total glutathione, as reported by Webber and his team (2014), was found in sparkling wine in which GSH was added to the must. GSH addition to base wine determined higher levels of free SO_2, irrespective of the amount of added GSH (Webber *et al.*, 2014). The levels of GSH in sparkling wines are similar to those found in still white wines (Marchand and de Revel, 2010; Janes *et al.*, 2010; Fracassetti *et al.*, 2011). The content of GSH in the sparkling wine production diminished during fermentation, as observed also in some previous studies (du Toit *et al.*, 2007; Kritzinger, 2012) and was lower than the quantity of GSH added to the must and/or base wine. In the case of sparkling wines too, GSH may have been consumed by the reaction with *ortho*-quinones to form the GRP or by its interaction with the yeast (du Toit *et al.*, 2007; Kritzinger, 2012). In previous studies Penninckx (2002) underlined that GSH is involved in many stress response mechanisms of *Saccharomyces cerevisiae* and it may also play a role in the maintenance of basic cell functions such as cell structural integrity. GSH is an important metabolite for the yeast multiplication during alcoholic fermentation and it is also a potential source of nitrogen and sulfur (Penninckx, 2002). GSH is the most abundant sulfur-containing organic compound in *Saccharomyces cerevisiae,* which can account for 0.5–1.0% of the cell dry weight (Elskens *et al.*, 1991). As a source of sulfur, glutathione may also generate undesirable sulfur-based odours. Some studies regarding actually pointed out the potential of GSH to be a source of hydrogen sulfide (H_2S), because cysteine, one of the amino acids constituents of GSH, can be degraded by cysteine desulfhydrase to form H_2S (Tokuyama *et al.*, 1973). Hallinan and co-workers (1999) researches reported that glutathione may contribute to up to 40% of the H_2S release, liberated from sulfate by nitrogen starved yeast, incubated in the presence of sulfate. In a more recent study Ugliano *et al.* (2011) reported the formation during aging of a higher concentration of H_2S in the wines treated with GSH prior to bottling than in untreated wines.

GSH influence and functions in must and wine, along with its evolution during the alcoholic fermentation or aging, is thus not completely understood, therefore, further studies are necessary to completely clarify the way in which GSH can contribute to the wine quality improving during all winemaking stages.

5. CONCLUSIONS

Glutathione is found in plants, especially in fruits, among which the grapes are an important source. Its presence in grapes ensures the antioxidant protection of the must and the crushed grape mash, as its chemical structure allows for the oxidation of its thiol group into a disulfuric group, thus protecting other molecules from the attack of reactive oxygen species. With its high affinity for oxygen, glutathione preserves the fruity aromatic notes of young wines and prevents the premature aging of the wine. Glutathione can also block the formation of *ortho*-quinones, which confer brownish colour to the wines, by reducing them to incolor phenolic compounds. Glutathione from grapes can also be used during must fermentation by the *Saccharomyces* yeasts as a source of sulfur, provided by its cysteinyl residue. Recent studies also demonstrated the beneficial influence of the addition of glutathione in the white wine production technology, especially for the preservation of the varietal character of the wines obtained from aromatic grapes. Many studies have demonstrated a direct relation between the oxidative stability of white wines, the values of pH, total phenol and total SO_2 levels and of GSH added to must or to wine during bottling. GSH can improve the wine stability and prevent the apparition of atypical oxidative flavours during wine ageing. Considering that it has a similar role of antioxidant protection across all living things, it is a logical assumption that glutathione can function similarly in processed foods and that can contribute to the reduction of the dosage of sulfur dioxide used for antioxidant wine protection. Athough, due to sulfur dioxide multiple functions in preservation of foods and wines, a complete replacement of sulfur dioxide cannot be envisaged, in the future, it might become a good candidate for partial replacement of sulfur dioxide. For now, it is important to continue the researches in order to establish the minimum/optimal amounts of free sulfur dioxide and/or ascorbic acid needed besides GSH to assure the wine stability.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

DETERMINATION OF THE FLOW UNIFORMITY AT TARAL 200 PITON TURBO SPRAYING MACHINE FOR PEST AND DISEASE CONTROL IN VINEYARDS, USING TWO TYPES OF NOZZLES

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Abstract

Pest and disease control is one of the most important technological links; otherwise the losses can be very high. Chemical control is the main method used in plant protection and for carrying out this work using specialized machinery. Sprayers are equipped with different construction types of nozzles made of different materials resistant to corrosion hydroabrasive to plant protection products. But with all their strength, their spray hole is decalibreate. Thus, the chemical solution will not effectively combat the diseases and pest, consumption of pesticide will be high. The phytosanitary solution no longer reaches the plant pollute soil, residues having a negative impact on microorganisms. For this reason, it is recommended that before each campaign to combat pests and diseases, nozzles should be tested by measuring powder flow. To this end, on the sprayer for pest and disease control in vineyards TARAL 200 TURBO PITON were mounted two types of hydralic nozzles, one with full cone jet, and other with air absorption and flat fan jet. In this respect has been tested spraying machine, spraying the two ramps for different working pressures (0.2; 0.4; 0.6; 0.8; 1.0; 1.2 and 1.4 MPa). Thus, for one minute, the flow rate of each nozzle was collected in the receptacle and then measured with a graduated cylinder. After determining the flow uniformity was found that the nozzles have recorded over 95% uniformity.

***Key words**: full cone nozzle, flat fan nozzle with air absorption, spraying machine, TARAL 200 PITON TURBO.*

INTRODUCTION

Direct and indirect energy consumption for spray application treatments account for about 28-30% of annual consumption technology (Berca, 2001). Damage caused by diseases and pests among vineyards and orchards causing economic losses by reducing production both quantitatively and qualitatively (Toma et al., 1981).
If the pesticide treatments are not applied effectively and timely production suffers heavy losses or may even be completely destroyed.
For this reason, pest and disease control is a very important technological component, without which production would not be safe and constant year.
Pesticides are the most effective means to combat pests and diseases, and to maintain current yields (Arias-Estévez et al., 2008).
Pesticides are toxic, and non management technology lead to pollution of soil, water and vegetation. Thus, foods lose their flavor, it distorts the content in nutrients and can even traces of pesticide residues (Jităreanu et al., 2007).
Soil is the most important environmental factor, since it is a "living organism". Pesticide residues in soil changes its physical properties, chemical and biological, affects microorganisms, so do not delay its degradation to occur.
Sprayers for pest and disease control must ensure effective treatment with superior quality indices, work to prevent production losses, high consumption of pesticides and reduce environmental pollution (Nagy et al., 2007). To do this, the machines are equipped with different types of nozzles, made of various materials (stainless steel, brass, plastics, ceramics) hydroabrasion resistant to chemical pesticides. However, with time, their spray hole is decalibreate. This will encourage a greater flow spray and spray unevenly, leading to overtreated areas or to other

untreated with increased risks of soil pollution. For this reason, before each campaign zone, it is indicated that the nozzles to be tested by the determination of the flow spray them. In this context, machine spraying in vineyards TARAL 200 PITON TURBO was equipped with two construction types of nozzles which was determined by flow uniformity.

MATERIALS AND METHODS

In order to determine flow uniformity machine for pest and disease control in vineyards type TARAL 200 PITON TURBO, were mounted on the two ramps of its two construction types of hydraulic nozzles, one of the ceramic material with full cone jet, AMT 1.2 from ALBUZ and other plastic with flat fan jet and air absorption, IDK 120-02 from LECHLER (Figure 1).

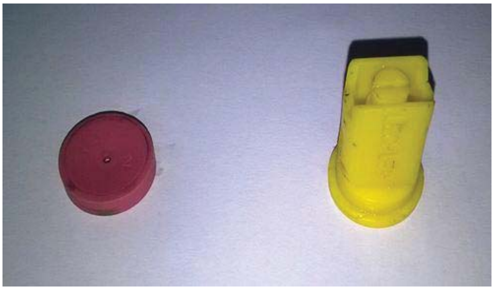

Figure 1. AMT 1,2 nozzle from ALBUZ (left) and IDK 120-02 nozzle from LECHLER (right)

Machine for pest and disease control PITON 200 TARAL TURBO presents the following parameters: tank capacity - 200 l, fan airflow - 7920 m³/h, maximum pump flow rate of 55 l/min, pump working pressure adjustable to 4.0 MPa, two ramps spraying with 4 nozzles each.
For experimental tests has been on idle tractor and PTO speed to asicron to 540/1000 rev/min.
Each flow spray nozzle spraying the two ramps was determined after installation of hoses at the end of each nozzles and collection solution (water) in containers (Figure 2).
The collected solution for one minute, was measured using a graduated cylinder, the working pressure of the spraying machine: 0.2; 0.4; 0.6; 0.8; 1.0; 1.2 and 1.4 MPa.

Figure 2. Collection of each nozzle spray solution on the two ramps spraying machine for pest and disease control in vineyards TARAL 200 PITON TURBO

After determining the flow rate of each nozzle spray (q_i) mounted on the two ramps spraying in three repetitions, average flow was debited liquid nozzle (q_m). The average flow rate of the liquid sprayed by each nozzle (q_m) was calculated with the following formula:

$$q_m = \frac{\sum_{i=1}^{i=n} q_i}{n} \text{ (l/min)},$$

in which:
q_i – spray rate of each nozzle;
n – number of determinations (repetitions).
According to FAO recommendations, the deviation from the average values must not be greater than ± 10%.
The uniformity of flow nozzle (C_d) for each type of nozzle and each pressure of the two ramps spraying was determined by the relationship:

$$C_d = \left[1 - \frac{\sqrt{\frac{\sum_{i=1}^{i=n} (q_i - q_m)^2}{n(n-1)}}}{q_m} \right] * 100 \text{ (\%)},$$

in which:

q_i – spray rate of each nozzle;
q_m – average flow liquid nozzles;
n – number of determinations (repetitions).
The uniformity of the fluid flow nozzle (C_d) should not exceed 95%.

RESULTS AND DISCUSSIONS

The uniformity of flow hydraulic nozzle with full cone jet was optimal for all 8 nozzles mounted sprayer TARAL 200 PITON TURBO and all working pressures, the lowest value being 99.44% for the nozzle 3, at pressure 0.2 MPa (Table 1).
Deviation of average flow nozzle on both ramps their mean was ± 10% for all pressures. The smallest deviation was obtained at pressure 1.4 MPa, is ± 2.98%.

Table 1. The uniformity of flow full cone jet nozzle, AMT 1.2 from ALBUZ

Pressure (MPa)	Right ramp				Left ramp				$\overline{X} \pm s_{\overline{X}}$ *
	Nr. nozzle	q_i (cm³/min)	q_m (cm³/min)	C_d (%)	Nr. nozzle	q_i (cm³/min)	q_m (cm³/min)	C_d (%)	
0.2	1	1236.66	1249.16	99.71	5	1256.66	1260.83	99.90	1255.00±5.00
	2	1240.00		99.78	6	1273.33		99.71	
	3	1273.33		99.44	7	1250.00		99.75	
	4	1246.66		99.94	8	1263.33		99.94	
0.4	1	1513.33	1521.66	99.84	5	1520.00	1532.50	99.76	1527.08±4.19
	2	1523.66		99.90	6	1543.33		99.79	
	3	1510.00		99.77	7	1530.00		99.95	
	4	1536.66		99.92	8	1536.66		99.92	
0.6	1	1784.00	1772.66	99.81	5	1783.33	1767.50	99.74	1770.08±6.35
	2	1773.33		99.98	6	1776.66		99.85	
	3	1743.33		99.52	7	1766.66		99.98	
	4	1790.00		99.60	8	1743.33		99.60	
0.8	1	2033.33	2060.00	99.62	5	2036.66	2072.50	99.50	2066.25±7.62
	2	2056.66		99.95	6	2083.33		99.84	
	3	2080.00		99.71	7	2086.66		99.80	
	4	2070.00		99.84	8	2083.33		99.84	
1.0	1	2236.66	2234.16	99.96	5	2226.66	2228.33	99.97	2231.25±3.82
	2	2223.33		99.86	6	2210.00		99.76	
	3	2233.33		99.98	7	2240.00		99.84	
	4	2243.33		99.89	8	2236.66		99.89	
1.2	1	2356.66	2376.66	99.75	5	2340.00	2376.66	99.55	2376.66±7.50
	2	2373.33		99.95	6	2396.66		99.75	
	3	2403.33		99.67	7	2393.33		99.79	
	4	2373.33		100.00	8	2376.66		100.00	
1.4	1	2559.33	2560.33	99.98	5	2563.33	2572.50	99.89	2566.41±2.98
	2	2553.33		99.92	6	2573.33		99.99	
	3	2565.33		99.94	7	2576.66		99.95	
	4	2563.33		99.95	8	2576.66		99.95	

* Values represent mean and standard deviation of the mean flow ($\overline{X}$).

The nozzles with air absorption and flat fan jet obtained lower flows. The uniformity of the flow rate thereof was optimal also for all the eight nozzles at all operating pressures. The lowest flow uniformity was 98.98% for the 6 nozzle at a pressure of 0.2 MPa (Table 2).
The standard deviation of the mean flow nozzles on both ramps had values of ± 10% at all working pressures. The slightest deviation from the mean was obtained at 0.8 MPa pressure, is ± 3.50%.

Table 2. The uniformity of flow flat fan jet nozzle and air absorbtion, IDK 120-02 from LECHLER

Pressure (MPa)	Right ramp				Left ramp				$\overline{X} \pm s_{\overline{X}}$*
	Nr. nozzle	q_i (cm³/min)	q_m (cm³/min)	C_d (%)	Nr. nozzle	q_i (cm³/min)	q_m (cm³/min)	C_d (%)	
0.2	1	683.33	680.00	99.85	5	676.66	689.16	99.47	684.58±4.95
	2	676.66		99.85	6	713.33		98.98	
	3	683.33		99.85	7	696.66		99.68	
	4	676.66		99.18	8	670.00		99.19	
0.4	1	950.00	956.66	99.79	5	943.33	960.83	99.47	958.75±6.04
	2	960.00		99.89	6	983.33		99.32	
	3	943.33		99.59	7	976.66		99.52	
	4	973.33		99.37	8	943.00		99.37	
0.6	1	1080.00	1091.66	99.69	5	1063.33	1082.50	99.48	1087.08±5.05
	2	1086.66		99.86	6	1100.00		99.53	
	3	1110.00		99.51	7	1090.00		99.79	
	4	1090.00		99.84	8	1076.66		99.84	
0.8	1	1303.33	1311.66	99.81	5	1313.33	1305.00	99.81	1308.33±3.50
	2	1326.66		99.66	6	1310.00		99.88	
	3	1313.33		99.96	7	1303.33		99.96	
	4	1303.33		99.74	8	1293.33		99.74	
1.0	1	1403.33	1393.33	99.79	5	1423.33	1401.66	99.55	1397.50±4.86
	2	1380.00		99.72	6	1403.33		99.96	
	3	1403.33		99.79	7	1393.33		99.82	
	4	1386.66		99.68	8	1386.66		99.69	
1.2	1	1520.00	1506.66	99.74	5	1503.33	1502.50	99.98	1504.58±5.43
	2	1503.33		99.93	6	1523.33		99.59	
	3	1506.66		100.00	7	1473.33		99.43	
	4	1496.66		99.85	8	1510.00		99.85	
1.4	1	1576.66	1572.50	99.92	5	1560.00	1563.33	99.93	1567.91±4.03
	2	1580.00		99.86	6	1566.66		99.93	
	3	1563.33		99.83	7	1580.00		99.69	
	4	1570.00		99.69	8	1546.66		99.69	

* Values represent mean and standard deviation of the mean flow ($\overline{X}$).

CONCLUSIONS

The uniformity of flow of the two types of nozzles has optimum of over 95% at all operating pressures.
The standard deviation of the mean flow to the eight nozzles mounted on both ramps had values of more than ± 10% at all operating pressures.

ACKNOWLEDGEMENTS

This paper was published under the frame of European Social Fund, Human Resources Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/ 132765.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE QUANTITY AND QUALITY OF GRAPES OF 'PREZENTABIL' TABLE GRAPES VARIETY BY THE INFLUENCE OF BIOLOGICALLY ACTIVE SUBSTANCES

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Abstract

The table grape production is an effective branch in Moldova. Increasing the quality and quantity of table grape is a necessity for society. The purpose of the research from this article is to study the influence of Gobbi Gib 2LG on the quantity and quality of grapes of 'Prezentabil' variety. The research was conducted in the vineyards of the „Terra Vitis" LTd, from Southern wine region in Moldova. Research results have shown that the dose of 0,98 l / ha is most useful for conditions south of Moldova, for 'Prezentabil' variety.

***Key words**: Prezentabil, table grape, growth stimulators.*

INTRODUCTION

There are a lot of agricultural branches, including viticulture, that use a new efficient proceeding – which is the use of growth regulators or biological active substances.
All growth regulators (natural and synthetic ones) are organic substances which, if used in low concentrations, are able to cause essential modifications within the growth and development processes of the plant body and incite their regulation. A specific particularity of the regulators action is their capacity to influence on the processes that are not responding on the influence of normal agricultural proceeding (Winkler A.J., 1966 (Уинклер А.Дж., 1966); Wear R.J.,1976; Winkler A.J., 1997; Smirnov K.V. and others, 1987 (Смирнов К.В. и др., 1987).
The use of gibberellins within table grape variety technology in most of the countries around the world (Japan, USA, Russia, Italy, Ukraine, Bulgaria etc.) is an obligatory agricultural process. Treating the inflorescences (within the blooming period, within the postfecundation period) leads to considerable modifications of the morphological and mechanical bunch particularities and to productivity increase as well as grain quality modifications.

MATERIALS AND METHODS

The purpose of the research was to study the influence of the Gobbi Gib 2LG, produced by „L Gobbi" Ltd., Italy on the table grapes varieties productivity.
To achieve the final purpose it was necessary to track down the following objectives:
- the action of Gobbi Gib 2LG on the table grapes variety Presentabil, on its berry morphological parameters and mechanical properties;
- the action of Gobbi Gib 2LG on the productivity and quality of the grapes;
- finding out the optimal concentration of the Gobbi Gib 2LG which has a more efficient action within the table grapes seedless varieties;

The research in the field of studying the action of Gobbi Gib 2LG as growth regulator needed to increase the productivity and quality of the

grapes was effectuated by “Terra-Vitis” Ltd. located in the Cahul district.
As the object of study it was taken the Presentabil a table grapes variety grafted on the Berlandieri x Riparia SO4 rootstock.
The GG2LG was used by means of treating the vines within different stages of its development: the technology used in Italy (3.6; 4.6 l/ha) – on 8 cm shoots length; one week before the blossom; while blossoming 30% of the bloom; while blossoming 50% of the bloom; while blossoming 80% of the bloom; the treatment of Ø 3-4 mm grains; 8-10 days after the last treating; the technology suggested for Moldova was the treatment of Ø 3-6 mm grains (2,0 and 2,4 l/ha).

RESULTS AND DISCUSSIONS

The reaction of the Prezentabil table grapes variety with seeds to the Gobbi Gib 2LG treatment.
Within the control variant the average bunch weight is 503,3; the weight of the berries in the bunch – 494,4; the weight of the cluster 8,9g. The bunch characteristic value (berries weight/cluster weight) - 55,6. The bunch is big, conically-shaped, dense.
The number of berries in the bunch – 167,0 pcs, including- 21 psc. of the undeveloped berries. The berries have an oblong shape with a length of - 24,1; width - 14,7 mm. A 100 berries weight – 395,8 g., The berry characteristic value (pulp weight/berries skin) – 10,1. As a rule, one big seed forms in each berry. The characteristic value of the seeds (pulp weight / seed weight) is rather high and reaches 71,28.
Within Prezentabil the mechanical properties of the berries, especially the crushing strength, is higher than seedless varieties and comes up to 2476 g/cm^2.
The harvest constitutes 3,8 kg/vine. There is s high sugar content in the juice of the berries – 22,6 %, titratable acidity content – 8,9 g/dm^3.
The usage of Gobbi Gib 2LG following the Italian technology.
While this type of treating Gobbi Gib 2LG was used in the postfecundary period (treating Ø grains of 3-4 mm -13.06.2013), (treating after 8-10 days before the last one - 23.06.2013) the bunch weight increased up to 16,4% (GG2LG-0,65 l/ha) and 27,2% (GG2LG-0,82 l/ha); the weight of the berries in the bunch accordingly up to 16,1 and 26,7 %. The cluster weight increased up to 1,4-1,6 times which leaded to a bunch characteristic value decrease (Table 1, Figure 1).
Under the influence of Gobbi Gib 2LG the number of berries in the bunch increased up to 1,2-1,3 times, but at the same time the quantity of undeveloped berries almost double if compared to the control. The dimensions of the berries, a 100 berries weight is the same as the one of the control, or a bit lower, as far the increase of the number of berries in the bunch brought to a decrease of their dimensions. The characteristic value of the berries is as that of the control or a bit higher.
The crushing strength of the berries is the same as that of the control. The harvest increases up to 1,2 (GG2LG-0,65 l/ha) -1,3 (GG2LG-0,82 l/ha) times. The sugar content is the same as that of the control, or a little higher. At the same time the concentration of the titratable acidity in the berries decreases.
It is important to notice that the biggest differences while using the specimen, if compared to the Witness, were observed in the dose of GG2LG-0,82 l/ha. Within this variant rise the bunch weight and parameters as well as the weight of grains in the bunch which leads to an increase of harvest vine up to 1,3 times. A small increase of seeds characteristic value takes place.
The usage of Gobbi Gib 2LG following the Moldova technology.
Using Gobbi Gib 2 LG within the post fecundation period (treating Ø grains of *3-6 mm* -13.06.2013) leads to the increase of bunch weight and the weight of the grains in the bunch up to 1,3 times, whatever the concentration of the specimen. It should be mentioned that took place the increase of the bunch, its length and width, especially in the middle part of it.

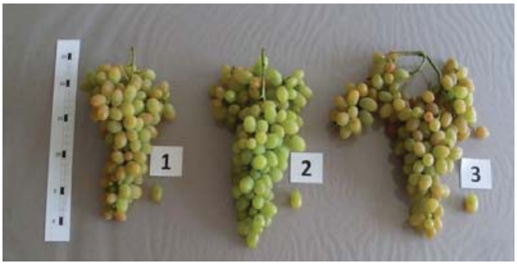

Figure 1. The Gobbi Gib 2LG influence on the external appearance of the bunch and berries.
The Prezentabil variety , "Terra vitis" Ltd., 2013, (Italian technology). The variant of experiment:
1-Control – H_2O; 2-GG2LG-0,65 l/ha; 3-GG2LG-0,82 l/ha

Table 1. The reaction of the Prezentabil variety to the Gobbi Gib 2LG treatment within postfecundary period.
„Terra vitis" Ltd., 2013, (Italian technology)

Value	*The variant of experience*					DL 0,95
	Control-H_2O	*GG2LG-0,65 l/ha*		*GG2LG-0,82 l/ha*		
	$\bar{x}$	$\bar{x}$	% to the control	$\bar{x}$	% to the control	
Bunch weight, g	503,3	586,0	*116,4*	640,0	*127,2*	
including - berry	494,4	573,9	*116,1*	626,2	*126,7*	
- cluster	8,9	12,1	*136,0*	13,8	*155,1*	
Bunch characteristic value (berries weight / cluster weight)	55,6	47,4	-	45,4	-	
Bunch dimensions, cm						
- length	22,0	25,0	*113,6*	28,0	*127,3*	
- width / on the top	16,0	20,0	*125,0*	23,0	*143,8*	
at the middle	11,0	12,0	*109,1*	15,0	*136,4*	
at the bottom	6,5	6,3	*98,9*	7,0	*107,7*	
Pedicle dimensions, mm	3,4	6,8	*200,0*	6,0	*176,5*	
The quantity of berries per bunch, pcs, total	167,0	208,0	*124,6*	214,0	*128,1*	
including undeveloped berries	21,0	43,3	-	47,0	-	
Berry size, mm						
- length	24,1	22,3	*92,5*	23,6	*97,9*	
- width	14,7	15,5	*105,4*	16,3	*110,9*	
100 berries' weight, g	395,8	368,4	*93,1*	403,2	*101,9*	
Berry characteristic value (pulp weight/ skin weight)	10,1	12,3	-	10,3	-	
Seeds characteristic value (pulp weight/ seeds weight)	71,3	73,3	-	77,5	-	
Crushing strength of berries, g/cm^2	2476	2146	*86,7*	2516	*101,6*	
Harvest, kg/vine	3,8	4,5	*118,4*	4,9	*129,0*	***0,49***
The content of:						
- sugar, %	22,6	22,0	-	23,3	-	
- titratable acidity, g/dm^3	8,9	8,5	-	8,3	-	

Under the influence of Gobbi Gib 2LG the number of grains in the bunch increased up to 1,5 (*GG2LG-0,98l/ha)* -1,2 *(GG2LG-1,3l/ha)* times, and at the same time grain dimensions, in most of the cases, are not bigger than those of the Witness. A 100 grains weight is the same as that of the Witness or a little lower.

The characteristic value of the grain (pulp weight/skin weight) rises up to 1,1-1,2 times; the characteristic value of the seminal index (pulp weight/seeds weight) is the same as that of the Witness or a little higher (Table 2, Figure 2).

Uтder the influence of Gobbi Gib 2 LG the harvest increases up to 1,3 times. The sugar content in the grains increases and the the concentration of the titratable acidity decreases.

Table 2. The reaction of the Prezentabil variety to the Gobbi Gib 2LG treatment within postfecundary period. „Terra vitis" Ltd.,2013 (Moldova technology)

Value	*The variant of experiment*					DL 0,95
	Control -H_2O	*GG2LG-0,98l/ha*		*GG2LG-1,3l/ha*		
	$\bar{x}$	$\bar{x}$	% to the control	$\bar{x}$	% to the control	
Bunch weight, g	503,3	649,0	*129,0*	651,5	*129,4*	
including - berry	494,4	637,9	*129,0*	640,5	*129,6*	
- cluster	8,9	11,1	*124,7*	11,0	*123,6*	
Bunch characteristic value (berries weight / cluster weight)	55,6	57,5	-	58,2	-	
Bunch dimensions, cm						
- length	22,0	23,3	*105,9*	22,7	*103,2*	
- width / on the top	16,0	21,3	*133,1*	19,5	*121,9*	
at the middle	11,0	14,7	*133,6*	11,8	*107,3*	
at the bottom	6,5	7,0	*107,7*	7,5	*115,4*	
Pedicle dimensions, mm	3,4	4,0	*117,6*	6,6	*194,1*	
The quantity of berries per bunch, pcs, total	167,0	255,0	*152,7*	196,5	*117,7*	
including undeveloped berries	21,0	50,0	-	18,0	-	
Berry size, mm						
- length	24,1	23,5	*97,5*	24,0	*99,6*	
- width	14,7	16,0	*108,8*	16,0	*108,8*	
100 berries' weight, g	395,8	376,2	*95,1*	404,6	*102,2*	
Berry characteristic value (pulp weight/ skin weight)	10,1	11,5	-	12,1	-	
Seeds characteristic value (pulp weight/ seeds weight)	71,3	105,2	-	83,9	-	
Crushing strength of berries, g/cm^2	2476	2445	*98,7*	2442	*98,6*	
Harvest, kg/vine	3,8	4,9	*129,0*	5,0	*131,6*	*0,49*
The content of:						
- sugar, %	22,6	23,6	-	21,6	-	
- titratable acidity, g/dm^3	8,9	8,6	-	8,4	-	

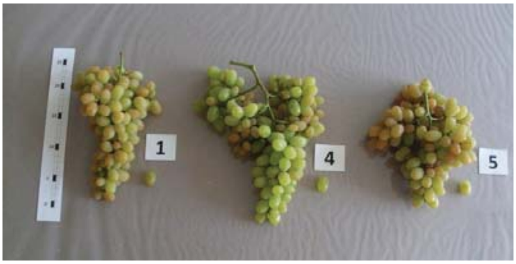

Figure 2. The Gobbi Gib 2LG influence on the external appearance of the bunch and berries.
The Prezentabil variety, "Terra vitis" Ltd., 2013, (Moldova technology).
The variant of experiment:1-Control – H_2O;2-GG2LG-0,98l/ha;3-GG2LG-1,3l/ha

The results of testing *Gobbi Gib 2LG* within the *Prezentabil* variety with seeds show that its action on the vines depends on the soil's biological particularities, treatment concentration and the duration of its usage. Taking into consideration the characteristic values sum (bunch weight and its parameters, the quality and weight of the grains in the bunch) it is necessary to note the variant Gobbi Gib 2 LG - 0,98 l/ha. While this very variant takes place an essential increase of the seed characteristic value up to 1.5 times which shows the rise of the seedless degree of grains.

Using Gobbi Gib 2 LG within the postfecundation period for 3-6 mm diameter grains leads to a harvest increase up to 1,3 times, rise of the seedless berries quantity which allows sugar quantity growth in the juice of the grain and the early ripening. The last one is very important, especially for early maturation sorts.

CONCLUSIONS

In the issue of the received data after using *Gobbi Gib 2LG* within the vitis it may be said that its action depends on the biological particularities of the sorts notwithstanding the method of using it. Within the Prezentabil variety the efficiency of the specimen showed through:

1. The rise of the bunch, grains, cluster parameters; also modifies bunch characteristic value (grain weight/cluster weight);
2. Rises the quantity of grans in the bunch up to 1,2-1,7 times, at the same time grain parameters decrease (length, width);
3. The harvest rises up to 1,2-1,3 times if compared to the Witness. Grows the seedless grains quantity; rises the seminal characteristic value which heightens sugar accumulation in the grain ant fastens the maturity.

Taking into consideration the obtained results on Gobbi Gib 2LG one can confirm that the specimen may be included into the table grape sorts levelling technological system as growth regulator aiming to increase the productivity and the quality of the production based on the 2 schedules:

Within the varieties with seeds (Prezentabil):

I schedule (Italian method), through vine spraying, using the specimen within periods:

✓ post fecundation period

II schedule (Moldova method), through spraying the zone of the bunch placement using the specimen only within one single period:

✓ post fecundation period

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

CUTTING PROPERTIES OF WINE GRAPE CULTIVARS

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Abstract

This study was carried out to determine the cutting properties of different wine grape canes as a function of moisture content, canes' diameter and variety. Cutting properties of cutting force, cutting strength, cutting energy and specific cutting energy were measured in eight different wine grape varieties. Canes of 'Tannat', 'Merlot', 'Cot', 'Chardonnay', 'Viognier', 'Cabernet Sauvignon', 'Shiraz' and 'Cabernet Franc' were profiled for their cutting properties during the dormant season. The results of data analysis showed that there was a significant difference between mean values of cutting properties varying based on variety. The results demonstrated that the maximum cutting force, cutting strength and cutting energy for 'Cabernet Franc' grape variety were 1397.60 N, 21.68 MPa and 3.68 J, respectively. The minimum cutting force, cutting strength and cutting energy were obtained at 'Tannat' grape variety and it was 981.65 N, 13.94 MPa, and 2.39 J, respectively. Whereas, the maximum specific cutting energy obtained at 'Chardonnay' was 0.256 Jmm-2, while the minimum specific cutting energy obtained at 'Tannat' grape variety was 0.219 Jmm^{-2}. In conclusion, findings demonstrated that the cutting properties were related to the physiological, physical and mechanical properties of the grape branches. Therefore, the grape variety should be taken into account for the design of a suitable pruner machine.

Key words: *Grapevine, Cutting, Energy, Force, Strength.*

INTRODUCTION

Winter pruning is one of the critical points in the management of a vineyard especially, in small farms, where the winter pruning is predominantly performed manually. Pruning with hand-powered pruning shears increases the risk of musculoskeletal disorders of hand and wrist disorders (Roquelaure, et al., 2004). However, with the increasing scarcity of manual labor for vineyard pruning operations, mechanized vine pruning has received much attention. In the late 1960s, grape producers indicated that once mechanical harvesting was totally implemented, the most time-consuming manual operations remained in the vineyard were pruning and tying. Grape producers complained for decreasing availability of qualified labor for pruning and tying and indicated that these should be the next operations mechanized. Utilization of a mechanical pruner could lower the manual labor necessary for the operation (Morris, 2000).

Vineyard mechanization greatly reduces manual labor in the vineyard. Today, pruner machines are used in vineyards in certain countries dominant in grape production. However, in our country, the pruning operations are completely accomplished via manual labor and also, there is no reliable information on grape cutting properties, a prerequisite for appropriate machine designs. But we know that the physical and mechanical properties of products depend on the species, variety, stalk diameter, maturity, moisture content, and cellular structure of the grape (Persson, 1987; Nazari Galedar, et al., 2008). The variation in the physical properties of plant stalks and the resistance of cutting equipment have to be identified in order to understand the behavior of material with respect to different operational conditions. Several plant factors influence the cutting force and energy, such as the fiber ultimate tensile strength, the fiber stiffness, and stem structure (Persson, 1987; Ghahraei, et al., 2011). Knowing those properties will be useful for both manufacturers and consumers of food processing equipment. Especially, information on plant properties and the power or energy requirements of an equipment would be very valuable for selecting design and operational parameters (Persson, 1987; Emadi, et al., 2004; Voicu, et all., 2011; Ghahraei, et al. 2011; Hoseinzadeh and Shirneshan, 2012). Perhaps, the stem of plants' cutting energy is one of the main parameters for optimizing the design of cutting elements in harvesting and pruning machines. Therefore, comparative performance of cutting elements applied in harvester and pruning machine designs could be judged by their cutting energy requirements, cutting force and stress applied (Alizadeh, et al., 2011).

A review of the literature revealed no information on direct cutting properties of cutting grape canes. However, many researchers have studied on energy consumption during the cutting process of different plants and have collected invaluable data, which might provide valuable aid for agricultural machinery manufacturers.

Chen, et al. (2004) performed a study about power requirements of hemp stem cutting properties and conditioning. The maximum hemp cutting force requirement was found to be 243 N and its energy requirement was obtained as 2.1 J. Some studies about cutting energy requirements have been conducted on soybean stalks (Mesquita and Hanna, 1995). Romano, et al. (2010) determined cutting force for certain vine branches such as Cabernet, Sauvignon and Chardonnay in different regions in Italy. The tests were conducted in the laboratory and the results were processed to show if the manual forces dispensed during cutting were a function of diameters and cultivated varieties. Heidari and Chegini, (2011) conducted studies on rose flower. They found that the average values of shear strength and energy per unit were estimated at 1.63 MPa and 5.16 $mJmm^{-2}$, respectively. Tekin, et al. (2012) evaluated the performances of two different machines used for pruning in viticulture in the Aegean region of Turkey. They found that local pruning machines provided higher performance as compared to imported machinery.

Also, similar studies have been conducted on sunflower stalk (Ince, et al., 2005), alfalfa (Nazari Galedar, et al., 2008), wheat (Hoseinzadeh, et al., 2009; Esehaghbeygi, et al., 2009; Tavakoli, et al., (2009a), barley straw (Tavakoli, et al., 2009b), rice straw (Zareiforoush, et al., 2010), cumin stem (Mahmoodi, et al., 2010), hemp (Kronbergs, et al., 2011; Kakitis, et al., 2012), sugar cane (Taghijarah, et al., 2011), kenaf stems (Ghahraei, et al., 2011).

These studies showed that the cutting energy is related to cutting force, cutting strength, stem diameter and moisture content. Therefore, this information is very important for suitable design of grape pruning knifes, pruning machines and harvesters for efficient energy use.

The main objectives of this study were to determine certain engineering properties such as cutting force, cutting strength, cutting power, and specific cutting energy requirements for eight different wine grape canes.

MATERIALS AND METHODS

Sample preparation and measuring apparatus

The study was carried out in the Agricultural Machinery Department, Faculty of Agriculture, Dicle University in Diyarbakir province, southeastern Turkey. Eight different wine grape varieties, namely Tannat, Merlot, Cot, Chardonnay, Viognier, Cabernet Sauvignon, Shiraz, and Cabernet Franc were selected to determine cutting properties in the experiment. To conduct the cutting test, the samples were collected from Mesopotamia (commercial farm) Vineyard (Figure 1) in Diyarbakır province and experiment tests were performed during the grape pruning season of the year 2012.

Figure 1. Experimental vineyard.

In order to determine the initial moisture content of grape canes, three samples of 30 g were weighed and dried in an oven of 105°C for 24 hours, and then reweighed to measure the moisture content using the gravimetrical method. The weights were measured using electronic scales with a capacity of 1.2 kg and with a precision of 0.01 g. The moisture content levels were determined at 35.4%, 42.4% and 46.0 % w.b. The results were evaluated according to these moisture content values.

Determination of cutting properties

The Lloyd LRX Plus biological materials testing instrument (Figure 2.) was used to measure the cutting force and the cutting energy. The cutting speed was constant at 100 mm*min^{-1}, for all tests.

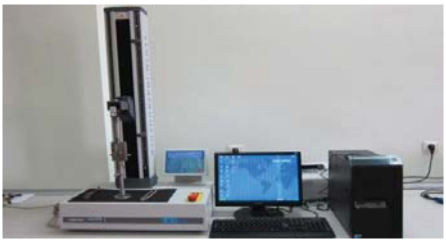

Figure 2. Instron universal test instrument.

The cutting force was measured by a double shearing apparatus (Mohsenin, 1982) (Figure 3). The shearing device was fabricated from steel. A series of holes with different diameters ranging from 4 mm to 10 mm were drilled. Before the experiment, the grape samples were divided into four different groups based on their diameter tanging from 4 mm to 10 mm (4, 6, 8, 10 mm) (Figure 4). The branch cutting diameters were measured before the test using a caliper. Testing was completed as rapidly as possible in order to reduce the effects of drying. All the required measurements for each variety were performed on the same day.

Figure 3. Shearing apparatus.

Figure 4. The grape samples.

Maximum shearing strength, obtained from the cutting force findings, was determined by the following equation (Mohsenin, 1980; Beyhan, 1998; Sessiz, 2005; Amer Eissa, et al., 2008; Tavakoli, et al., 2009b; Zareiforoush, et al., 2010):

$$S\sigma = \frac{\mathrm{Fma}}{2\mathrm{A}}$$

Where: σs is the maximum cutting strength in (MPa), F_{max} is the maximum cutting force in (N) and A is the cross-sectional area in (mm^2).

The cutting energy was calculated by measuring the surface area under the cutting force-deformation curve (Chen, et al., 2004; Nazari Galedar, et al., 2008; Zareiforoush, et al., 2010; Heidar and Chegini, 2011). The cutting energy and displacement was calculated by Instron universal testing instrument. A computer data acquisition system recorded all the force-displacement curves during the cutting process. A typical force-deformation curve is given in Fig. 5.

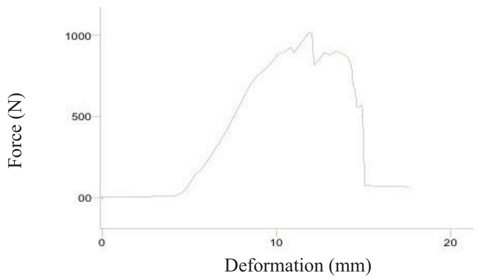

Figure 5. Typical force-deformation curve.

Using the cutting energy data, a specific cutting energy was determined using the following equation (Taghijarah, et al., 2011; Heidar and Chegini, 2011):

$$\mathrm{Esc} = \frac{\mathrm{Ec}}{\mathrm{A}}$$

Esc: Specific cutting energy, J/mm^2
Ec: Cutting energy, J
A: Cross-section area, mm^2

Statistical analysis

The experimental results were tested using standard variance analysis (ANOVA) for the randomized complete block design. Cutting properties were determined with 3 replications in each treatment of the branches. Mean separations were made for significant relations using LSD and the means were compared at the 1% and 5% levels of significance using the Tukey multiple range tests in JAMP software.

RESULTS AND DISCUSSIONS

The relationship between grape variety and cutting properties are presented in Figures 6,7,8,9. The results displayed in the Figures indicated that there is a significant difference between Cabernet Franc and the rest of the varieties in terms of cutting force, cutting strength, cutting energy and specific cutting energy requirements at a probability level of % 5. The cutting force and energy requirement varied from variety to variety. The maximum cutting force, cutting strength and cutting energy obtained at Cabernet Franc grape variety were 1397.60 N, 21.68 MPa and 3.68 J, respectively. Followed by the varieties Shiraz, Cabernet Sauvignon, Viognar, Chardonnay, Cot, Merlot and Tannat, respectively. The minimum cutting force, cutting strength and cutting energy obtained for Tannat grape variety were 981.65 N, 13.94 MPa, and 2.39 J, respectively. The maximum specific cutting energy obtained for Chardonnay was 0.256 Jmm^{-2}, while the minimum specific cutting energy obtained for Tannat grape variety was 0.219 Jmm^{-2} (Fig. 9). There were big differences among varieties in terms of cutting force, cutting strength and cutting energy.

This variance was due to different physiological, physical and mechanical properties of grape varieties (Esehaghbeygi, et al., 2009; Hoseinzadeh and Shirneshan, 2012). However, there were no significant differences between varieties in terms of the specific energy requirement. All varieties showed similar properties, except for Tannat, Merlot and Viognier grape varieties, where there was no significant difference between those and the rest of the varieties statistically.

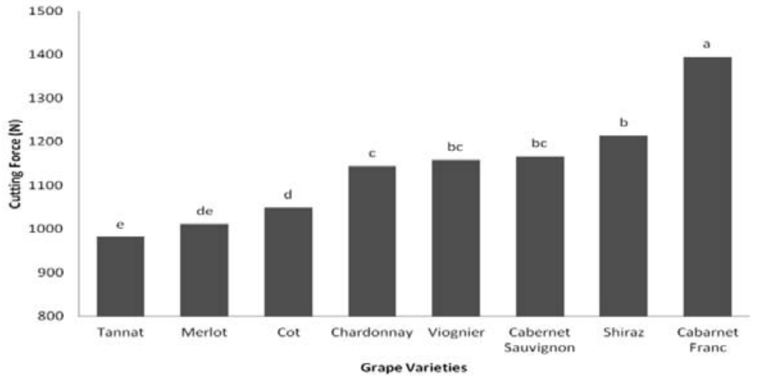

Figure 6. The relationship between grape varieties and cutting force.

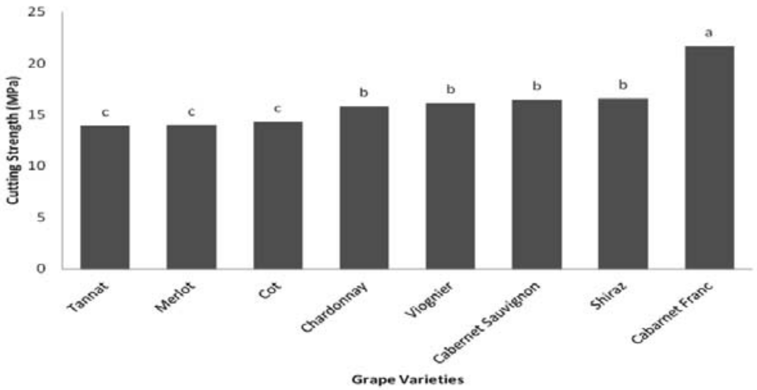

Figure 7. The relationship between grape varieties and cutting strength.

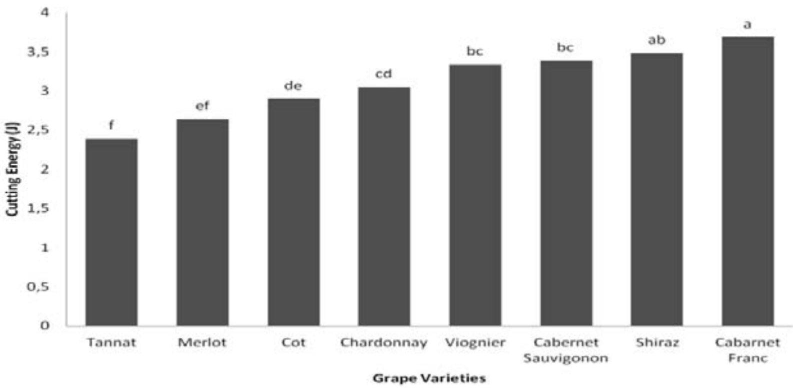

Figure 8. The relationship between grape varieties and cutting energy.

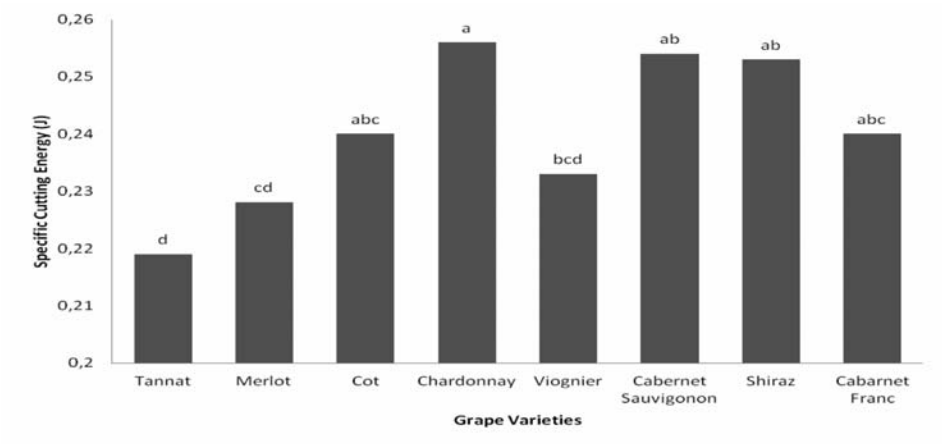

Figure 9. The relationship between grape varieties and specific cutting energy.

Selection of suitable cutting apparatus and equipment plays an important role on economizing on cutting force requirements. Based on our results, the cutting properties of grape branches varied as a function of the variety. So, a separate grape harvester or pruning machine for each variety is recommended. Study results could be considered in designing a prototype for cutting or pruning machines.
According to Skubisz (2001) mechanical properties are correlated with the structure of plant stems. Similar trends were reported by Nazari Galedar, et al. (2008) for alfalfa stem, by Tavakoli, et al. (2009 b) for barely stem, by Ince, et al. (2005) for sunflower stalk, by Esehaghbeygi, et al. (2009) for wheat, by Zareiforoush, et al. (2010) for rice straw and by Kronbergs, et al. (2001) for different hemp varieties.
Study findings showed that there is a significant difference between mean values of cutting properties based on the variety. The grape variety Cabernet Franc was found to be the strongest, while the variety Tannat, Merlot and Cot were found to be the weakest based on the shear cutting and energy requirement findings.

CONCLUSIONS

In conclusion, study findings clearly demonstrated that the mechanical properties depended on the variety to a great extend. The maximum shear force, shear strength and shear energy were obtained at Cabernet Franc grape variety at 1397.60 N, 21.68 MPa and 3.68 J respectively, followed by varieties Shiraz, Cabernet sauvignon, Viognar, Chardonnay, Cot, Merlot and Tannat. These findings show that the cutting force, cutting strength and cutting energy are related to grape branches' physical and mechanical properties. Thus, it was demonstrated that the cutting strength and energy requirements depend on the variety. Therefore, we should consider cutting properties of grape varieties for suitable designs for pruner machines.

ACKNOWLEDGMENTS

This study was supported by Dicle University Scientific Research Funding (DÜBAP-08-ZF-59). The authors are grateful to Mesopotamia Vineyard Farm for their help and also to Dr. Tahsin Sogut for statistical analysis.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

SUSTAINABLE USE OF FUNGICIDES AND BIOCONTROL AGENTS FOR BOTRYTIS GRAY MOLD MANAGEMENT IN GRAPES

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Abstract

Gray mold disease or Botrytis rot, caused by Botrytis cinerea, it is well known for significant economic losses in vineyards worldwide, in both yield and quality. Management of gray mold it is traditionally based on fungicide treatments and cultural practices. Fungicide programmes specifically target critical periods during the growing season: late-bloom, bunch closure, veraison and preharvest. However, controlling Botrytis cinerea is still a challenge, because the pathogen is able to rapidly develop resistance. Also, more stringent regulations governing fungicide residues have severely restricted chemical control options in conventionally managed vineyards, particularly during the preharvest period. The objective of our study was to assess the potential of an integrated programme to reduce Botrytis rot, involving fungicides and biological control agents (BCAs). Two experimental bioproducts were tested: Trichopulvin Td85 25 PU (Trichoderma koningii Td85 strain) and Saccharopulvin 25 PU (Saccharomyces cerevisiae L30b yeast strain). The efficacy of the proposed integrated programme was assessed based on disease incidence and disease severity in field trials, conducted in Tohani vineyards. This integrated strategy that combines fungicides and bioproducts could offer the option to reduce the number of fungicide treatments, thus minimizing the chemical residues, and manage fungicide resistance development.

Key words: *biocontrol agents, fungicides, sustainable viticulture.*

INTRODUCTION

Botrytis cinerea, the causal agent of gray mold or botrytis bunch rot in grapes, is responsible for significant economic damage in vineyards worldwide. Botrytis gray mold can develop in the vineyard after harvest, during long-distance transport, cold storage, and shelf-life. *Botrytis* can cause severe processing problems for winemakers also (loss of colour, enzymic oxidation, off-flavours, taints and reduced shelf life).
Fungicide programmes for botrytis bunch rot management are widely used, specifically targeting critical periods during the growing season: flowering, bunch closure, veraison and preharvest. This approach, however, is not regarded as sustainable: *B. cinerea* is well known as a high risk fungicide-resistant pathogen (Elmer and Raglinski, 2006). Also, there is an increasing restriction on botryticides available for protection during berry ripening because of some market specifications for low or no fungicide residues in wine (Hill, Beresford and Evans, 2010).
Biological control of plant pathogens by microorganisms has been considered a more natural and ecofriendly disease control measure. *Trichoderma* fungi are well known for their antagonism against plant pathogens. *Trichoderma harizanum*, *T. viride*, *T. virens*, *T. hamatum, T. roseum* and *T. koningii* are the most common fungal biological control agents (BCAs) that have been extensively researched and deployed throughout the world. Their activity is mainly due to faster metabolic rates, mycoparasitism, spatial and nutrient competition, antibiosis by enzymes and secondary metabolites and induction of plant defence system (Verma *et al*., 2007).

Yeasts are a major component of the epiphytic microbial community on the surfaces of fruits and vegetables. A diverse range of yeasts (*Rhodotorula glutinis*, *Candida* spp., *Pichia membranifaciens*, *Kloeckerea apiculata*, *Saccharomyces* spp.) have shown efficacy against *B. cinerea*.
The objective of our study was to assess the potential of an integrated programme to reduce *Botrytis* rot, involving fungicides and biological control agents (BCAs).

MATERIALS AND METHODS

The trial was carried out in 2014 in Tohani Valley vineyard (Romania) on grapes of *Feteasca alba* variety, which is sensitive to grey mould disease (*Botrytis cinerea*). The trial was conducted using a completely randomized designed block. The tested variants (products, application rate and timing of aplication) are presented in table 1.

Table 1. Treatment variants tested against Botrytis cinerea infection in Feteasca alba grapes

V	Treatment	Rate(kg/ha)	Timing of application			
			A	B	C	D
V1	Control (untreated)	-	-	-	-	-
V2	Switch 62.5 WG	1.2	T1	T2	T3	T4
V3	Trichopulvin Td85 25 PU	2.0	T1	T2	T3	T4
V4	Switch 62.5 WG	1.2	T1	T2		
	Trichopulvin Td85 25 PU	2.0			T3	T4
V5	Switch 62.5 WG	1.2	T1	T2		
	Saccharopulvin 25 PU	2.0			T3	T4

Two commercial bioproducts produced by Research Institute of Plant Protection (RIPP) Bucharest-Romania were tested: Trichopulvin TD 85 (*Trichoderma pseudokoningii* Td85 strain) and Saccharopulvin (*Saccharomyces cerevisiae L30b* yeast strain) alone or integrated with Switch 62.5WG (cyprodinil 37.5% and fludioxonil 25%), produced by Syngenta. Four treatments were applied at the following stages: A (caps fall), B (bunch closure), C (beginning of color change) and D (three weeks before harvest). Botrytis bunch rot attack was assessed for each plot before harvest.
Disease incidence (frequency) was estimated as percentage of infected bunches on 100 bunches observed per plot). Disease severity was recorded using a grade scale, as the percentage of berries or tissue exhibiting botrytis infection symptoms for each bunch, on 100 bunches per plot. The average severity describes the amount of botrytis present in the vineyard and is sometimes referred as botrytis crop loss or percentage crop infection.
The efficacy of applied treatment was calculated based on disease severity compared to untreated control. The efficacy of fungicide was calculated according to Abbott's formula = (severity in untreated control culture - severity in treated culture) /severity in untreated control culture x 100. All data were subjected to statistical analysis based on ARM-8 software.

RESULTS AND DISCUSSIONS

Symptoms were assigned to botrytis bunch rot if there were brown or pink-brown (discoloured) berries, with a turgid or shrivelled aspect, in a manner characteristic of botrytis rot (figure 1) and if *B. cinerea* sporulation (grey mould) was visible on at least some berries or pedicels of the bunch.

Figure 1. Botrytis bunch rot symptoms

To assess the presence of botrytis bunch rot, disease incidence and severity were recorded (table 2). Disease severity is the variable of utmost interest to grape growers and wine makers, because it better reflects the impact of Botrytis bunch rot on yield and wine making than the variable called incidence (Hill, Beresford and Evans, 2010).
Almost a complete control of Botrytis bunch rot was achieved with four application of Switch 62.5 WG (cyprodinil and fludioxonil), at recommended rate, compared to untreated

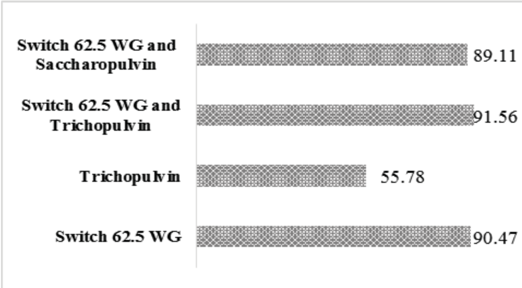
control. In this variant, mean Botrytis incidence at harvest was 18.75%, with a severity of 3.5%.
Disease severity was significantly reduced (3.25%) when Switch 62.5 WG was applied in the first two treatments, followed by 2 other treatments with Trichopulvin 25 PU spray. Similarly, two applications of Switch 62.5 WG and two applications of Saccharopulvin 25 PU reduced the disease severity to 4.0% compared to untreated control (36.75%).
Botrytis bunch rot incidence was reduced in all treated variants, with values which slightly varies, between 15.0% (Trichopulvin 25 PUalone) and 18.25% (Switch 62.5 WG and Saccharopulvin 25 PU).

Table 2. Botrytis bunch rot incidence and severity in a Feteasca alba vine plantation

Var.	Treatment	incidence %	severity %
1	Untreated	76.00 a	36.75 a
2	Switch 62.5 WG	18.75 d	3.50 e
3	Trichopulvin Td85 25 PU	15.00 d	16.25 c
4	Switch 62.5 WG Trichopulvin Td85 25 PU	20.75 d	3.25 e
5	Switch 62.5 WG Saccharopulvin 25 PU	18.25 d	4.00 e
LSD (P=.05)		5.395	3.531
Standard Deviation		3.696	2.419
CV		12.83	18.14
Bartlett's X2		4.502	6.087
P(Bartlett's X2)		0.809	0.638
Replicate F		0.729	0.203
Replicate Prob(F)		0.5450	0.8936
Treatment F		106.242	82.495
Treatment Prob(F)		0.0001	0.0001

The efficacy of the tested programmes was assessed based on disease severity in field trials (figure 2). All treatments significantly reduced the overall severity of Botrytis bunch rot compared to untreated control. A spray programme with four Switch 62.5 WG applications (caps fall, bunch closure, beginning of colour change and 3 weeks before harvest) reduced disease severity (90.47% efficacy) with almost the same efficacy as a programme with only two early-season sprays (caps fall and bunch closure) and two late-season sprays (beginning of color change and three weeks before harvest) with Saccharopulvin 25 PU (89.11%).

Figure 2. Treatments efficacy (%) in botrytis bunch rot infection



The highest efficacy (91.56%) was registered for the programme with two early-season application of Switch 62.5 WG and two late-season application of Trichopulvin 25 PU. However, when applied alone, at four application, Trichopulvin 25PU was less effective compared to treated variants (55.78%). Biological control alone is often less effective compared with commercial fungicides or provide inconsistent control. To achieve a similar level of efficacy provided by conventional fungicides, the microbial antagonists must be integrated in the classical chemical programme, to protect berries, as late-season sprays.

CONCLUSIONS

Field trials conducted with four application of Trichopulvin 25 PU, an experimental bioproduct based on *Trichoderma pseudokoningii* provided only partial control of Botrytis bunch rot. This level of control is insufficient considering that *B. cinerea* is well known for significant economic losses in vineyards worldwide, in both yield and quality. A good level of efficacy and a significant reduction in disease severity it is possible when Trichopulvin 25 PU and Saccharopulvin 25 PU are applied at the beginning of colour change and three weeks before harvest, integrated with only two fungicide applications, at caps fall and bunch closure. This integrated strategy that combines fungicides and bioproducts could offer the option to reduce the number of fungicide treatments, thus minimizing the chemical residues and manage fungicide resistance of Botrytis.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESEARCH ON QUALITATIVE AND QUANTITATIVE PERFORMANCE OF GERMAN ORIGIN VARIETIES IN ECOPEDOCLIMATIC CONDITIONS OF THE EXPERIMENTAL FIELD U.S.A.M.V. BUCHAREST

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Abstract

It is well known that the area of culture defines fundamentally the phenotypic, agrobiological and technological manifestations, also the quantity and quality of varieties of grape-vines. They practically, by the values of the main elements that define their degree of adaptation, can achieve better results compared with the area in which they formed or were naturalized. In this study we analyzed six varieties of German white wine: 'Rhine Riesling', 'Müller Thurgau', 'Silvaner', 'Bacchus', 'Ortega' and 'Phoenix', which are found in the experimental, teaching and research field within U.S.A.M.V. Bucharest. The research was conducted in wine-year 2012-2013 and target tracking these sorts in terms of quantitative and qualitative performance in the production and also the veg-productive balance. The results obtained highlight the fact that the varieties had a good rapport between production and the wood removed at pruning, as evidenced by values 4,04-8.82 (Index of Ravaz) and 11,58 – 24,38% (Vegetative and productive balance index - VPBI).

Key words: *balance, grapevine, index of Ravaz, maturity, varieties.*

INTRODUCTION

The varieties of grape-vines, regardless of origin, force, production capacity, production direction, are characterized by morphological variability and enhanced technology, given by their genetics, but also that they are influenced by a large climatic factors and agrotechnical factors, thus manifesting differently depending on the area of culture. Therefore, in studies that aims adaptation of the varieties of grape-vines in areas different from their place of origin, increasingly more attention is given to outstanding research aimed at showing how they manifest veg-productive, as direct result of physiological processes and cultural practices applied (Belea, 2008). The study focused on tracking the behavior of six varieties of German origin, Rhine Riesling, Silvaner, Müller-Thurgau, Bacchus, Phoenix and Ortega, in south area of Romania. The varieties come from the same vineyard where they emerged as basic varieties, but in Romania, except the first two, were rarely investigated and the less cultivated. The varieties are distinguished by a high degree of similarity between them, having in common a certain genetic lineage, as follows: the first three are found as genitors variety of Bacchus and Müller-Thurgau variety is a result of crossing between Rhine Riesling and Silvaner. In addition, Phoenix is a hybrid variety obtained between Bacchus and Villard Blanc variety and the Ortega variety is a cross between Müller-Thurgau and Siegerrebe (Table 1). Data were extracted from Vitis International Variety Catalogue (www.vivc.de). The study was discussed based on two reasons: to determine and assess the quantitative and qualitative performance of varieties in an area different from home and veg-productive balance assessment using indicators (Index of Ravaz, Vegetative and productive balance index - VPBI). To calculate these indicators, balanced loads of buds are left behind cuts, in order to link the photosynthetic capacity of the plant to the number and weight of the grapes, which regulates the two activities (vegetative and productive) and thus improve production quality. By properly sizing the number of buds and appropriate allocation of production elements, the ratio of the processes of growth and fructification are effectively adjusted in favor of the latter, it is increased or maintained the longevity of plantation and is obtained large crops of grapes, economic and relatively stable. Watching the relationship between the influence of fruit load on the quantity and quality of crop at Müller-Thurgau, Rhine Riesling and Silvaner varieties during the years 1976-1981 in conditions of Germany (Kiefer and Crusius 1984 quoted by Belea, 2008) have obtained variable production as follows: Müller- Thurgau variety, if awarded a load of 15 buds /m^2 was obtained an average of 20.61 t/ha, compared to 12.56 t/ha at a load of six buds/m^2.

The Rhine Riesling variety, production increased from 7.65 t/ha at a load of six buds/m^2 to 12.55 t/ha in 15 buds/m^2, and the variety Silvaner, production ranged from 9.26 t/ha and 14.99 t/ha. Basically, the allocation of large loads of buds/vine, increased, grape production without experiencing loss of quality. Were found, however, significant reductions on organoleptic and analytical quality during the years when productions were recorded over 15 to 23 t/ha.

Table 1. Genetic origin of studied varieties

Prime name	Rhine Riesling	Silvaner	Müller-Thurgau	Bacchus	Phoenix	Ortega
Variety number VIVC	10077	3865	8141	851	9224	8811
Country of origin of the variety	Germany	Germany	Germany	Germany	Germany	Germany
Species	*Vitis vinifera* L.	*Vitis vinifera* L.	*Vitis vinifera* L.	*Vitis vinifera* L.	*Vitis vinifera* L.	*Vitis vinifera* L.
Pedigree as given by breeder/bibliography	-	-	Riesling Weiss x Silvaner Gruen	(Silvaner Riesling) x Müller Thurgau	Bacchus x S.V. 12-375	Müller Thurgau x Siegerrebe
Pedigree confirmed by markers	- x Heunisch Weiss	- x Heunisch Weiss	Riesling x Madeleine Royale	(Silvaner x Riesling) x Müller Thurgau	-	Müller Thurgau x Siegerrebe
Prime name of pedigree parent 1	-	-	Riesling Weiss	Silvaner x Riesling	Bacchus Weiss	Müller Thurgau Weiss
Prime name of pedigree parent 2	-	Heunisch Weiss	Madeleine Royale	Müller Thurgau	Villard Blanc	Siegerrebe
Year of crossing	-	-	1882	1933	1964	1948
Last update	11.02.2015	11.02.2015	30.01.2015	29.09.2014	29.09.2014	29.09.2014

MATERIALS AND METHODS

The research was conducted in 2012-2013 wine year, in the experimental field of U.S.A.M.V. Bucharest and the varieties that are object of these research were applied the same technology culture: Guyot on semi-stem type cutting, planting distance of 2.2/1.2 m, with a load of 32 buds/vine (12 buds/m^2) considered optimal for obtaining quality white wines.

Climatic data focused on daily observations regarding the evolution of parameters - temperature, precipitation, insolation, which helped calculating climatic indexes that define the level of favorability of an area: - real heliothermic index (IHr), hydro-thermic coefficient (CH), vine plant bioclimatic index (Ibcv), oenoclimatic aptitude index (IAOe), and also Huglin index calculus. Huglin index (HI) is calculated from April the 1st to September the 30th in the northern hemisphere and is defined as follows:

$$IH = \sum_{01.04}^{30.09} \frac{[\![(Tm-10)+(Tx-10)]\!]}{2} \times k$$

Tm = Medium air temperature (ºC)
Tx = Maximum air temperature (ºC)
k = Day length coefficient in relation with latitude, with values between 1,02-1,06 for latitudes of 40-50º and for Romania ($44{,}1^0$ – $46{,}0^0$) this has the value of 1,04.

The benchmark index in viticulture is widely used in France because it provides information about the potential heat in the vineyard, showing importance in appropriate choice of product, on the one hand and is positively correlated with the amount of sugars accumulated in grapes, on the other hand. The values of this indicator in different wine regions causes a general classification of these areas and establishing minimum temperature necessary to conduct the vegetative cycle of varieties of grape-vines in that area, (Huglin, 1978, Tonietto and Carbonneau, 2004). From this perspective, recent research conducted at the Bavarian Research Center for Viticulture and Horticulture state established a minimum standard Huglin's index for fructification of investigated varieties, as follows: IH is 1300^0C for Ortega variety, 1400^0C for Müller-Thurgau varieties, Phoenix and Bacchus, 1600^0C Silvaner variety, Rhine Riesling variety 1700^0C (Ulrike and Schwab, 2011), 1700 ^{0}C for Chardonnay and Syrah variety almost 2100^0C. The minimum limit for grape-vine is considered by some authors to an IH = 1600^0C (Laget et al., 2008).

During the experience, observations and determinations were made used in determining the elements of fertility and productivity, with special focus on those who have shown interest in calculating the vegeto-productive index balance covered by this study: average weight of a grape, 100 berries weight, production/vine, sugars (g/l), total acidity (g/l tartaric acid).

To assess the balance between production of grapes and vine growth, in practice, is used Ravaz index in formula: IR = Production/removed wood.

In general, values of this indicator varies within wide limits from 1.2 to 27.7, values between 5-7 are being considered ideal; for varieties with medium vigor, the IR is ideal between 4-6; varieties with reduced vigor take the value 8; values lower than 3 and bigger than 10 should be avoided, since it causes big vigor or delays in maturation and reduced quality, as appropriate. (Celotti et al., 2001).

The relation between growth and fruiting was established using vegeto-productive balance index (VPBI). It highlights the percentage share of the vegetative part, expressed by weight of removed wood at pruning to achieve total production and it represents the ration between „weight of wood removed at pruning x 100/grapes production + removed wood” expressed in kg/vine (Maccarone and Scienza, 1996). If grape varieties are for quality wines, the result must be within the 22.1 to 33.5% (Celotti et al., 2000) at Cabernet Sauvignon and 18 to 23% (Dejeu et al., 2003) at Feteasca regala.

RESULTS AND DISCUSSIONS

The analysis of climatic elements for the wine year 2012-2013 was performed by comparing the defining climatic elements of this year with the annual average of the last 10 years (2001-2011), due to the frequency of extreme weather events and the lack of constancy of the values recorded.

The values of the four synthetic indexes (Table 2) shows that when the thermal resources are high, the water resources are low and the most fluctuating indicator is the bioclimatic one, whose spectrum is within the 9,9- 14.32.

Table 2. Evolution of climatic elements (2001-2013)

Specification		Average 2001-2011	Year 2012	Year 2013
Agroclimatic indices	The hydro-thermic coefficient CH)	0,75	0,97	0,50
	The real heliothermic index (IHr)	1,3	1,08	1,38
	The viticultural bioclimatic index (Ibcv)	9.9	11.2	14,32
	Index of the oenoclimatic aptitude (IAOe).	5231	5075	6493
	Huglin index	2392	2739,7	2358,2

Regarding the development of Huglin index values, it is noted that tends to increase, which exceeds the multiannual average in 2012, reaching a peak of 2739.76, conditions in which the vineyard, characterized by a warm temperate climate in general (IH4), acquires the appearance of a warm climate type (IH5) - (IS1, IH5, IF3).

The observations made show that the area in which the didactic-experimental field of U.S.A.M.V. Bucharest is found is favorable for growing varieties of grape-vines studied (registered in the south of Romania), and the elements of microclimate positively put their mark on the behavior of the studied varieties, although varieties are adapted to a cooler climate. Assigning the same number of buds per vine 32 buds/vine highlights their differentiated behavior in terms of quality and quantity of production, but its performance touch the limit required to obtain quality white wines (Table 3).

Table 3. Evolution of quality parameters on the experimental varieties

Varieties	Average weight of a grape (g)	Weight of 100 berries (g)	Yield (kg/ vine)	Sugar (g/l)	Acidity (g/l tartaric)
Rhine Riesling	90,17	132	4,68	226,69	7,56
Müller-Thurgau	92,17	203	4,83	238,38	6,52
Silvaner	113,39	177	4,12	230,32	6,61
Bacchus	80,66	209	2,85	201,21	5,57
Phoenix	91,92	220	2,86	205,45	5,38
Ortega	119,68	174	2,99	212,89	5,67

The appreciation is based on their accumulated sugar levels, on the background of a pretty balanced acidity. The data show a highlight in quality of the varieties Rhine Riesling (226.69 g /l), Müller-Thurgau (238.38 g/l) and Silvaner (230,32g /l), but no other varieties are in imbalance, the minimum being registered at Bacchus variety (201.21 g /l). Appreciation of balance between the production of grapes and vine growth, made using Ravaz index, indicates that the most varieties are found in a balance with a slight imbalance registered at varieties Silvaner, Phoenix, Ortega, even the values are within the ideal highlights from this point of view (5-7).

Basically, wine year 2012 -2013 was a good wine year, favorable to the development and fruiting of varieties analyzed so they have been in steady growth and fruiting (Table 4).

Analysis of vegetation and productive balance index - VPBI (%) shows that varieties are in a veg-productive balance because they are close to the normal range of grape varieties for quality white wines (Table 4).

Highlighting the percentage share of the vegetative part of the vine to achieve the production of grapes, this index ranged from 11.58 to 24.38%.

We can say that the balance between vegetative growth and fruiting capacity was greater tilted in favor of fructification, except variety Silvaner, where the index (24.38%) is in the average necessary to obtain high quality wines. Therefore, the higher the values recorded are, the more favorable and positive correlation is for the accumulation of large amounts of sugars in grapes.

Table 4. Overview of Ravaz index and vegetative and productive balance index – VPBI (%)

Experimental varieties	Index of Ravaz	Vegetative and productive balance index – VPBI (%)
Rhine Riesling	5,92	16,34
Müller-Thurgau	8,56	11,58
Silvaner	3,81	24,38
Bacchus	8,82	13,92
Phoenix	4,43	20,6
Ortega	4,04	14,85

Highlighting the percentage share of the vegetative part of the vine to achieve the production of grapes, this index ranged from 11.58 to 24.38%. We can say that the balance between vegetative growth and fruiting capacity was greater tilted in favor of fructification, except variety Silvaner, where the index (24.38%) is in the average necessary to obtain high quality wines.

Therefore, the higher the values recorded are, the more favorable and positive correlation is for the accumulation of large amounts of sugars in grapes.

Following the evolution of accumulated sugars according to the Huglin index in 2012-2013 vine year (Figure 1) there is a positive direct correlation in all varieties, and in addition, it was observed an increase from varieties potential, in general (Hillebrand et al., 1997). This is explained from the genetic origin of Varieties, the area of culture and not least less favorable climatic conditions.

Comparing the index values of Huglin from the areas of origin (Germany) with those recorded in the area of culture where the experience took place, we observe that Rhine Riesling variety accumulates 200 g/l sugars, index of Huglin being 1700^{0}C in cool area, making it possible to obtain white table wines; at 2358,2 ^{0}C value of the same index in the south area of Romania, the amount is much higher - 226.69 g/l, which makes it possible to obtain quality white wines. This can be seen in other studied varieties, which leads us to affirm that the southern areas of Romania create the possibility of obtaining quality white wines from varieties of grapes analyzed.

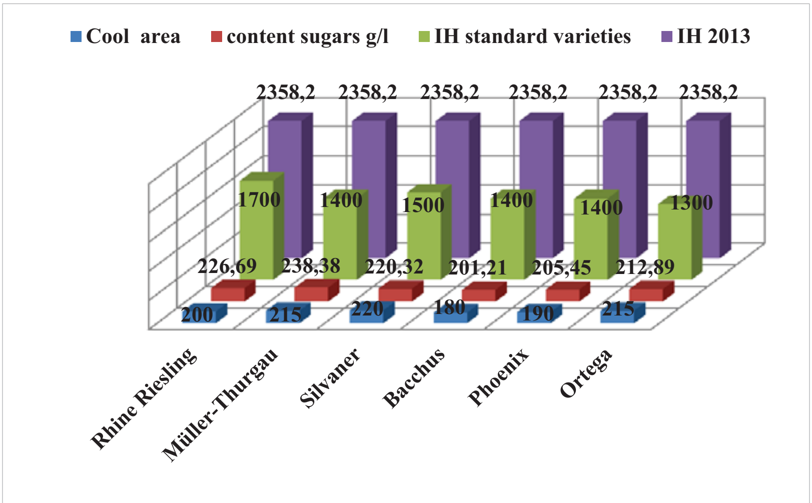

Figure 1. Correlation between Huglin index values and sugar contents g/l

CONCLUSIONS

The area in which took place the experience is favorable for cultivating the studied varieties (the entire south area of Romania) and specific factors (annual temperatures average, the ones from the vegetation period of grape-vines, rainfall) have a positive contribution on the behavior of the studied varieties.

The varieties are distinguished by a high degree of similarity between them in terms of quantitative and qualitative performance based on the genetic lineage, as follows: the first three are found as genitors of Bacchus variety and Müller-Thurgau variety is a result of interbreeding Rhine Riesling x Silvaner's.

Assigning the same number of buds per vine 32 buds/vine highlights their differentiated behavior in terms of quality and quantity of production, but their performance reach the limits necessary to obtain quality white wines.

Following the results, the varieties of german origin - Rhine Riesling, Müller-Thurgau, Silvaner, Bacchus, Phoenix and Ortega are in veg-productive balance in climate conditions of south area, and therefore can be successfully introduced into the wine culture in southern Romania, with great possibilities of obtaining outstanding production quantitatively and qualitatively.

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VEGETABLE GROWING

EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE INFLUENCE OF CULTURE TECHNOLOGY UPON THE PHYSICAL QUALITY OF SOME EARLY TOMATOES VARIETIES

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Abstract

The quality of the Romanian vegetable production is currently of a great importance as far as alimentation, horticultural economy and commerce with such perishable products because that determines competition on both internal and external market and, implicitly, the maintaining of the market for Romanian products in the context of an open, competitive market. Our researches aimed to establish the most appropriate culture technological sequences for three varieties of early tomatoes ('Isalnita 29', 'Isalnita 50', 'Buzau 47') in order to obtain high quality fruit with suitable physical qualitative indicators. All tomatoes varieties that were tested benefited in culture for three different density variants (25,000 plants/ha, 40,000 plants/ha, 55,000 plants/ha) and two levels of fertilization (c1 = N:200 kg/ha; P2O5:100 kg/ha; K2O:100 kg/ha, c2 = N:300 kg/ha; P2O5:200 kg/ha; K2O:100 kg/ha). Immediately after harvesting, certain physical determinations were carried out concerning the main physical qualitative indicators of the fruit: average weight, thickness of the pericarp, specific weight and texture firmness. Results show that the physical qualitative indicators vary depending on variety, planting density and lightly on fertilizer dose of culture. Between the three varieties that were studied, the variety 'Buzau 47' is distinguished through the largest fruits (average weight=97.75 g), high specific weight (0.9726 g/cm3) and the thickness of the pericarp (6.66 mm). At the same time, the variety 'Buzau 47' has the fruits with the lowest firmness (145.87 PU), this indicator having values inversely proportional to the size of fruits. Regarding the planting density, this influences, according to the physical qualitative indicator, in a different way. As the density is lower, the average weight of the fruit has higher values. Between tested fertilization variants, at a level of nutrition below the limits of 300 kg/ha N, 200 kg/ha P2O5 and 100 kg/ha K2O, there are no essential differences in the values of the main physical qualitative indicators, beside the average weight of the fruits, which increases from 69.97 g in the case of fertilization variant c1, to 82.92 g in the case of fertilization variant c2.

Key words: *average and specific weight, firmness, level of nutrition, planting density.*

INTRODUCTION

Tomatoes are one of the most important vegetable species in our country, due to the fact that they can be consumed both fresh and processed in different ways (Stan et al., 2003).
Tomatoes are healthy and contain very few calories. They have a significant content of vitamin C, minerals (e.g.: potassium) and important micro-nutrients.
Supplying market with fresh tomatoes obtained in open field is possible beginning with the second half of June by performing early cultures. This type of culture, which occupies a significant share in our country, is practiced in the areas with more favourable climatic conditions for tomatoes, such as: Western Plain, Danube Plain, a part of Dobrogea.
Researcher Vînătoru (2006) affirmed that the Romanian tomato is tasteful, aromatic and beneficial for health, being cultivated on natural soil, not forced with chemical substances.

The cultivating method on unconventional substrata is still relatively new in Romania (Makobo and Du Plooy, 2008), so that the classical method, on soil, still occupies the largest part of the surface in our country destined for tomato cultures (Ciofu et al., 2004). The aim of the applied different culture technologies has to not only be the obtaining of large productions, but also to ensure a high quality, which means that the technological links have to take into account the destination of the production. From this point of view the fertilization system and regime have significant effects (Neata, 2002; Cioroianu et al., 2010; Anton, 2011; Cioroianu et al., 2011). Also at the creation of new varieties and hybrids should be taken into consideration the fact that they respond differently to both environmental conditions and technological links applied to the culture (Draghici and Pele, 2012).
In appreciation of the quality and nutritive-alimentary value of the fruits, is taken into consideration the physical and sensory characteristics (size, shape, colour, specific weight, texture firmness, flavour, taste etc), technological characteristics (storage capacity, transport and handling resistance, presence of diseases or pests attack, remanence of pesticides) and the biochemical properties: water content, dry matter, carbohydrates, acids, cellulose, vitamins, pigments, mineral salts (Salunkhe et. Kadam , 1998; Alexe et al., 2013).
This paper presents some aspects regarding the influence of variety, planting density and fertilization of early tomato culture upon the certain physical qualitative indicators of the fruits.

MATERIALS AND METHODS

The researches were conducted during period 2013-2014, using Romanian varieties of early tomatoes, obtained in a vegetable farm located in an area of the Romanian seaside.
The trial was organized as a trifactorial experience, with following experimental factors:

A – planting density (plants/ha)	**B – variety**	**C – ferilization level** (kg/ha)
a1 – 25,000	**b1**- Isalnita 29	**c1** – N:200; P_2O_5:100; K_2O:100
a2 – 40,000	**b2** - Isalnita 50	**c2** – N:300; P_2O_5:200; K_2O:100
a3 – 55,000	**b3** - Buzau 47	-

The observations and determinations regarding the main physical qualitative indicators (average weight, thickness of the pericarp, specific weight, texture firmness) were made at Research and Development Institute for Processing and Marketing of the Horticultural Products - Horting Bucharest and at University of Agricultural Sciences and Veterinary Medicine Bucharest. The determination of the fruit firmness was performed by means of a mass penetrometer OFD, the measurement being in penetrometer units (1PU = 0.1 mm) of the depth of the conical needle penetration (length = 24mm, diameter at base = 4 mm) in the pulp. Measurements were performed on a total of 25 fruit/variant, each fruit being penetrated in four points in the equatorial zone.

RESULTS AND DISCUSSIONS

The average weight of the fruit is a characteristic indicator for every variety. Between 3 varieties of early tomatoes that were studied, taking into account the average of variants, Isalnita 29 variety has the smallest fruits, with the average weight of 51.78 g, varying, depending on the distance of planting and fertilization variant, between 51.0 g and 53.3 g (Table 1).
Variety Isalnita 50, with the value of average weight of fruits of 79.80 g, has much larger variation limits depending on the variant of culture (67.0-93.1 g).
The largest fruits are found at variety Buzau 47, with the average weight of 97.75 g and variation limits between 76.0 g and 108.3 g.
Specific weight is high at all 3 varieties, the average value being between 0.9256 g/cm^3 at variety Isalnita 29 and 0.9726 g/cm^3 at the variety Buzau 47. Higher differences between variants were observed at variety Buzau 47, with limits from 0.8876 g/cm^3 to 1.1028 g/cm3, while the variety Isalnita 29 presented more constant values around the average (0.8903-0.9712 g/cm^3).

Table 1. The influence of variety upon physical qualitative indicators of early tomatoes

Variety	Variant	Average weight (g)	Specific weight (g/cm^3)	Thickness of pericarp (mm)	Firmness (PU)
b1	a1c1	52.1	0.9044	5.5	91.8
	a2c1	52.0	0.8916	5.5	108.3
	a3c1	52.0	0.8903	5.3	106.3
	a1c2	52.3	0.9941	5.5	102.5
	a2c2	51.0	0.9712	5.7	107.5
	a3c2	51.3	0.9021	5.8	92.0
	average	51.78	0.9256	5.55	101.40
b2	a1c1	80.9	0.9614	6.6	131.7
	a2c1	81.8	0.9404	6.5	140.3
	a3c1	67.0	0.9645	6.5	130.5
	a1c2	93.1	0.9761	6.6	130.4
	a2c2	88.1	1.0091	6.6	135.4
	a3c2	67.9	1.0041	6.4	103.5
	average	79.80	0.9759	6.53	128.63
b3	a1c1	108.3	0.8876	6.6	151.1
	a2c1	83.1	0.9334	6.6	147.5
	a3c1	76.0	0.9019	6.5	130.5
	a1c2	114.1	0.9881	6.8	148.3
	a2c2	108.3	1.0221	6.8	150.5
	a3c2	101.2	1.1028	6.7	147.3
	average	97.75	0.9726	6.66	145.87

The thickness of pericarp is, as well, a character of variety, being lower at Isalnita 29 variety, of 5.55 mm (which presents also the smallest weight of the fruits) and very close at the other 2 varieties (6.53 mm at variety Isalnita 50, respectively 6.66 mm at variety Buzau 47). There were not registered differentiated values within the variants.

Firmness of the pulp presented values inversely proportional to the size of fruit, being the lowest at variety Buzau 47 (145.87 PU), the highest at variety Isalnita 29 (101.40 PU) and with intermediary values at variety Isalnita 50 (128.63 PU).

The results presented in Table 2 show that the planting density is also influencing some physical qualitative indicators of fruits. The average weight is higher at a lower planting density.

At a planting density of 25,000 plants/ha, average weight had the average value of 82.31g, while at a planting density of 55,000 plants/ha, this was only 76.16 g. However from table 2 results that the indicator average weight is influenced by the culture density only at varieties Isalnita 50 and Buzau 47, whose fruits are smaller as the density increases.

Table 2. The influence of planting density upon physical qualitative indicators of early tomatoes

Plan-ting density	Variant	Average weight (g)	Specific weight (g/cm^3)	Thickness of pericarp (mm)	Firmness (PU)
a1	b1c1	52.1	0.9044	5.5	91.8
	b2c1	80.9	0.9614	6.6	131.7
	b3c1	98.3	0.8876	6.6	151.1
	b1c2	52.3	0.9941	5.5	102.5
	b2c2	93.1	0.9761	6.6	130.4
	b3c2	117.2	0.9881	6.8	148.3
	average	**82.31**	**0.9519**	**6.27**	**125.96**
a2	b1c1	52.0	0.8916	5.4	108.3
	b2c1	81.8	0.9404	6.5	140.3
	b3c1	93.1	0.9334	6.6	147.5
	b1c2	52.3	0.9712	5.5	102.5
	b2c2	88.1	1.0091	6.6	135.4
	b3c2	114.1	1.0221	6.8	150.5
	average	**80.23**	**0.9613**	**6.23**	**130.75**
a3	b1c1	51.0	0.8903	5.3	116.3
	b2c1	76.0	0.9642	6.5	148.5
	b3c1	94.5	0.9019	6,7	155.3
	b1c2	51.3	0.9021	5.8	112.0
	b2c2	75.9	1.0041	6.4	143.5
	b3c2	108.3	1.1028	6.7	157.3
	average	**76.16**	**0.9609**	**6.23**	**138.81**

The average weight of fruits from variety Isalnita 29 presented constant values, regardless of the culture density. This variety allows therefore higher culture densities, without being affected the uniformity of production, while, at the other 2 varieties, the density of 55,000 plants/ha may lead to unevenness of average weight and implicitly of production.

The firmness of fruits, which is a variety distinctiveness, presents a great importance for a superior valorification, for which it is necessary to be given attention in the application of technological links of culture. This indicator is influenced by the planting density. The fruit firmness decreased from the value of 125.96 PU at variant a1 to 130.75 PU and respectively to 138.81 PU in case of variants a2 and a3 respectively. The softest fruits at harvest are met therefore at the culture density of 55,000 plants/ha, at variety Buzau 47. The thickness of pericarp is also a physical indicator of a great importance, which, in the case of mechanical conditioning, should be taken into consideration. This indicator did not presented significant modifications along with the increasing of planting density.

Specific weight and thickness of the pericarp was less influenced by planting density. However, variant a1 presented a slight decreased value of specific weight (0.9519 g/cm^3) comparatively with variant a2 (0.9613 g/cm^3) and variant a3 (0.9609 g/cm^3).

The influence of fertilization levels upon physical indicators is represented in Table 3.

The average weight of fruits is influenced by the level of fertilization doses, that increasing, from 69.97 g in the case of fertilization variant c1, to 82.92 g in the case of fertilization variant c2, considering the average of variants planting density x variety. It is observed repeatedly the stability of Isalnita 29 variety, to whom the modifications from c1 to c2 are insignificant.

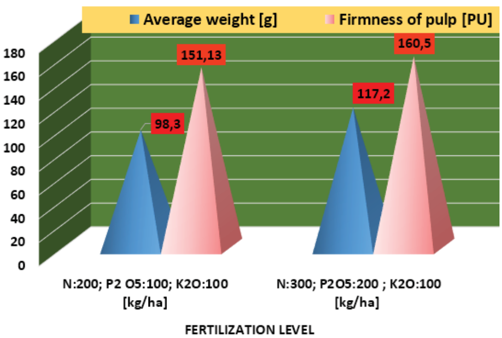
Table 3. The influence of fertilization level upon physical qualitative indicators of early tomatoes

Fertilization level	Variant	Average weight (g)	Specific weight (g/cm^3)	Thickness of pericarp (mm)	Firmness (PU)
c1	a1b1	52.1	0.9044	5.4	91.8
	a1b2	71.9	0.9614	6.6	131.7
	a1b3	98.3	0.8876	6.8	151.1
	a2b1	52.0	0.8916	5.4	108.3
	a2b2	70.8	0.9404	6.6	140,3
	a2b3	84.1	0.9334	6.6	147.5
	a3b1	51.0	0.8903	5.3	106.3
	a3b2	66.0	0.9642	6.5	130.5
	a3b3	83.5	0.9019	6.6	145.3
	average	69.97	0.9194	6.18	128.09
c2	a1b1	52.3	0.9941	5.5	107.5
	a1b2	93.1	0.9761	6.6	130.4
	a1b3	117.2	0.9881	6.9	160.5
	a2b1	51.3	0.9712	5.7	109.5
	a2b2	88.1	1.0019	6.6	135.4
	a2b3	114.1	1.0221	6.7	148.3
	a3b1	51.0	0.9021	5.8	115.0
	a3b2	75.9	1.0041	6.4	143.5
	a3b3	103.3	1.1028	6.7	157.3
	average	82.92	0.9958	6.32	131.93

Concerning the specific weight, thickness of the pericarp and firmness of the pulp, there are no essential differences between the 2 levels of fertilization. It is observed however a slight increase of the average values of specific weight and pericarp thickness and a small decrease of the fruits firmness in the case of variant c2 beside c1.

Results concerning the interaction of factors A x B x C show that the fertilization acts independently of variety and planting density, but in both variants, variant c1 and variant c2, the higher value of average weight (98.3 g respectively 117.2 g), thickness of the pericarp (6.8 mm, respectively 6.9 mm), and texture firmness (151.3 PU, respectively 160.5 PU) was recorded at variant a1b3 (a1: planting density=25,000 pl/ha; b3: variety Buzau 47), proving the influence of variety and planting density (Figure 1).

Fig. 1. The influence of interaction of the factors variety (Buzau 47), planting density (25,000 pl/ha) and fertilization level upon some physical qualitative indicators of the early tomatoes



CONCLUSIONS

The main physical qualitative indicators (average weight, thickness of the pericarp, specific weight, texture firmness) varies depending on variety and culture technology conditions.

Between the three varieties that were studied, the variety Buzau 47 is distinguished through the largest fruits (average weight=97.75 g), high specific weight (0.9726 g/cm^3) and the thickness of the pericarp (6.66 mm). At the same time, the variety Buzau 47 has the fruits with the lowest firmness (145.87 PU), this indicator having values inversely proportional to the size of fruits.

Regarding the planting density, this influences, according to the physical qualitative indicator, in a different way. As the density is lower, the average weight of the fruit has higher values. From this point of view, the tomatoes that came from culture with plantig density of 25, 000 plants/hectars recorded the best results. However the average weight of fruits from variety Isalnita 29 presented constant values, regardless of culture density. This variety allows therefore higher culture densities, without being affected the uniformity of production, while, at the other 2 varieties the density of 55,000 plants/ha may lead to unevenness of average weight and implicitly of production. Along with the increasing of density, the firmness decreases, the softest fruits at harvest are meeting at the culture density of 55,000 plants/ha.

In the case of different fertilization level, at a nutritional level below the limits of 300 kg/ha N, 200 kg/ha P_2O_5 and 100 kg/ha K_2O, there are no essential differences in the values of the main physical qualitative indicators, beside the average weight of the fruits. This increases, from 69.97 g in the case of fertilization variant c1, to 82.92 g in the case of fertilization variant c2, having into consideration the average of the variants planting density x variety. It is observed repeatedly the stability of Isalnita 29 variety, to whom the modifications from variant c1 to variant c2 are insignificant.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

CREATING LAND ASSESSMENT DATABASE FOR VEGETABLE CROPS IN PERUSHTITZA VILLAGE, BULGARIA

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Abstract

Development of vegetable crops is an increased process in Bulgaria. The region of Perushtitza Village is a special area because of its tomatoes production. The main purpose of this report is to investigate and analyse some of the important factors for sustainable vegetable cultivation. The volume of data include information about biological requirements for cultivation, climate, irrigation, atmospheric conditions, elevating, meteorological geographical features, land cover and land use, soil, monitoring and agricultural facilities, socio-economic conditions like existing irrigation systems, road systems, mechanization, production transporting, etc. All the information is prepared for using GIS application by converting it into spatial database.

Key words*: vegetable crops, GIS, assessment, spatial database.*

INTRODUCTION

Agriculture is one of the world's most important branches, necessary for people livelyhood. Economy of Bulgaria country is predominantly based on agriculture and majority of population depends on agricultural occupation. Therefore, it requires to carry long term scientific land use planning and to implement for the balanced, multi-dimensional and sustainable development of the country on the basis of physical features, composition, quantity and capability of the land. Main vegetable cultures cultivated are tomatoes. The present study took place on the land of Perushtitza Village, Bulgaria. This region is known with its wine fields, but there are complex of very good physical land characteristics for growing of vegetable crops. In this region, land use refers to the major classification of the use of the different parcels of land in the holdings. All land operated by agricultural holdings are classified as either agricultural land or non-agricultural land. The total numbers of all agricultural holdings has been increasing during the last few years. The area used for output of vegetables, especially tomatoes, depends on their biological requirements and land characteristics. The factors for good quality productions are based on land, soil and climatic parameters. In addition, they are combined with some characteristics, which refer to the nearest roads systems and collecting centres. Attributes of the study area has marked effects on the tradition and culture and in turn to the cultivation practices (Baniya, 2008). All information is collected from different scientific, experimental and literary sources. This data is gathered, analysed and presented by thematic maps. For establishing sustainable vegetable cultivation all collected data is transformed into spatial data for using GIS application. The aim of this study is preparation of combined and varied database of profitable vegetable development for suitability land assessment by using GIS tools.

MATERIALS AND METHODS

Cultivation is the act of making use of environmental resources to get production for livelihood of mankind. Therefore, cultivation involves both characteristics including qualities and human activities. For profitable use of land and getting more quality yields of vegetable productions is important to know based factors about crops development. They are complex characteristics and depend on biologically requirement of vegetables.

– **Geographic information**

- Digital administrative maps of the region, municipality, digital cadastral maps and maps of reclaimed property in the studied area. The digital model formats are ZEM, CAD. Information source: the Geodesy, Cartography and Cadastre Agency.
- Digital soil map of the area in scale M 1:10000. Soil maps reflect in detail the boundaries between the separate soil types. Information source: The Soil Resources Agency and the Institute of Soil Science "Nikola Pushkarov".
- Topographic maps in scale M 1:25000 and digital elevation models

– **Attribute information**

- Air temperature in °C for period of 10 years (2004-2013), especially the months from April to October. This period is enough to establish dependence between variety of maximum, minimum and average temperatures.
- Summarized characteristics for tomatoes growing include complex of important factors, necessary for vegetable development. It combines information about temperature, soil texture, organic content, soil reaction, irrigation, soil depth, slope, access of road and access to collection center. The values are got from some established books and full papers (N. Panaiotov et.all, 2006; T. Murtazov et.all, 1987; Baniya, 2008). All necessary and vital information about tomatoes growing is presented on the next table.

Table 1. Diagnostic characteristics for suitability of tomato

Parameters	Potential Ratings		
	High	Moderate	Low
Temperature (° C)	18 -26	15 -18, 28 -35	< 15 & > 35
Soil texture	Loamy, sand	Sandy, loam	Clay, sand
Organic matter content (%)	> 2	1.5 - 2	< 1.5
Soil reaction (pH)	5.6 - 6.6	6.6 - 7.5	< 5.6 & > 7.5
Irrigation	Regular	Readily available	Rained
Soil depth	> 80 cm	50 - 80 cm	30 - 50 cm
Slope (degree)	Flat to 2	1 - 5	5 - 8
Access of Road (km)	near < 10	10	> 10
Access to collection centre (km)	near < 20	20	> 20

– **Assessment rate**

- In land suitability analysis, a map represents each evaluation criterion with alternatives (like S1, S2, S3) indicating the degree of suitability with respect to a criterion. These classes have to be rated, how important is the class S1 with respect to a particular criteria to contribute for the final goal (suitability). In this particular land suitability analysis the criteria are mainly related to climate factors, elevation structure, soil characteristics, infrastructure and environmental information. The next table explains suitability criterions.

Table 2. Suitability rate

Suitability classification	Explanation
igh suitable (S1)	Suitable capacity of locations is high and satisfies all criteria set up.
Medium suitable (S2)	Suitable capacity of locations is medium and satisfies most of the criteria set up, but some criteria are not satisfied.
Low suitable (S3)	Suitable capacity of locations is low and satisfies some of the criteria set up, but most of the criteria are not satisfied.

The methodology is based on matching soil/land characteristics against agronomic requirements of crop and then the suitability classification will be assessed. The physical land suitability evaluation used limiting factors method assigning the suitability classes, in which the lowest suitability class will limit for the rest of factor (Baniya, 2008).

All collected information is classified by suitability rate and prepared for using of GIS applications. Using suitability classification for land assessment, gathering data can be presented by thematic maps, using GIS tools.

RESULTS AND DISCUSSIONS

Attributes of the study area has marked effects on the tradition and culture and in turn to the cultivation practices. So the result of the data collection is influenced by characteristics of farmers, climate and topography research locations (Baniya, 2008). The information shows the basic facts, which have to be considered for the data analysis and interpretation of the results. Being one of the complex areas and variety topography, consideration of the study area information is of prime importance. This study includes information from the climate, meteorology, environmental characteristics and infrastructure of the Perushtitza Village, Bulgaria. This region covers 4871.6 ha, including 2298.9 ha land using area. Elevation changes from 150m to 800 m. The relief is various from plane to hilly. The urban part is situated on plane and agricultural land. There is concerned most of the useful area for vegetable growing. Most important biological requirements of tomatoes, gathered on Table 1 are presented by thematic maps, using GIS applications. All collected data is transformed and ready to use in GIS for assessment purpose.

Vegetables crop production is an integrate part of Bulgarian agriculture. Extensive experience and rich national traditions in growing vegetable crops determine Bulgaria as an established producer of vegetables. According to Toskov (2013) the proportion of fresh vegetables and potatoes in the gross production of agriculture sector is 10.2% and the gross production in crop production - about 20%. These facts determine the importance of vegetable growing.

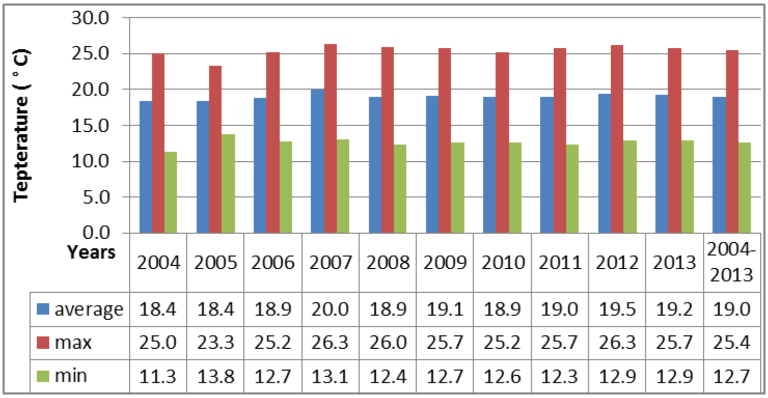
The using of GIS database in vegetables crop production will help to increase the knowledge of the vegetable growers relating with the selection of areas, selection of suitable productions direction and varieties and applying of good agricultural practices for sustainable vegetable production sector. Several authors point the need for developing strategies for the production and realization of vegetable production (Stoeva, 2013; Christova et al, 2013; Toskov, 2013; Nikolova, 2013). According to them, the developed measures should be complex are reflected in a general system for effective management of vegetable farms. One of important aspects of these strategies is to support vegetable growers by creating a database which allows quick access to practical and applicable information. This could be achieved by using GIS information systems (Haytova et al, 2014).

The Perushtitza Village belongs to the temperate continental climate zone. However, topographic setting causes to have great variation in climatic condition between the valley basin and the surrounding hilly area. The topography of different regions creates a complex mosaic of topoclimates. Temperature is one of the most important data for vegetables. Studied range of air temperature in °C is 10 years - from 2004 to 2013. The vital months for tomatoes growing are from April to October. This period is enough to establish dependence between variety of maximum, minimum and average temperatures. This state is followed by the next charge.

Elevation is the main influencing factor on temperature, together with geographical location and aspect. About 99% of the variation in temperature can be explained by elevation and geographical location, and 90% by elevation alone (Baniya, 2008). Average monthly minimum temperature at the study area ranges from 12.3°C to -13.8°C. Similarly, maximum temperature ranges from 25.0°C to 26°C. From analysed data on the Figure 1 can be made a conclusion that the temperature variety is between established frames, mentioned on Table 1. According to suitability classification, rate S1 is appropriate for this region.

According to the relief, the region is characterized of varied types of land forms. In the North part slope is 1-2 degree, but in the South part it slowly transformed to the hilly with degree up to 12. This part is taken by forest and rocks. In the next map this part is coloured by no fill. Next thematic map (Figure 2) shows all slope distribution in Perushtitza region. From analysed data 63.4% (1423.4 ha) of the area is with slope 2°, 34.2% (768.0 ha) with slope to 5° and 2.3% (53.7 ha) with slope more of 5°. Compare to the biological elevation requirement, the slope is classified on rate S2, because of its variety relief.

The thematic map on Figure 3 presents soil types covered this region. Predominated are clay and rendzins types. Map depicted for the soil classification according to FAO system, show eight soil groups present within small area of the region, presented on Figure 3.



Years	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2004-2013
average	18.4	18.4	18.9	20.0	18.9	19.1	18.9	19.0	19.5	19.2	19.0
max	25.0	23.3	25.2	26.3	26.0	25.7	25.2	25.7	26.3	25.7	25.4
min	11.3	13.8	12.7	13.1	12.4	12.7	12.6	12.3	12.9	12.9	12.7

Figure 1. Distribution of air temperature for period of 10 years (2004-2013)

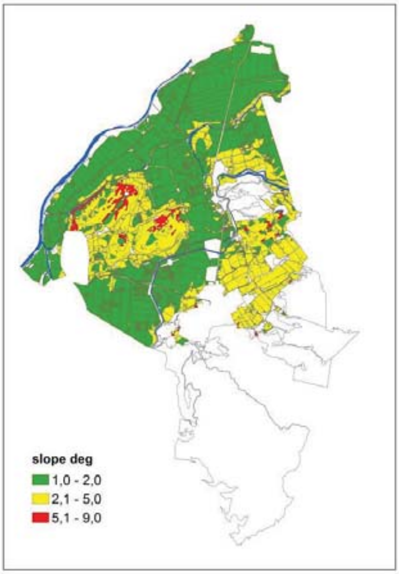


Figure 2. Slope Distribution

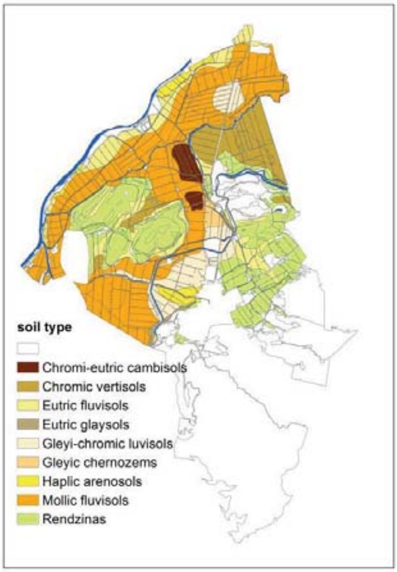


Figure 3. Soil type

On this basis it can be concluded that variations in the soil types can be related in the variation and orientation in the land form and cultivation practices. Pattern of land use and cultivation implies that soil appears to be exhausted in terms of nutrients. To bring back soil into good quality require to increase the organic matter contents, therefore need of constant application of organic manure seems necessary (Baniya, 2008). Most spread soil types convert the region into suitable land for vegetable production.

Soil parameter to be studied has been categorised into physical characteristics and chemical characteristics. Soil texture means the relative proportion of the various size groups of individual soil particles. Texture provides important information regarding water holding capacity, permeability, irrigation requirement and erodibility. Growth and development of the plant primarily based on the soil texture. Root penetration, nutrition absorption through soil particles, water holding capacity, water infiltration and percolation are affected by texture type. There is a big vegetable diversity found in terms of soil texture in Perushtitza Village. It possesses Loamy, loamy skeletal and loamy bouldery type of broad texture class. Loam and sandy loam are much more preferred soil type for the vegetable farming community which is one of the most suitable categories and accounts for 61.3% of the total existing agricultural land area of the valley. About 1.6% i.e. 823.0 ha of agricultural land area have very rough texture and apparently not able to support any crop cultivation, this is categorized into unsuitable on the basis of texture parameter. This distribution is presented on Figure 4.

Soil reaction is the degree of acidity or alkalinity of the soil and pH is the negative logarithm of the H ion activity. This refers to the relative activity of the H ion in the soil solution. In present investigation pH value ranges from 5.6 to 7.5. pH of given soil presents an indication of the degree of availability of many soil nutrients and the favourability of soil condition to microbial activity which contributes to the fertility in turn. Thematic map (Figure 5) presents the area with the best content of pH in the soil - 80.1% of the area is with soil pH from 6.6 to 7.5. So the soil reaction is enough for vegetable development.

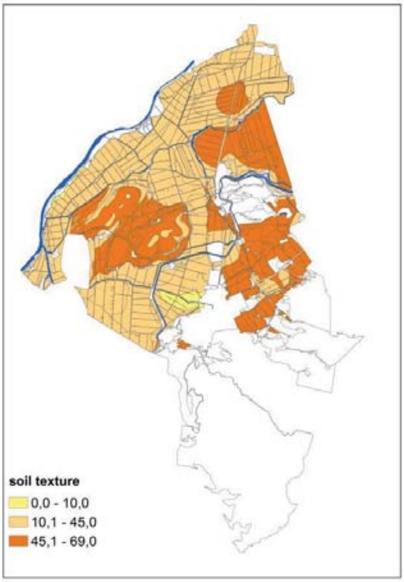


Figure 4. Soil texture

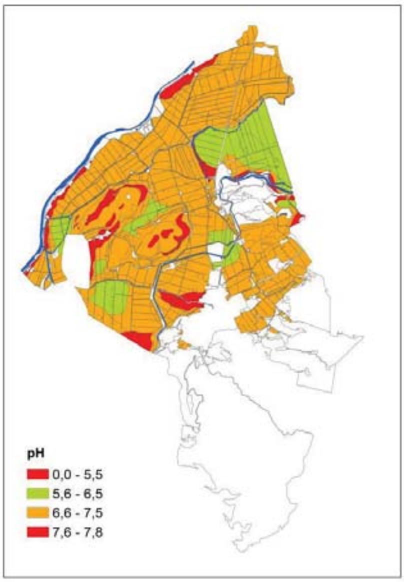


Figure 5. Soil pH

Organic matter content of the soil is an important parameter related to soil fertility. Further decomposition of organic matters by microbial activities yields humus. These are true nutrient to the plant available in soil. Good humus content in soil improves infiltration rate and water holding capacity. The most organic matter is ranging to 2%. It covers 53.3% of useful agricultural land (Figure 6). Irregular spread of humus influence on variety of vegetable quality productions. Data analyze shows good diversity of humus in this region.

This region is situated between different kinds of road systems. There are one of the biggest important marketing roads and market-places for vegetable production. Nearby are collecting centres for vegetable production in Plovdiv city, Yoakum Gruevo, Parvenec and other manufacturing centres. Link between them is realized by good supported road systems. Irrigation is realized by built irrigation canals and good environmental conditions. There are located some of the rivers Vacha, Kriva, Qdenica, Stara, et.all. The terrain is with high-level water holding capacity. The map on Figure 7 presents roads distribution and irrigation canals in this region.

Christova and Ilieva (2013) recommended the development of the sector Vegetables crop production is used both economic and technological tools. On the one hand will increase the technology base, and the other will increase knowledge of vegetables growers. The creation of a GIS database has practical effect and allows producers to receive in accessible all relevant information for the specific parts of agriculture land. The use of GIS in vegetable could facilitate the planning, organization and production of vegetable production, in compliance with the requirements for quality. Assessment of land use is directly related to the determination of suitability for vegetables crop production and also the determination of the limiting factors for the cultivation of vegetable crops (Haytova et all, 2014). So, farmers will receive specific recommendations well-founded in research for growing vegetable species according to their biological requirements and potential. It obtained a classification of vegetable species under their suitability to a specific area, relevant with the interests of vegetables growers.

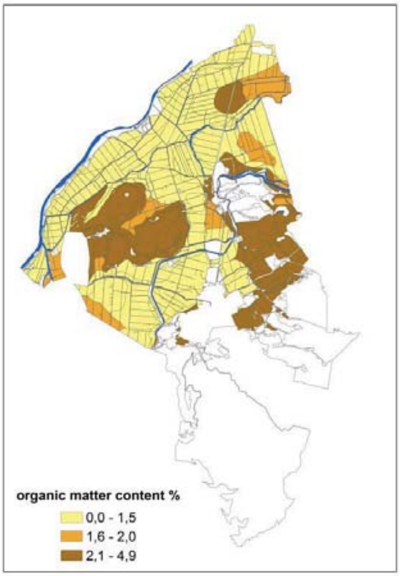


Figure 6. Organic matter content

Figure 7. Infrastructure-roads and irrigation canals

Refers to the climatic and infrastructure characteristics of studied area, the suitability rate can be defined to the S1- high suitability region for tomatoes growing. This assessment can be useful for more farmers and profitable for marketing centres.

All studied factors present important frame for good profit of tomatoes growing. Necessary characteristics are reduced to suitability classification. In this way all information can be presented mixed or separately. The item of doing it is called GIS.

By its large resources possibilities, commands and tools, this Geographical Information Systems has a power to action with huge amount of information. But for working with it, all collected and necessary information has to be transformed into spatial data. The process of converting non-spatial information into spatial database is firstly and the most important step of analysing. Using suitability rate the spatial data can be assessed and the result can be presented by thematic maps. The using of GIS database in vegetables crop production will help to increase the knowledge of the vegetable growers relating with the selection of areas, selection of suitable productions direction and varieties and applying of good agricultural practices for sustainable vegetable production sector.

CONCLUSIONS

Geographical Information Systems (GIS) consists of various components, starting with the incorporation of geographical data from remote sensing sources or maps and is then converted into a computer-readable form (Baniya, 2008). Useful suitability assessment is based on biophysical and infrastructure resource information. The spatial data can be manipulated and overlaid for analytical operations. This functionality required to work with different data structures. Crop analyse includes soil/water requirement, geostatistic analysis, land use are used to identify and make sense of complicated spatial relationships and, ultimately, substantiate trends and theories. It helps to solving spatial problems depend on climate, soil, elevation, area structure and socio-economic conditions, visible appeared on the thematic map.

Vegetable cultivation is one of the most important parts of agriculture development. All comprehensive conditions and factors, which influenced on plan production, are presented by thematic maps. Agriculture database activities as collecting, organizing, transforming, analyzing and presenting the land using of the studied area, are realized by GIS modeling. Establishing appropriate suitability factors is the construction of suitability analysis (Stefanova et.all, 2014).

It is very essential to understand environmental capacity to support appropriate vegetable cultivation. GIS analyzing gives us overview of all necessary factors and parameters for sustainable and profitable vegetable development. Using assessment maps agricultural activities can be planned for further improved activities and aimed minimizing yield losses. It is essential to can make forecast of vegetable benefits and to achieve complex management for improving environmental conditions.

ACKNOWLEDGEMENTS

The report and participations on the congress was financial supported by Project 05-14 of Research Centre in Agricultural University, Plovdiv.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE INCIDENCE AND PREVALENCE OF ROOT-KNOT NEMATODE SPECIES (*MELOIDOGYNE* SPP.) ASSOCIATED WITH DIFFERENT DICOTYLEDONS ORIGINATED FROM TWO VEGETABLE CROPPED AREAS, VĂRĂŞTI (GIURGIU), AND BĂLENI (DÂMBOVIȚA)

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Abstract

Although the vegetable fields is reduced in Romania, the production losses remain high and this concern is not owed only to fungui, viruses, bacteria or insects, but also to nematodes, these last organisms being less known and acknowledged. Meloidogyne incognita (Kofoid & White, 1919) and Meloidogyne hapla (Chitwood, 1949) are considered important parasitic nematodes, but quite little studied in Romania, for different species of dicotyledon vegetables and this article demonstrates and compares the development and reproduction of these two species related to one of the most important vegetable cultures from the economic point of view. It seems that the Meloidogyne hapla species especially prefer the species from the Apiaceae family, unlike those belonging to Meloidogyne incognita which develop a more intense shock on Brassicaceae and Solonaceae botanic family species. However, the eggs masses detected for both root-knot nematodes species show a unitary type of distribution at the surface of the of roots cortical area of all analyzed vegetable species. A contamination with the Meloidogyne incognita species, unusually high, has been noticed for the first time in our country in Brassica oleracea species.The diagnosis through biomorphometry on semi-permanent microscopic preparations, completed with the molecular biology techniques (restriction fragment length polymorphism - RFLP$_s$) led to the conclusion that the twocategories of diagnosis methods can be considered as being complementary.

Key words: *diagnosis, galles, larves, root-knot nematodes (Meloidogyne* spp.*).*

INTRODUCTION

The genus *Meloidogyne* Göldi 1892 or the root-knot nematodes (RKN) consists of sedentary, polyphagous root endoparasites (Sharon *et al*. 2007). More than 100 species have been reported worldwide (Karssen & Moens 2013). Although nematodes from the *Meloidogyne* family were reported for the first time in Romania, at the end of the 40s, under the name of “root worms” or *Heterodera maroni* Cornu (Manolache *et al*. 1949), the studies elaborated along the time, focused on the control issues, attack methods and to the produced damages, and less on the attacked host plants. At the same time, there are little references regarding the share of *Meloidogyne* species, in the large fields cultivated with vegetables in our country. The nematode is very harmful causing essential losses especially in the tropical and subtropical areas. Unfortunately, our country is not avoided by their more or less aggressive attack, despite its location in the temperate area.

The root-knot nematodes (RKN) are making the object of large studies regarding the aggression level of the attacks and the management of such attacks, having as final purpose, to reduce the application of chemical or non-chemical (in tests) nematocides. In order to reach this, a new approach is needed, based on a correct identification of *Meloidogyne* species.

Therefore, the objectives of this study were to establish the incidence and the prevalence of RKN species, in two important vegetable fields, the vegetables host associated with the attack of these nematodes, the density of the last ones, as well as the combination of the classic diagnosis methods with those of molecular biology.

MATERIALS AND METHODS

The nature of the samples was constituted of soil and roots resulted from two important vegetables fields, Vărăşti, respectively Băleni. Vărăşti commune is located in the passage of Săbarului valley, at the east limit of Giurgiu County (South-Eastern Romania), at 30 km from Bucharest. Băleni commune is located in the south side of Dâmbovița County (Central-Southern Romania) situated at a distance of around 20 km from Târgovişte Municipality. Both areas are under the incidence of the temperate-continental climate, characterized by very hot summers, moderate rainfalls and not so cold winters, with rare winter blizzards and frequent warming periods.

The biotic and abiotic diversity allows the cultivation of a large variety of vegetables, on protected fields and especially on agrarian fields, providing an important amount from the vegetables production of the country.

However, none of both fields was avoided by the pest attack, including the root-knot nematodes (RKN).

The samples (mixture of soil and vegetables roots) were collected within April 2014 – November 2014 and the identification of root-knot nematodes species belonging to *Meloidogyne* family was made on stages.

There were mainly chosen plants with low fructification, dwarfing phenomena and different levels of wilting.

The soil was collected from a depth of 15-20 cm, using a hand shovel, following a zig-zag model. The adherent soil on roots collected from 11 micro-farms (6 from Băleni - 5ha, respectively 5 micro-farms from Vărăşti – 6ha) was carefully shacked, attentively observing the roots (presence/absence of galls). Then two samples of 1 kg soil and roots/ha were collected. The samples were divided in sub-samples of around 200 g. This sub-division was necessary for a better laboratory processing.

The samples were stored in polyethylene bags at temperatures of 7 - 10˚C, until their processing.

The storage of the last ones was performed on stages for a period of 5-7 days.

The nematodes extraction from soil was performed using the Cobb's method, through sieving and decantation and afterwards using the Baermann modified method (Southey, 1985). The nematodes were collected in aqueous suspension during no more than three days, numbered on counting dish, using a binocular stereomicroscope (Leica MZ95) and the density was established as number of nematodes on 200 g soil.

To establish the density in roots, they were shacked to remove the adherent soil, carefully washed and cut in pieces of 1-2 cm.

The nematodes extraction was performed placing the roots (aprox 10 g) in hatching chamber to produce juveniles hatching from the eggs (McKenry and Roberts, 1985). After five days, the nematodes were numbered under a binocular stereomicroscope.

The perineal pattern was placed in glycerine, after the females were dissected from the roots galls to be identified (Jepson, 1987).The nematodes were killed in water at 70˚C, fixed in TAF and placed in glycerine, on a glass slide sealed with paraffin ring, for identification, using a stereomicroscope Leica DMLB with camera Leica DC300 and Leica DFC295 image-processing software. The severity of the attack on roots was evaluated on a scale from 0 to 5, as it follows: 1= 1-2 galls; 2= 3-10 galls; 3= 11-30 galls; 4= 31-100 galls; 5= over 100 galls (Taylor and Sasser, 1978).

The reception of the samples, their storage, the extraction of the nematodes, their preliminary examination, the microscopic preparations and the bio-morphometric identification were performed at the Regional Laboratory of Nematology-Braşov while the bio-morphometric observations of species confirmation and diagnosis through molecular biology were performed at the Central Phytosanitary Laboratory–Bucureşti.

The RKN incidence for each culture (host plant), for each vegetable field, as well as the global (total) incidence, were calculated using the formula below (Hussain, 2012):

$$\text{Incidence (\%)} = \frac{\text{Total number of infected plants}}{\text{Total number of observed plants}} \text{ X } 100$$

The prevalence for each vegetable field was calculated using the formula below (Hussain, 2012):

$$\text{Prevalence (\%)} = \frac{\text{Total number of fields with root-knot nemaodes}}{\text{Total number of fields surveyed}} \text{ X } 100$$

The incidence of each RKN species (occurrence) for each vegetable field was calculated using the formula (Norton, 1978):

$$\text{Occurrence of specie (\%)} = \frac{\text{Number of sample within species}}{\text{Total number of samples observed}} \text{ X } 100$$

In terms of molecular biology analysis there were used juveniles of the two species, following the steps below. Therefore, DNA extraction was carried out using ten juveniles collected directly from samples.
The juveniles were crushed between a glass slide and the cover slip by gentle pressure.
The extract was recovered with 20 µL of lysis buffer (10 mM Tris pH = 8.8, 1 mM EDTA, 1% Triton X-100, 100 mg/mL proteinase K) incubated at 60°C for 1 h, then at 95°C for 10 min (Ibrahim *et al*., 1994). The ITS regions of rDNA were amplified using the forward primer 18S 5'-TTG ATT ACG TCC CTG CCC TTT-3' and reverse primer 26S 5'-TTT CAC TCG CCG TTA CTA AGG-3' (Vrain *et al*., 1992).The PCR mixture (total volume 25 µL) contained 1x buffer enzyme, 1, 5 mM $MgCl_2$, 0.6 µM of each primer, 1 U Taq DNA polymerase (MP Biomedicals), 0.2mM dNTPs (MP Biomedicals) and 5 µL DNA extract
AMasterCycler Pro S (Eppendorf) was used for amplification, and the reaction consisted of a denaturation step at 94°C for 15 min followed by 45 cycles at 94°C for 15 s, 58°C for 30 s, 72°C for 1 min, and a final extension step of 10 min 72°C. Following PCR, 10 µL of the amplified product was analysed by electrophoresis in a 1% agarose gel.Amplified DNA was digested with DraI and RsaI restriction endonucleases (Fermentas and Promega) using an aliquot of 5 µL of the PCR product and 5 U of each enzyme, according to the manufacturer's instructions. Species-specific ITS–RFLP profiles for *Meloidogyne* were generated using these two restriction enzymes (Zijlstra *et al*., 1995).
Fragments were resolved by electrophoresis in 1,5-2% agarose gel. Data analysis was performed using GENi (Syngene) and 100 bp DNA Ladder (GeneRuler, Fermentas) as a molecular size marker.
Analyses of nematodes density were carried out using SPSS Statistics (Statistical Package for the Social Sciences, available online at https://statistics.laerd.com/spss-tutorials/one-way-anova-using-spss-statistics.php) and the Standard error calculation (available online at http://www.investopedia.com/terms/s/standard-error.asp).

RESULTS AND DISCUSSIONS

The most important vegetable cultures from Băleni (Dâmbovița County), namely Vărăşti (Giurgiu County) were studied: beet, celery, parsnip, carrot, parsley, lettuce, broccoli, cauliflower, cucumber, vegetable-marrow, tomato and pepper.

Among the 120 analysed samples, the majority composed of a mixture of soil and roots, 105 samples were positive for RKN.

From the total number of samples which were examined, from both regions, it resulted that the global incidence is 87.5 % infested samples with RKN, but there are differences concerning the incidence reported to different vegetables species.

Therefore, the incidence from Băleni area starts from 50% for *Lactuca sativa* and *Cucurbita pepo*, achieving the maximum percentage in case of *Apium graveolens* (Figure 1*), Pastinaca sativa* (Figure 2)*, Brassica oleracea* and *Brassica oleracea* var. *botrytis* (Table 1).

From Vărăşti area the incidence starts from 50% for *Beta vulgaris* achieving the maxim percentage to *Daucus carota* and *Petroselinum crispum,* among others (Table 2).

Figure 1. Infested roots – *Apium graveolens*

In Vărăşti area, the incidence for all positive (+) samples of vegetables is 88.33 %, unlike Băleni area, where this incidence was 86.66%. Although these differences between the two vegetable areas are not too significant, it is to be noticed the RKN incidence of 100% to the family members of *Brassicaceae* from Băleni area, along with a significant deformation of the roots.

Figure 2. Infested roots – *Pastinaca sativa*

This deformation is due the galls. Each gall usually contains three to six giant cells, which are due to substances contained in the "saliva" secreted by the nematode in the giant cells during feeding. The giant cell crush xylem elements already present but degenerate when nematodes cease to feed or die. In the early stages of gall development the cortical cell enlarge in size, later, they also divide rapidly.

Frequently other parasites can easily attack the weakened root tissues and the hypertrophied, undifferentiated cells of the galls (Agrios, 2005).

Table 1. The incidence of RKN (%) for crop host at Băleni – Dâmbovița
(+ present, - absent, RKN root – knot nematode)

Botanic family	Crop host	Total soil samples	+	-	Incidence RKN %
Amaranthaceae	*Beta vulgaris*	4	3	1	75
Apiaceae	*Apium graveolens*	4	4	-	100
	Pastinaca sativa	6	6	-	100
	Daucus carota	7	6	1	85.7
	Petroselinum crispum	7	6	1	85.7
Asteraceae	*Lactuca sativa*	2	1	1	50
Brassicaceae	*Brassica oleracea*	5	5	-	100
	Brassica oleracea var. *botrytis*	7	7	-	100
Cucurbitaceae	*Cucumis sativus*	3	2	1	66.66
	Cucurbita pepo	2	1	1	50
Solanaceae	*Lycopersicon esculentum*	11	10	1	90.90
	Capsicum annuum	2	1	1	50
Incidence of RKN/area 86.66 %					

Table 2. The incidence of RKN (%) for crop host at Vărăşti – Giurgiu
(+ present, - absent, RKN root – knot nematode)

Botanic family	Crop host	Total soil samples	+	-	Incidence RKN %
Amaranthaceae	*Beta vulgaris*	2	1	1	50
Apiaceae	*Apium graveolens*	3	3	-	100
	Pastinaca sativa	8	7	1	87.5
	Daucus carota	7	7	-	100
	Petroselinum crispum	5	5	-	100
Asteraceae	*Lactuca sativa*	1	1	-	100
Brassicaceae	*Brassica oleracea*	3	2	1	66.66
	Brassica oleracea var. *botrytis*	3	2	1	66.66
Cucurbitaceae	*Cucumis sativus*	4	3	1	75
	Cucurbita pepo	2	1	1	50
Solanaceae	*Lycopersicon esculentum*	13	13	-	100
	Capsicum annuum	9	8	1	88.88
Incidence of RKN/area 88.33 %					

The incidence of each species of nematodes (occurrence) in different cultures of host-plants, underlines the fact that *Meloidogyne incognita* species is predilected to *Solanaceae, Cucurbitaceae* and to *Brassicaceae* (Table 3). The *Meloidogyne hapla* species grow better on species of root vegetables, in other words species of vegetables of the *Apiaceae* family (Table 4). Occurrence of species *Meloidogyne hapla* at Băleni area is predominant (50%) unlike the species *Meloidogyne incognita* (36.66%). Occurrence of species *Meloidogyne incognita* is higher at Vărăș ti area (53.33%) while *Meloidogyne hapla* was found in less than 50% (31.66%). The index of the galls is a sign of the nematodes presence or absence in roots and implicitly in soil. This index indicates the severity of the attack. Therefore, this severity is maximum (5) to *Brassicaceae* family (Figure 3) from Băleni while the index of the galls is raised (4) to *Apiaceae* family (Figure 4) and *Solanaceae* families from Vărăşti.

The mixed RKN population are relatively common in the vegetables plantations, only that in our study they were found only to *Lycopersycom esculentum* specie from Băleni area.

Table 3. The incidence of each RKN species (occurrence) and the index of the galls at Băleni - Dâmbovița area (*M.i. = Meloidogyne incognita, M.h. = Meloidogyne hapla*)

Botanic family	Crop host	*M.i.*	*M.h.*	Non detected	Gall index
Amaranthaceae	*Beta vulgaris*	-	3	1	2
Apiaceae	*Apium graveolens*	-	4	-	4
	Pastinaca sativa	-	6	-	2
	Daucus carota	-	6	1	3
	Petroselinum crispum	-	6	1	4
Asteraceae	*Lactuca sativa*	-	1	1	1
Brassicaceae	*Brassica oleracea*	5	-	-	5
	Brassica oleracea var. *botrytis*	7	-	-	5
Cucurbitaceae	*Cucumis sativus*	2	-	1	3
	Cucurbita pepo	-	1	1	3
Solanaceae	*Lycopersicon esculentum*	7	3	1	4
	Capsicum annuum	1	-	1	2
	Occurrence RKN (%)	36.66	50	13.34	

Table 4. The incidence of each RKN species (occurrence) and the index of the galls at Vărăști - Giurgiu area (*M.i. = Meloidogyne incognita, M.h. = Meloidogyne hapla*)

Botanic family	Crop host	*M.i.*	*M.h.*	Non detected	Gall index
Amaranthaceae	*Beta vulgaris*	1	-	1	1
Apiaceae	*Apium graveolens*	3	-	-	3
	Pastinaca sativa	-	7	1	4
	Daucus carota	-	7	-	4
	Petroselinum crispum	-	5	-	4
Asteraceae	*Lactuca sativa*	1	-	-	2
Brassicaceae	*Brassica oleracea*	2	-	1	1
	Brassica oleracea var. *botrytis*	2	-	1	1
Cucurbitaceae	*Cucumis sativus*	3	-	1	3
	Cucurbita pepo	1	-	1	3
Solanaceae	*Lycopersicon esculentum*	13	-	-	4
	Capsicum annuum	8	-	1	4
	Occurrence RKN (%)	53.33	31.66	15.01	

Figure 3. Infested roots – *Brassicaceae (Brassica oleracea*)

Figure 4. Infested roots – *Apiaceae (Daucus carota)*

The prevalence was of 100% in both vegetable fields, so that all studied fields were infested with root – knot nematodes.

At least 40 perineal patterns from each vegetable field were examined for better identification accuracy (Figure 5 and 6).

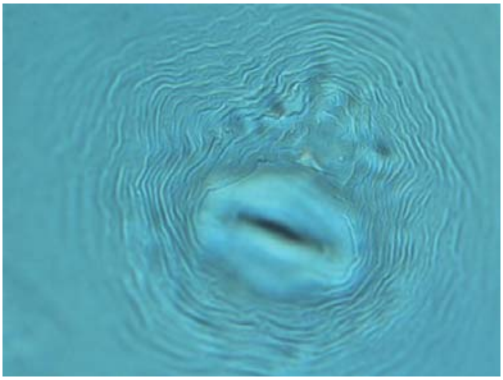

Figure 5. *Meloidogyne incognita* – female perineal pattern (100x magnification). Scale bar =20µm

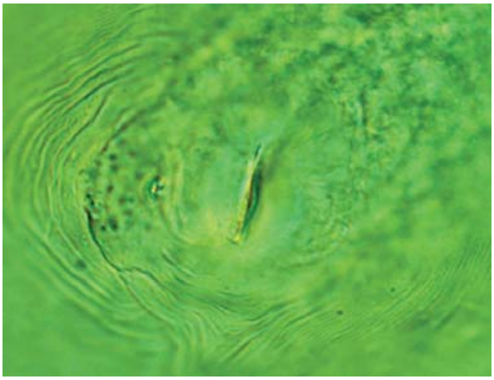

Figure 6. *Meloidogyne hapla* - female perineal pattern (100x magnification). Scale bar =20µm

Statistical analysis used fuctions Mean and ANOVA belonging program SPSS. Mean number of nematodes on roots was significantly higher at Băleni (11/10 g roots) compared to 8.25/10 g roots al Vărăș ti (Sig. 0.0006). At Băleni the total number of nematodes (soil+roots) was significantly higher compared to Vărăș ti (16.89)(Table 5).

At Băleni area the highest total mean number of nematodes was found at *Brassica oleracea* var. *botrytis* (134.8).

The highest total mean number of nematodes at Vărăș ti area was at *Cucurbita pepo* of which 42.2 nematodes/200 g soil and 51.4 nematodes/10 g roots (Table 6).

Table 5. Nematode population density per 200 g soil + 10 g roots of diseased crop host at Băleni (± Standard error)

Crop host	Positive samples (+)	Mean number of nematodes ±Standard error		
		200 g soil	10 g roots	Total
Beta vulgaris	3	6.53±0.40	6.73±0.34	13.27±0.61
Apium graveolens	4	9.40±0.76	10.75±0.48	20.15±0.97
Pastinaca sativa	6	3.37±0.34	3.27±0.35	6.63±0.49
Daucus carota	6	6.63±0.34	5.07±0.41	11.70±0.55
Petroselinum crispum	6	6.80±0.34	6.67±0.38	13.47±0.55
Lactuca sativa	1	2.40±0.51	10.60±1.81	13.00±1.38
Brassica oleracea	5	32.08±0.75	35.60±0.92	67.68±0.95
Brassica oleracea var. *botrytis*	7	61.60±1.03	73.20±1.46	134.80±1.07
Cucumis sativus	2	21.40±1.71	30.80±1	52.20±2.16
Cucurbita pepo	1	21±2.05	26.00±1.52	47.00±1.70
Lycopersicon esculentum	10	4.38±0.28	5.12±0.40	9.50±0.47
Capsicum annuum	1	2.43±0.27	2.83±0.31	5.26±0.41
Mean at Băleni	52	9.75±0.72	11.0±0.9	20.8±1.55

Table 6. Nematode population density per 200 g soil + 10 g roots of diseased crop host at Vărăș ti (± Standard error)

Crop host	Positive sample (+)	Mean number of nematodes ±Standard error		
		200 g soil	10 g roots	Total
Beta vulgaris	1	7.00±0.63	2.20±0.49	9.20±1.02
Apium graveolens	3	8.67±0.40	12.67±0.61	21.33±0.79
Pastinaca sativa	7	8.91±0.37	8.23±0.36	17.14±0.58
Daucus carota	7	6.20±0.31	7.26±0.25	13.46±0.36
Petroselinum crispum	5	14.72±1.01	12.48±0.26	27.20±1.27
Lactuca sativa	1	21.40±0.51	19.20±1.24	40.60±1.50
Brassica oleracea	2	1.10±0.28	2.80±0.51	3.90±0.64
Brassica oleracea var. *botrytis*	2	1.03±0.19	0.37±0.12	1.40±0.22
Cucumis sativus	3	11.70±0.78	14.00±2.07	25.07±2.28
Cucurbita pepo	1	42.20±0.80	51.40±4.76	93.60±4.48
Lycopersicon esculentum	13	5.91±0.23	4.85±0.53	10.75±0.61
Capsicum annuum	8	30.60±1.60	21.10±1.53	51.70±1.86
Mean at Vărăș ti	53	8.63±0.50	8.25±0.53	16.89±0.99

Restriction fragment length polymorphisms ($RFLP_s$) method has the advantage that it distinguishes species after extraction and purification of genomic DNA, restriction digestion and visualisation of banding patterns in gel electrophoresis. The 760 bp PCR product we obtained for the amplified ITS region with 18S and 26S primers. After digestion PCR products with the two restriction enzymes , *Meloidogyne hapla* isolate showed the following restriction patterns: 380 bp with DraI and 620, 140 bp with RsaI and for *Meloidogyne incognita* isolates: 220, 200, 180, 160 bp with DraI and 760 bp with RsaI (Figure 7).

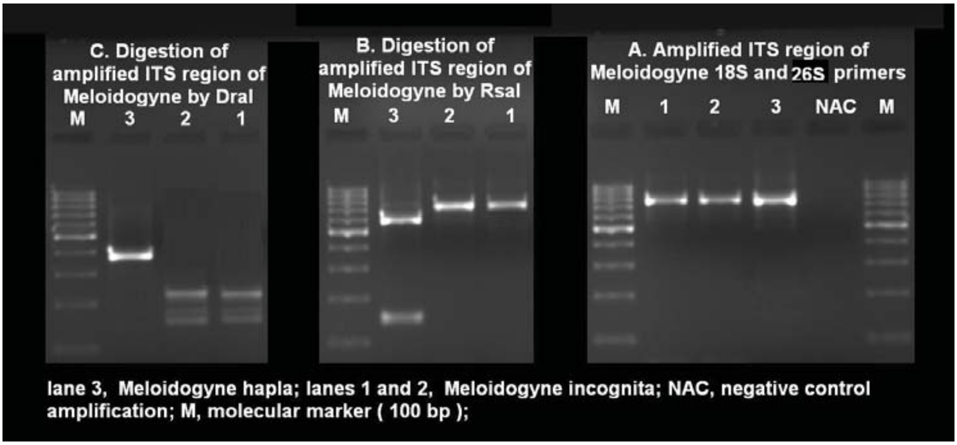

Figure 7. **A**, typical amplification by polymerase chain reaction (PCR) of 760 bp product from template of total DNA extracted from juveniles of *Meloidogyne hapla* and *Meloidogyne incognita* ; **B, C,** size of DNA fragments (bp) obtained after restriction enzyme digestion of the 760 bp internal transcribed spacer regions of *Meloidogyne hapla* and *Meloidogyne incognita* with RsaI and DraI.

CONCLUSIONS

The present study was elaborated to identify and quantify one of the most encountered species of polyphagous phyto-parasite nematodes in our country.

To better understand the economic impact of the attacks in case, a correct identification of RKN was necessary.

Both vegetables fields are favourable to the RKN development due to the soil, the temperature and the host-plants presence, as proved by the high global incidence which reaches 87.5%.

Until present, there was no aggressive attack to *Brassica oleracea* reported in the specialty literature from our country.

In this case, the significant density of nematodes in soil and roots, probably the susceptibility of the variety, leaded to an incidence of 100% to *Brassicaceae* family in Băleni.

The preponderance of the *Meloidogyne hapla* (50%) species was observed in Băleni unlike Vărăşti where the *Meloidogyne incognita* (53.33%) species predominates.

It is to remark that as far as *Lycopersycom esculentum* (culture of major economic importance) is concerned, the occurrence of the RKN was 100% which could be due, among other factors, to the use of Monkeymaker variety, sensible to RKN attack.

An index of the galls over 100/root was reported to the members of *Brassicaeae* family (Băleni).

The density of nematodes (in soil and embedded in the roots) is relatively close to each host plants.

The difference in terms of density among different plant species are due to climate, soil type, plant varieties, which favours the survival and multiplication of RKN.

Although molecular techniques are not readily available to every diagnostician, they complement and confirm the bio-morphometrical identification, thus increasing the reliability of diagnosis.

The combination of the conventional and molecular methods represents, from our point of view, a challenge for the discovery of other species of *Meloidogyne* parasitic in the vegetable areas from different areas of the country.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

PRE-BREEDING FOR DIVERSIFICATION OF PRIMARY GENE POOL IN ORDER TO ENHANCE THE GENETIC PEPPER RESOURCES

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Abstract

Exploitation of new and diverse sources of variation is needed for the genetic enhancement of Capsicum annuum L. *species. Variety is an important factor of production and has to be in accordance with consumer needs. This study represents a screening of physiology and biochemistry of pepper, particular the Romanian cultivars. The investigated parameters were selected because of their importance in pepper quality, with the final purpose to identify the most valuable resources to be used in breeding as staring material. In this purpose, the study focused on the phenological observation, biometrical measurements and also physiological processes that occur in fruits during their growth and development, which included the following characteristics: total dry content and water content; content in soluble glucides and titratable acidity, content in β carotene and anthocians, content in ascorbic acid, all parameters investigated are related with fruit quality. The most valuable cultivars, regarding nutritional quality were: Creola, characterised by 7.90% content in dry substance, TA 0.343 mg g^{-1} malic acid, AA 200.4 mg g^{-1}, and carotenes 23.452 mg g^{-1}; Lider, 7.80 % content in dry substance, TA 0.344 mg g^{-1} malic acid, AA 200.2 mg g^{-1} and carotenes 23.47 mg g^{-1}; Cornel content in dry substance 7.40%, TA 0.331 mg g^{-1}, AA 199.2 mg g^{-1} and carotenes 23.0 mg g^{-1}.*

Key words: *biometrical measurements, phenological observation, physiological investigations.*

INTRODUCTION

The pepper fruits are very tasty, healthy owing to their content of biologically active chemicals with antioxidant properties. The vegetable is an abundant source of vitamin C (Buczkowska and Najda, 2002). Physiologically ripe fruits are abundant in carotenoid pigments.

Moreover, pepper is an important source of minerals for humans (Bubicz et al., 1999). Consumers have high demands in terms of color, shape, size and taste of fruit and the producer must meet these requirements, making extra productivity, precocity and resistance to pathogens. There is the need to create better varieties with higher yield and quality to satisfy a growing demand (Pérez-Grajales et al., 2009).

The narrow genetic bases of cultivars coupled with low utilization of genetic resources are the major factors limiting production and productivity globally. Wild relatives with enhanced levels of resistance/tolerance to multiple stresses provide important sources of genetic diversity for pepper improvement. Otherwise, the local population or the developed cultivars can represent valuable sources for pepper improvement in terms of nutritional quality.

Pre-breeding provides a unique opportunity, through the introgression of desirable genes from wild germplasm or into genetic backgrounds readily used by the breeders with minimum linkage drag, to overcome this. Pre-breeding activities using promising landraces, wild relatives, and popular cultivars have been initiated, in a diverse range of programs.

Demand for pepper richer in compounds like ascorbic acid, capsaicin, beta-carotene and lycopene is increasing especially because of their demonstrated antioxidant potential.

The future production of cultivated pepper depends on improving their genetics and developing new superior cultivars with traits such as nutritional quality, disease resistance, and higher yield potential. Reported levels of phytochemical variation is due in large part to various environmental conditions (abiotic and biotic stresses) acting on plants during their growth and development (Leskovar et al., 2009). None the less, continual selection of material containing higher levels of these phytochemicals is a valuable component of a breeder's program and will undoubtedly result in creation of improved germplasm consumers can eat to benefit their well-being (Crosby et al., 2007).

Significant variation in phytochemical expression within pepper fruit tissue is dependent upon several factors. Genotypic, as well as, environmental differences have both contributed to material of variable phenotypic expression (Draghici, 2014). The ultimate goal of pepper breeders is, therefore, to use knowledge and apply it in a special manner to exploit more effectively match the best genotype with its optimum environment to achieve the most desirable output.

MATERIALS AND METHODS

The experiments were conducted at the Vegetable Research and Development Station Bacau.

The investigated genotypes were grown in open field, natural conditions.

The biological material was represented by twelve Romanian cultivars, as follows: 'Splendid', 'Madalin', 'Meteorit', 'Cornel', 'Lider', 'Creola', 'Granat', 'Timpuriu de Bucureşti', 'Titan', 'Rubin', 'Superb', 'Globus', all cultivated in similar experimental condition.

All fruits harvested for investigations were selected at an appropriate maturity stage and size, and were healthy and turgid.

The phenological observations and the biometrical measurements were accomplished in the experimental parcels, and involved: colour at physiological maturity, fruit's length (cm), fruit's diameter (cm), ratio length/ diameter, number of lobs, fruit's weight (g), number of fruits /plant, pulp's width (mm).

Fruit measurements were conducted on fruits to gain insight into their potential variation.

The physiological changes monitored were: the content in total dry matter, water and minerals, soluble dry matter, titratable acidity, β carotene, anthocians, ascorbic acid, glucides, all related with nutritional quality of pepper.

Maturated peppers have been collected in the same week of ripening and were chemically analyzed.

The determination of total dry matter substance was carried out by weighing the fresh vegetal material, drying it for 24 hours at 105°C, cooling it, and then weighing again the dry vegetal material. The obtained results were expressed in percentage. The difference till 100% represents the water content.

The content in mineral elements was determined by tissue incineration at 560 ^{o}C temperature and the results were expressed in percentage.

The soluble dry matter content was determined using a refractometer method and the results were expressed as a percentage.

Titratable carotene content was extracted in petrol ether and determined using a spectrometer at λ=415 nm. The content of β carotene was expressed in mg 100^{-1} g. The anthocianic pigments were extracted in methyl alcohol + 1 % HCl and spectrophotometrically determined at 540 nm wave length.

Ascorbic acid was extracted in oxalic acid 1 %, and determined with a Nexus spectrometer (FT-IR). The quantity of ascorbic acid was expressed in mg 100g $^{-1}$.The content in soluble sugar was determined by Fehling method.

RESULTS AND DISCUSSIONS

The breeding program of pepper, founded by Cardi in 1997, has managed to get results in three directions; among those is the use of local landraces. A selection for stability has permitted creation of valuable cultivars from local landraces (Herman, 2005).

Our germplasm study has a multiple approach (1) the screening of phenological and morphological aspects in order to detect the most valuable resources according to the market request: pulp's width, number of lobs, colour, shape - ratio length/ diameter, fruit's weight; (2) investigation of internal quality: total dry matter, water and minerals, soluble dry matter, titratable acidity, β carotene, anthocians, ascorbic acid, glucides, in order to distinguish the most favorable germplasm for potential release in the future.

The main fruit's characteristics investigated are presented in table 1 - round pepper (12 genotypes). The most obvious trait of interest to breeders and growers is uniformity. Because pepper are a self-pollinating crop, this has been accomplished by inbreeding peppers, while selecting for important shape, flavor, appearance and yield traits by breeders throughout the world.

Table 1. Phenological observations and biometrical measurements – round pepper

Variety	Fruit			
	Length (cm)-	Diameter (cm)	Ratio L/D	No of lobs
Splendid	7.2 ± 0.030	8.6 ± 0.02	0.83 ± 0.03	3.2 ± 0.10
Madalin	7.8 ± 0.021	7.9± 0.01	0.98 ± 0.06	3.8 ± 0.10
Meteorit	7.1 ± 0.010	7.9± 0.02	0.89 ± 0.18	2.8 ± 0.04
Cornel	7.1 ± 0.040	8.2± 0.01	0.86 ± 0.21	2.9 ±0.05
Lider	7.0 ± 0.031	8.2± 0.02	0.85 ± 0.05	2.9 ± 0.17
Creola	7.9 ± 0.012	8.8± 0.01	0.89 ± 0.02	3.6 ± 0.12
Granat	7.1 ± 0.013	7.6± 0.02	0.93 ± 0.04	2.6 ± 0.9
Globus	5.6 ± 0.012	5.9 ± 0.02	0.94 ± 0.04	2.1 ± 0.14
Titan	7.4 ± 0.011	8.7± 0.02	0.85± 0.02	3.2 ± 0.52
Rubin	5.2 ± 0.020	5.9± 0.03	0.88± 0.01	2.8 ±0.42
Superb	5.9 ± 0.050	6.2± 0.04	0.95 ±0.04	2.7 ± 0.37
Timpuriu de Bucureşti	5.3 ± 0.040	6.0 ± 0.05	0.88 ± 0.05	2.8 ±0.12
Average	6.7	7.5	0.89	2.70
Standard deviation	2.56	1.33	1.6	0.29
LSD 0.05	0.98	0.72	0.85	0.20

Table 2. Phenological investigation at round pepper fruits (weight, pulp's width, number fruits/plant)

Variety	Shape	Colour at physiological maturity	Fruit		
			Weight -g-	Pulp's width -mm-	Number of fruits /plant
Splendid	round - flattened	Red	70.8 ± 2.5	7.8 ± 0.090	9.2 ± 0.75
Madalin	round - flattened	red-carmine	80.6 ± 3.9	9.1 ± 0.047	6.8 ± 0.82
Meteorit	round	dark red	85.7 ±2.23	9.4 ± 0.180	7.3± 0.75
Cornel	round	Red	90.8 ± 2.4	10.2 ± 0.550	8.5 ± 0.80
Lider	round - flattened	red-carmine	75.4 ± 1.55	9.5 ± 0.600	10.3 ± 0.98
Creola	round	shiny red	215 ±4.20	12.9 ±0.190	12.8 ± 1.21
Granat	round	dark red	110 ±1.55	9.8 ±0.500	9.1 ± 1.23
Globus	globular	red-carmine	98 ± 2.20	11.2 ± 0.420	15.2 ± 1.55
Titan	spherical	dark red	180 ± 1.95	11.6 ± 0.370	6.2 ± 1.21
Rubin	round	red	90.5 ±2.45	8.9 ± 0.620	9.4 ± 1.6
Superb	round - flattened	red	97.4 ± 2.33	8.2 ± 0.550	-
Timpuriu de Bucureşti	globular	red	90.9± 1.9	8.8 ± 0.230	11.9 ± 0.66
Average			107.09	9.78	8.89
Standard deviation			85.8	1.02	2.66
LSD 0.05			30.26	0.45	0.98

Some of the most important features related with visual quality of pepper are the external color, weight of fruit, shape and pulp' weight. The tremendous variability regarding shape, color and weight of bell pepper fruits is totally different, being lower in case of round pepper germplasm. In any case, the fruit of round pepper must be fully red to be acceptable for processing and desirable for their decorative color and the flavor they impart to processed food. The consumers prefer a red fruit in a ready-to-eat stage with an attractive appearance, a crisp texture and have a specific flavor.

In our collection, the shape varied from round flattened to round, globular, with an average of ration length / diameter 0.89 (Table 1 and 2). Comparing the length and diameter of investigated genotypes, we observed that eight genotypes registered large fruits with length more than 7 cm and diameter more than 7.6 cm. The smallest fruits regarding length and diameter values were harvested from genotype ‘Rubin”, 5.2 cm length and 5.9 cm diameter.

The variation of total number of lobs was between 2.1 and 3.8 with an average of 2.7. Table 2 presents the variability of fruit weight, pulp width and number of fruit per plant. The value of fruit weight varied from 70.8 g (‘Splendid’), to 180 g (‘Titan’) and 215 g (‘Creola’). The heaviest fruits of ‘Creola’ genotype, registered the highest value of pulp’s width (12.9 mm).

The shape, the size and the fruit’s weight are important parameters of yield and quality as follows: fruit’s weight cumulated with number of fruits per plant, density, etc. - especially in case of yield potential estimation and fruit’s weight, pulp’s width, fruit’s shape, and fruit’s size for establishment of crop use - fresh consumption or as raw material, in food industry.

Figures 1 to 5 presents the results of the analyses focused toward the determination of the chemical composition of 12 genotypes of round pepper. The size and the quality of mature peppers were determined by interaction of genotype x environmental climate. One of the indicators of size and round pepper quality is represented by the accumulation of water and total dry matter.

The total dry matter (TDM) content varied from 7% to 7.9 %. The highest content was registered in fruits of ‘Lider” and “Creola” genotypes, 7.9%, respectively 7.4%. One of the factors affecting the production of plant biomass is the concentration of mineral elements.

Regarding mineral accumulation, the total amount of minerals in round pepper fruits varied in limits of 0.09%, from 0.46% at ‘Spelendid’, ‘Madalin’, ‘Titan’, ‘Rubin’ to 0.55% at ‘Globus” genotype (Figure 1).

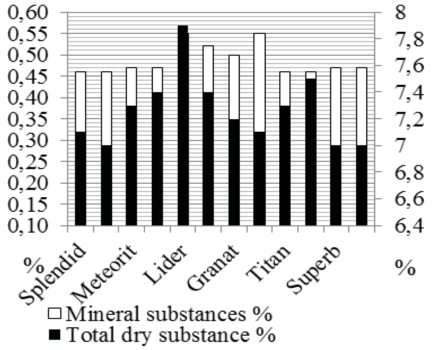

Figure 1. Total dry mater and mineral accumulation

Fruit quality and consumer acceptability in round pepper are strongly related with the pigments concentration, soluble solids content (TSS) titratable acidity (TA) and ascorbic acid (AA) in the ripened fruits. During ripening process, some substances of important nutritional quality, particularly vitamin C and carotenoids are accumulated in large quantities (Navarro et al., 2006).

Ascorbic acid, known as vitamin C, needs to be consumed via food or medicine, as it is not produced in the human organism (Manela-Azulay et al., 2003). The levels of vitamin C are variable and may be affected by maturity, genotype and processing. Ascorbic acid is the least complex vitamin found in plants and is synthesized from glucose or some other simple carbohydrate (Kays, 1991).

According to our study, the fully ripened round pepper fruits have the highest levels of ascorbic acid (AA), the titratable acidity and the total soluble solids also.

The round pepper, totally maturated represents an important source of vitamin C for human consumption, presenting values of higher than 190 mg 100 g^{-1} (‘Meteorit’), till 200.4 mg 100 g^{-1} (‘Creola’). Ascorbic acid (AA) concentrations were highly variable among the accessions (Figure 2).

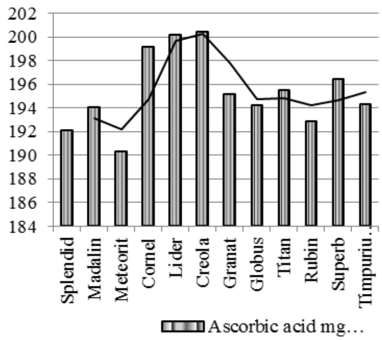

Figure 2. Ascorbic acid in maturated fruits

Our results highlight the antioxidant potential of round pepper species, stronger than those of mango (84 mg 100 g-^{1}), guava (67 mg 100 g^{-1}) and orange (40 mg 100 g^{-1}), Toda Fruta, 2004).

Round pepper is one of the most important sources of vitamin C, and also the β-carotene content, the predecessor of vitamin A. The content of β-carotene was very high in most investigated varieties and fluctuates from 18.96 mg 100g $^{-1}$ ('Meteorit') to 23.45 and 23.47 mg 100g^{-1} at 'Creola', respectively 'Lider'. This compound increased dramatically in mature colored fruit for all lines tested.

Carotenoids concentrations varied tremendously among the germplasm accessions. Six accessions registered low β – carotene content, (under 20 mg 100g^{-1}), and other six genotypes were characterized by extremely high (above 20 mg 100g^{-1}) total carotenoids at the maturated stage (Figure 3).

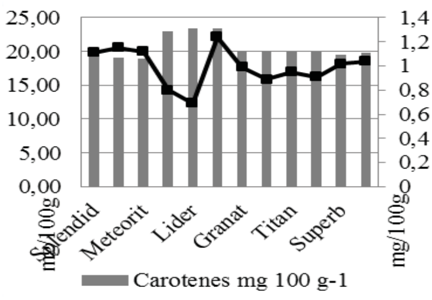

Figure 3. Pigments accumulation in pepper fruits

Investigated peppers are a good source of vitamin C and carotenoids that are important nutritional antioxidants found in the human diet. Many authors reported increase of carotenoids, during development of pepper fruits. In general, ripening of pepper fruits is strongly associated with carotenoids accumulation (Marcus et al., 1999). Anthocians synthesis is also responsible for color of maturated fruits.

The average of the anthocians content was 0.992 mg 100g^{-1}, with a variation form 0.69 mg 100g^{-1} (at 'Lider') to 1.24 mg 100g^{-1} at 'Creola' (Figure 4).

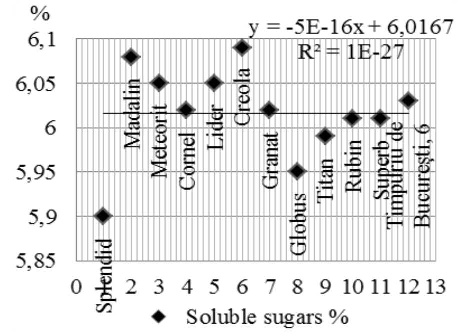

Figure 4. Soluble sugars content

The genotype 'Creola' is distinguished by its highest content in anthocians and also in β-carotene. Significant accumulation of soluble sugars during pepper fruit ripening was confirmed by findings of (Howard et al., 2000). In our study the range of soluble sugars varied from 5.90% at fruits of 'Splendid" cultivar to 6.90 % at 'Creola'.

Titratable acidity (TA) as well as TSS are commonly measured to give an overview of pepper maturity at harvest, and are used for harvest scheduling. TA indicates the total amount of organic acids. It is already known the fact that titratable acidity (TA) of the round peppers is increased with ripening, while during the ripening process the metabolic reactions increase, increasing the concentration of organic acids involved in the Krebs cycle.

Apart from this, these acids make up the energetic reserves and the metabolic reactions that involve the synthesis of pigments, enzymes and other materials and the degradation of pectins and celluloses, which are essential for the ripening process. Acidity is important for flavor balance. Our study shows a small variation in case of titratable acidity (TA) of investigated genotypes from 0.330 mg g^{-1} malic acid ('Madalin' and 'Superb') to 0.334 mg g^{-1} at ('Lider') (Fig.5). The total soluble solids

(TSS) increased as ripening of the fruit increased due to the greater degradation or biosynthesis of the polysaccharides and the accumulation of sugars.

The metabolic processes related to the advance of ripening, probably due to disassociation of some molecules and structural enzymes in soluble compounds, directly influence the levels of total soluble solids, where fruits in advanced stages of ripening present the highest levels of soluble solids (Lyon et al., 1992). Regarding the content of total soluble solids (TSS), the variation was form 7.1 % at 'Superb', 'Globus', 'Cornel', and 'Madalin' to 8.3 % at 'Creola'.

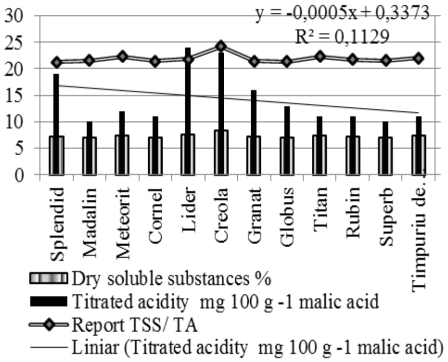

Figure 5. TTS, TA and report between

As TSS, TA and the report between, can be easily and objectively measured, and commonly used as basic quality specifications related to maturity of peppers and therefore suitability for harvest. The report total soluble solids (TSS), and titratable acidity (TA) represents an important qualitative parameter TSS/TA. In our investigation the value of this report varied from 21 to 25 (Figure 5).

CONCLUSIONS

For pepper improvement exists sufficient genetic diversity, especially local germplasm can constitute a gene pole that is still insufficient exploited. However, utilization of these resources in breeding programs is time-consuming and resource demanding. To overcome this, pre-breeding activities should be initiated to generate new genetic variability using promising and valuable genetic material for use by the breeders in pepper improvement programs. Results from this experiment provide evidence that elite pepper materials exist for these characteristics of interest.

This preliminary study can be potentially examined in future investigations and possibly exploited in various breeding methods to maximize their potential superiority as parent material for development of several improved specimens.

Three genotypes present superior qualitative traits: Creola, characterised by 7.90% content in dry substance, TA 0.343 mg g^{-1} malic acid, AA 200.4 mg g^{-1}, and carotenes 23.452 mg g^{-1}; Lider , 7.80 % content in dry substance, TA 0.344 mg g^{-1} malic acid, AA 200.2 mg g^{-1} and carotenes 23.47 mg g^{-1}; Cornel content in dry substance 7.40%, TA 0.331 mg g^{-1}, AA 199.2 mg $g^{-1}$and carotenes 23.0 mg g^{-1}.

Our study highlight the need of enormous efforts needed to evaluate germplasm for traits of economic importance, for identifying potential donors. The success of pepper improvement program depends on the availability of sufficient genetic variability, but this variability must be in conventionally usable form.

ACKNOWLEDGEMENTS

This research work was cofinanced from PN-II-PT-PCCA-2011-3.2-1351 developed with support of ANCS, CNDI – UEFISCDI, contract registration 68/2012.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

PERSPECTIVES IN WINTER PEAS BREEDING PROGRAM

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Abstract

Peas (Pisum sativum) are an excellent source of protein, carbohydrates and many essential micronutrients therefore is considered a nourishing flow throughout the body. Field pea is the main large-grain legume in Europe. According to the purpose, peas can be divided into grain and fodder peas. Grain pea cultivars are mostly spring crop, while the majority fodder pea cultivars are winter-forms. The field pea it is a main protein crop used for both, human and animal nutrition, being an alternative European plant species that will reduce imports of soybean from the United States, Argentina etc. In the last 20 years, in Romania, the grown area with field pea decreased considerable, the average cultivated being approximately 25.000 ha/year. The main reason of this aspect is the drastic reduction of number of animal big farms. However, winter peas can be an alternative to improve the area grown with peas in Romania. Preliminary data obtained at NARDI Fundulea shown that the yield of winter forms of peas was between 4267-4800 kg/ ha, over yield the spring type, sown in the spring with 191-215 %. Winter peas have some advantages over spring peas like: a better establishment and more efficient use of humidity during the winter season - which makes it less vulnerable to drought over the spring, frequently in Romania in the last years; winter peas can be sown in mixture with some cereal (barley, triticale) for obtaining high nutritive green forage; earlier harvest; has a longer vegetation period and get higher productivity and more stable yield than spring peas type. The winter peas breeding programs at international level have several objectives: frost is one of the main climatic stresses which have to be overcome by a winter pea crop; realized the winter pea varieties with better performance in no-till technology systems to obtain the green forage in mixture with some cereals. In Romania, the initiation of winter peas breeding program started at NARDI Fundulea in 2010, following acquisition of some winter peas germplasm from USA and Austria. The main goals of this program are related to: realized winter pea varieties adapted to specific climatic conditions from Romania, and initiation of the program for obtaining the green forage.

Key words: *winter pea, green forage, breeding.*

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important annual cool season legumes in the world today (Mihailovic and Mikic 2010). Producing pea (*Pisum sativum* L.) is one of the least expensive and at the same time most quality answers to a perennial demand for plant protein by animal husbandry (Maxted and Ambrose 2000). Pea also represents a valuable addition to or a complete replacement for soybean meal in the years with less favorable conditions for the cultivation of the latter (Mikic et al. 2003). Their total area in Europe may and should be increased due to many environmental, economic and social reasons. Recent agroeconomic research in contrasting regions of the European Union confirmed that pea and other grain legumes may profitably be included in diverse crop rotations every 3–6 years (Nemecek et al. 2008). Achieving this strategic goal requests the vivid and strengthened interactions between genetics, breeding, agroecology and agronomy.

Pea is considered rather well adapted to wide temperature ranges, with seedlings able to survive even -20°C (Shereena and Salim, 2006). From a physiological viewpoint, pea becomes tolerant to frost if first exposed to low non-freezing temperatures, causing the so-called cold acclimation, where regular light intensity improves the freezing tolerance and where a close relationship between the soluble sugar concentration of leaves just before the frost and the degree of freezing tolerance exists (Bourion et al. 2003). Pea plants are also able to modulate their photosynthetic rate during growth at low temperature and adjust it as needed for survival (Yordanov et al. 1996).

Delayed floral initiation helps some forage pea genotypes to escape the main winter freezing periods, as susceptibility to frost increases during the transition to the reproductive state (Lejeune-Henaut et al. 1999). Numerous studies describe the physiological and phenological effects of the main loci governing the transition to flowering in pea, such as *Lf* and *Hr*, known to delay floral initiation of autumn-sown peas until a longer day length is reached in the following spring (Lejeune-Henaut and Delbreil 2009). The oldest winter pea cultivars carry the dominant allele, *Hr*, although some bear *hr* (Bourion et al. 2002). They are generally characterized by prominent winter hardiness and a long growing season, from sowing in early October until either cutting for forage production in late May or harvesting seeds in mid-July. A study of one population of recombinant inbred lines (RILs) allowed detection of six quantitative trait loci (QTL) for frost tolerance, which is in agreement with an oligogenic determinism of frost tolerance in pea.

In this population, the most explanatory QTL was found to localize with the Hr locus (Lejeune-Henaut et al. 2008). Further studies in the same genetic background gave an insight in the genetic determinism of physiological traits potentially involved in cold acclimation, showing for example the colocalization of QTLs for raffinose concentration or RuBisCO activity with QTLs for frost tolerance on linkage groups 5 and 6 (Dumont et al. 2009).

Breeding winter forage pea emphasizes the development of the lines with satisfying tolerance to low temperatures and more prominent earliness, with great potential for both forage and grain yields.

Breeding and the cultivation of fall-sown pea confirm that it could be one of the least expensive and most efficient ways to decrease the unpredictable and destroying effects of spring droughts and other manifestations of climatic changes on protein-rich crops such as pea. They also establish a solid basis for the anticipation that the existence of high-yielding, early and winter hardy fall-sown dry pea cultivars will increase the total area under grain legumes, especially in Europe, and thus contribute to a significant increase of the protein needed for ever demanding animal husbandry.

The paper presented the preliminary results obtained in the winter pea breeding program NARDI Fundulea.

MATERIALS AND METHODS

The winter peas breeding program started at NARDI Fundulea in 2010, using a germplasm originated from USA (Specter and Windham) and from Austria, (Checo). Beside this winter type germplasm was added several spring Romanian genotypes with some tolerance to winter hardiness after autumn planted test.

During the 2012 and 2013 has been tested yield performance and winter hardiness level of resistance at three winter genotypes and eight spring genotypes in one trial, in three reps planted in autumn. Also in 2013, in head rows are tested, for the first time 940 F3 lines selected from winter /winter or winter/spring crosses pea genotypes for winter hardiness, plant height and earliness. Among this in the paper are presented only 20 F3 lines selected from the crosses Specter/Checo.

The level of resistance to winter hardiness was estimated in the field, early in the spring, in a scale 1to 9, where score 1 is very resistance and 9 very susceptible. Plant height was measure in cm, total length of plant from the ground till the top to the end of flower time. The earliness was appreciated like number of days from 1st January till the end of flowering time.

The statistical analyses of data have been evaluated by ANOVA and calculation of linear regressions between traits.

RESULTS AND DISCUSSIONS

The yield performances and the winter hardiness of winter and spring pea genotypes planted in autumn in two years are presented in the table 1. It is notice that the all three winter varieties out yielded significantly, in average, in the both years, the spring pea genotypes. In some case the level of yield of the winter varieties has been almost double against the spring control variety Aurora. Of course the differences between the winter form and the spring form can be higher in the years with a severe winter.

In the tested years, 2012 and 2013, as can see the score data of level winter hardiness in the spring forms, the winter in both years was too mild.

Table 1. Yield and winter hardiness of several winter and spring pea genotypes sown in autumn.

Genotype	**Yield kg/ha (2012)**	**Yield kg/ha (2013)**	**Yield mean**		**Winter hardiness**
			kg/ha	**%**	
Checo (W)	2800	3840	**3320**	145	1,5
Windham (W)	4267	3180	**3990**	174	1
Specter (W)	4800	2544	**3672**	160	1,5
Aurora (S)	1866	2714	2290	100	3
Dorica (S)	1533	1969	1751	76	3
Marina (S)	1700	1856	1778	78	3
Nicoleta (S)	1433	1444	1439	63	4
F05-2039 (S)	1800	2235	2018	88	4
F98-492 (S)	1600	1552	1576	69	5
F98-603(S)	1400	2267	1834	80	2
F95-927 (S)	1167	1495	1331	58	3
LSD 5%	705	626	666	29	-

Yield advantage of winter pea varieties against spring varieties remained also when was compared the yield of winter forms planted in autumn with the spring forms planted in spring (Table 2). This can be explain that the winter pea varieties used much better the water accumulated during the winter time and are much lower affected by the drought period in the early spring.

Table 2. Comparison between yields of spring pea varieties planted in spring with those of winter pea type planted in autumn

No	Genotypes	Growth habit	Time of planting	Yield (2012/2013)		
				Kg/ha	Diff.	%
1.	Nicoleta (control)	spring	spring	2360	0	100
2.	Rodil			1766	-594	74
3.	Aurora			1846	-514	78
4.	Specter	winter	winter	3672	1312	155
5.	Windham			3724	1364	157
6.	Checo			3320	960	140

Among the winter germplasm used in the NARDI-Fundulea breeding program there are genotypes with long vegetation period, like Specter and Windham form USA, and earliness European type (Checo from Austria) both with good level of resistance to winter hardiness (fig.1).

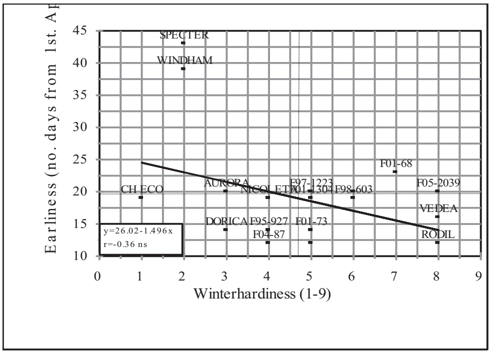

Fig.1 The relationship between earliness and winter hardiness of 25 winter and spring pea genotypes planted in autumn.

The relationships between earliness and winter hardiness had shown that different genetic mechanisms for winter hardiness are involved in the winter pea germplasm from USA and Austria one.

The preliminary data presented in this paper has been like aims to demonstrate if it is possible to recombine the plant height and high biomass from American variety Specter with earliness and high level of winter hardiness from the Austrian variety Checo.
The correlation between winter hardiness and earliness of the F3 lines selected from the cross Specter/Checo suggested that it is easier to identify the genotypes which combine earliness and with high winter hardiness (fig. 2).

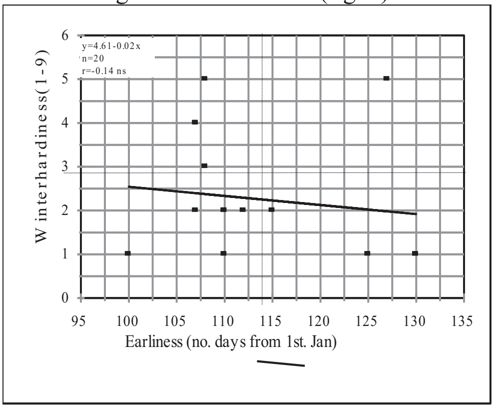

Fig. 2 *Relationships between earliness and winterhardiness of F3 lines selected from the cross Specter/Checo (winter peas/winter peas)*

Also, the data shown that there are no problems to recombine plant height and winter hardiness, correlation between those traits, of the lines F3 from the same cross, was no significantly (fig.3).

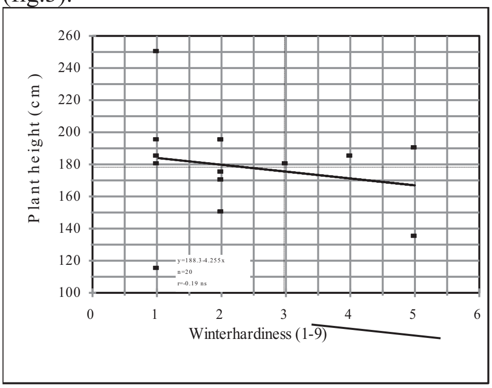

Fig. 3 *Relationship between plant height and winterhardiness of F3 lines selected from the cross Specter/Checo (winter peas/winter peas)*

More interesting it is the no significantly of correlations between earliness and plant height (fig. 4). That suggests the possibility to improve the biomass of the very early winter pea genotypes.

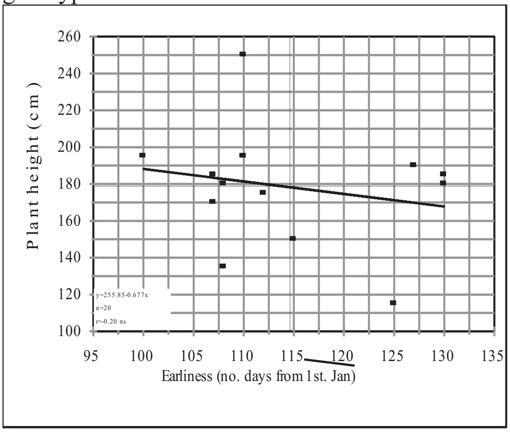

Fig. 4 *Relationship between plant height and earliness of F3 lines selected from the cross Specter/Checo (winter peas/winter peas)*

Of course, the researches which will develop in the next future will be emphasized to select the winter pea cultivars that must combine earliness, with high biomass, high yield, and lodging resistance and improve winter hardiness.
For that it is needed to developed better method to screen the breeding material, as early as possible for winter hardiness, in artificial (growth chamber) or field conditions and even using marker assistant selection for the QTL's well known involve in winter hardiness.

CONCLUSIONS

The preliminary data obtained suggested that the winter pea forms out yielded the spring pea type either in the planted in the autumn even when was compare with the yield of the spring type planted in the spring;
Our data shown the possibility to combine earliness, with high biomass, high yield and improve winter hardiness.
For that it is needed to developed better method to screen the breeding material, as early as possible for winter hardiness, in artificial

(growth chamber) or field conditions and even using marker assistant selection for the QTL's well known involve in winter hardiness.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EFFECT OF MULCHING ON WEED INFESTATION AND YIELDS OF LEEK (*ALLIUM PORRUM* L.)

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Abstract

The aim of this field experiment was to study the effect of two mulching materials on weed infestation and yield of leek, cv. 'Bulgarian Giant'. The field experiment was carried out in the period 2010-2012 in the experimental field on University of Forestry – Sofia. The experimental design was the randomized block with four replicates. Two different mulching materials – barley straw mulch (BSM) and mulch from spent mushroom compost (SMCM) were compared with two control variants – non-mulching, but weeding control (WC) and non-mulching and non-weeding control (NWC). The mulching materials were spread manually in a 5 cm thick layer, one week after transplanting the seedlings of leek. On the 30th, 60th and 90th day after mulching were recorded the number of weeds on each plot. It was found out that mulching with BSM and SMCM have a significant depressing effect on weeds, especially on Echinochloa crus-galli L., Setaria glauca (L.) Beauv., Galinsoga parviflora Cav., Polygonum lapathifolium L. and Portulaca oleracea L. The yields were increased from 3.7 to 4 times when the leek was grown with mulches, compared with NWC. Data were subjected to statisticall analysis using dispersion method. Means were separated by application of Duncan's Multiple Range Test at p ≤ 0.05.

Key words: *barley straw mulch, spent mushroom compost mulch, weed infestation, leek.*

INTRODUCTION

Leeks (*Allium porrum* L.) are members of onion family, closely related to onion, garlic, shallots and chives. (Cholakov, 2009).

Weeds are competitors of most vegetable crops and can reduce their yields significantly. The main annual weeds that occur on arable land under cultivation of species of family Alliaceae are different types of amaranth, fat-hen, thorn-apple, pale persicaria, bristle-grass, cockspur, red finger-grass etc. Also, infestation of arable land with perennial weeds such as Johnson grass, creeping thistle, field bindweed, etc. has been observed (Tonev, 2000). Decrease of weed infestation depend on fact that leek is growing under irrigation and natural fertilizer.

One of alternative method for weed control is use of different kinds of mulch. In the integrated and ecological agriculture systemsmore attention is being paid to the longest possible periodof soil coverage with plant mulches and mulches from straw left aftercereal grain harvest (Szymona, 1993). Organic mulch can block light to the soil surface,reducing the germination and growth of weeds (Anyszka, Dobrzański, 2008).A number of studies have documented that straw mulch isa good means of decreasing weed emergence and growth (Duppong et al., 2004; Grassbaught et al., 2004; Teasdale and Mohler, 2000). Covering or mulching the soil surface canreduceweed problems bypreventing weedseed germination or by suppressing the growth of emerging seedlings (Bond et al., 2003). Mulching decrease the numbers of hand-hoeing and mechanical cultivations for remove of weeds. The key factors that make straw mulchattractive are low cost and easy in availability and application(Ramakrishnaetal., 2006).

According to the data of experiments, straw mulchis best for weed control. In plots with straw mulch weeddensity wasestablished at2.8–6.4 times lower compared with weed density in plots without mulch (Sinkevičienė et al., 2009). According to Radwanand Hussein (2001) broad-leaved weeds were more susceptible than grassy weed to mulching treatments. Mulching improves plant growth, increases yields their quality (Sharma, Sharma, 2003; Singh et al., 2007).

In studying of effect of different organic mulches on weed infestation was establish that mulching with spent mushroom compost, crushed corn cobs and long wheat straw reduced weed germination and weed growth. They suppressed bettermonocotyledonous than dicotyledonous weeds, except straw mulch (Yordanova, Shaban, 2007).

The aim of thepresentstudy was to evaluate the influence of different organic mulches on weed infestation and yield of leek.

MATERIALS AND METHODS

The studies were conducted in the period 2010-2012 in the experimental field on University of Forestry – Sofia, on the Fluvisol soil type.

The leek cultivar "Bulgarian giant" was grown through seedlings which were planted in the second half of June by scheme 60+25+25+25+25/15. The preceding crop was broccoli. The leek was cultivated by drip irrigation. Each trial was laid out in a randomized block-design with four replications (4x40), with protection zones.

The experiment was carried-out with four treatments: 1 - non mulching, but weeding control (WC); 2 - non mulching and non-weeding control (NWC); 3 – mulch from spent mushroom compost (SMCM); 4 – barley straw mulch (BSM). The mulching materials were spread manually in a 5 cm thick layera month after planted of leek.

The occurrence, extent and types of weeds werestudied at 30 and 60 daysafter mulching (DAM) at fixed sites of $1m^2$for each treatment and replicate. All weeds in eachquadrat were identified, counted and recorded forsubsequent data analysis.

The efficacy of the tested mulching materials was recorded by Abbot's formula:

WG% = (CA-TA/CA) x 100, where:

WG% - the percentage efficacy of the herbicides;

CA - living individuals in the control after treatment;

TA - individuals living in the variant after treatment.

The length and diameter of the false stem were measured on 10 plants and presented the average results. The total yield is established in tones per decare (t/da) in replications and variants.

Data were subjected to statistical analysis using dispersion method. Means were separated by application of Duncan's Multiple Range Test at $p \leq 0.05$.

RESULTS AND DISCUSSION

The level of weed infestation in agrocenoses of leeks recorded on 30^{th} and 60^{th}DAM is given in Table 1 - 3. In this agrocenoses the following weed species were established: cockspur (*Echinochloa crus-galli* L.), red finger-grass (*Digitaria sanguinalis* (L.) Scop.), green foxtail (*Setaria viridis* (L.) Beauv.), yellow foxtail (*Setaria glauca* (L.) Beauv.), galinzoga (*Galinsoga parviflora* Cav.), amaranth (*Amaranthus retroflexus* L.), common lambsquarters (*Chenopodium album* L.), purslane (*Portulaca oleracea* L.), and pale persicaria (*Polygonum lapathifolium* L.). In the variant with barley straw mulch (BSM) was recorded and barley (*Hordeum vulgare* L.).

The unmulched plots showed a greaterdiversity of weed species than the mulched plots in period 2010-2012. At 30DAM mulching from spent mushroom compost (SMCM) showed lower weed infestation than barley straw mulch (BSM) (table 1). In this variant weed species *Amaranthus retroflexus* had average number per square meter 10.5. The other weeds in agrocenoses of leek were with single numbers which didn't affect on leek. At 60DAM was establishing low increase of weed infestation in V3. *Amaranthus retroflexus* again was with the most numbers per square meter - 11.75. In treatment with BSM was established higher weed infestation with annual monocotyledonous weeds than dicotyledonous. Weed scores showedsignificant differences ($p \leq 0.05$) in three experimental years.

Analogous results were obtained in year 2011 (table 2). The most effective weed control was recorded in the plots with mulch from spent mushroom compost (SMCM) except for amaranth (*Amaranthus retroflexus* L.) which average number was 18.75 per 1 m^2. In spite of this a significantdifferencewas observed between mulching by spent mushroom compost and non-mulching control. Mulching with barley straw (BSM) showed a slightly difference with SMCM, which is in little higher growth of annual monocotyledonous weed species greenfoxtail (*Setaria viridis* (L.) Beauv.). There were established single numbers in particular replications of weed species *Galinsoga parviflora* and *Portulaca oleracea* in which there was delay in its grow up.At 60DAM the applied organic mulches affected in high extent theweed species. The number of *Amaranthus retroflexus* in SMCM was unaffected but in BSM it was increase. In this variant has reported the single plants of barley (*Hordeum vulgare* L.), which is because of the presence of barley seeds in straw mulch. A significant differences in the average number of weeds in 1m^{2}was observed between NWC, SMCM and BSM.

Table 1. Average number of weeds in 1 m^2 after mulching (2010)

Weed species	NWC		SMCM		BSM	
	30 DAM	60 DAM	30 DAM	60 DAM	30 DAM	60 DAM
Echinochloa crus-galli	17.75 ^{a}	51.5 ^{a}	1.5 ^{b}	1.75 ^{b}	2.50 ^{b}	2.75 ^{b}
Digitaria sanguinalis	9.75 ^{a}	11.5 ^{a}	0 ^{b}	0.75 ^{b}	1.50 ^{b}	2.00 ^{b}
Setaria viridis	11.25 ^{a}	17.5 ^{a}	0 ^{b}	0 ^{b}	9.50 ^{a}	9.50 ^{a}
Setaria glauca	3.50 ^{a}	6 ^{a}	0 ^{b}	0 ^{b}	0 ^{b}	0 ^{b}
Hordeum vulgare	0	0 ^{b}	0	0 ^{b}	0	7.00 ^{a}
Galinsoga parviflora	11.00^a	19.5 ^{a}	0 ^{b}	0.75^b	1.25 ^{b}	2.25^b
Amaranthus retroflexus	43.50 ^{a}	52.5 ^{a}	10.5 ^{b}	11.75 ^{b}	2.75 ^{c}	7.50 ^{c}
Chenopodium album	2.25 ^{a}	3.25 ^{a}	0 ^{b}	0 ^{b}	0 ^{b}	0 ^{b}
Portulaca oleracea	18.75 ^{a}	21.5 ^{a}	0.5^b	0.50^b	0^b	0^b
Polygonum lapathifolium	1.75^a	3.5^a	0^b	0^b	0^b	0^b

Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

Table 2.Average number of weeds in 1 m^2 after mulching (2011)

Weed species	NWC		SMCM		BSM	
	30 DAM	60 DAM	30 DAM	60 DAM	30 DAM	60 DAM
Echinochloa crus-galli	27.75 ^{a}	45.75 ^{a}	1.25 ^{b}	1.25 ^{b}	1.25 ^{b}	1.50 ^{b}
Digitaria sanguinalis	10.25 ^{a}	21.50 ^{a}	0 ^{b}	0.25 ^{b}	1.50 ^{b}	1.50 ^{b}
Setaria viridis	9.75 ^{a}	9.75 ^{a}	0 ^{b}	0 ^{b}	9.50 ^{a}	9.50 ^{a}
Setaria glauca	0.75 ^{a}	2.00 ^{a}	0 ^{b}	0 ^{b}	0 ^{b}	0 ^{b}
Hordeum vulgare	0	0 ^{b}	0	0 ^{b}	0	9.00 ^{a}
Galinsoga parviflora	8.00 ^{a}	15.50 ^{a}	0.50 ^{b}	1.00^b	1.25 ^{b}	2.25^b
Amaranthu sretroflexus	24.50 ^{a}	32.50 ^{a}	18.75 ^{b}	18.75 ^{b}	1.75 ^{c}	6.00 ^{c}
Chenopodium album	0.25 ^{a}	0.25 ^{a}	0 ^{b}	0 ^{b}	0 ^{b}	0 ^{b}
Portulaca oleracea	4.25 ^{a}	4.25 ^{a}	1.00^b	1.25^b	0^b	0^b
Polygonum lapathifolium	0.25^a	0.25^a	0^b	0^b	0^b	0^b

Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

Table 3.Average number of weeds in 1 m^2 after mulching (2012)

Weed species	NWC		SMCM		BSM	
	30 DAM	60 DAM	30 DAM	60 DAM	30 DAM	60 DAM
Echinochloa crus-galli	10.50 ^{a}	32.75 ^{a}	0.75 ^{b}	1.75 ^{b}	1.25 ^{b}	2.50 ^{b}
Digitaria sanguinalis	3.75 ^{a}	6.50 ^{a}	0 ^{b}	0. 50 ^{b}	0.75 ^{b}	1.75^b
Setaria viridis	7.50 ^{a}	13.50 ^{a}	0 ^{b}	0 ^{b}	4.75 ^{a}	5.00 ^{a}
Hordeum vulgare	0	0 ^{b}	0	0 ^{b}	0	6.50 ^{a}
Galinsoga parviflora	7.50^a	12.25^a	0 ^{b}	0.50^b	0.25 ^{b}	0.75^b
Amaranthu sretroflexus	22.75 ^{a}	24.25 ^{a}	0.50 ^{b}	0.75 ^{b}	0 ^{b}	0.50 ^{b}
Chenopodium album	1.50 ^{a}	3.50 ^{a}	0 ^{b}	0 ^{b}	0 ^{b}	0 ^{b}
Portulaca oleracea	9.75 ^{a}	10.50 ^{a}	0^b	0.50^b	0^b	0^b
Polygonum lapathifolium	1.50^a	2.75^a	0^b	0^b	0^b	0^b

Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

In year 2012 was established lower weed infestation than previous experimental years (Table 3). In SMCM treatmentwere monitored single plants in particular replications at 30 and 60 DAM of *Echinochloa crus-galli, Digitaria sanguinalis, Galinsoga parviflora, Amaranthus retroflexus* and *Portulaca oleracea*. In BSM treatment again was established higher growth of monocotyledonous weed species than dicotyledonous. Straw mulch's favourable effect on the limiting ofweeds infestation was also confirmed in the study by Ramakrishna et al. (2006).

The lowest weed infestation was recorded in mulching variants. This show the effectiveness of this method in the suppressing weed germination. The spend mushroom compost has a strong depressing effect on the development of annual monocotyledonous weeds, which has been found by other authors (Yordanova, Shaban, 2007). Lowerinfestation on the covered plots was due to the fast rateof crop plant growth and higher possibilities to competewith weeds compared to plants with non-mulching and non-weeding control.The results showed that two types of mulch caused a decreasein weed infestation, compared to the control plot. This was confirmedin the study by Kosterna (2014).

The efficacy of applied soil mulches on weeds is shown in Figure1-2. In year 2010 at 30 DAM mulching from spent mushroom compost (SMCM) showed higher efficacy than barley straw mulch (BSM). It range from 75,9% against *Amaranthusretroflexus* to 100% against *Digitaria sanguinalis, Setaria viridis, Setaria glauca, Galinsoga parviflora, Chenopodium album* and *Polygonum lapathifolium*. The lowest efficacy in BSM was recorded against *Setaria viridis* – 15.6% (fig. 1). In year 2011 the lowest efficacy to *Amaranthus retroflexus* - 23.5% at 30 DAM and 42.3% at 60 DAM and to *Portulaca oleracea*– 76.5% at 30 DAM and 70.6% at 60 DAM was established in SMCM.The toxicity of mulch from spent mushroom compost on the other weeds of agrocenoses that interfere with leek production was above 93%. In BSM treatment the efficacy to monocotyledonous weeds were from 2.6% to *Setaria viridis* at 30 DAM to 96.7% to *Echinochloa crus-galli* at 60 DAM. Barley straw mulch shows lower efficacy for *Amaranthus retroflexus* than mulch from spent mushroom compost (92.9% at 30 DAM and 81.5% at 60 DAM). In year 2012 at 30 DAM was established higher efficacy of mulching from spent mushroom compost than barley straw mulch. There were only single numbers of weed species *Echinochloa crus-galli*and *Amaranthus retroflexus* in SMCM.

At 60 DAM the efficiency of mulching materials retained high (Figure 2). Mulching variants were characterized by low growth rate of existing weed species as they did not competed with the growth of leek plants. The used mulching materials showed good efficacy at 60 DAM against weed species in leek agrocenosis.

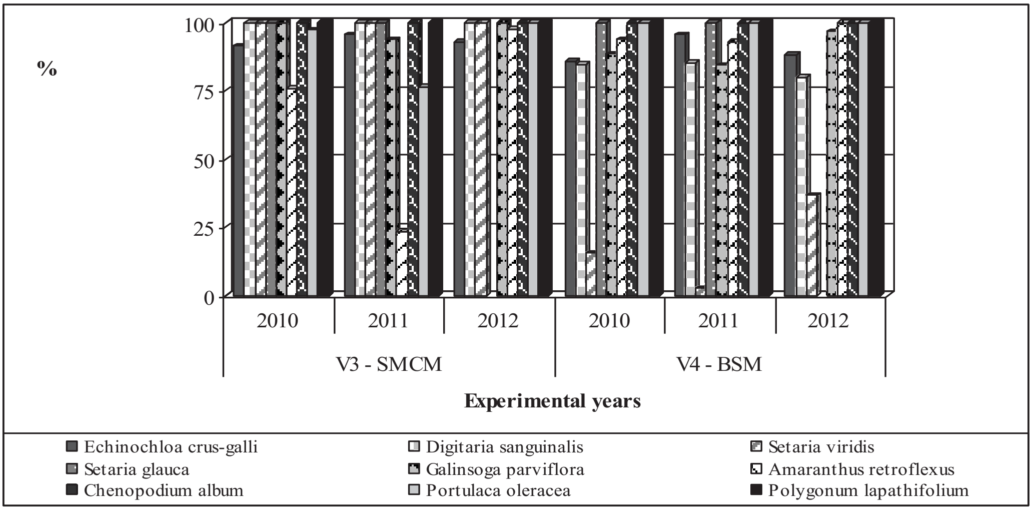


Figure 1. Efficiency of soil mulches compared to the control at 30 DAM (2010-2012)

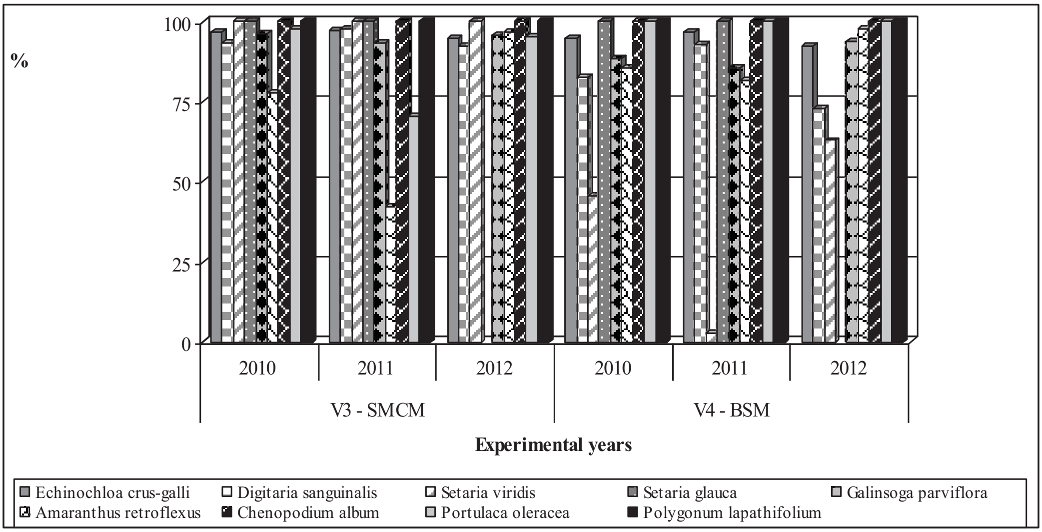
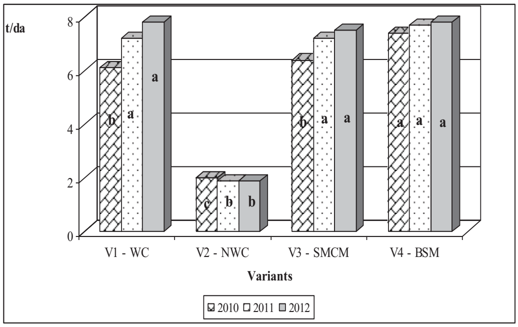


Figure 2. Efficiency of soil mulches compared to the control at 60 DAM (2010-2012)

The results obtained after gathering crop show that the yield of leek is lowest at the variant 2 – non-mulching and non-weeding control (NWC) (Figure 3). The yield obtained by the other variants is highest in year 2012 when the weed infestation was poorly developed compared to the other experimental years. During the three years of the field experiment the highest average yield was obtained in plots, mulched with barley straw mulch – 7.4 t/dain 2010, 7.7 t/da in 2011 and 7.8 t/da in 2012. In the variants mulching with spent mushroom compost the average yields were 6.4 t/da in 2010, 7.2 t/da in 2011 and 7.5 t/da in 2012. The lowest yield was obtained in plots from the second control, which is with non weeding plots (NWC).

The higher yield of mulching plots, compared with both controls – weeding control and non weeding control proves the efficiency of the mulches against weeds, but also in increasing the yields. These results were observed in studies made by other authors (Sharma & Sharma, 2003; Singh et al., 2007).



Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

Figure 3Average yield (t/da) of leek

Differences between non weeding control (NWC) and other variants were very well statistically proven in the three years of field experiment.Weed infestation of non weeding plots decreased significantly the yield – from 3.7 to 4 times lower yield compared with mulching plots.

After the statistical analysis of data we can make the conclusion that yields obtained at mulching by spent mushroom and barley straw mulches differ statistically from the control.

CONCLUSIONS

It was found that growing leek by mulching with barley straw or spent mushroom compost reduces weed infestation.

It is proved that mulching leading to increased yields by 3.7 to 4 times in comparison with plots with weeds.The yields obtained in mulching plots with these studied mulches are similar or higher than those of the weeding plots. This indicates that the mulching is suitable for growing leek through reduced tillage.

The applied mulches can be used easily during the growing stage of leeks and they control efficiently the widespread monocotyledonous and dicotyledonous weed species.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESPONSE OF SEXUAL EXPRESSION OF ZUCCHINI SQUASH TO SOME FOLIAR FERTILIZERS TREATMENS

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Abstract

The application of foliar sprays is an important crop management strategy, which may help maximizing crop yield and quality. The influence of different agricultural practices, such as foliar application on generative expressions of zucchinis is slightly studied. The objective of our research was to assess the influence of some foliar fertilizers treatments on sexual expression of zucchini squash. The experiments were carried out during the period 2007-2009, on Experimental field of Department of Horticulture at the Agricultural University of Plovdiv, Bulgaria. Variety 'Izobilna F1' was used as an object of the experiments. The field experiments were done by randomized block design with four replications. Complex foliar fertilizers Fitona 3, Hortigrow and Humustimin in three concentrations, separately and in background on soil fertilization $N_{16}P_{16}K_{16}$ were used. The number of male and female flowers per plant, proportion male:female flowers, number of fruits per plant and percentage of fructification were determinate. The results of this experiment indicate that optimal mineral nutrition and providing additional nutrients through foliar application during the period of intensive growth and fruiting influenced positively on the number of fruit formation and increase the percentage of fruit development. The highest number of fruits and the highest percentage of fruit formation is outstanding the variant $N_{16}P_{16}K_{16}$+0.3% Humustim, followed by $N_{16}P_{16}K_{16}$ + 0.2% Hortigrow and by $N_{16}P_{16}K_{16}$ + 0.3% Hortigrow.

Key words: *fertilization, foliar application, fruits formation, Cucurbita pepo L.*

INTRODUCTION

In monoecious plants, such as cucurbits, the ratio between males and females flowers varies considerably depending on various environmental conditions. The formation and differentiation, as well as their ratio also depend of nutrient regime, on the activity of endogenous phytohormones and by treatment with growth regulators (Lau and Stephenson, 1993; Swiader et al, 1994). Change from vegetative growth to generative stages is a complex process regulated by many factors (Sure et al. 2013).

Studies on specificities of flowering under zucchinis are conducted by many scientists (Nitsch et al, 1952; Yakovlev, 1987; Loy, 2004; Grumet, 2011). One of the main conclusions of the authors is that the formation of female flowers and sufficient male flowers are the limiting factor in production.

The application of foliar sprays is an important crop management strategy, which may help maximizing crop yield and quality (Panayotov, 2004; Panayotov, 2005; Fernandez and Eichert, 2009). The influence of different agricultural practices, such as foliar application on generative expressions of zucchinis is slightly studied.

In this study we aimed to trace the formation of male and female flowers, the ratio between them, and the percentage of initiated fruit set to female flowers in separately foliar application and combining it with soil fertilization.

MATERIALS AND METHODS

The investigations were conducted in the period 2007–2009 under open field conditions with zucchini (*Cucurbita pepo* L. var. *giromontia*), cultivar Izobilna F1 on the experimental field of the Agricultural University of Plovdiv, Bulgaria. The soil of the field is classified as Molic Fluvisols (Popova and Sevov, 2010). The depth of the humus horizon is 28–30 cm. The soil is loamy (clay content from 30% to 41%).

Chemically, the soil is characterized by a low content in organic matter (1.46 %), pH neutral to slightly alkaline (7.17–7.37) and by the presence of large amounts of $CaCO_3$, which gives more favorable physicalchemical water and soil properties, despite the heavy physical composition. Nitrogen content was low (32–46 $mg.kg^{-1}$), while there was a good stock of soluble phosphorus (P_2O_5 - 16.7-18 $mg.kg^{-1}$) and potassium (K_2O – 67 - 96 $mg.kg^{-1}$).

For the purpose of the experiment three different complete foliar fertilizers were used: Fitona (7.20% N, 5.20% K_2O, 1.5% Ca, 0.9% Mg, 0.1% Fe, 0.1% B, Cu, Zn, Mn, Mo. Fitotech Ltd., Bulgaria), Hortigrow® (20% N, 20%, P_2O_5, 20% K2O, 0.06% Fe, 0.02% Zn, 0.01% Mn, 0.01% Cu, 0.02% B, 0.001% Mo and 1% amino acids, Hortiland Ltd,. The Netherlands), Humustim® (on base of potassium humates-3% N, 1.14% P_2O_5, 7.83% K_2O, 3.92% Ca, 1.1% Mg, Cu, Zn, Mo, Mn Co, B, S. Agrospeis Ltd., Bulgaria).

Soil fertilization was carried out with NPK using a ratio $N_{160}P_{160}K_{160}$. Phosphorus [Ca $(H_2PO_4)_2$ – 46% P_2O_5]; and potassium (K_2SO_4 – 50% K_2O) fertilizers were applied with last tillage of soil before planting. Nitrogen fertilizer, introduced as NH_4NO_3 (34% N), was applied twice during the growing season.

First application was after formation of new leaves of plants after planting, and the second – 20 days after the first. Water solution of foliar fertilizers was prepared. Foliar fertilizers were applied in the given concentrations three times in the following phases: beginning of flowering, beginning of fruit production and beginning of mass fruit production. Solution with the needed concentration was prepared for the different treatments. Control plants were treated with pure water. The consumption of working solution in the first spraying was 600 $l.ha^{-1}$, and in the second and third 800 $l.ha^{-1}$. Plants were cultivated according to the conventional technology for early field production of marrows, using previously produced seedlings (Cholakov, 2009).

The seedlings were planted after thirty days of cultivation in non-heated polythene tunnel. Plants were planted on bed-furrow surface, according to scheme 100+60/50 cm and density of plantation 25000 $plants.ha^{-1}$ in beginning of May.

Growth period was 45 days after planting.

Treatments of the experiment:

1. Control - non fertilized;
2. Foliar fertilization with 0.2% Fitona;
3. Foliar fertilization with 0.3% Fitona;
4. Foliar fertilization with 0.4% Fitona;
5. Foliar fertilization with 0.1% Hortigrow;
6. Foliar fertilization with 0.2% Hortigrow;
7. Foliar fertilization with 0.3% Hortigrow;
8. Foliar fertilization with 0.2% Humustim;
9. Foliar fertilization with 0.3% Humustim;
10. Foliar fertilization with 0.4% Humustim;
11. Soil fertilization with $N_{160}P_{160}K_{160}$;
12. Soil fertilization with $N_{160}P_{160}K_{160}$ + 0.2% Fitona;
13. Soil fertilization with $N_{160}P_{160}K_{160}$ + 0.3% Fitona;
14. Soil fertilization with $N_{160}P_{160}K_{160}$ + 0.4% Fitona;
15. Soil fertilization with $N_{160}P_{160}K_{160}$ + 0.1% Hortigrow;
16. Soil fertilization with $N_{160}P_{160}K_{160}$ + 0.2% Hortigrow;
17. Soil fertilization with $N_{160}P_{160}K_{160}$ + 0.3% Hortigrow;
18. Soil fertilization with $N_{160}P_{160}K_{160}$ + 0.2% Humustim;
19. Soil fertilization with $N_{160}P_{160}K_{160}$+ 0.3% Humustim;
20. Soil fertilization with $N_{160}P_{160}K_{160}$ + 0.4% Humustim.

The number of fruits per plant, number of male and female flowers per plant, in tree phases - beginning of fruitfulness, mass fruitfulness and end of fruitfulness were determined. Proportion ♂:♀ was determinate and percentage of fructification.

Statistical analysis: the results were elaborated using the dispersion analysis method for one factor field trial and regression analysis (Dimova and Marinkov, 1999), using the program BIOSTAT (ANOVA).

RESULTS AND DISCUSSIONS

The results of field experiments show that zucchini are consistent in their flowering, despite the known differences in climatic conditions from year to year (Table 1). However, the factors do not change with variations outside the biological requirements of the species, in any of the experimental years. Growing zucchini without soil fertilization and foliar application (control) leads to a lowering of the number of male and female flowers, compared to the other variants of the experiment. At the same time, plants form a smaller number of fruits (Table 1.) and the lowest rate of fructification (Table 2).

Table 1. Number of fruits per plant, number of male and female flowers per plant, and proportion ♂: ♀, per year and average for 2007-2009

Variants			number of fruits			♂	♀	♂:♀
			2007	2008	2009			
1.	Control		3.50	3.50	3.25	29.75	24.25	1.23
2.	Fitona	0.2%	3.50	4.25	3.75	19.42	16.08	1.21
3.	Fitona	0.3%	3.50	4.00	3.50	20.17	16.92	1.19
4.	Fitona	0.4%	3.75	4.00	3.50	22.25	19.08	1.17
5.	Hortigrow	0.1%	3.50	4.25	3.50	22.25	19.00	1.17
6.	Hortigrow	0.2%	4.00	4.50	3.75	18.17	16.00	1.14
7.	Hortigrow	0.3%	3.25	3.75	3.25	17.08	14.83	1.15
8.	Humustim	0.2%	4.00	4.50	4.25	20.08	18.00	1.12
9.	Humustim	0.3%	3.75	4.25	3.75	19.25	16.33	1.17
10.	Humustim	0.4%	3.75	4.00	3.75	15.92	13.67	1.16
11.	$N_{160}P_{160}K_{160}$		4.00	4.50	4.00	14.83	13.00	1.14
12.	$N_{160}P_{160}K_{160}$ Fitona	0.2%	4.00	4.75	4.25	11.75	12.25	0.96
13.	$N_{160}P_{160}K_{160}$ Fitona	0.3%	4.00	4.50	4.00	12.75	11.58	1.10
14.	$N_{160}P_{160}K_{160}$ Fitona	0.4%	4.50	5.25	4.50	12.67	11.58	1.09
15.	$N_{160}P_{160}K_{160}$ Hortigrow	0.1%	4.50	5.00	4.75	11.33	11.08	1.02
16.	$N_{160}P_{160}K_{160}$ Hortigrow	0.2%	4.50	5.00	4.50	11.00	10.33	1.06
17.	$N_{160}P_{160}K_{160}$ Hortigrow	0.3%	5.00	5.50	5.00	10.83	10.92	0.99
18.	$N_{160}P_{160}K_{160}$ Humustim	0.2%	4.75	5.50	4.75	11.75	11.67	1.01
19.	$N_{160}P_{160}K_{160}$ Humustim	0.3%	5.50	5.75	5.25	10.83	10.67	1.01
20.	$N_{160}P_{160}K_{160}$ Humustim	0.4%	5.25	5.75	5.00	13.75	12.58	1.09

This specificity is most likely due to the fact that the plants are placed in conditions of lack of nutrients to ensure that the vegetative growth, normal course of flowering and fruit set of formed. Additionally, the reason can be found in the large number of aborted flowers, which is most likely due to the poor quality of pollen fertility declining ability under the influence of foliar fertilization applied alone or with soil fertilization there are changes in the number of flowers of each gender, by year and average for the period.

The number of male flowers on average for the period decreased by 29.75 units for the control to 10.83 units for $N_{160}P_{160}K_{160}$ + 0.3% Humustim and $N_{160}P_{160}K_{160}$ + 0.3%Hortigrow.

The number of female flowers remains relatively constant at all tested variants both in years and average for the period. In variants of separately foliar application this number is slightly higher than those in which plants are grown $N_{160}P_{160}K_{160}$ background. On the other hand, in these variants are formed by a smaller number of fruits (Table 1.) and fructification rate is lower (Table 2).

Table 2. Percentage of fructification in different variants of fertilization

Variants			Average for year		
			2007	2008	2009
1.	Control		15.24	14.05	13.21
2.	Fitona	0.2%	23.41	25.66	22.35
3.	Fitona	0.3%	21.93	22.55	20.17
4.	Fitona	0.4%	21.42	20.13	17.78
5.	Hortigrow	0.1%	19.49	21.66	17.78
6.	Hortigrow	0.2%	26.88	27.78	23.27
7.	Hortigrow	0.3%	21.94	24.22	21.75
8.	Humustim	0.2%	23.26	23.85	21.61
9.	Humustim	0.3%	23.33	25.50	22.12
10.	Humustim	0.4%	30.28	28.37	29.12
11.	$N_{160}P_{160}K_{160}$		32.32	33.67	30.44
12.	$N_{160}P_{160}K_{160}$ Fitona	0.2%	36.91	35.89	35.04
13.	$N_{160}P_{160}K_{160}$ Fitona	0.3%	36.91	36.99	37.11
14.	$N_{160}P_{160}K_{160}$ Fitona	0.4%	40.65	43.85	38.33
15.	$N_{160}P_{160}K_{160}$ Hortigrow	0.1%	42.59	47.06	41.61
16.	$N_{160}P_{160}K_{160}$ Hortigrow	0.2%	45.09	48.61	44.00
17.	$N_{160}P_{160}K_{160}$ Hortigrow	0.3%	50.30	50.13	42.61
18.	$N_{160}P_{160}K_{160}$ Humustim	0.2%	44.04	45.79	40.09
19.	$N_{160}P_{160}K_{160}$ Humustim	0.3%	53.81	50.73	47.81
20.	$N_{160}P_{160}K_{160}$ Humustim	0.4%	45.45	45.05	40.01

Zucchinis as annual crops for their short growing season are unable to keep plenty of underlying flowers, as well as regulating and preserving formed fruits. The number of male flowers is reducing. The ratio ♂: ♀ is changing, respectively of 1.22 for the control, to 1.00 for variants which utilize Humustim at concentrations 0.2% and 0.3% and fertilization with $N_{16}P_{16}K_{16}$. In 2008 and 2009 the ratio ♂: ♀ is slightly lower than 1.00 only for $N_{16}P_{16}K_{16}$ + 0.2% Fitona, respectively 0.98 and 0.96. The result is probably an anomaly caused by the fluctuation in the number of male flowers.

Used for the experiment cv. Izobilna F1 is characterized by continuous flowering in terms of early field production. Differences between variants are insignificant. Not observed deviations from normal course of flowering, which are caused as a result of the use of fertilizers. Foliar fertilizers applied separately or soil fertilization background with $N_{160}P_{160}K_{160}$ affects the number of initiated fruits (Table 1). The amendments between variants are small, but with a greater number of shaped fruit per plant are distinguished those with mixed fertilization (soil and foliar). Fertilization $N_{16}P_{16}K_{16}$ + 0.3%Humustim causes the formation of the largest number of fruits per plant in comparison with the control. The same trends were observed in the percentage of fructification (Table 2). The highest percentage of fructification has plants fertilized with $N_{160}P_{160}K_{160}$ + 0.3%Humustim in the three years of experiments, respectively, 53.81%, 50.73% and 47.81%. Immediately after them of rank are $N_{160}P_{160}K_{160}$ + 0.3% Hortigrow, $N_{160}P_{160}K_{160}$ + 0.2% Hortigrow and $N_{160}P_{160}K_{160}$ + 0.4% Humustim. Adequate mineral nutrition and additional nutrients in an easily absorbable form in periods of rapid growth and fructification have a positive impact on the number of fruits and increase the percentage of fructification. The reason for such a reaction of zucchinis, Stephenson et al. (1988) found in “dominance of the first fruits", which temporarily inhibit flowering during the growth of fruits.

CONCLUSIONS

The results of the assays on the influence of foliar fertilization on the biological behaviours of zucchini indicated that the use of foliar fertilizers during the growing season have a positive influence on the growth and development of plants.

Optimal mineral nutrition and providing additional nutrients through foliar application during the period of intensive growth and fruiting influenced positively on the number of fruit formation and increase the percentage of fruit development.

The highest number of fruits and the highest percentage of fruit formation is outstanding the variant $N_{160}P_{160}K_{160}$+0.3% Humustim, followed by $N_{16}P_{16}K_{16}$ + 0.2% Hortigrow and by $N_{160}P_{160}K_{160}$ + 0.3% Hortigrow.

ACKNOWLEDGEMENTS

The authors would like to thank the Research Fund of the Agricultural University of Plovdiv, Bulgaria for financial support.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESEARCH REGARDING THE EFFECT OF APPLYING HERBICIDES TO COMBAT WEEDS IN QUICKLY-POTATO CULTURES

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Abstract

The infields from our country have a very high degree of becoming full of weeds because its composition, the ratio of participation of various species and the degree of infestation vary and modify according to the region, vegetable crop rotation, applied combat measures and technology. The research was conducted in the vegetable region of Lunguletu, Dambovita county, with quickly-potato, 'Impala' variety, applying the herbicides Sencor 70 WG 1 kg/ha and Titus 25 DF 50g/ha, applied pre-emergent, post-emergent and combined, according to the action manner of the products, in order to establish the effectiveness of weed combat and level of damages caused by weeds. It was noticed that the best results were obtained by applying both herbicides, the degree of weed combat being 91%, compared to applying only one product, where the combat degree was 57% for Sencor 70 WG and 78 % for Titus 25 DF. The tubercle production was influenced by the degree of weed combat, the highest production being obtained for the variant that recorded the highest degree of combat, meaning the variant with both products applied.

Key words: *potato, herbicides, production.*

INTRODUCTION

Potato represents the second species within human diet after the basic cereals, because it is a complex aliment, substantial, rich in vitamins and minerals. Obtaining large potato productions involves practicing the specific culture technology, in compliance with all technological phases. Among these, a special role is played by combating weeds, which can cause serious damages by competing with the culture plants for water, air, light and nutrients. Weeds have a high reproduction capacity; their seeds have a wide lifespan and the capacity to germinate gradually for a long time, thus being able to compromise the culture when controlling them may result difficult.
In case of potatoes, after the plants have sprung up and covered the soil and the effects of herbicides applied pre-emergently, late weeds appear, which influence less the production but hinders the mechanical harvesting, increases the percentage of mechanical damaging of the tubercles and of losses, reduces the productivity of the harvesting machines (Berindei, M. 1985; Frâncu, Georgeta, 1995; 1996; 1998,; 1999). Weeds can represent bridges for the diseases and pests to be transmitted from one year to the next or from one culture to another oen, because many species of weeds represent hosts for different pests (Frâncu, Georgeta 1996 b; Ianosi, S. şi Boțoman, Gh. 2004).
The most dangerous weed, which can cause serious problems for combating, reproduce very fast, invade the potato culture and threaten the production, are called "*problem weeds*". The majority of these are perennial species that reproduce both by seeds and by vegetative reproduction, whose number and diversity across large areas increased with the unilateral use of herbicides that these species are resistant to (Berindei, M. 1985; Frâncu, Georgeta, 1987; Ianosi, S. 2002).

MATERIALS AND METHODS

The experiment was organized in Lungulețu, Dâmbovița County. The quickly-potato culture was realized on an non-evolved alluvial soil, with loamy-sandy texture, the thickness of horizon A of 21 cm, content in humus of 1.24% (weakly ensured), content in clay of 1,02%, mobile phosphor of 21.4 mg/100 g soil, mobile potassium of 60 mg/100 g soil and pH value of 6.2.

The biological material was represented by the IMPALA soil, with a vegetation period of 80-90 days, resistant to nematodes (Ro_{1-4}) and a medium content of starch of 14 %. For weed combat, two herbicides were used: Titus 25 DF and Sencor 70 WG, applied separately and combined, according to the experimental scheme:

V1 = control 1 not worked and without herbicides.

V2 = control 2 worked both mechanically and manually and without herbicides.

V3 = SENCOR 70 WG-1,0 kg/ha applied (pre-emergent).

V4 = SENCOR 70 WG-1,0 kg/ha (pre-emergent)+TITUS 25 DF- 50 g/ha applied (post-emergent).

V5 = TITUS 25DF- 50 g/ha applied (post-emergent).

Planting density was 57.000 nests/ha (70 x 25 cm), and the density after springing up was 51.000 nests/ha. There was an agricultural basis of: N150, P150, K150 kg/ha ensured by applying 1000 kg of the chemical fertilizer Complex 15:15:15 when preparing the soil. The pre-emergent culture was autumn cabbage.

Working method, observations and measurements

a. *Mapping weeds*

The measurement of weeds was made by using a metric frame, recording the number of weeds per square meter. The result from the control 1 (V1) represents the first level of infestation, while the results from the variants V3-V5 represent the combat effects of the used herbicides.

In order to evaluate the degree of weed infestation and effectiveness of control methods, the following evaluation methods were used:

- covering degree *(G. a. %) = (no. of weeds per variant / no. of weeds for control 1) x 100.*
- combat degree *(G. c. %) = 100 - G. a.*
- participation degree (*G. p. %*) = *(no. of weeds per species / total no. of weeds per variant) x 100.*

b. *Production analysis*

At the final harvest (20 June) the total production, the consumption fraction (tubercles over 30 mm diameter) and the under STAS fraction (tubercles under 30 mm diameter) were measured.

The estimation of damages produced to the culture by weeds was made based on the mathematical relations used in plant protection, proposed by Rotaru, V; Mihăiță, A; Alexandri, Al. (1999), by using the following formulae:

$P = (1 - q_0 / q_1) \times 100$ where:

P = damage (%),

q_0 = average production for the variant with weeds (t/ha),

q_1 = average production for the variant without weeds – control 2 (t/ha)

RESULTS AND DISCUSSIONS

a. *Number of weeds measured for the control 1 – not worked and without herbicides*

The number of per species and per group (plants/m^2), as well as the participation ratio (%) to the infestation degree for the control 1 variant is different depending on the weed species. Among annual weeds, the largest numbers of plants for one species were recorded for bristle grass (*Setaria glauca*) 31 plants/m^2, for amaranth (*Amaranthus retroflexus*) 12 plants/m^2; for orache (*Chenopodium album*) 11 plants/m^2 (Table 1). Among the perennial dicotyledonous species, the following numbers were recorded: 6 plants/m^2 for pelamid (*Cirsium arvense*); 5 plants/m^2 for bindweed (*Convolvulus arvensis*); 5 plants/m^2 for sow thistle (*Sonchus arvensis*); for the perennial monocotyledonous the largest number was recorded for cane (*Sorghum halepense*) 4 plants/m^2.

Among the species with large number of plants, the bristle grass (*Setaria glauca*) participates to the infestation degree by an average of 34 % the amaranth (*Amaranthus retroflexus*) by 13 %, the orache(*Chenopodium album*) by 12 %, the pelamid (*Cirsium arvense*) by 8 % and the bindweed (*Convolvulus arvensis*) by 5%.

b. *Number of weeds per species for the variants with herbicides*

The herbicides used (V3-V5) totally combated (table 2) the annual monocotyledonous weeds. The perennial monocotyledonous weeds, represented by cane (*Sorghum halepense*) were combated for the variant with SENCOR 70WG 1 kg/ha applied pre-emergently and TITUS 25DF 50 g/ha applied post-emergently (V4), but remained partially combated for the variants with only one herbicide SENCOR 70WG 1 kg/ha applied pre-emergently (V3) and TITUS 25DF 50 g/ha post-emergently (V5). Regarding the combating of dicotyledonous weeds, it could be observed that, except for the V3 were weeds were not combated, for the majority of variants the results were good. The major problem is represented by *Convolvulus arvensis* (bindweed) that was not combated in any of the variants. However, it could be observed that for the variant V4 the rest of the weeds were successfully combated by applying herbicides both pre-emergence and post-emergence.

Table 1. Number of weeds measured for the control 1 – not worked and without herbicides

Group of plants/species	Nr./m^2	G. p. %
Annual monocotyledonous		
Setaria glauca	31	34
Total annual monocotyledonous	*31*	*34*
Perennial monocotyledonous		
Sorghum halepense	4	4
Total perennial monocotyledonous	*4*	*4*
Total monocotyledonous	*35*	*38*
Annual dicotyledonous		
Amaranthus retroflexus	12	13
Brassica rapa	7	8
Chenopodium album	11	12
Galinsoga parviflora	7	8
Polygonum persicaria	3	3
Total annual dicotyledonous	*40,0*	*44*
Perennial dicotyledonous		
Cirsium arvense	6	8
Convolvulus arvensis	5	5
Sonchus arvensis	5	5
Total perennial dicotyledonous	*16*	*18*
Total dicotyledonous	*56*	*62*
TOTAL weeds (nr./m^2)	91	100

For V3, the pre-emergent application of SENCOR 70WG led to the combat of annual monocotyledonous weeds (*Setaria glauca*) and of several annual dicotyledonous weeds. The perennial dicotyledonous weeds were not combated. As a result of applying this herbicide, the covering degree was 43% and the combat degree was 57%.

For V4, the combination between the two herbicides, SENCOR 70WG and TITUS 25DF, ensured a culture with very few weeds, resulting a covering degree of 9% and a combat degree of 91%.

For V5, the variant only with post-emergence TITUS 25DF, the results were good, the herbicide having proper effects both on monocotyledonous and dicotyledonous weeds. For this variant, with 20 plants/m^2 not combated, the covering degree was 22% and the combat degree was 78%.

Table 2. Number of weeds per species for the variants with herbicides

Group of plants/species	V1 Mt.1	V 3	V 4	V 5
Annual monocotyledonous				
Setaria glauca	31	0	0	0
Total annual monocotyledonous	*31*	*0*	*0*	*0*
Perennial monocotyledonous				
Sorghum halepense	4	3	0	2
Total perennial monocotyledonous	*4*	*3*	*0*	*2*
Total monocotyledonous	*35*	*3*	*0*	*2*
Annual dicotyledonous				
Amaranthus retroflexus	12	10	3	1
Brassica rapa	7	0	0	2
Chenopodium album	11	8	0	2
Galinsoga parviflora	7	0	0	0
Hibiscus trionum	-	-	-	-
Polygonium persicaria	3	2	0	0
Sonchus oleraceus	-	-	-	-
Total annual dicotyledonous	*40*	*20*	*3*	*5*
Perennial dicotyledonous				
Cirsium arvense	6	6	0	2
Convolvulus arvensis	5	5	5	5
Sonchus arvensis	5	5	0	2
Total perennial dicotyledonous	*16*	*16*	*5*	*9*
Total dicotyledonous	*56*	*36*	*8*	*18*
TOTAL weeds	91	39	8	20
covering degree *G.a. %)*	100	43	9	22
combat degree (*G.c. (%)*	*0*	*57*	*91*	*78*

The economic analysis of the efficiency of weed combat in quickly-potato culture was performed according to the obtained productions and their value for the studied variants. These results are presented in figure 1, where it can be noted that for the control variant 2 (V2-worked manually and mechanically), which recorded the highest cost (500 lei/ha), the combat degree was rather high (91 %).

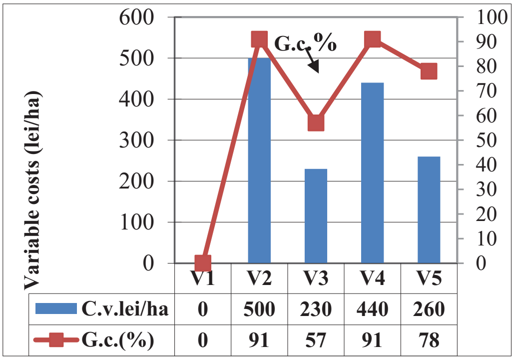

Figure 1. Treatment cost and combat degrees per variant

The variant with pre-emergence herbicide recorded the lowest costs, meaning V3 only with SENCOR 70Wg 1 kg/ha applied, the cost level was 230 lei/ha and the combat degree was 57 %. For V4, where both herbicides were applied, SENCOR 70WG - 1 kg/ha and TITUS 25DF – 50g/ha, the cost was 440 lei/ha, but with a combat degree of 91 %. For the variant only with TITUS 25DF -50 g/ha applied (V5), the cost was 260 lei/ha for a combat degree of 78%. The total tubercle production, per consumption fraction and under STAS fraction (fig. 2) and the percentage allocation (table 3) was influenced by the application of herbicides.

Table 3. Percentage allocation of the production of tubercles for consumption and under STAS from the total production

Variant	% of production	
	consumption	under STAS
V1 (control 1 not worked)	89.8	10.2
V2 (control 2 worked)	95.0	5.0
V3 (Sencor 70WG)	91.8	8.2
V4 (Sencor 70WG+Titus 25DF)	92.5	7.5
V5 (Titus 25DF)	91.4	8.6
Average	92.1	7.9

Regarding the total production, it was noted that for the variant where pre-emergent SENCOR was used, the obtained production was of 28.2 t/ha, while for the variant where post-emergent TITUS 25DF was used the production obtained was 30.3 t/ha. For the V4 variant, where two herbicides were applied, the production was 36 t/ha. The additional post-emergent herbicide with TITUS 25DF influenced the total tubercle production due to the wider span of weeds combated by that particular herbicide.

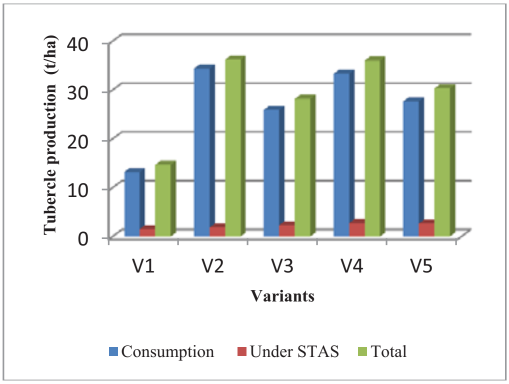

Figure 2. Tubercle production, total and per fractions (t/ha)

The production of tubercle for consumption was only of 13.2 t/ha for the control variant 1 (V1), while for the control variant 2 (V2) the production was of 34.4 t/ha; 21.2 t/ha larger due to combating the weeds and soil loosening. As in the case of total production, the production of tubercles for consumption for the control variant 1 (13.2 t/ha) was lower than for the other variants, while the production for the control variant 2 (34.4 t/ha) was higher than for the variants with herbicides, except for the one with both herbicides - SENCOR 70WG and TITUS 25DF (V4).

For the variant with SENCOR 70WG, the production of tubercles for consumption was of 25.9 t/ha, for the variant with TITUS 25DF the production was of 27.7 t/ha, and for the variant with both of them (V4) the production was of 33.3 t/ha.

The production of tubercles under STAS (with diameter under 30 mm) generally represent 10-15 % from the total tubercle production; in this case it represents 7.8 %.

The damages caused by weeds to the total tubercle production (table 4) are serious for the variants without combat measures, 59 % for

V1, compared to 0,5 % for the combined application of the herbicides Sencor and Titus and 0 % for soil maintenance.

Table 4. Damage caused by weeds to total production and to the production for consumption

Variant	Total production		Production for consumption	
	Prod. t/ha	Damage %	Prod. t/ha	Damage %
V1 (control 1 not worked)	14.7	59	13.2	61
V2 (control 2 worked)	36.2	0	34.4	0
V3 (Sencor 70WG 1 kg/ha)	28.2	22	25.9	25
V4 (Sencor + Titus)	36.0	0,5	33.3	3
V5 (Titus 25DF 50g/ha)	30.3	16	27.7	19
Average per variant	29.08	24.3	26.9	27.0

CONCLUSIONS

The highest level of weeds was produces by the annual dicotyledonous and monocotyledonous species (80 %), which must be taken into consideration when choosing herbicides, because these species can be combated relatively easy and cheaper by applying herbicides pre-emergently

The analysis of weed combat effectiveness, for the herbicides applied pre-emergently to the quickly-potato from Lunguleţu, showed that for the variant with pre-emergent application of the herbicide SENCOR 70WG the combat degree was 57 %, for the variant with post-emergent application of TITUS 25DF the degree was 78 %, and for the double herbicide variant, with pre-emergent SENCOR and post-emergent TITUS, the combat degree was 91%

The economic study related to costs and combat degree conducted on the variants showed that for the control 2 (V2 worked), for which he highest cost of 500 lei/ha was recorded, the combat degree was 91 %. The variant with only pre-emergent herbicide recorded the lowest cost, thus for SENCOR 70WG a cost of 230 lei/ha and combat degree of 57 %, while for the variant with only post-emergent the cost was 260 lei/ha and the combat degree of 78%. The pre-emergent application of SENCOR 70WG and post-emergent application of TITUS 25DF, led to a cost of 440 lei/ha and a combat degree of 91%, the same result as for variant 2.

Among the weed combat variants for the quickly-potato cultivated in Lunguleţu, the lowest productions were obtained from control 1, while the highest were obtained from the control 2 and the variants with herbicides. The productions obtained from variant 2 or the variant with both herbicides were significantly higher than the other variants with herbicides applied. The degree of weed infestation strongly influenced the level of tubercle production.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDY ON THE INFLUENCE OF THE TYPE OF SUBSTRATE AND THE QUANTITY UPON THE TOMATO CROP

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Abstract

The research aims to present the influence of the type of substrate and the irrigation frequency upon the tomato crop. With this occasion the modern irrigation equipment will be tested too. The study was conducted in the research center Hortinvest in the frame of the University of Agronomic Sciences and Veterinary Medicine of Bucharest. The biological material used was the tomato hybrid 'Cindel'. In order to obtain reliable conclusions we provided the same quality parameters of irrigation water, using the same technology and culture in all experimental variants. The main goal of this research was to identify the best irrigation norms on culture in order to achieve a sustainable crop production with a precocious development. During the growing season we monitored vegetative growth and biometric measurements and determined the duration of each phenological phase, depending on the technique used. Objectives consist in establishing the percentage of early production to the total output depending on the culture substrate and to determine the early production on the variants grown on a substrate made of perlite and coir; determine the total production per plant, the allocation on quality ranks of the total production obtained with the perlite substrate and coir substrate.

Key words*: modern irrigation, substrate, tomato hybrid.*

INTRODUCTION

Tomatoes occupy a significant place in the crops within protected space, greenhouses or solariums. Under the conditions set out in our country, in the last few years, it can be established an increasing interest of some vegetable producers for the unconventional crop technologies that open new attractive prospects for the professional growers (Atanasiu, 2009).

Plant production in hydroponics and soilless culture is rapidly expanding throughout the world, raising a great interest in the scientific community (Raviv and Lieth, 2007).

Soilless crop has a series of advantages:

- The production grows with 20-25%, compared with the soil culture. On tomatoes there have been obtained productions of 40.5 kg/m2 in greenhouse in the first crop cycle;
- The early maturity of the tomato crop is within 10 days compared to the conventional crop;
- The steam or chemical disinfection of the soil is not necessary;
- The rotation of the crops is also not necessary;
- Because of the lower humidity of atmosphere, there are created less favourable conditions for the emergence of diseases;
- There is a better product quality (the tomatoes have more solid fruits that are rich in sugars and vitamin C);
- Complete automation conditions of the technological processes are created.

The temperature values during the vegetation and fructification period can largely influence the tomato crop (Drăghici and Dobrin, 2014). In recent years, the use of soilless culture has increased significantly throughout the world (Grillas et al, 2001). More than 60% of the vegetable greenhouses in the Netherlands are cultivated using rockwool media, but it is costly and difficult to dispose because it is not biodegradable and environmental friendly. Perlite which is less expensive than rockwool

has been used as soilless culture substrate around the world for successful production of vegetables, in the greenhouse (Asaduzzaman, and all. 2007).
The quality of the planting material can largely influence the crop (Drăghici, 2014), and also the fertigation and irrigation norm (Tüzel et al. 2008).
The consumption of nutrient solution in the case of hydroponic growing is an important technological and economic matter. It should be emphasized from the beginning the fact that all variants of crops within the hydroponic growing are characterized by low water consumption, which is very important for the expansion of horticultural production in where water resources are insufficient for the classical horticulture. In the long term, in the context of global warming, the matter of economic use of natural resources is becoming more important, especially in the case of water used for human consumption and irrigation.
The consumption of water (nutrient solution) for unconventional crops depends on the species, phenophase plant height and the surface of the appliance foliar, temperature, light, atmospheric humidity and soil. The nutrient solution flows from the place where it's prepared, from the bottom of the plants, throughout the drip irrigation system. The fitted nozzles of the drip irrigation systems have flow rates of 2/4 l /hour at a water pressure of 1 bar. The according flow rates are ensured by activating the irrigation system for a pre-set period of time. (Atanasiu, 2009).

MATERIALS AND METHODS

The experiments were executed in the greenhouses of the Research Centre Hortinvest, University of Agronomic Sciences and Veterinary Medicine of Bucharest, in the first crop cycle, year 2014. In the experiment we have used the Cyndel tomato hybrid (Figure 1).
Variety description: extra-early hybrid with indeterminate growth, opened habits, airy, recommended for cultivation in protected crops or open fields.

Figure 1. The tomatoes hybrid CINDEL F1

The plant is vigorous, highly productive, produces uniform fruits of medium size, resistant to storage and transportation. Weight of a fruit: 120 - 130g. Fruit colour: dark red.
Cultivation method: direct seeding, seedling. We used two types of substrate: 1. mattresses filled with perlite with a grain size of 4 mm; 2. coir mattresses.
In the crop we applied specific care work in the greenhouse culture that consisted of: trellising, removing shoots shoot tipping, defoliation of basal leaves, inflorescence limit of the number of fruit, ensuring pollination using bumblebees. All growth factors were monitored.
The fertigations were made daily through the nutrient solution, the distribution of the solution became computerized. The nutrient solution was determined according to the recipe, based on the water analyses. The recipes were made according to the development stage of the plant – for the vegetative phase, the flowering and fruiting phase.
Throughout the whole period the pH was intended to be of 5.5-5.7, the electroconductivity of 2.8-3.0 mS/cm (depending on development stage) and the drainage was intended to be between 3.8 and 4.2 mS/cm. The amount of each nutrient solution for fertigation was of 50 ml/plant in the first 4 weeks, then 120 ml/plant. The number of watering was correlated with the growth of the plants. We have observed: the influence of crop substrate and of the irrigation on early and total crop, and also the standard quality of the crop.

RESULTS AND DISCUSSIONS

In the data presented in Figure 2 we can see that the variant grown on coconut substrate has obtained a smaller early production than the early production obtained on the perlite substrate, 26.04 % and 32.91% from the total production.

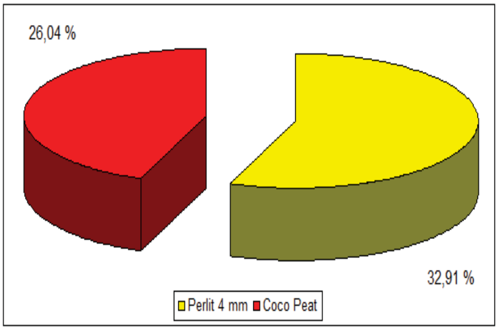

Figure 2. The percentage of early production to total output depending on the culture substrate

Early production was of 4.1 kg/m^2 on the variant planted with perlite and only 2.83 kg/m^2 on the variant grown on coir substrate (Figure 3).

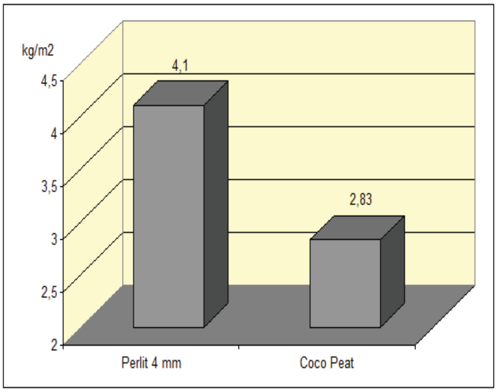

Figure 3. Early production established on the variants grown on a substrate made of perlite and coir

The total production was 12.46 kg/m^2 on the variant grown on perlite substrate and only 10.87 kg/m^2 on the variant grown on coir, Figure 4.

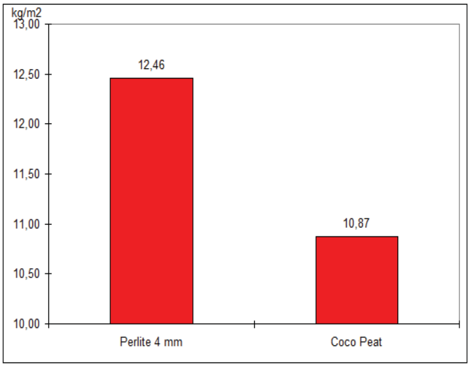

Figure 4. The total production obtained per plant

If we analyze the fruit percentage according to the quality standard, we notice that the highest percentage of fruit for the first quality category was registered in the variant grown on perlite, of 73.84% of total production. The percentage of under standard fruit was of only 12.84% (Figure 5).

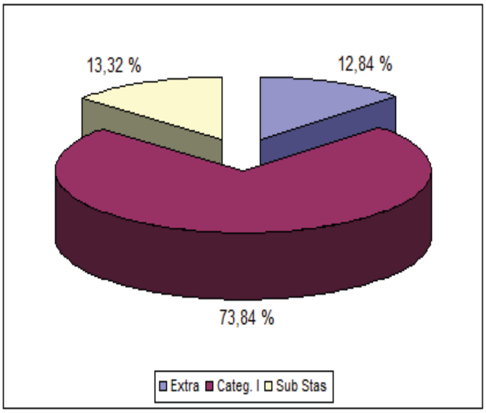

Figure 5. The allocation on quality ranks of the total production obtained with the perlite substrate

The highest percentage of fruit registered in the category Extra, of 20%, was also obtained in the variant cultivated on coir substrate. The fruit percentage under quality standard obtained was of 14%, being composed of split fruit, small or damaged fruit (Figure 6).

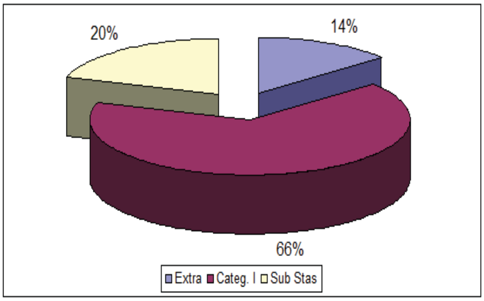

Figure 6. The allocation on quality ranks of the total production obtained with the coir substrate

CONCLUSIONS

The crop's substrate had an influence on the early production of tomatoes, having 4.1 kg/m^2 in the variant cultivated on perlite and only 2.83 kg/m^2 in the variant cultivated on coir substrate. Although the difference in the production between the two variants was of 1.59 kg/m^2, we appreciate that by achieving early production, revenues are higher in the case of the perlite culture.

The highest percentage of fruit in the first category was achieved in the variant grown on perlite substrate. This also indicates a certain uniformity of its production.

ACKNOWLEDGEMENTS

This paper was published under the frame of European Social Fund, Human Resources Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/132765.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EFFECT OF PLANTING DEPTHS ON SOME AGRONOMIC CHARACTERISTICS OF *ALLIUM TUNCELIANUM*

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Abstract

Allium tuncelianum [(Kollman) N. Ozhatay, B. Mathew & Siraneci] (Syn: A. macrochaetum Boiss. and Hausskn. subsp. tuncelianum Kollman) is an endemic plant species and has been proposed as the wild ancestor of garlic. This study reports agronomic and morphological feature of a field experiment conducted during October 2013 to July 2014 under arid conditions of Turkish province of Diyarbakır to investigate the effect of 7.5 and 15 cm planting depth on morphological features of the plant. The experimental results indicated significantly positive effects of shallow sowing (7.5 cm depth) on vegetative characteristics like plant height, stem diameter, leaf length, bulb circumference, bulb diameter, number of bulbils per plant and bulb weight compared to deep sown (15 cm) bulbs. Flower diameter values varied between 5.74 and 6.07 cm, bulb diameter 2.79 and 3.06 cm and bulb weight between 21.01 and 23.67 g, respectively. Deep sowing had positive effects on generative characteristics like leaf width, number of leaves per bulb, length of leafless stems and inflorescence diameter.

Key words: *Tunceli garlic, agronomy, bulb growing, yield.*

INTRODUCTION

Allium tuncelianum [Allium tuncelianum (Kollman) N. Ozhatay, B. Mathew & Siraneci](Syn: *A. macrochaetum* Boiss. and Hausskn. subsp. *tuncelianum* Kollman) is native to “Tunceli” province in Turkey and grows in limited area especially close to Ovacik and Pulumur districts. Like all other forms of garlic, Tunceli garlic is odourless until the plant cells are damaged through biotic or abiotic means. Physical injury to bulbs generate strong-smelling and biologically-active organic sulphur compound, allicin (thio-2-propene-1-sulphinic acid S-allyl ester). Allicin has been reported to have anti-coagulant, anti-hypertensive, anti-microbial, anti-biotic, anti-parasitic, anti-mycotic, anti-viral, anti-tumor, anti-oxidant, and anti-aging activities (Jacob, 2006; Ozkan et al., 2013; Kizil et al., 2014). Allicin is also known to detoxify heavy metals, be hypo-lipidaemic (i.e., lipid-lowering), anti-carcinogenic, and anti-mutagenic (Munchberg et al., 2007; Iciek et al., 2009; Ozkan et al., 2013). These smelly compounds also serve to defend plants against predators, parasites and diseases (Block, 2010). Development of garlic for the nutraceutical industry has resulted in growth of another specialty market with high levels of sulfur compounds such as allicin that are often correlated with strong flavour.

Unlike commonly used garlic, Tunceli garlic is a single clove plant that can be easily propagated using seeds and bulbs. The plant can be stored for a long time at 18-20°C. Bulb plants are a hardy perennial that prefer full sun and fertile, well drained soils with plenty of organic matter. Suitable planting depth influences available space for development of plant and, therefore, bulbs and seeds should be planted accordingly.. Additionally, the planting depth influences time to emergence and subsequently flowering time and total crop duration. Hence, planting at a uniform depth is necessary for a uniform crop time (Padhye and Cameron, 2007).

This study aimed to find effects of planting depth of Tunceli garlic outside its natural habitat under arid conditions of South-eastern Anatolia by planting bulbs at two depths.

MATERIALS AND METHODS

Field studies were conducted under semi-arid Diyarbakır South East Anatolian ecological conditions (latitude 37^o 53' N and longitude 40^o 16' E, 680 m above sea level), Dicle University during October 2013 to July 14 growing season using bulbs of *Allium tuncelianum* L. obtained from local producers at Ovacik in Tunceli province of Turkey.

Soil conditions of the experimental site, taken at depth of 0 to 40 cm, showed that it had 1.16%, organic matter, 0.16% total salts, 66.0% saturation percentage (%) with water, no lime ($CaCO_3$), 61 kg ha^{-1} phosphorus (P_2O_5), no potassium (K_2O) with soil pH of 7.45 and Electrical conductivity ($mmhoscm^{-1}$) of 3.8.

Climatic conditions in the experimental year, with mean temperature, relative humidity and total precipitation from September to July 2013-14 was 20.1 ^{o}C, 56.7%, and 44.7 mm. Long term with September to July, mean temperature, relative humidity % and precipitation were 12.8 ^{o}C, 59.1% and 48.74 mm, respectively.

Experimental fields were watered before planting. Planting was done with row spacing of 70 cm and plant spacing of 20 cm in the month of October.

The experimental design was a randomized complete block design with three replications with two planting depths. The experiment was planted on September 1 with 48 bulbs in each plot. Plots size was kept 6.3 m^2 (2.1 × 3 m) in each experiment. Planted bulbs had diameter of 17 to 19 mm and were hand planted at a depth of 7.5 ±1 cm and 15±1 cm in the soil.

The plots were weeded as and when required.

The plots were harvested manually on 5th July, 2014.

Plant height, plant stem diameter, leaf length, leaf width, number of leaves per plant, length of leafless stem, number of bulbils per plot, bulb circumference and bulb weight using IBM SPSS 20 for windows statistical software. The means were grouped, using "t" test at 0.01 level of significance.

RESULTS AND DISCUSSIONS

The results of the study showed significant effects of sowing depths on different morphological features of Tunceli garlic (Table 1& 2).

Table 1. Some agronomical traits obtained from different planting depths of Tunceli garlic

Deep (cm)	Plant height (cm)	Stem diameter (cm)	Leaf length (cm)	Leaf width (cm)	Number of leaf	Length of leafless stem
7.5±1	115.7a	1.20a	39.7a	1.41b	6.8b	85.8b
15±1	114.7b	1.18b	38.3b	1.74a	7.1a	88.0a
Mean	115.2	1.19	38.9	1.57	6.9	86.9

*Each value is a mean of 45 bulbs and values given in a single column are significantly different using t test.

The maximum plant height, stem diameter and leaf length values were obtained in shallow planting. The study revealed that leaf width and number of leaf per plant values were significantly high in the deep planting.

Greater sprouting was recorded when plants were planted with both 7.5 and 15 cm depths. The results showed that Tunceli bulbs gained positive gains in terms of vegetative growth at 7.5 ±1 cm depth.

Bulb sowing increased plant height (115.7 cm) at 7.5 ±1 cm deep sowing. Growing plant showed more increase in plant stem diameter (1.20 cm) with significantly longer leaves (39.7 cm); bulb circumference (12.81 cm), bulb diameter (3.06 cm) and bulb weight (23.67 g) (Table 1 & 2, Figure 1).

There is no information about stem diameter and length, leaf length & width of Tunceli garlic under natural conditions. It gains bulb diameter of 6-7 cm with bulb weight of weight (10-30 g) depending on culture conditions (OGM, 2014).

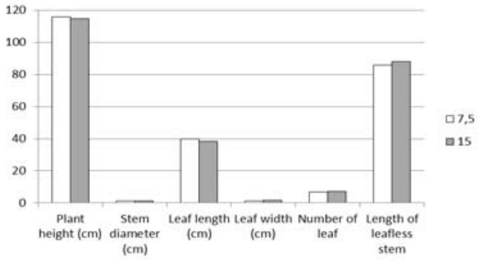

Figure 1. Variation of some agronomical traits obtained from 7.5 and 15 cm planting depths of Tunceli garlic

It is reported that plants were taller when bulbs were planted deep because of better soil temperature for growth and soil holding around the bulbs which helped in maximum nutrients uptake from the soil (Amjad and Ahmad, 2012). These results are not compatible with the results of this study in terms of plant height and leaf length.

Larger bulb containing higher food reserves produced higher number of flowers and had positive impact on other characteristics. Finally, it was observed that the deeper planting produced the highest flower diameter (6.07 cm) while the lowest bulb weight also was noted from 7.5 cm planting depth. However, characteristics like leaf width, number of leaves per bulb, length of inflorescence stem, inflorescence width and number of scales that have direct bearing on generative growth were significantly affected at deeper (15 ±1 cm) sowing (Table 1 & 2, Figure 2). The results showed deeper sowing with more leaf width (1.74 cm), number of leaves per bulb (7.1 cm), longer inflorescence stem (88.0 cm), inflorescence width (6.07 cm), inflorescence length (65.18 cm) and number of scales per bulb (2.23). This information is in line with the OMG (2014).

Table 2. Some agronomical traits obtained from different planting deep of Tunceli garlic

Deep (cm)	Flower diameter (cm)	Bulb circumference (cm)	Bulb diameter (cm)	Number of bulbils	Number of scales	Bulb weight (g)
7.5±1	5.74b	12.81a	3.06a	0.86a	2.16b	23.67a
15±1	6.07a	12.25b	2.79b	0.8.0b	2.23a	21.01b
Mean	5.90	12.53	2.92	0.83	2.19	22.34

*Each value is a mean of 45 bulbs and values given in a single column are significantly different using t test.

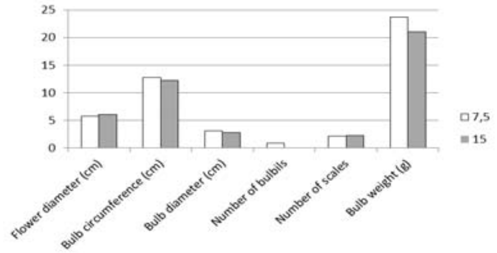

Figure 2. Variation of some agronomical traits obtained from 7.5 and 15 cm planting depths of Tunceli garlic

There is no report about the effects of sowing depth on Tunceli garlic. Tunceli farmers generally sow Tunceli garlic at depth of 2- 3 cm without considering effects of sowing on physiological parameters. It is normally sown during October and harvested during August (approximately 300 days). Temperature of the area remains 18 - 20 °C during growth period. This is first experiment that has been performed outside natural habitat of Tunceli Garlic. The results of experiment clearly indicate that this bulb could be successfully grown out of its natural habitat without adverse effects on growth. Performance of Tunceli garlic propagated by vegetative reproduction is influenced by the sowing depth. Variable response of different parameters in differential vegetative and generative growth may be attributed to the bulbs planting at differential depths. Deeper sown bulbs needed more time to come out of soil after sprouting and were adversely affected towards vegetative growth. However, they induced earlier flowering. Furthermore, the bulbs sown at shallow depth had more chance to remobilise reserved metabolites, mainly carbohydrates for their own growth and development due to early start of photosynthesis. The deeper sown bulbs went to generative growth earlier compared to shallow sown bulblets. The results are in agreement with Rabinowich and Brewster (1990) and Pooler and Simon (1994).

CONCLUSIONS

Shallow sown bulbs produce large bulbs at harvest and have better bulbil formation as compared to deep sown bulbs. Therefore, growers must prefer shallow sowing for increased bulb yield. However, deep sowing could be preferred for seed harvest.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

MANIFESTATION OF VARIABILITY AND HERITABILITY OF SOME QUANTITATIVE CHARACTERS IN TOMATO

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Abstract

The paper was aimed to present the results of study of variability and heritability of some tomato characteristics: plant height, number of branches, number and weight of fruits per plant, size, length and diameter of the fruit, thickness of pericarp, number of locules which were presented for four tomato hybrids 'Maestro' x 'Irişca', 'Maestro' x 'Dwarf Moneymaker', 'Mihaela' x 'Irişca', 'Mihaela' x 'Dwarf Moneymaker'. Analyzing the coefficient of variability of quantitative characters of parents, hybrid combinations F_1, F_2 and backcrosses, it was found that the coefficient for the number and weight of fruits per plant for both, parents and all hybrid combinations was high, the average being 36.5 and 37.1%, respectively. Small variability was demonstrated for the plant height and diameter of the fruit. The heritability of quantitative characters depended significantly on parental forms. The highest values of heritability for the number and weight of fruits per plant were registered for 'Maestro' x 'Irişca' and 'Mihaela' x 'Dwarf Moneymaker' hybrid combinations. The combination 'Maestro' x 'Irişca' was highlighted as having high coefficient of variability for the most characters.

Key words: *tomato hybrids, breeding, variability, heritability.*

INTRODUCTION

The tomatoes Solanum lycopersicum L. were the second crop after potato in respect of the consumption level as well as the most popular garden crop (http://faostat.fao.org.). This was largely due to taste, special dietary and medicinal properties (Avdeev, 1982).

After FAO data, tomatoes were grown worldwide in the area of 4 million hectares. The most significant areas were in China (974, 000 ha) and India (520,000 ha). There was obviously a considerable increase in interest to this crop. In 2009 Moldova produced 84,070 tons of tomatoes (http://faostat.fao.org/).

The increase of agricultural plants harvests in agrocenoses was due to both, optimizing their growth conditions and the use of more productive and resistant genotypes. Under these conditions varieties and hybrids of cultivated plants played the crucial role in agriculture innovation progress which resulted in obtaining a sufficient product quantity of high quality.

Optimization and efficiency progressive programmes for tomato improvement were inconceivable without knowledge of the genetic basis of characters for which research was conducted and hence, technologies for genotypes with desirable characters were developed (Agong et al., 2000). In relatively recent studies it was shown that there existed a high genotypic and phenotypic variability of fruit weight, number of flowers in inflorescence, number of branches (Haydar et al., 2007, Mohamed et al., 2012), that offered opportunities for creating valuable genotypes with successful combination of characters, elucidating the impact of environmental conditions on character manifestation and hereditary transmission capacity. Of particular importance was knowledge on variability of characters that were determined by both, the genotype and environmental factors.

The degree of characters variability indicated genotype response norm peculiarities under different environmental conditions (Haydar et al., 2007, Mohamed et al., 2012 Mohanty, 2002).

The coefficient of variation was widely used while studying regularities of organisms' adaptive responses. The information about characters' variation driven by the variety of genotypes demonstrated possibility of changing the parameter in the direction required at this stage of selection. Establishing peculiarities of characters' variability and heritability provided possibility for optimizing the selection programme optimization (Fasoulas, 1973).

Most characters valuable for tomatoes were quantitative and that was why evaluation of their variability and heredity attracted great attention primarily for development of genetic and improving programmes and successful completion of the improvement process (Agong et al., 2000, Mihnea, 2008).

The aim of the research was complex evaluation of quantitative characters in new intra-specific hybrid combinations and study of variability and heredity of these characters for effective forecasting of the improvement process.

MATERIALS AND METHODS

The experiments were conducted in year 2010 under field conditions in the experimental plot of the IGFPP. Six components (P1, P2, F1, F2, BC1, BC2) in 4 hybrid combinations obtained under intraspecific hybridization (Maestro x Irişca, Maestro x Dwarf Moneymaker, Mihaela x Irişca, Mihaela x Dwarf Moneymaker) were used as a starting material for the intended research. Field experiments were conducted in triplicate in randomized blocks of seedlings cultivation without irrigation. The sowing took place in greenhouses in the first decade of April according to the scheme 7 x 10 cm and field planting - in the scheme of 70 x 30 cm. Field planting was performed in the second decade of May, and harvesting was done gradually (4-6).

Determination of heritability of quantitative characters was effectuated basing on Borojevic (1990). Morphological descript-tion was done according to the general principles and methodology of carrying out tests on Distinctness, Uniformity and Stability TG / 44/11 UPOV (2011). The data were statistically processed by the software package STATISTICA 7. Graphical representation, tabular and textual, was performed through the Microsoft Office and Microsoft Excel software.

RESULTS AND DISCUSSIONS

According to the relevant data biological characters and elements of productivity of the parental varieties and hybrids F_1, F_2 and backcrosses in year 2010 varied largely (Figure 1, 2, 3).

Plant height (Figure 1.A) Varied within 45,2 ... 75,0 cm in parents; 57,4…68,4 cm in hybrids F_1 and 51,1…68,3 cm in offspring hybrids F_2 and backcrosses. Significant differences were found for BC_1 F_1 (Maestro x Dwarf Moneymaker) x Maestro and BC_2 F_1 (Maestro x Dwarf Moneymaker) x Dwarf Moneymaker.

Number of branches (Figure 1.B) Presented were values within 4.4 ... 4.9 in parents, which showed that parents did not differ essentially by this character. Significant differences were certified only in BC_2 F_1 (Maestro x Dwarf Moneymaker) x Dwarf Moneymaker and F_1 Mihaela x Iriș ca.

Number of fruits per plant (Figure 1.C) Recorded were values 20,3 ... 50,5 in parents; 33,6…42,8 and 32,6…45,9 in F_2 and BC. Hybrids BC_1 F_1 (Mihaela x Iriș ca) x Mihaela, BC_2 F_1 (Mihaela x Iriș ca) x Iriș ca showed significant values.

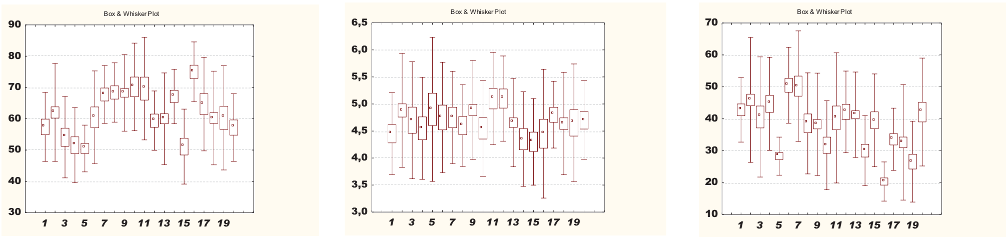
Weight of fruits per plant (Figure 2.A) Included were values within 1236,9…1999,4 g in genitors; 1835,0…2180,0 g in F_1 and 1363,1…2007,0 g in F_2 and BC. Significant differences were established in F_1 Maestro x Dwarf Moneymaker, Mihaela x Irişca and BC_1 F_1 (Mihaela x Irişca) x Mihaela, BC_2 (F_1 (Mihaela x Irişca) x Irişca.

Weight per fruit (Figure 2.B) Recorded were values within 24,7…83,7 g in parental forms; 47,1…62,1 in F_1 and 32,3…66,0 g in segregating populations F_2 and BC. No significant differences were recorded either in a hybrid combination.

Pericarp thickness (Figure 2. C). Varied within 3,6…7,9 mm in parents; 4,9…7,8 in F_1 and 4,1…7,8 mm in F_2 and BC.

Significant differences were found in F_1 Mihaela x Dwarf Moneymaker, BC_1 F_1 (Mihaela x Irişca) x Mihaela, BC_2 F_1 (Mihaela x Dwarf Moneymaker) x Dwarf Moneymake].

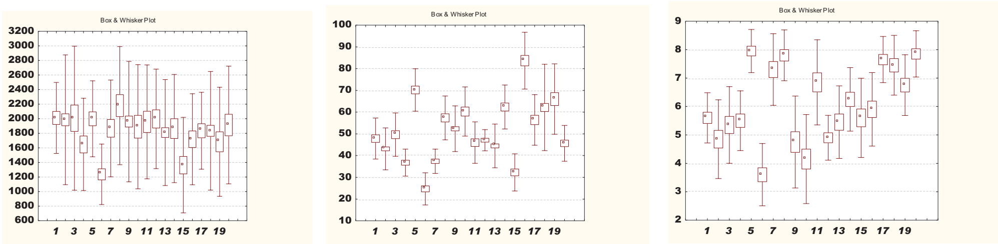
Cm. No. No.



A B C

Fig. 1. Comparative data on plant height (A), number of branches (B), number of fruits per plant (2010)
1 - F_1 Maestro x Irişca, 2 - F_2 Maestro x Irişca, 3 - BC_1 F_1 (Maestro x Irişca) x Maestro, 4 - BC_2 F_1 (Maestro x Irişca) x Irişca, 5 – Maestro, 6 - Irişca, 7 - Dwarf Moneymaker, 8 - F_1 Maestrox Dwarf Moneymaker, 9 - F_2 Maestro x Dwarf Moneymaker, 10 - BC_1F_1 Maestro (x Dwarf Moneymaker) x Maestro, 11 - BC_2 F_1 (Maestro x Dwarf Moneymaker) x Dwarf Moneymaker], 12 - F_1 Mihaela x Irişca, 13 - F_2 Mihaela x Irişca, 14 - BC_1 [F_1 (Mihaela x Irişca) x Mihaela, 15 - BC_2 F_1 (Mihaela x Irişca) x Irişca, 16 – Mihaela, 17 - F_1 Mihaela x Dwarf Moneymaker), 18 - F_2 Mihaela x Dwarf Moneymaker, 19 - BC_1 F_1 (Mihaela x Dwarf Moneymaker) x Mihaela, 20 - BC_2 F_1 (Mihaela x Dwarf Moneymaker) x Dwarf Moneymaker.

Gr. Gr. Mm.



A B C

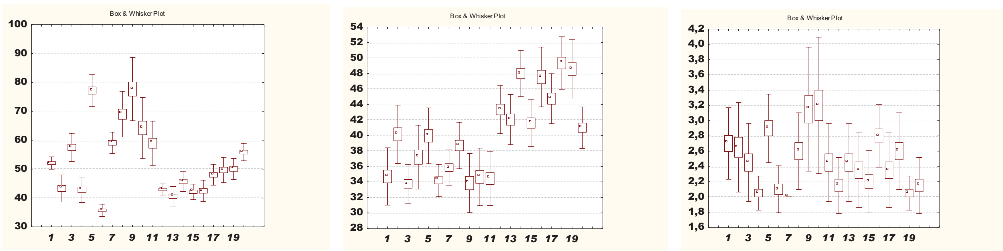
Fig. 2. Comparative data of fruit weight per plant (A), weight per fruit (B), pericarp thickness (C) parents and hybrid populations (year 2010)
1 - F_1 Maestro x Irişca, 2 - F_2 Maestro x Irişca, 3 - BC_1 F_1 (Maestro x Irişca) x Maestro, 4 - BC_2 F_1 (Maestro x Irişca) x Irişca, 5 – Maestro, 6 - Irişca, 7 - Dwarf Moneymaker, 8 - F_1 Maestrox Dwarf Moneymaker, 9 - F_2 Maestro x Dwarf Moneymaker, 10 - BC_1 F_1 (Maestro x Dwarf Moneymaker) x Maestro, 11 - BC_2 F_1 (Maestro x Dwarf Moneymaker) x Dwarf Moneymaker, 12 - F_1 Mihaela x Irişca, 13 - F_2 Mihaela x Irişca, 14 - BC_1 F_1 (Mihaela x Irişca) x Mihaela, 15 - BC_2 F_1 (Mihaela x Irişca) x Irişca, 16 – Mihaela, 17 - F_1 Mihaela x Dwarf Moneymaker, 18 - F_2 Mihaela x Dwarf Moneymaker, 19 - BC_1 F_1 (Mihaela x Dwarf Moneymaker) x Mihaela, 20 - BC_2 F_1 (Mihaela x Dwarf Moneymaker) x Dwarf Moneymaker.

Fruit height (Figure 3. A). Presented values within 35,7…77,2 mm in parents; 42,9…69,0 mm in F_1 and 40,6…77,7 mm in segregating populations F_2 and BC. Significant differences were established in BC_1 F_1 (Mihaela x Irişca) x Mihaela.

Fruit diameter (Figure 3. B). Included values within 34,2…47,5 mm in parents; 34,7…44,7 in hybrid combinations F_1 and 33,7…49,3 in hybrids F_2 and BC. Significant differences were recorded in F_2 Mihaela x Dwarf Moneymaker) and BC_1 F_1 (Mihaela x Dwarf Moneymaker) x Mihaela

Number of locules (Figure 3. C). Varied within 2,9…2,0 in plant varieties; 2,1…2,7 in hybrids F_1 and 2,0…3,2 in hybrids F_2 and BC. Significant differences were established in segregating populations - F_2 Maestro x Dwarf Moneymaker, BC_1 F_1 (Maestro x Dwarf Moneymaker) x Maestro.

Mm. Mm. No .



A B C

Fig. 3. Comparative data of fruits per plant height (A), fruit diameter (B), the number of locules (C) in parental and hybrid populations (2010)

1 - F_1 Maestro x Irişca, 2 - F_2 Maestro x Irişca, 3 - BC_1 F_1 (Maestro x Irişca) x Maestro, 4 - BC_2 F_1 (Maestro x Irişca) x Irişca, 5 – Maestro, 6 - Irişca, 7 - Dwarf Moneymaker, 8 - F_1 Maestrox Dwarf Moneymaker, 9 - F_2 Maestro x Dwarf Moneymaker, 10 - BC_1 F_1 Maestro (x Dwarf Moneymaker) x Maestro, 11 - BC_2 F_1 (Maestro x Dwarf Moneymaker) x Dwarf Moneymaker, 12 - F_1 Mihaela x Irişca, 13 - F_2 Mihaela x Irişca, 14 - BC_1 F_1 (Mihaela x Irişca) x Mihaela, 15 - BC_2 F_1 (Mihaela x Irişca) x Irişca, 16 – Mihaela, 17 - F_1 Mihaela x Dwarf Moneymaker, 18 - F_2 Mihaela x Dwarf Moneymaker, 19 - BC_1 F_1 (Mihaela x Dwarf Moneymaker) x Mihaela, 20 - BC_2 F_1 (Mihaela x Dwarf Moneymaker) x Dwarf Moneymaker.

Analysis of the data presented in Table 1 demonstrated essential differences of genotypes / populations by variability of evaluated characters. A rather sufficient diversity was revealed in plant height depending on both, genotype and climatic conditions, which gave us possibility to choose genotypes for creating new varieties more suitable to carry out mechanized tillage. The average variation coefficients for characters of the plant height and number of branches were 21,0 and 19,5%, which showed that the characters were environmental variables. *The number of fruits per plant and weight of fruits per plant* in analyzed tomato forms were 36,5 and 37,1 which demonstrated the pronounced variability of characters. Variability in the number of fruits per plant was more pronounced in varieties of Dwarf Moneymaker (34,4%), Mihaela (30,1%) while hybrid populations were within 23,6…47,7%.

Table 1. Variability of some biological and productive tomato characters

Hybrid combinations and parental forms	Variation coefficient, %			
	Plant height, cm	Number of branches	Number of fruits per plant	Weight of fruits per plant
F_1 Maestro x Irişca	19,3	17,1	23,6	24,2
F_2 Maestro x Irişca	25,2	21,5	42,6	44,9
BC_1 (F_1 (Maestro x Irişca) x Maestro	24,0	23,0	46,4	49,2
BC_2 F_1 (Maestro x Irişca) x Irişca	23,3	20,6	32,6	38,4
Maestro	14,8	27,1	21,1	26,1
Irişca	24,5	21,5	23,6	33,5
Dwarf Moneymaker	13,6	17,9	34,4	35,6
F_1 Maestrox Dwarf Moneymaker	13,8	16,3	41,1	37,2
F_2 Maestro x Dwarf Moneymaker	17,9	18,6	41,9	42,1
BC_1 (F_1 Maestro x Dwarf Moneymaker) x Maestro	19,5	19,6	44,0	45,1
BC_2 (F_1 Maestro x Dwarf Moneymaker) x Dwarf Moneymaker	23,6	16,7	35,5	39,9
F_1 Mihaela x Irişca	15,9	15,5	30,3	34,2
F_2 Mihaela x Irişca	24,4	17,4	32,4	40,2
BC_1 (F_1 (Mihaela x Irişca) x Mihaela	12,9	20,2	36,6	39,8
BC_2 (F_1 (Mihaela x Irişca) x Irişca	23,4	18,6	40,7	48,1
Mihaela	12,7	26,3	30,1	18,9

Hybrid combinations and parental forms	Variation coefficient, %			
	Plant height, cm	Number of branches	Number of fruits per plant	Weight of fruits per plant
F_1 Mihaela x Dwarf Moneymaker	22,3	12,7	29,1	14,1
F_2 Mihaela x Dwarf Moneymaker	24,8	20,3	55,5	44,4
BC_1 (F_1 (Mihaela x Dwarf Moneymaker) x Mihaela	27,6	23,4	47,7	44,4
BC_2 (F_1 (Mihaela x Dwarf Moneymaker) x Dwarf Moneymaker	18,8	15,5	40,1	42,2
Environment	20,1±1,1	19,5±0,8	36,5±2,0	37,1±2,1

Among many features of the fruit the main feature was its weight, as it represented the economic value of the character. Requirements for the fruit size were different and determined by their use specificity and the trend towards tomatoes improvement. Big fruits were used mainly for fresh consumption and making juice. Lately, more attention was given to improving tomato plants with small and medium fruits, because they could be used both, fresh and for the food industry to prepare various products. Variability of the *fruit weight* was more pronounced in cultivar Irişa (29,9%) and segregating populations F_2 Maestro x Irişca (22,4%), Mihaela x Irişca (22,6%), BC_1 [F_1 (Maestro x Irişca) x Maestro] (26,5%), F_2 (Mihaela x Dwarf Moneymaker). The average variation coefficient of evaluated character was 20,1 indicating that the character was environmentally variable.

Requirements for the fruit shape were also different depending on the use and destination. The character had a special importance for mechanized cultivation. It's known that the degree of damage to the fruit as a result of mechanical cultivation depended both, on fruit density and form (length and width). Therefore, it was recommended to use egg shaped samples as they easily detached from the pedicel. The data obtained (Table 2) demonstrated slight variability of these characters. This allowed the character to be qualified of low variability, demonstrating its strong genetic determinism. Pericarp thickness was very important for determining the shape and quality of the fruit. Lately, improvements were targeted at obtaining tomatoes with medium or thick pericarp, which provided their safety when shipping for long distances. The forms assessed on this character differed essentially. Calculation of the variation coefficient showed a strong variability of the evaluated character where the average variation coefficient was 24.2%. Pericarp thickness variability was more pronounced in the cultivars Irişa (30,2%), Mihaela (21,3%), in hybrid combinations F_2 Maestro x Dwarf Moneymaker (34,1), (Maestro x Irişca) (28,6), backcrosses [F_1 Maestro (x Dwarf Moneymaker) x Maestro] (37,6%), [F_1 (Maestro x Irişca) x Maestro] (25,2%), [F_1 (Mihaela x Irişca) x Irişca] (24,8%).

The number of seminal locules was a very important feature. Depending on the need of seeds quantity might be creates cultivars with small or big seminal locules Experimental results showed a wide range of variability in the number of locules in the analyzed cultivars / populations ranged within 0 to 27,8%. The average variation of this character was 18,7% which showed a rather high variability.

Table 2. Variability of some quantitative indices of tomato fruit in parents and hybrids

Hybrid combinations and parental forms	Variation coefficient, %				
	Fruits weight	Fruit height	Fruit diameter	Pericarp thickness	Number of locules
F_1 Maestro x Irişca	19,7	4,1	10,7	15,7	17,4
F_2 Maestro x Irişca	22,4	10,8	9,2	28,6	22,3
BC_1 (F_1 (Maestro x Irişca) x Maestro	20,0	8,5	7,4	25,2	20,8
BC_2 F_1 (Maestro x Irişca) x Irişca	16,9	10,2	11,1	19,1	10,7
Maestro	13,9	7,2	9,0	9,5	15,5

Hybrid combinations and parental forms	Variation coefficient, %				
	Fruits weight	Fruit height	Fruit diameter	Pericarp thickness	Number of locules
Irişca	29,9	5,9	6,0	30,2	14,8
Dwarf Moneymaker	14,9	6,3	6,3	17,3	0,0
F_1 Maestrox Dwarf Moneymaker	17,6	11,4	7,7	11,4	19,2
F_2 Maestro x Dwarf Moneymaker	20,1	14,1	11,2	34,1	25,7
BC_1 (F_1 Maestro x Dwarf Moneymaker) x Maestro	18,8	16,4	10,7	37,6	27,8
BC_2 (F_1 Maestro x Dwarf Moneymaker) x Dwarf Moneymaker	20,7	13,0	10,1	21,9	20,8
F_1 Mihaela x Irişca	10,3	4,5	7,1	16,1	17,2
F_2 Mihaela x Irişca	22,6	8,3	7,7	23,5	20,8
BC_1 (F_1 (Mihaela x Irişca) x Mihaela	16,2	7,5	6,1	17,9	20,8
BC_2 (F_1 (Mihaela x Irişca) x Irişca	26,5	6,3	7,2	24,8	18,6
Mihaela	15,6	8,6	8,1	21,3	14,6
F_1 Mihaela x Dwarf Moneymaker	20,6	7,4	7,2	10,6	20,8
F_2 Mihaela x Dwarf Moneymaker	31,9	8,6	6,9	14,1	19,2
BC_1 (F_1 (Mihaela x Dwarf Moneymaker) x Mihaela	24,6	7,2	7,7	15,8	10,7
BC_2 (F_1 (Mihaela x Dwarf Moneymaker) x Dwarf Moneymaker	18,0	5,4	6,5	10,3	17,2
Environment	20,1±1,2	8,6±0,7	8,1±0,4	20,2±1,8	18,7±1,0

One of the basic genetic indices that demonstrated the type of inheritance in F_1 generations was the degree of domination (hp). Study of the dominance degree of the biological elements and tomato productivity showed that the most of F_1 hybrids manifested intermediary domination and positive supra-domination of the character (Table 3). Our research showed that in 36 variants (4 hybrids F_1 x 9 characters) hp were positive for 67% of cases. This revealed predominant manifestation of the parents with high character values.

Table 3. The degree of dominance of tomato quantitative indices

Characters	Hybrid combinations			
	Maestro x Irişca	Maestro x Dwarf Moneymaker	Mihaela x Irişca	Mihaela x Dwarf Moneymaker
Plant height	+0,40	+1,10	-1,14	-1,74
Number of branches	-4,00	-2,00	+3,67	+1,67
Number of fruits per plant	+0,31	-0,07	+0,45	-0,11
Weight of fruits per plant	+1,03	+3,74	+2,16	+0,56
Fruit weight	+0,01	+0,22	-0,24	-0,18
Fruit length	-0,07	+0,67	+0,13	+1,43
Fruit diameter	-0,21	+0,09	+1,12	-0,34
Pericarp thickness	-0,82	+0,41	+0,37	+0,52
Number of seed locules	+0,50	+0,33	-1,00	-0,25

Heritability coefficient was a genetic trait that allowed determining the contribution of the genetic factor to the total phenotypic variability. In selection practice it is important to determine at the initial stages of hybrid combinations in which selection can be more effective. The heritability coefficients of the main quantitative characters of the studied combinations were shown in Table 4. The analysis of the obtained data showed a considerable variability of the heritability coefficient of the studied hybrids which, in a broad sense, ranged from 0.01 to 0.76%, and, in the narrow sense, - from 0.00 to 0.94. The highest heritability values at most characters were recorded in Maestro x Irişca combination.

Table 4. Heritability coefficient in large (H) and narrow (h^2) senses of tomato quantitative characters

Characters	Hybrid combinations							
	Maestro x Irişca		Maestro x Dwarf Moneymaker		Mihaela x Irişca		Mihaela x Dwarf Moneymaker	
	H	h^2	H	h^2	H	h^2	H	h^2
Plant height	0,50	0,30	0,40	0,10	0,58	0,49	0,06	0,12
Number of branches	0,45	0,04	0,25	0,06	0,14	0,00	0,55	0,05
Number of fruits per plant	0,73	0,26	0,02	0,18	0,08	0,07	0,71	0,32
Weight of fruits per plant	0,70	0,13	0,04	0,02	0,12	0,07	0,58	0,08
Fruit weight	0,04	0,26	0,01	0,00	0,76	0,10	0,65	0,58
Fruit length	0,79	0,01	0,48	0,29	0,67	0,17	0,31	0,40
Fruit diameter	0,03	0,18	0,39	0,10	0,09	0,15	0,09	0,19
Pericarp thickness	0,58	0,24	0,69	0,11	0,62	0,03	0,36	0,18
Number of locules	0,35	0,54	0,62	0,94	0,50	0,23	0,04	0,64

CONCLUSIONS

As a result of the analysis of the complex of 16 hybrid combinations created on the base of intraspecific hybridization there were obtained genotypes which differed by productivity, shape and size of the fruit and the pericarp thickness that might be used for obtaining new cultivars with valuable traits and high transportability.

Statistical calculations proved the veridity of differences between parents and F_1, F_2 hybrids and BC for 8 of 9 evaluated characters.

As a result of the analysis of the variation coefficient of quantitative characters from parents and hybrid combinations F_1, F_2 and BC it was found that in all hybrid combinations in respect of the number and fruit weight per plant the variation coefficient was high and more pronounced in the combination BC_1 F_1 (Maestro x Irișca) x Maestro (46,4 and 49,2%), F_2 Mihaela x Dwarf Moneymaker (55.4 and 44,4%), BC_1 F_1 (Mihaela x Dwarf Moneymaker) x Mihaela (47,7 and 44,4%, respectively).

The heritability coefficient of quantitative characters in broad and narrow senses depended largely on parental forms. The highest heritability values were recorded for the number and fruit weight per plant in combinations of Maestro x Irișca și Mihaela x Dwarf Moneymaker. High values of heritability for the pericarp thickness being within the limits of 0,39 to 0,69 demonstrated possibility to obtain forms with high transportability.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

SOME EAR PROPERTIES OF EARLIER PRODUCED SWEET CORN

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Abstract

In this trial it was compared the effect of propagation time and floating cover on the growing season on some valuable morphological properties of early harvested sweet corn. The following technological variations were compared with help of the variety Spirit (normal sweet, very early ripening): 1. direct seeded plants with floating cover (early sowing time); 2. direct seeded plants without cover (early sowing time); 3. transplanted plants with floating cover (early transplanting time); 4. direct seeded plants without cover (usually sowing time, regarded as control). The covering by earlier sowing time had favourable influence on, ear weight, ear length, depth of seeds. Major influence of covering resulted in harvesting time: earliness was observed among covered and uncovered treatments between 5-19 days.

***Key words**: earliness, plants covering, sweet corn, transplanted plants.*

INTRODUCTION

As early as in the beginning of the 20th century some researchers (Cserháti, 1901) highlighted the importance of the sowing date. Ripening can occur earlier when sowing earlier and using high quality seeds as compared to normal or late sowing. I'só (1969) and Pásztor (1966), after their multi-year sowing date trial, concluded the following: in the case of an earlier sowing seed germination will be more protracted, but from the point of view of fruit maturing it was more favourable than late sowing.
Also I'só and Szalay (1966, 1969) were studied occur of maize generative phenophases. They concluded, that by earlier sowing germination will be more protracted, but silking and harvesting occur sooner than by lately sowing time.
After multi-year trial Berzsenyi et al. (1998) have studied the effect of different sowing times on maize development. They concluded the following: a 3 weeks lately sowing time delay one week occur of silking time.
Several techniques are known in the art for the purpose of early fresh market shipments: seedling growing or direct seeding with temporary plant cover (Kurucz, 1998; Hodossi, 2004). Direct seeded sweet corn under vlies cover showed earlier ripening and gave better yields in the experiments of Kassel (1990). The plots under vlies cover reached harvest maturity 12 days earlier as compared to the plots with no cover. In case of direct seeding, as propagation method, another earliness increasing solution is the temporary covering with plastic or vlies, used in different combinations. This method reaches about 7-10 days earliness (Hodossi and Kovács, 1996). About the covered early sowing as a technological variation Aylswirth (1986) mentioned, that from an early sowed crop, made in first week of April, arranged in twin rows (42cm) and covered by plastic, we could harvested marketable cobs by the fourth of July.

MATERIALS AND METHODS

The experiment was set up in 2013 on an area equipped for irrigation at Curteni village, Mures country. Average temperature of vegetation period in April and May was in concordance with multiyear average values, in June and July presented higher values with 0.5°C, respectively 1.5°C compared to average values. Quantity of precipitation in vegetation period correspond to multiyear quantity, excepted in July, this Month presented a lack of 33 mm. The test variety was Spirit, a normal sweet corn with a very early growing period (85 days). Average plant height is 159 cm, ear height is 37 cm. Average ear length was 19.6 cm in the variety comparison trials carried out by the Central Agricultural Office and average ear weight was 245 g (Kovács, 2002).

The following treatments were applied during the experiment:

P1 = uncovered direct seeded (April 19th)

P2 = covered direct seeded (April 19th)

P3 = covered transplanted (April 19th)

P4 = the control, uncovered direct seeded (May 2nd)

By both sowing times (April 19th and May 2nd) a part of the stand was covered with Novagryl floating row cover having a weight of 19 g/m^2 at the two propagation times in order to enhance earliness.

The floating row cover was removed on May 18th. The stand was created to contain 60,607 plants per hectare, according to the recommendations of the owner of the variety, at a spacing of 110+40x22 cm in twin rows.

Each plot had an area of 6x7m (8 parallel rows and 30 seeds sown in each row). The edge was the outer two rows of the 8 rows of the plot, respectively. All treatments were set up in four replications.

Fertilization was done by top dressing with N. No farmyard manure was applied.

Ears, together with the husks, were collected from the four central (two twin) rows. 25 ears of average appearance were selected from each row and the following measurements were carried out:

- unhusked ear weight (gram);
- total ear length (cm);
- depth of seeds (mm).

The statistical analysis of the results was carried out by using the programme RopStat 1.1. When the standard deviations were identical the mean values were compared by pairs using the Tukey-Kramer test, while in the case of the non-identical standard deviations the means were compared using the Games-Howell test, Vargha (2007).

RESULTS AND DISCUSSIONS

According to obtained results, harvesting time (measured in days) was the shortest in the treatment P3 (VII. 2) and P2 (VII.12), merely 74, respectively 84 days, i.e. the corns became ready for harvest 19, respectively 9 days earlier than those of P4 (VII.21, control). In case of P1 treatment, harvesting began 5 days (VII.16) earlier compared to P4 (control).

Results of the one of the major characteristics in connection with yield rating, unhusked ear weight, are summarised in Figure 1.

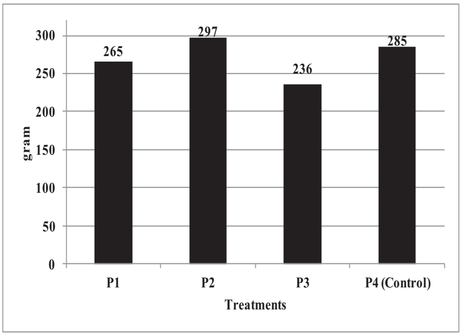

Figure 1. Unhusked ear weight

Studying the measured data for unhusked ear yield, we saw that the average weight of the ears of the treatment P2 (earlier sowed, covered plants) was significantly (at $p<0.01$ level) higher as compared to the other treatments (excepted P4, control treatment).

The average unhusked ear weight of the P3 treatment (earlier transplanted, covered plants) was significantly lower (at $p<0.01$ level) compared to other treatments.

The data concerning, an important characteristics for market appeal, total ear length (cm) are contained in Figure 2.

The average total ear length of the P2 treatment (earlier seeded, covered plants) was significantly higher (at $p<0.01$ level) compared to the other treatments. Analysing the data of other treatments, we found statistically significantly (at $p<0.01$ level) different results compared to the sizes of the other treatments (P1, P3 and P4, control).

From customer viewpoint depth of seeds (mm) is an important parameter and the measured average results are presented on Figure 3.

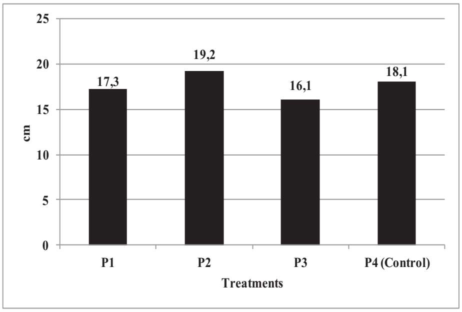

Figure 2. Total ear length

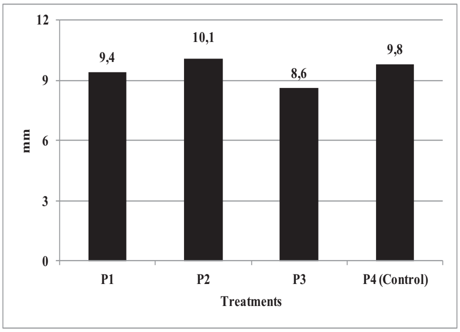

Figure 3. Depth of seeds

Analyzing the size (depth) of seeds we observed a statistically demonstrable (at $p<0.01$ level) difference among P2 (earlier sowed, covered) treatment and P3 (earlier transplanted, covered) treatment. Among seeds depth of other compared treatments has been measured differences, but no statistically (at $p<0.01$ level), demonstrable.

CONCLUSIONS

Effect of covering has favourable effect on harvesting time, P3 (earlier transplanted, covered) and P2 (earlier seeded, covered), treatments ears became ready for harvest 19, respectively 9 days earlier than those of P4 (later sowed, uncovered, control).

The unhusked ear weight presented the highest results in case of treatment P2 (earlier seeded, covered).

Measuring ear length, we observed the same tendency as in case of ear weight. P2 treatment's ear produced the highest values.

From customer viewpoint important parameter, depth of seeds, the same results were measured as in case of previous mentioned important properties unhusked ear weight and length of seeds.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INFLUENCE OF THE DIFFERENT RATE OF NITROGEN ON THE POSSIBILITIES FOR POST-HARVEST RIPENING OF THE CAPE GOOSEBERRY (*PHYSALIS PERUVIANA* L.) FRUITS

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Abstract

The main goal of the present study was to establish the influence of the different quantity of nitrogen on the possibilities for post-harvest ripening of fruit of cape gooseberry (Physalis peruviana L.). Some part of the cape gooseberry fruit can not ripen until the end of the growing season. Therefore, it is necessary to be carried out the studies in relation with after harvest ripening. By this way the overall productivity are increased. The experiments were carried out with two genotypes of cape gooseberry – first Bulgarian variety Plovdiv and Columbian ecotype Obrazec 1. The plants were grown with non-pricked out seedling in five level of nitrogen fertilization 0, 70, 140, 210 and 280 N kg.ha^{-1} applied in three times – in pre sowing tillage, in stage of flowering and 20 days later. In the end of vegetation normal development fruits, without damage and injuries, but unripe were placed for after harvest ripening in ambient conditions. In a period of 7 days the quantity of ripening and damaged fruits, the content of dry matter and sugars and weight of the fruits were established. The highest percentage of after harvest ripe fruits for variety Plovdiv was found in variants with 140 N kg.ha-^{1}- 67.0%. For Obrazec 1 these values were the highest in rate of 210 N kg.ha-^{1} - 71.67%. Dry matter and sugar content increased, while the fruit weight decreased. The periods for economic efficiency of after harvest ripening were 14 days to maximum 21 days for both varieties.

***Key words**: cape gooseberry, maturity, chemical components, nitrogen, fertilization.*

INTRODUCTION

Several researches conducted studies in different crops to establish the relationship of fertilization and post-harvest behaviors such as additional maturity and storability (Ivanova, 1997; Ivanova and Vasilev, 2003; Cholakov, 2003; Todorova et al., 2009; Cholakov and Boteva, 2012; Haytova, 2013; Haytova et al, 2014). Cape gooseberry is a comparatively new vegetable crop for Bulgaria and for Europe, but with increasing sales and expanding market. Part of the available at the market fruit for fresh consumption are the result of further post-harvest ripening. The flowering, fruit-set formation and maturity of cape gooseberry fruits are directly dependent on the applied agrotechnology and often can be delayed in case of a strong vegetative growth (Prasad, 1979). Chernook (1997) reported that part of fruit of cape gooseberry usually does not ripen on the plant itself and also points out that these green fruit are with very good opportunity for post- harvest ripening. This crop is characterized by very good ability for after harvest ripening and for storage, and these two aspects are the main economic features that often are used in practice. This contributes to increasing the marketed production and the income and consequently to increase also the efficiency of cultivation (Christov, 2010). One of the reasons for immature fruit is a high vegetative growth. In cape gooseberry growing one must pay particular attention to appropriate fertilization with nitrogen (Chernok, 1997; Kendall, 2008; Christov, 2010), because a higher quantities of nitrogen approximately with 50 kg.ha^{-1} N caused much more luxuriant vegetative growth, in which case the setting of flowers and fruits and their maturity greatly reduced (Crawford, 2004; Paksi et al., 2007).

Further ripening causes in green and semi-green fruits of cape goosberry chang of the content of sugars and the total amount of the salts (Sarkar et al., 1993). For a long-term storage is recommended to be picked semi-green fruits and to be placed for ripening. In the process of ripening the fruit color changes from green to yellow or orange, which is associated with degradation of chlorophyll and an increase of carotenes, primarily of β-carotene. The process of ripening is associated with increase of the content of sugar, total soluble salts, the relationship between soluble salts and acids, and ascorbic acid, while the starch decreases and the ratio of sucrose: glucose: fructose changed. Initially in the ripening the content of acidity increases, but then gradually reduces until the fruit reaches full maturity (Fischer and Lüdders 1997; Fischer et al. 2000; Sarangi et al. 1989; Baumann and Meier, 1993; Majumder and Mazumbar 2001).

The main goal of present study was to determine the influence of different rate of nitrogen fertilizer, applied in cultivation of cape gooseberry on the possibility of after harvest ripening of its fruit.

MATERIALS AND METHODS

The experiments were carried out during 2008-2010 years in Agricultural University, Plovdiv, with two genotypes – one was the first Bulgarian variety Plovdiv and the other was Obrazec 1. During autumn plowing 160 $kg.ha^{-1}$ P_2O_5 and 120 $kg.ha^{-1}$ K_2O as triple superphosphate and potassium sulphate, respectively were applied. Seeds were sown in a plastic green house in the middle of March at 1.5 g/m^2. On 20 of May the seedlings were planted by scheme 70 × 50 cm on the experimental plots of 10 m^2, in four replications. The soil classified as Molic-Fluvisols, is loamy, with 30 % clay. Five rate of N as an ammonium nitrate fertilizer (34,27 % N) – 0 (control), 70, 140, 210 and 280 N $kg.ha^{-1}$ were applied in three times – ⅓ before planting soil preparation and the remainder was divided into two doses and used in two stages of development - beginning of flowering and twenty days later. During vegetation each agro-technological practice that are necessary were performed. At maturity of the fruit regularly harvests are carried out.

At the end of the growing season, before the first autumn frost, well-formed fruit with normal size, but unripe, undamaged and illnesses were harvested and placed for post-harvest ripening. It carried out in four replications, in ambient conditions in storage house with temperature 20-22^{0}C and 60-65% air humidity. The fruits in quantity of 500 g were placed in plastic, very good disinfected boxes with depth of layer of 7-8 cm. Through periods of 7 days until depletion of healthy fruit, the ripe fruits were taken and their weight was measured, while the rotting and damaged ones were removed. The weight per fruit, content of dry matter (refracto-metrically) and sugar (by the methods of Hagedorn – Yensen, described by Stambolova et al., 1978) were established in four replications on the day of placing for post-harvest maturation and every seventh day of the trial was conducted. Data of the study were subjected to analysis of variance, and least significant differences between means were calculated by the Fisher test at p = 0.05(described by Fowel and Cohen, 1992). The presented data are mean values from the three years of the investigation periods, because the trends were similar.

RESULTS AND DISCUSSIONS

Christov (2010) reported that under Bulgarian condition not all cape gooseberry fruits can mature by the end of the growing season. The proces of maturation according to Sahoo et al. (2002) and Crawford (2004) have a direct relationship with the technology of growth and especill of the applied quantity of nitrogen fertilizer. Different rate of nitrogen affects on the amount of unripe fruits (Table 1). For both varieties they were at least, in the control and their portion augmentation with applying of nitrogen. This could be due eventually to a weak vegetative growth in non-fertilizing plants and the possibility for large-scale ripen of their fruits. The amount of unripe fruits was the highest for Plovdiv in variant with N_{70} – 550.4 $kg.ha^{-1}$ while for Obrazec 1 in N_{140} - 368.7 $kg.ha^{-1}$. Differences between the two genotypes are almost nonexistent, but the quantity of unriped fruits is more in variety Plovdiv. For ripening, as outlined above, are placed well shaped fruit with normal size. At last variant, with the highest fertilizer rate, the mentioned quantities of unripe fruits are lower in compared with the previous levels of nitrogen. However it should be borne in mind that these are only fruit that were fit and matching requires for further ripening. It can be assumed that their amount is less because the plants, eventually in results of higher nitrogen fertilization developed stronger vegetative growth. This in turn may have caused for formation of smaller, weaker and underdeveloped fruits, which are not eligible to be placed for post-harvest ripening, which is why the reported quantity is lower, but this applies only for fit for ripening fruit. This assertion confirmed by the next indicator, determining the proportion of immature to all formed fruit. The differences between most of the variants have statistical significance.

The proportion of unripe fruits, to all formed ones increases with increasing of level of fertilization. It was higher for Plovdiv from 9.41 % to 13.31 % and for other variety was between 8.17 % to 15.88 %. These not small amounts suggest that the after harvest ripening of cape gooseberry fruit is a necessary and indispensable practice.

As a result of conducting the after harvest ripening the percentage of riped fruits for variety Plovdiv was the highest in variant N_{140} – 67.0 %, while for Obrazec 1 it was observed for the next level N_{210} – 71.16 %. The values of this index was the least for Obrazec 1 in control and for Plovdiv in N_{280}.

The total quantity of ripe fruits by means of post-harvest ripening increased. The least this increase was in Plovdiv for the control and for the highest amount of nitrogen 4.19 % and 5.68 % and for Obrazec 1 also for the control and for the least quantity of fertilizer – 3.07 % and 4.28 %. The proportion of after harvest ripe fruits was more significant for N_{140} and N_{210} – 8.67 % (Plovdiv) and 6.71 % (Obraze 1), respectively. Therefore more appropriate and economically efficient is the application of his practice in the above mentioned two levels of nitrogen application.

Table 1. Quantity on non maturity fruits and ratios between maturity and after harvest ripping fruits of cape gooseberry

Varieties	Non maturity fruits (kg.ha^{-1})		Portion of the unripe to all formed fruits (%)		After harvest ripe fruits (%)		Portion of after harvest ripe to whole quantity of maturity fruits(%)	
	Plovdiv	Obrazec 1	Plovdiv	Obrazec 1	Plovdiv	Obrazec 1	Plovdiv	Obrazec 1
$N_0P_{160}K_{120}$	250.5	222.5	9.41	8.17	41.93	38.83	4.19	3.07
$N_{70}P_{160}K_{120}$	550.4	294.0	11.60	9.58	57.33	46.67	6.99	4.28
$N_{140}P_{160}K_{120}$	525.4	368.7	12.41	9.99	67.00	62.67	8.67	5.89
$N_{210}P_{160}K_{120}$	459.5	361.3	11.91	10.04	49.22	71.67	6.23	6.71
$N_{280}P_{160}K_{120}$	385.8	341.3	13.31	15.88	40.83	44.78	5.68	6.64
P=5.0%	54.93	11.52						
GD P=1.o%	75.56	16.69						
P=0.1 %	119.34	25.04						

The dynamic of after harvest ripening is shown on Figure 1. Special differences between the two genotypes were not observed. The most fruits ripe on the seven days and the highest quantity were obtained from variant N_{70} – 41.67 % for Plovdiv and from N_{210} - 37.0 % of Obrazec 1. Secondly for both genotypes were the fruits from N_{140} – 37.56 % and 35.0 % for first and for second variety, respectively. After that day, the percentage of post-harvest ripe fruits began to decrease gradually. After harvest ripening, even in insignificant amount detected until 35 days in Obrazec 1 in N_{140} but in extremely low quantity – 2.0 %, while in Plovdiv it compiled in each variants on 28 day, as the control and N_{280} was even earlier on 21 day. The highest decrease was observed between 7 and 14 days for N_{70} and N_0 with 33.34 % and 26.14 %, respectively in Plovdiv and for Obrazec 1 – in N_{140} and $N1_{70}$ – 23.33 % and 21.0 %. Appropriate period for after harvest ripening was up to 14 days and maximum to 21 day, when for Plovdiv obtained additional ripen fruit within 2.56 % (N_0) to 6.0 % (N_{210}), and for Obrazec 1 between 2.33 % (N_{280}) to 9.33 % (N_{140}).

The weight of the fruit during after harvest ripening decreased relatively slowly from the first to the last day (Figure 2). It could be assumed that this is due to natural processes of transpiration and loss of water from the fruit during post- harvest ripening, which affects on their weight. More sharply this process is observed in Plovdiv on 21 day in variants N_{140} – decrease with 8.29 %, while for the other ones was established on 28 day – with 5.73 % in the same variant. On last day of post-harvest ripening the reduction toward the initial weight was with 3.45 % (N_0 on 21 day) to 10.51 (N_{140} on 28 day) for Plovdiv. In genotype Obrazec 1 this decrease varied between 4.84 % (N_{210} on 21 day) to 12.42 % (N_{140} on 28 day). The initial weight of fruit that were placed for post-harvest ripening was lower for Obrazec 1. The coloring in orange of fruit during post- harvest ripening is an indication for reaching the suitable for consumption maturity and according to Fischer et al. (2000), as it was above mentioned, it is in the result of degradation of chlorophyll and increasing of the carotens.

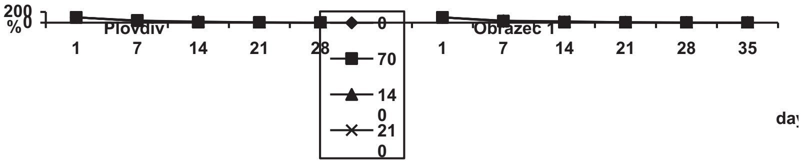

Figure 1. Dynamic of maturation of cape gooseberry fruits during the period of after harvest ripening (0, 70, 140, 210, 280 kg.ha^{-1} N)

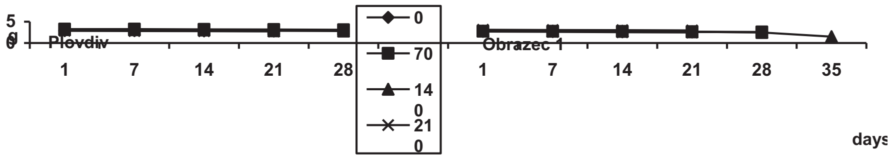

Figure 2. Weight of one fruit during the period of after harvest ripening (0, 70, 140, 210, 280 kg.ha^{-1} N)

The dry matter content increased in the period of after harvest ripening in each variant (Figure 3). The highest increase was observed between 7 and 14 days. For Obrazec 1 the highest increae was observed for level of fertilizer of N_{210} in period 1 - 7 day with 2.12 %. In this genotype sharply decrease was recorded on 35 day for varinat N_{140} with 4.78%. In Plovdiv, the increase up to 28 days. The augmentation for this variety was the highest between 7 and 14 day for N_{140} with 2.19 %. It can be assumed that the reason which was mentioned about weight decrease, i. e. normal water loss is also associated with the increase of dry matter in the fruit.

The processes of post-harvest ripening are associated with convert of nutrients into the fruits. Similar dynamic, such as in the dry mater, has been established also for sugar content (Figure 4). In Obrazec 1 in almost all variants increased without concern for 35 day in N_{140} where the decrease was monitored. Similar trend to increase a sugar was established in Plovdiv in each level of nitrogen application. Sarkar et al. (1993) in an investigation of the chemical composition of the cape gooseberry fruits, with different stage of maturity, placed for additionall after harvest ripening, also indentified change in quantity of the sugar content as well as in the total quantity of salts.

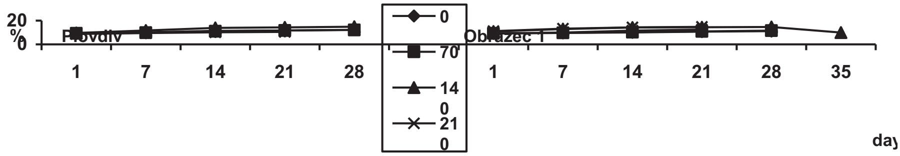

Figure 3. Content of dry mater of cape gooseberry fruits during the period of after harvest ripening (0, 70, 140, 210, 280 $kg.ha^{-1}$ N)

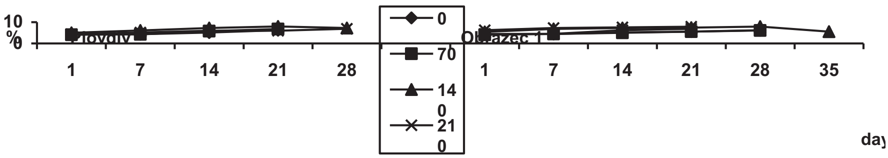

Figure 4. Content of sugar of cape gooseberry fruits during the period of after harvest ripening (0, 70, 140, 210, 280 $kg.ha^{-1}$ N)

CONCLUSIONS

Applied of nitrogen fertilizer in cape gooseberry affects on the amount of unripe fruit during the vegetation season. This quantity was more in fertilization with 70 and 140 $kg.ha^{-1}$a nitrogen.

The portion of unripe fruits to all formed ones was the highest for the biggest amount of nitrogen. A higher percentage of post-harvest ripe fruits in Plovdiv was observed in variant N_{140} but in Obrazec 1 it was recorded in N_{210}.

Post-harvest ripening is economically efficient when it is done with fruits from plants that are grown by fertilization with quantity of ammonium nitrate in level from 70 to 140 $kg.ha^{-1}$ nitrogen, where unripe fruits were more, and increase of the total amount of ripe fruit as a result of this practice was higher. The dynamics of the after harvest ripening of cape gooseberry fruits indicates that it is appropriate to continue to 14 days.

The weight of the fruit during after harvest ripening decreases the dry mater such as also the sugar content in both genotypes increases.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INFLUENCE OF ILLUMINATION WITH LEDs ON GROWTH AND DEVELOPMENT OF LETTUCE SEEDLINGS

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Abstract

The paper aimed to present the evolution of lettuce (Lactuca sativa L.) grown in different light conditions. Plants were grown in a climate chamber of the Faculty of Horticulture-UASVM Bucharest, using as light sources LED and neon. There have used two varieties of lettuce namely 'Lollo Rosa' and 'Lollo Bionda'. Both of varieties have better development (eg germination period, number of leaves) in the case of LED luminaries compared with those developed under neon light. Thus, masses obtained after 30 days of growth were 30.8% higher in case of the variety 'Lollo Rosa' and 29.8 for variety 'Lollo Bionda'. As a general conclusion it can be say that use of LED light has a lot of advantages against neon light being ecological and offering a reduced energy consumption which determine a lower greenhouse warming phenomenon compared to overheating caused by neon lighting. In addition, it is important that to pursue the studies by assessing the behavior of plants at different radiation emitted by the LED.

Key words*: lettuce, LED illumination, growth characteristics.*

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a species commonly cultivated in protected areas especially during the autumn-winter-spring.

For some varieties of lettuce external factors such as light and temperature can influence the quality leaves or heads. For example Piroga lettuce varieties (var. Crispa) and Paris White (var. Romanian) under short-day conditions with increased cloudiness and low temperature (2-4°C) leaves occurring embossed, coarser, crunchy, stained, without commercial aspect. To these varieties leaf tenderness may return only when the temperature rises above 7°C and light conditions are improved (Draghici, 2014).

Light is one of the most important environmental factors that exerts different influences on plants, it is not only a source of energy in photosynthesis, but also the promoter of germination, growth and development of plant organisms. The reaction of plants to light, counts both the quantity and quality of radiation incidents as well as length of the lighting period, respectively photoperiod.

As stated Tikhomirov (1994), spectral changes of light determines the recording - to the green organs of each plant – of morphogenetic and different photosynthetic reactions with intra- and interspecific variations or even intra-individuals.

LEDs are widely used in various fields of activity. In the last years, there were indoor plant growers who use LED light to grow plants used for their own food (Yeh and Chung, 2009). Light-emitting diodes (LEDs) have long been recognized for their benefits, long life, energy efficiency and flexibility.

In the last decade LED technology evolution has been outstanding, the market being rising significantly in recent years. However, in comparison with the rest of the lighting industry, the introduction of LEDs in horticultural cultivation techniques is more recent being materialized only in recent years. Introducing of LEDs on the horticultural market in is largely due to significant advances in technology (Matioc, 2012).

In recent years, studies have shown that plants are more sensitive to certain wavelengths of light to increase the absorption of chlorophyll and photosynthesis standing out exposure to red (~ 640-660 nm) and blue (~ 450 nm) light. These studies showed that the peaks of the spectral light absorption for the *chlorophyll a* is within the ranges of 400 to 500 nm and 600 to 700 nm. The use of additional lighting using lamps helps to produce greenhouse vegetable salad and their use has skyrocketed over the past 15 years in the Netherlands. The main reasons for using additional lighting are ensuring high yields throughout the year and the level of quality that meets market demand (Marcelis et al., 2002).

In the Netherlands, in 1999 additional illuminated surfaces in greenhouses increased by about 13% compared to 1994 (Bakker et al., 2000). Until 2002 about 22% of the Dutch greenhouse made use of supplementary lighting, the digit having increased by 1.7 percent annually compared to 1994 (Knijff and Benning, 2003).

The study aimed to identify the best light spectrum to produce seedlings of lettuce.

MATERIALS AND METHODS

The experiment was conducted in the Department of Bioengineering Hortiviticultural Systems, Faculty of Horticulture Bucharest, during the period 2013-2014.

The study was conducted in the climate chamber, under controlled environment, ensuring a temperature of 22 °C day and 20 °C night, a constant atmospheric humidity of 65%. The duration of lighting was 16 hours / day light and 8 hours dark.

Have been sown seeds of lettuce varieties Lollo Bionda and Lollo Rosa, 150 seeds for each varieties, in three repetitions.

Determinations were carried out on emergence, the growth of salad plants, dynamics of leaves formation, the seedlings mass. It used one type of LEDs.

RESULTS AND DISCUSSIONS

It was found that after three days from sowing that the highest percentage of emergence was recorded at Lollo Bionda variety (20%), the variant exposed to light LED.

At the all variants, the emergence of plants was higher for all cultivars exposed to LED light (figure 1).

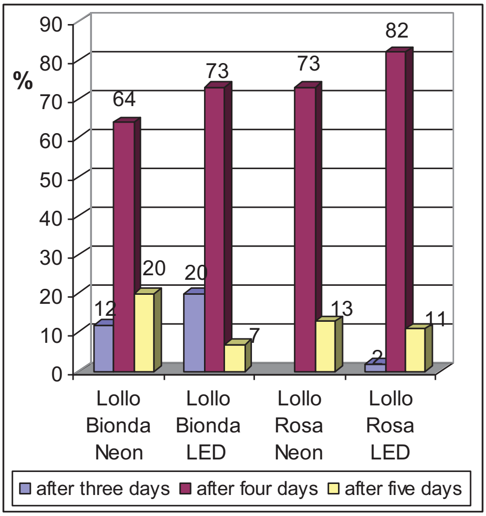

Figure 1. The duration and the percentage of the plants emergence.

Notice that the highest percentage of emergence was Lollo Bionda variety of 100% followed by 95% variety Lollo Rosa to variants lighting by LED, figure 2.

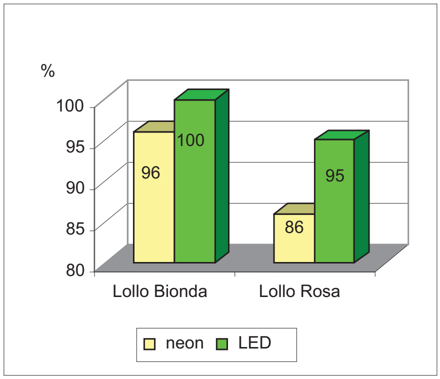

Figure 2. The total percentage of seeds emerged

Observations on the dynamics of lettuce leaves, Lollo Bionda and Lollo Rosa varieties, showed that for both varieties has been formed a greater number of leaves when seedlings growth under LED lighting (figure 3 and figure 4).

Likewise, following the plant masses after 30 days it can see that these have the same aspect. Namely, the salad masses after 30 days of development is higher at both varieties by about 30% (30.8% Lollo Rosa and 29.8% for

Lollo Bionda) to plants grown under illumination provided by LED compared to those grown under neon lighting.

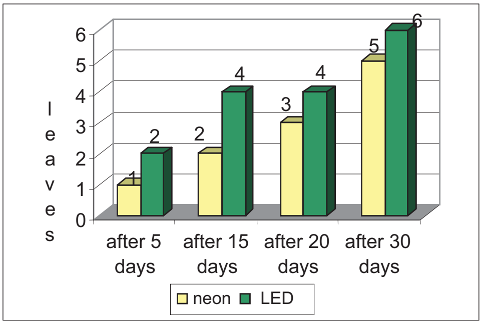

Figure 3. The dynamics of formation of leaves for the variety Lollo Bionda.

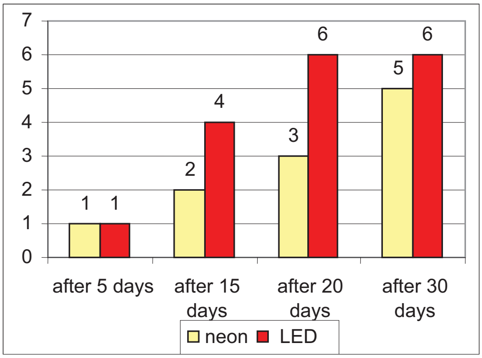

Figure 4. The dynamics of formation of leaves for the variety Lollo Rosa

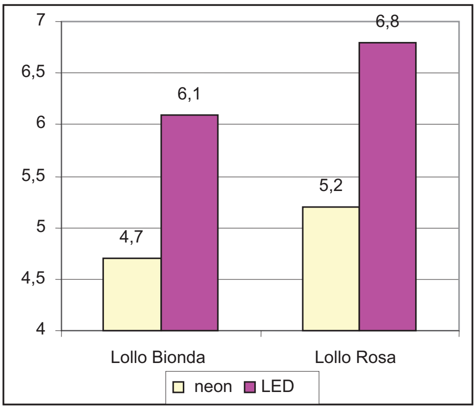

Figure 5. The mass of seedlings after 30 days

CONCLUSIONS

The results obtained clearly confirmed by the fact that they were very close to rehearsals conducted under the same conditions (3 repetitions for the same conditions) shows the obvious advantage of using LED luminaries.
Important is that they are ecological and of reduced energy consumption point of view which determine a lower greenhouse warming phenomenon compared to overheating caused by neon lighting.

ACKNOWLEDGEMENTS

This work was supported by a grant of the Romanian National Authority for Scientific Research, CNDI – UEFISCDI, financed from project number PN-II-PT-PCCA-2011-3.2-1351 - Contract No.68/2012 and the European Social Found, Human Resources Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/13276.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDY ON THE INFLUENCE OF SUBSTRATE CULTURE ON THE PRODUCTION OF CUCUMBERS IN UNCONVENTIONAL SYSTEM

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Abstract

Cucumbers are one of the basic crops in greenhouse being grown on large areas in both the cycle and cycle II of culture. It is a very demanding species to the conditions of culture, but if you apply an adequate technology can bring obtained yields with important benefits. In greenhouse is practiced both the culture on soil and soilless culture. The advantages of cultivation on soilless consist of an effective monitoring of medium of culture, in particular irrigation and nutrition. Culture substrates are selected such that they do not interact with the nutritional solution. Perlite is a substrate inexpensive, reusable and ensuring earliness and production increase. The present study was conducted in greenhouses at Hortinvest Research Centre of University of Veterinary Medicine from Bucharest. Culture of cucumber was established in the first cycle and used Pyralis hybrid, specific for greenhouse crop. We used three experimental variants of mattresses filled with grain of 2, 4 and 5 mm diameter. The best solution to a grain size of perlite was the variant with 4 mm diameter, ensuring the most satisfying results for early and total production. The aim of the study was to identify the best solution culture substrate games and recommend the use of crops without soil growers.

Key words: *perlite substrate, cucumbers, size grain.*

INTRODUCTION

In Romania, cucumbers culture occupies an important place. The cucumbers are cultivated in different growing systems, as: greenhouse, solar, polytunnels or open field, so the production is covered market throughout the year. Growing cucumbers on nutrient substrate is practiced only on farms that have appropriate technology as this type involves careful coordination of all environmental factors, in particular the fertigation.

FAO Yearbook 2012 states that in 2004-2011, the production and the cultivated areas with cucumbers had had on all continents a significant increment. Increased production was based on improving production efficiency as a result of technical progress in this area, diversification assortment of varieties grown, expanding culture of hybrids with high yield potential, reduce losses caused by pests and diseases through integrated control of their sector developer of greenhouses and solariums by increasing the surface and generalization of modern technologies, concentration of production in favourable areas.

In recent years, many studies have been made on soilless cucumber production in greenhouses in Turkey (Özgür, 1991; Canatar, 1997; Saracoglu, 1997; Öztan, 2002; Kaptan, 2006; Gül et al., 2006; Gül et al., 2007. cited by Engindeniz and Gül, 2009). Though, there is still need for study, especially on economics of soilless cucumber production at farmers' level.

Therefore, the researchers are permanently constrained to finding new modern growing technology, perfumed that to assure a high production.

The most frequently unconventional system is the system of cucumber growing on substrate of Grodan (Petre et al., 2014).

In view of the above, it is necessary to develop technologies that are not expensive, can be made with cheap materials and handy, but at the same time ensuring high productivity both quantitatively and qualitatively.

The culture of perlite substrate has two major advantages: it is very accessible from economically within the global trend as organic.

Results made of Peyvast et al., 2010, showed that substrates had a significant effect on the plant growth, total fruit yield, marketable fruits, fruit weight and number of fruits per m^2.

In the global horticultural production, vegetable crops "without soil" had begun already gain a leading position. These unconventional systems of culture are great interest both for researchers and for those who practice in order to achieve products for human consumption.

In Romania, expansion of these systems raises serious technical and economic issues, so it is necessary to establish culture technologies applicable, using local materials and equipment imported or to be accessible to a larger number of users.

Extending this systems create some problems referring to polluting because the Grodan is a substrate that is difficult to recycled.

Purpose of research in this study was to identify the best composition based on perlite substrate and recommend it to obtain early and high yields, quality and price of low cost. Expanded perlite is a substrate of culture that completely replaces soil.

MATERIALS AND METHODS

The study was conducted within the greenhouses of Hortinvest Research Center – University of Agronomic Sciences and Veterinary Medicine Bucharest, between February and June 2014. The biological material used was the cucumber hybrid Pyralis.

The experiments consisted in cultivation on the Perlite substrates presented in Table 1 and monitoring various growth factors.

The culture was established in greenhouse heated to 10 February 2014. The planting seedlings had 32 days.

Table 1. Experimental variants

Variants	Substrate types	Growing
V1	Perlite 2mm	Growing on mattresses
V2	Perlite 4mm	Growing on mattresses
V3	Perlite 5mm	Growing on mattresses

Of each variant we use twenty four mattresses of 1 m long for each where we had planted each three plants. For each plant has been assured 10 l perlite substrate. Mattresses had contained 30 l of substrate. Plant density was 18,500 plants per ha.

Hydroponics mattresses were made of biodegradable polyethylene, triple laminated, composed of two layers, colored black inside and white outside. Mattresses have a length of 1 m and a width of 20 cm

The fertilizing recipe was modified according to phenophase.

In the first phenophase, immediate period after planting, for each plant were provided an amount of 50 ml of solution per fertigation - for 2 weeks.

Daily it has been administrated a number of six watering.

The amount of solution per plant as the plants increased in height was increased, so had administrated between 150 and 200 ml depending on temperature and light.

During the growing season were conducted observations and determinations so:

- Plant growth in height;
- Early production;
- The quantity of fruit harvested per plant;
- The average fruit per harvest;
- The total production;

Fruit production was determined by weighing. Each assay was performed at least 3 times.

For each determination was made statistical analysis

RESULTS AND DISCUSSIONS

During the period of culture the greenhouse temperatures were recorded and the averages are shown in Figure 1.

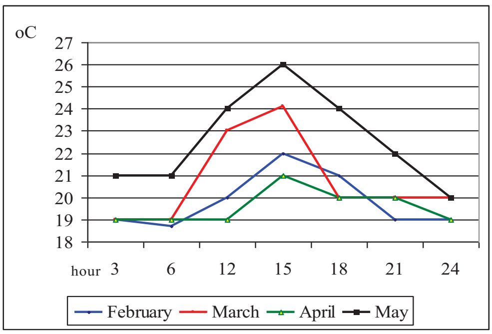

Fig. 1. Average temperature recorded in greenhouse

The plants had grown in height between 163.8 cm and 171.2 cm V1 to V3 (table 2).

Table 2. Dynamic growing in height of cucumber plants

Variant	UM	Number days after planting			
		10	20	30	40
V1	cm	26.8	127.5	147.5	163.8
V2	cm	24.5	117.1	140.7	165,0
V3	cm	24.3	122.8	143.2	171.2

From the statistical point of view, we could notice insignificant differences in plant height growth after ten days of planting (table 3).
In March, the largest quantity was harvested from V2 (1804 kg / plant). The lowest production was obtained at V3 (1,155kg / plant).

Table 3. Summary of results of differences in height after 10 days of planting

Variant	Hight	Difefference		Significance
		(cm)	(cm)	(%)
V(0) Average	25.20	0.00	100.00	Mt
V(1)	26.80	1.60	106.35	N
V(2)	24.50	-0.70	97.22	N
V(3)	24.30	-0.90	96.43	N
DL5% =	1.750	DL5% in % =		6.9444
DL1% =	3.800	DL1% in % =		15.0794
DL01% =	12.890	DL01% in %=		51.1508

Also, we could notice, insignificant differences regarding plant height growth of point of view statistically, table 4.

Table 4. Summary of results of differences in height after 40 days of planting

Variant	Hight	Difference		Significance
	cm)	(cm)	(%)	
V(0) Average	166.67	0.00	100.00	Mt
V(1)	163.80	-2.87	98.28	N
V(2)	165.00	-1.67	99.00	N
V(3)	171.20	4.53	102.72	N
DL5% =	7.010	DL5% in % =		4.2060
DL1% =	15.220	DL1% in % =		9.1320
DL01% =	51.550	DL01% in %=		30.9300

In April, we recorded the highest production of 7.811kg / plant at V2 followed by V1 with 7.166 kg / plant and V3 with a production of 6.431 kg / plant.

In May it were harvested from V2 the quantity of 5.249 kg / plant, and from V1 only 4.914 kg / plant (figure 2).

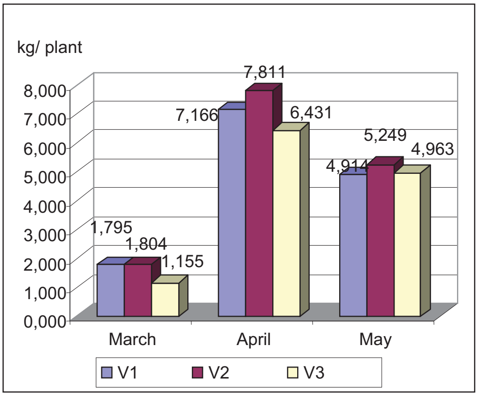

Figure 2. The production obtained per plant

The biggest total production per plant was obtained at V2 (14.864 kg/plant), followed by V1 (13.875 kg/plant). The lowest production I got it from V3 of 12.550 kg / plant (figure 3).

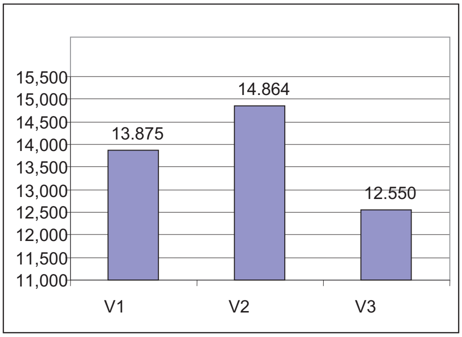

Figure 3. Total yield obtained per plant -kg/plant

CONCLUSIONS

Results show that both in terms of total and per plant production, the best culture substrate is Perlite 3. Reduced particle size of Perlite 1 cause a reduced aeration to roots level and therefore a slow development respectively a lower production. In the case of Perlite 3, the larger size of grains leads to a more rapid drain of fertilizer solutions and therefore a lower consumption of nutrients by plants.
The earliest production was found in the cultures developed on Perlite 3, too.

It has to be emphasized that a problem in greenhouse culture is the temperature variations, because the outside temperature has a real influence on inside temperature even though it is used a good system to keep the temperature at the same value. So, evaluation of temperature variations shows a clear increase in temperature in the greenhouse in May. The explanation is in the fact that the warm weather outside cause an increase in the temperature inside the greenhouse. Therefore it requires a temperature control of greenhouse temperature through the use of appropriate ventilation systems. Of cause, this action will lead to a relatively high consumption of electricity.

Thus, as a general conclusion, the best substrate of those tested for growth of cucumbers in greenhouses is Perlite 3.

ACKNOWLEDGEMENTS

This work was supported by a grant of the Romanian National Authority for Scientific Research, CNDI – UEFISCDI, financed from project number PN-II-PT-PCCA-2011-3.2-1351 - Contract No.68/2012 and the European Social Found, Human Resources Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/13276.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EFFECT OF THE AGE AND PLANTING AREA OF TOMATO (*SOLANUM LYCOPERSICUM* L.) SEEDLINGS FOR LATE FIELD PRODUCTION ON THE VEGETATIVE BEHAVIOUR OF THE PLANTS DURING THE GROWING PERIOD

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Abstract

The aim of the study was to established the influence of age and the size of the planting area of the seedling plants grown in containers, on the vegetative behaviour of plants during the growing period in the conditions of late field production of tomatoes. The experiments were carried out during the period 2011 - 2013 on experimental field, Department of Horticulture at the Agriculturalal University – Plovdiv with cultivar 'Opal F1'. The variants with 20-25, 30-35 and 40-45 day seedlings, cultivated in containers with 40, 66 and 104 cells and planting area respectively 44, 28, 17cm^2, were tested. As a control was a used 20-25 day seedling, grown in a transplanting bed and planting area 26-28 cm2 per plant (350-380 plant / m^2). It was found that the size of the planting area and the age of the seedling plants influenced on the vegetative behaviour of plants during the growing period after planting. The processes of growth and development of the plants, during the growth period, are most intensive at the variant with 20-25 days seedlings, grown in containers with 66 cells.

Key words: *tomato seedlings, planting area, seedlings age, leaf area.*

INTRODUCTION

The use of high quality seedlings is important to realize biological potential of plants in field production of tomatoes and obtaining better economic results (Kim Yeong-Bong et al., 1999; Singh et al., 2005).

Growing seedlings in containers is an advanced technological variant winning strong recognition in the field production of vegetables (Csizinszky and Schuster, 1988; Weston, 1988; Liu and Latimer, 1995).

For late field production of tomatoes the seedling production is done on transplanting bed. Cultivation of seedlings in containers is a progressive technological option.

In Bulgaria research on container-grown tomato seedlings is scanty (Simidchiev and Kanarska, 1986) and no studies are done on the late field production of tomatoes.

There is no scientific information on vegetative behavior of the plants during the growing season when using seedlings, grown in containers.

Unclear are a number of important questions relating to the parameters of the containers and the biology of the seedlings, and the influence of these factors on the growth and development of plants during the growing season.

The aim of the investigation is to determine the influence of the age of the seedlings and the size of the provided nutritional area on the vegetative behavior of plants during the growing period.

MATERIALS AND METHODS

The experimental work was carried out during the period 2011-2013 in an educational-experimental field of the Department of Horticulture.

For the cultivation of seedlings was used standard peat-pearlite mixture with components: peat by Durpeta of Lithuania and Agroperlit in a 3: 1 by volume. Peat substrate is pre-enriched N-250 mg / l, P_2O_5 - 270 mg / l, K_2O, 270 mg / l and Fe, Cu, Mn, B, Mo, Zn - 1,2 mg / l.

The salt concentration of peat, measured in ms / cm is 1.2, and the pH - 5.5-6.5.

The sowing of seeds was carried out in 3 types of containers made from expanded polystyrene

(EPS) with 40, 66 and 104-cells, providing nutritional area of a plant, respectively 44, 28 and 17 cm^2.

In the containers was grown seedlings of three ages - 40-45 days, 30-35 days and 20-25 days. To provide this age difference of the seedlings on the day of planting, the seeds were seeded in containers at an interval of 10 days and placed under optimum conditions for germination.

The control seedlings was grown in a transplanting bed, formed of the same mixture, at a rate of 2 g/m^2, the number of transplants being 350-380/m^2 by applying thinning during the second true leaf stage.

The sowing of seed was performed the period 30.05-04.06.

Setting up, the experiment was carrying out in the scheme of the block method in four replications.

The plant was plant in a permanent place in early July, in high bed-furrow surface in two-roll band in a schema - 110 + 50/30 cm. Growing them was done at the adopted technology for late field production with attachment on low wire construction with regular branches and one stem formation, with removal of vegetation peak after shaping fourth truss.

On the field the plant was planting during the period July 1-5.

The biometric measurements were performed on the 20th, 40th and 60th day after planting with parameters: height of the stem, number of leaves, leaf area and fresh weight of stem and leaves.

The leaf area was determined empirically by the formula (Konyaev M., 1970).

The mathematical processing of the data was done by using standard software SPSS – Duncan's Multiple Range Test (Duncan, 1955) and BIOSTAT.

RESULTS AND DISCUSSIONS

The results of the biometric measurement made on the 20th day after planting (Table 1) show differences in the values of the investigated biometric indicators. From the average results can be seen that for this stage of development of the plants the height of stem is greatest (53 cm) at 40-45 day seedlings, grown in containers with 40 cells, and the smallest (31.7) at 20-25 day seedlings, grown in containers with 104 cells. The values of this indicator decrease by decreasing the age of seedlings and increasing the number of container cells.

The differences between all investigated variants for the index number of leaves are smaller.

Average for the experimental period, the formed leaf area is greatest at the variant of the third age group, grown in containers with 40 cells, which exceeded the control variant with 18.8%.

The leaf area of plants compared to the control is greater at the all variants with 66 cells - 4.9% to 7.3%. Only in the variants with 104 cells, reported values are smaller compared to the control.

Table 1. Biometric indicators of plants on the 20th day after planting average for the period

Number of cells (plant area, cm^2)	High of stem (cm)	Number of leaves	Leaf area		Fresh mass stem + leaves,	
			cm^2	% to the control	g	% to the control
40-45 day seedlings						
1. 40 (44)	53.0	13.5	1696.0	115.8	143.3	123.2
2. 66 (28)	46.0	12.0	1571.3	107.3	128.7	110.6
3.104 (17)	42.0	11.0	1274.7	87.0	108.7	93.4
30-35 day seedlings						
4. 40 (44)	48.7	12.2	1612.0	110.1	137.0	117.8
5. 66 (28)	41.7	11.4	1537.7	105.0	129.0	110.9
6. 104 (17)	35.3	11.1	1295.0	88.4	110.7	95.2
20-25 day seedlings						
7. 40 (44)	37.7	11.1	1740.0	118.8	147.0	12.4
8. 66 (28)	33.0	10.6	1536.0	104.9	121.0	104.0
9. 104 (17)	31.7	10.0	1283.0	87.6	105.3	90.6
10. control	39.3	10.2	1464.3	100.0	116.3	100.0

The basic indicator of the vegetative manifestations of plants is the size of the formed fresh vegetative mass.

For this indicator the highest average values during the experimental period were recorded in plants of the third (20-25) age group, grown in containers with 40 cells, followed by the same variant of the first (40-45) age group.

As can be seen from the results for these two variants the increase relative to the control is with 26.4% and 23.2%.

The reported values for the variant with 66 cells of the third age group are relatively high. They exceed the control with 4.0% to 10.9%. Only for variants with 104 cells the fresh phytomass is smaller compared to the control, as the average values are 4.8% - 9.4% lower. The presented results and the fact that at the time of planting the 40-45 day seedlings has a greatest leaf area and vegetative mass, may can considered that by the 20th day after planting the biologically younger plants are growing more intensively.

The growth rate of vegetative organs is greatest between the 20th and 40th day after planting, when plants form the main part of the leaves-stem mass. This biological feature is characteristic of the later field tomatoes (Cholakov, 1987) and is related to the fact that at the end of this period, the fruits formed of first and second truss are growing intensive, which requires the synthesis of larger quantities of organic substance.

At this measurement (Table 2), the reported differences between the variants by indicators of the stem height and number of leaves of one plant are smaller.

Average for the period the values for the stem height and number of leaves are lowest at variants of the third age group, in which falls and the control.

Table 2. Biometric indicators of plants on the 40th day after planting, average for the period

Number of cells (plant area, cm^2)	High of stem (cm)	Number of leaves	Leaf area		Fresh mass stem + leaves,	
			cm^2	% to the control	g	% to the control
40-45 day seedlings						
1. 40 (44)	107.7	21.6	5260.7	106.2	597.7	102.5
2. 66 (28)	102.3	20.6	5563.3	112.3	645.7	110.7
3.104 (17)	103.7	20.1	4876.3	98.4	580.3	99.5
30-35 day seedlings						
4. 40 (44)	106.3	20.9	5283.3	106.6	605.3	103.8
5. 66 (28)	102.0	20.3	5901.0	119.1	669.7	114.8
6. 104 (17)	101.3	19.8	5330.0	107.6	605.0	103.7
20-25 day seedlings						
7. 40 (44)	102.0	19.0	5944.0	120.0	665.3	114.1
8. 66 (28)	96.7	18.8	6199.3	125.1	695.3	119.2
9. 104 (17)	84.3	18.7	5688.0	114.8	639.7	109.7
10. control	96.7	19.1	4954.0	100.0	583.3	100.0

A comparison the variants on leaf area and stem + leaves mass show several trends.

On the 40th day after planting, the values for both indicators are highest at the plants, grown in containers with 66 cells.

For the leaf area the increase relative to control is respectively 12.3%, 19.1% and 25.1% and it's highest in the third age group.

Well expressed is the advantage of variants with 66 cells in terms of indicator fresh mass stem + leaves.

Average for the period of the study, the increase compared the control is respectively 10.7%, 14.8% and 19.2% and it's highest in the third age group.

Comparison of the variants with the same number of cells of the three age groups showed an advantage for the third (20-25), in which are recorded the highest values.

Between 40th and 60th day after planting the growth rate of vegetative organs reduced (Table 3).

In the middle of this period, in all variants are formed the fruits in the fourth truss, and the most of the synthesized plastic materials are used for their grown.

In addition at the end of this period is committed removing of vegetation peak of plants. This is the reason for minor differences between the variants of the stem height and number of leaves.

The plants, grown in containers with 66 cells stand out.

At that measurement, the values of leaf area and fresh vegetative mass in those variants are greatest. The increase, relative to control for the first indicator is respectively by 0,8%, 4.2% and 12.5%, and for the second - by 1.3%, 7.4% and 13.7%.The values for the both indicator are highest at the variant from the third age group.

Table 3. Biometric indicators of plants on the 60th day after planting, average for the period

Number of cells (plant area, cm^2)	High of stem (cm)	Number of leaves	Leaf area		Fresh mass stem + leaves	
			cm^2	% to the control	g	% to the control
40-45 day seedlings						
1. 40 (44)	113.7	21.5	6027.7	96.5	786.3	95.7
2. 66 (28)	110.0	21.2	6293.7	100.8	831.9	101.3
3.104 (17)	110.0	20.3	5674.7	90.9	750.0	91.3
30-35 day seedlings						
4. 40 (44)	105.0	20.7	6054.7	96.9	818.0	99.6
5. 66 (28)	104.3	20.8	6510.0	104.2	881.7	107.4
6. 104 (17)	107.3	19.7	6100.3	97.7	850.7	103.6
20-25 day seedlings						
7. 40 (44)	105.3	19.7	6547.0	104.8	868.7	105.8
8. 66 (28)	105.3	20.0	7025.0	112.5	934.0	113.7
9. 104 (17)	104.0	19.8	6673.0	106.8	887.3	108.0
10. control	104.7	19.0	6246.0	100.0	821.3	100.0

CONCLUSIONS

The size of nutritional area and the age of seedling, grown in containers for late field production of tomatoes influenced the vegetative behaviors of plants, during the vegetation period after planting.

On the 20th day after planting, the formed leaf area and fresh vegetative mass increases with decrease the number of container cells size. The reported values for both indicators are greater at the variant from third age group with 40 cells. The increases compared to the control are 118.8 % for leaf area and 126, 4 % for fresh vegetative mass.

The growth of leaf area and vegetative mass is greater between 20th and 40th day after planting. For the three age groups, reported values are greater at the variants with 66 cells.

At the end of the reporting period, the plants of variants with 66 cells of third age group form a large leaf area and fresh vegetative mass and increasing compared to the control is respectively with 12.5% and 13.7%.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

DETECTION AND IDENTIFICATION OF ALTERNARIA SPECIES CAUSING DISEASES OF CARROT IN ANKARA PROVINCE, TURKEY

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Abstract

Carrot (Daucus carota var. sativus) is widely planted in the Ankara provinces. In order to identify species of Alternaria causing disease on root and foliage, surveys of carrot production areas in Ayaş and Beypazarı districts of Ankara province between June and November in 2008–2009 were undertaken. Sixty isolates of Alternaria spp. have been obtained from necrotic lesions on the leaves and roots. Alternaria radicina, A. alternata, A.tenuissima and A.dauci were isolated from symptomatic plants collected in our survey and the pathogenicity of fungi have been tested. Species identification was done based on culture and conidial morphology, growth rate and rDNA sequences. Pathogenicity test such as hypocotly test, carrot disc method, 6–8 weekly seedling andplant test were conducted Isolates of A.radicina, A.dauci were shown high virulence although Alternaria alternata were found as moderately or low virulence.

***Key words**: Carrot, root rot, Alternaria blight, Alternaria spp., Turkey.*

INTRODUCTION

Carrot (*Daucus carota* ***var.*** *sativus* Röhl.) is one of the most popular and commonly consumed vegetables (Rubatsky, 2002). Commercial carrot production is an economically important industry worldwide. In the Turkey, the most productive land is in the Central Anatolia Region and Eastern Mediterranean Region. Carrot is widely planted in the Anatolia region that includes Ankara producing nearly 60% of Turkey's carrots. In 2013, carrot cultivated area is about 104,404 da and annual production is 557,977 tons in Turkey (Anonymous, 2014). Root and foliar diseases are among the most important factors limiting carrot production worldwide.

Fungi are the most common pathogens of *D. carota*. Species of the genus *Alternaria* such as *Alternaria carotiincultae* E. G. Simmons, *Alternaria dauci* (J. G. Kuhn) J. W. Groves & Skolko, *Alternaria. petroselini* (Neerg.) E. G. Simmons, and *Alternaria radicina* Meir, Drechsler &E. D. Eddy, have been reported on *D. carota* for several countries (Farrar et al., 2004).

Alternaria Nees is an widely spread mould genus which can be found on plants, in soil, food and indoor air. Most frequent species are *A. alternata* and *A. tenuissima* (Lõiveke et al., 2004). The pathogenic species *Alternaria radicina* and *Alternaria dauci* are isolated from diseased carrot plants in all growing stages (Stranberg, 2002). Alternaria leaf blight caused by *A. dauci* and Alternaria black rot caused by *A. radicina* are widespread on carrot crops in the world where are reported to cause considerable damage (Davis and Raid, 2002).

Black rot (*Alternaria radicina*) is found in all the main carrot-production areas. Although this disease is important as a storage disease of carrots, it also causes seedling damping-off, foliar and crown infection ((Koike et al., 2009). Alternaria leaf blight (*Alternaria dauci*) is one of the most important foliar diseases of carrot and occurs worldwide. Severe epidemics reduce carrot root size and yields (Koike et al., 2009). In Turkey, *A.dauci* was first described as leaf blight caused on carrot in the Hatay province of Turkey (Soylu et al., 2005).

The objective of the present study was to determine the *Alternaria* species causing diseases in carrot growing areas in Ankara province, Turkey.

MATERIALS AND METHODS

Survey and fungal isolation

In order to identify species of *Alternaria* causing diseases on carrot root and foliage, surveys were carried out in production areas in Ankara province between June and November in 2008-2009 growing seasons (Figure 1). Samples were taken from fields in Ayaş and Beypazarı districts of Ankara.

Infected carrot leaves and root pieces were surface-sterilized (1,0% (w/v) sodium hypochlorite) for 2-3 min then rinsed in sterile water three times before they were placed onto potato dextrose agar (PDA, Merck) containing streptomycin and incubated at 23±1°C with a 12-h photoperiod for 7-10 days. Single spore isolates were stored on PDA slant tubes at 4°C.

Figure 1. Survey area for Alternaria diseases of carrot in Turkey

Identification of fungus

For identification, culture morphology, growth rate and conidial morphology were observed from 12-15 day-old cultures grown on PDA and PCA (Ellis 1970, 1971; Rotem 1994; Simmons 1995). The shape, length and width of 50 conidia for each isolate were determined and mean length and width were calculated. In addition, the number of transepta per conidium and the production of conidia in catenate arrangement was determined.

Pathogenicity tests

The pathogenicity of isolated fungi from diseased plants was assessed. Carrot disc pathogenicity test (modified from Pryor et al., 1994), the 6-8 week old seedling test (Coles and Wicks 2003) and plant test (Pryor and Gilbertson 2002) were used.

Carrot disc pathogenicity tests

Mature "Maestro" carrots were assessed for pathogenicity of *Alternaria* spp. Mature carrot roots were washed in tap water and sliced into disks approximately 5 mm thick. The disks were surface-disinfested by soaking in 0,1% sodium hypochlorite for 5 min. then triple rinsed with water and placed on a paper towel for 1hr to dry. The four carrot discs were then placed in each petri dishes (20 x 100 mm) containing two Whatman No. 1 filter papers moistened with 2 ml of streptomycin sulphate solution (100mg/l) Twenty discs were used for each isolate. Carrot discs were inoculated with mycelial plugs (4 mm diameter) cut from the margins of actively growing culture (Figure 2). Controls were treated similarly using similar sized pieces of water agar. The dishes containing inoculated disks were incubated on wire racks in clear plastic trays for 10 days at 24 ± 2 ° C, 12 h light with 12-hour dark cycle. After 10 days, pathogenicity was evaluated on a scale of 0 to 4 (Coles and Wicks, 2003). A total of 60 isolates of Alternaria. was tested, and each test was replicated four times.

Figure 2. Carrot disc pathogenicity tests

Six-eight week old seedling test

The second method used fresh 6 and 8-week old carrot seedlings of the commercial cultivar “Nantes”. Seedlings were placed on surface sterilised aluminium foil sheets in prewashed plastic trays with pre-moistened absorbent paper. Five seedlings per treatment were inoculated by taking 1.0 x 0.5 cm water agar pieces from mature colonies of *A. radicina* and placing the mycelial surface down on to the hypocotyl region near the crown of each seedling (Figure 3). Controls were treated similarly using similar sized pieces of water agar. The trays were enclosed in a clear plastic bag and incubated on the laboratory bench at room temperature for 10 days. The level of disease was assessed by measuring the extent of necrosis from the point of inoculum. Fungi causing blackening, or soft decomposition of the hypocotyl region, or death of the upper stem and petioles were classed as pathogenic. After 10 days, fungal growth and pathogenicity were evaluated on each plant based on 0-4 scale (Coles and Wicks 2003). Each treatment was replicated three times.

Figure 3. Six-eight week old seedling test

Plant test

Eight seeds from Nantes variety were sown in 10.5 cm diameter plastic pots containing a sterilized mixture of carrot field soil, peat and sand (1:1:1,v/v/v). Pots were maintained under optimum greenhouse conditions at temperatures ranging from 23–26 °C, and 35–40% humidity.

Conidial suspensions were prepared in sterile distilled water using 14-day-old cultures. Spore suspensions were adjusted to $2x10^3$ conidia/mL for *A. radicina* (Pryor and Gilbertson, 2002) and other *Alternaria* spp. $1x10^3$ (Pryor et al., 2002) and sprayed onto areial parts of each test plant, until run-off, with an pressure hand sprayer. Controls were sprayed with sterile distilled water. Four replicates were used for each isolates.

Two weeks after inoculation, pathogenicity were evaluated on 0 to 5 scale (Pryor and Gilbertson, 2002).

Disease assessment

Isolates of *Alternaria* spp. were assessed for their pathogenicity on carrot disc and 6-8 week old seedling test using 0 to 4 scale from Coles and Wicks (2003): 0= no discoloration, 1=slight discoloration, 2= slight discoloration with mycelial growth, 3= grey to black necrosis with the production of conidia, 4 = grey to black necrosis with abundant production of conidia.

Isolates of *A. radicina* and *A. dauci* were assessed for their pathogenicity on plant test using a 0 to 5 scale from Pryor and Gilbertson (2002):

0 = no disease, 1= 1% leaf necrosis, 2= 5% leaf necrosis, 3= 10% leaf necrosis, 4= 20% leaf necrosis, 5= more than 40% leaf necrosis

These scale values were converted to disease severity values (Xi et al., 1990) using the following formula:

$$\text{Disease sev.} = \frac{\Sigma(\text{no. of plant in category x category value})}{\text{max. category value x total no.of plants}} \text{x100}$$

The isolates were classified according to disease severity values such as highly virulent (75-100%), moderately virulent (50-74,9 %) and weakly virulent 0-49,9%).

The data were subjected to ANOVA, and the means were separated by the least significant difference (LSD) test.

Molecular analysis

Approximately, 300 mg mycelium were harvested and ground with liquid nitrogen in a sterile mortar for DNA extraction from culture medium. Genomic DNA was extracted using a Qiagen DNeasy ®Plant Mini Kit, as specified by the manufacturer, and stored at 20 °C prior to use. PCR reaction mixtures and condition were modified from previous studies (Aroca and Raposo 2007; Cobos and Martin, 2008). The reaction mixtures of PCR, a final volume of 50 µl, contained 5µl of 10X buffer [75 mM Tris HCl, pH 9.0, 50 mM KCl, 20 mM (NH4)2SO4], 2 µl of 5 µM each primers, 5 µl of 1.5mM MgCl2, 2 µl of 10 mM deoxynucleoside triphosphates (dNTPs), 1 U Taq polymerase (Fermatas), 5 µl of DNA template for each reaction and 5 µl of bovine serum albumin (BSA: 10 mg/ml).

DNA amplifications were carried out in a Techne TC-5000 thermal cycler by the following program: 94 C for 2 min, followed by 34 cycles of (1) denaturation (94°C for 30 s), (2) annealing (60 °C for 30 s) and (3) extention (72 °C for 30 s), and a final extension step 10 min at 72 °C. The ITS region of the isolates was amplified using the universal primers ITS-1 (5' TCC GTA GGTGAA CCT GCGG 3') and ITS -4 (5'TCC TCC GCT TAT TGA TATGC3'). The PCR products were separated in 1.5 % agarose gels stained with ethidium bromide, and visualized under UV light. They were sequenced by REFGEN (Gene Research and Biotechnology Company, Ankara, Turkey).

RESULTS AND DISCUSSIONS

Identification of Alternaria isolates and their pathogenicity

A total of 2,297 da carrot growing areas were surveyed in Ayaş and Beypazarı districts of Ankara province in 2008–2009. Sixty isolates of *Alternaria* were obtained from infected carrot root and foliage. *Alternaria radicina, A. alternata A. tenuissima, A. dauci,* were isolated from diseased plants collected in the survey. Of the identified isolates, 22,42% were *A. radicina*, 56,14% were *A. alternata*, 7,14 % were *A. tenuissima* and 14,28 % were *A. dauci*.
Our survey showed that *A. radicina* was associated with root and leaf of carrot and was widespread in carrot plantings in Ankara. The fungus was encountered most frequent from carrot rot and crown in summer and autumn. In our study *A. alternata* was obtained from dissected diseased tissue. *A. alternata* is one of the most common saprotrophs or facultative parasites associated with various parts of plants (Scheffer, 1992). Up to 68% of carrot root samples collected in several European countries were found to be contaminated with the fungus (Solfrizzo et al., 2005). As much as 70% of mature carrots can be rendered unmarketable if heavily infested or infected by *A. radicina* and *A. alternata* (Solfrizzo et al., 2005).
Fungal identification was confirmed by DNA sequencing.

Alternaria radicina

Alternaria radicina was isolated from roots and crown of young and mature carrots. Symptoms of the disease as the black rot was observed by dry, black, decay, sunken lesions on carrot roots. Lesions were quickly expand, and decay the entire root (Figure 4). Symptoms seen on the roots and crown of carrot seedlings were observed initially as small chlorotic spots and these spots were joined together by expanding. Lesioned tissues were significantly separated from the healthy tissue.

Figure 4. Black rot symptoms on the root and crown of carrot

During the survey it was observed that maturing carrots were often damaged around root regions. Our results showed that this was the effect of *Alternaria radicina* infection.
The colony color was dark green–blackish on PDA in 10-14 days. We shown that conidia were borne singly, or occasionally in chains of two, and were typically dark olive-brown to natal brown, broadly ellipsoid to ovoid, 12–17x19–37 µm, with one to four transepta and one to two longisepta in any or all segments, except basal and apical segments, which usually are free of septa (Figure 5).
Morphological features of our tested isolates on PDA were similar with descriptions of Ellis (1970, 1971), Rotem (1994) and Simmons (1995).

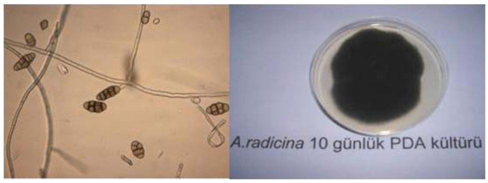

Figure 5. Morphology of conidia of *A. radicina* (x40): colony appearance of *A.radicina* on PDA

The resulting sequences were compared to other *A.radicina* sequences in the GenBank and were 99 and 100 % identical.
Isolates of *A.radicina* were tested using all three pathogenicity tests. All isolates showed a large variation in virulence. In the results of carrot disc pathogenicity tests, disease severity values of isolates were found between 52,1 to 75,0 %. Disease values were determined as 41,7-85,0% and 45,0-98,6% in seedling and plant tests, respectively. *A.radicina* caused the

high and moderate disease ratio on carrot disc, seedling and plant in pathogenicity tests.

Alternaria alternata

Alternaria alternata was usually the fungus most frequently isolated from symptomatic root rot.
Colonies were usually black or olivaceous black on PDA. Conidiophores arising singly or in small groups, simple or branched, straight or flexuous, pale to mid olvaceous or brown, one or several conidial scars. Conidia were formed in long chains, obclavate, obpyriform, ovoid or elipsoidal, with up to 3-5 transverse and several longitudinal septa, overall length 9-11x20-32 µm and 5-16 chains (Figure 6).

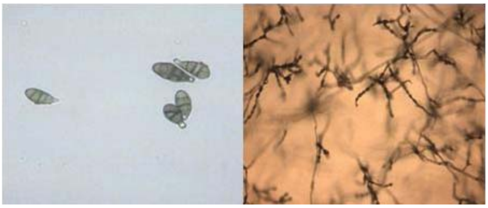

Figure 6. Morphology of conidia of *A.alternata* (x40) and chain structure (x20)

The resulting sequences were compared to other *A.alternaria* sequences and were 98-99% identical to other *A.alternata* sequences in the GenBank.
As a result of the pathogenicity test, we have found differences in virulence of tested isolates of *A. alternata.* Disease severity values of *A. alternata* were between 32,6 to 81,25% in carrot disc pathogenicity method.

Alternaria tenuissima

The fungus was isolated from symptomatic chlorotic leaf spot, discoloration and crown rot.
Colonies usually were pale black or olivaceous black on PDA. Conidiophores solitary or in groups, simple or branched, straight or flexuous, septate, pale brown, with one or several conidial scars.
Conidia formed 3-5 chains, obclavate, obpyriform or elipsoidal, generally with 3–5 transverse and several longitudinal, overall length 8–10x18–20 µm, beak measurment 5–9 µm (Figure 7).

Figure 7. Morphology of conidia (x40) and chain structure of *A. tenuissima* (x 20)

The resulting sequences were compared to other *A. tenuissima* sequences in the GenBank and were 97 and 99% identical.
As a result of the carrot disc pathogenicity test, *A. tenuissima* isolates were found to be weakly pathogenic (31,3-35,4% disease severity) on carrot plants.

Alternaria dauci

During survey, foliage infection by *Alternaria dauci* was observed on carrot plants growing in Ankara. Initial symptoms first appeared on older leaves as irregularly-shaped, minute, dark brown-to-black spots, with yellow borders on the edge of the leaflet blade. As the disease progressed the lesions expanded, causing the leaflets to turn brown and die (Figure 8).
The fungus was consistently isolated from the margins of these lesions.

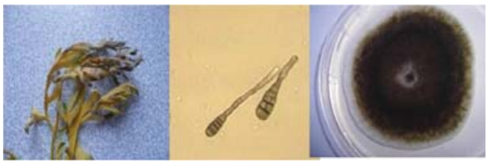

Figure 8. Alternaria leaf blight symptoms, morphology of conidia (x40) and colony appearance of *A.dauci* on PDA

The colony color was pale or dark gren-blackish on PDA in 10-14 days (Figure 8). Conidiophores were medium olivaceous brown, and either simple, with a single terminal conidiogenous site, or 1-2 geniculate and conidiogenous. Conidia were typically borne singly, but occasionall a sturdy terminal secondary conidiophore bearing a secondary spore is produced. Conidia were medium to dark olive-brown, long ellipsoid to obclavate, 10-22x45–70 µm (spore body), with 3 to 7 transepta and 1 to 2 longisepta in fewer than half of the transverse segments (Figure, 8). Mature conidia are rostrate with a terminal filamentous beak 30–120 µm, conidia occasionally in chains of single or two.

Morphological features of isolates on PDA were similar with descriptions of Ellis (1970, 1971), Rotem (1994) and Simmons (1995).

As a result of the plant pathogenicity test, we have found that *A.dauci* isolates were highly virulent with 89,25 to 92,75 % disease severity values.

CONCLUSIONS

Detection and identification of *Alternaria* species pathogenic in carrot growing areas in Ankara is fundamental to guide the development of appropriate strategies for disease management. *Alternaria radicina, A. alternata A. tenuissima, A. dauci* were identified through classical and molecular methods among the 60 isolates obtained from carrot growing areas in Ankara province.

Isolates of *A. radicina* and *A. dauci* showed high virulence although *A. tenuissima* were found as low virulent. *A. alternata* isolates were determined as moderately virulent. It was found differences among the virulence of isolates of *A. alternata*.

These results will be useful in developing of integrated strategies for disease management and breeding programs to Alternaria leaf blight and black rot disease on carrot.

ACKNOWLEDGEMENTS

We are grateful to Filiz ÜNAL because of molecular analysis of Alternaria isolates. This research was carried out with the support of Republic of Turkey Ministry of Food, Agriculture and Livestoc (TAGEM-BS-/08/10-09/02-07).

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

NEW TOMATO HYBRIDS OBTAINED AT VRDS BUZAU

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Abstract

The goal of Romanian tomato hybrid favored the introduction of foreign cultivars usually inadequate for our climatic conditions. VRDS (Vegetable Research and Development Station) Buzau has tradition for tomato breeding, were achieved many cultivars that have demonstrated their genetic stability, durability and performance in crop production. Special attention was to establishment the germplasm resource; the collection presently holds a total of more than 800 genotypes in various breeding stages. After evaluating the germplasm collection, valuable genotypes have demonstrated genetic stability and useful features for the breeding process and were promoted from field collection in field work. Selected genotypes were subjected to intensive breeding work, the general and specific combinative capacity was tested, thus achieving a large number of hybrid combinations. To obtain new hybrid creations were detained genitors and hybrid combinations that showed the heterosis phenomenon in F1. Nineteen hybrid combinations manifested heterosis phenomenon clearly and was used as reference 'Siriana F1' hybrid. Hybrid combinations that exceeded significantly 'Siriana F1' regarding the quality and yield, will be proposed for approval at ISTIS.

Key words: *fenotype, genitors, genotype, heterosis.*

INTRODUCTION

Tomato breeding is a continuous process in which the researcher explores the genetic variability and selects genotypes possessing character or combination of characters and attributes corresponding to current and future needs of growers and consumers.

The number and value of these new combinations of genes that can be achieved by improvement depends on the diversity and value of the available genes from the germplasm collection available to the breeder.

It should be noted however that the breeder is working with hereditary potential whose expression may be enhanced or hindered by environmental conditions that are grown new creations.

The aims of tomato breeding for fresh consumption foresee getting new varieties and hybrids with high yield potential, earliness, high quality value and corresponding physiological traits. "Increased availability and adoption of improved varieties or hybrids have been recognized as a plausible solution for enhancing the productivity levels of vegetables."(Sudha et al., 2006)

"The trend of F1 hybrid seed usage in vegetable is increasing globally in term of species, cultivars and volume of seed used." (Tay, 2002)

Study and use of heterosis phenomenon lately is a primary goal of research, opening promising quantitative and qualitative increase of tomato yield.

Concerning tomato breeding at VRDS Buzau existed since the beginning. Over time were obtained valuable biological creations, durable, very much appreciated by growers. Although valuable varieties were obtained shortly after

its establishment, the hybrids were obtained quite late. The first hybrid was obtained and approved in 2006, as the 'Siriana'.
In the breeding works, emphasis was placed on the use of local populations.
"Less than 5% of the available genetic variation exists in tomato cultivars and the remainder is found in wild species of the genus" (Hu et al., 2012)
This paper aims to present some of the results of the tomato breeding at Buzau presently completed 20 hybrid valuable combinations.

MATERIALS AND METHODS

The unit has a valuable germplasm base in this species consists of over 965 lines in various stages of improvement. This germplasm base has been established over time and is enriched with new genotypes annually.
Germplasm base consists of a wide range of varieties of the *Lycopersicum* genus .
Germplasm base was divided into three groups according to the type of growth: indeterminate growth lines (SP +) semideterminate lines (SP) and determined growth lines. Their dispersion and genetic stability is shown in figure 1.

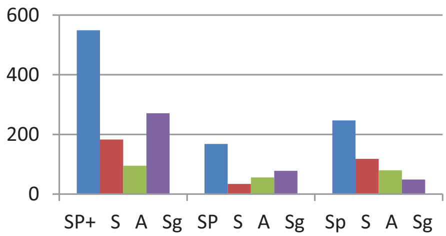

Figure 1. Germplasm base content and breeding phase. SP+(indeterminate growth lines)- 549 lines of which S (genetical stable) 183, A (advanced)- 95 and Sg (segregant)-271 lines
SP (self pruning lines) - 168 lines of which S (Stable) 34, A (advanced)- 56 and Sg (segregant)-78Sp- (determinated)- 247 lines of which S (Stable) 118, A (advanced)- 80 and Sg (segregant)-49

Sheets were prepared and each germplasm base genotype has undergone a thorough study.
The sorting of biological material and its use in the breeding work was done according to the scheme shown in Figure 2.

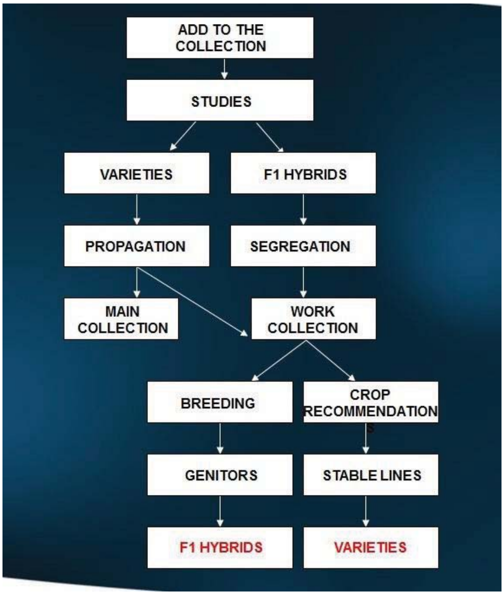

Figure 2. The use of germplasm base resource

Particular emphasis was placed on evaluating the two collector fields: general collection and collection work. Genotypes from the work collection have undergone extensive improvement works and were subject to general and specific combinative capacity test and 40 of these showed availability genetic hybridization process and showed visible phenomenon of heterosis.

RESULTS AND DISCUSSIONS

Breeding works have been completed to date with the establishment and evaluation of valuable germplasm base in this species. were obtained Stable lines that can be proposed for approval as varieties. It was obtained a large number of genetically distinct stabilized genitors that showed heterosis phenomenon in the process of hybridization.
Their relevant phenotypic expressivity is shown in Figure 3.

L 2 M
- 10 g fruits;
- High content of C vitamin;
- Yield/plant > 3 kg.

L 35
- High content of caroten;
- 10-15 g fruits;
- High yield potential.

L 532
- 120-140 g fruits
- yellow, banana type

L 519
- big fruits, of over 250 g
- heavely ribbed

L 204
- 180 g fruits;
- striped, average firmness, yellow pulp

L 305
- 180 g fruits, chocolate orange colour

L 203
- yellow fruits, average firmness, of 140 g
- High yield potential

L 310
- 10-20 g fruits, striped
- Special taste and flavour
- Dens purple brownish pulp

L 208
- 180-220 g fruits
- Reduced number of seeds, 40-60 seed/fruit
- Seminal lodges with holes.

L 2000 C
240 g fruits, pink colour
- SP+, for open field

L 524
- Big fruits, 265 g
- Bell pepper type

L 529
- Big fruits, of over 500 g
- Pineapple type

L 311
- 120-140 g fruits
- striped, long pepper type

L 6 M
- 20 g fruit, orange yellowish, pink pulp, linear inflorescence.
- Yield/plant > 3,5 kg.

Figure 3. Distinct genitors obtained through breeding process

Following the large number of hybridization and their evaluation confirmed that 19 hybrid combinations showed heterosis in F1 visible phenomenon. Siriana hybrid was used as a control for assessing the qualitative and quantitative characteristics expressed by these hybrid combinations.

The main features of the new hybrids of plants obtained are presented in table 1.

Table 1. The main characteristics of tomato hybrids studied in the greenhouse

Studied features/hybrids	Growth type	Offspring no.	Leaves no./plant	Leaves no. Under the first inflorescence	Inflorescence no.	Inflorescence type	Flower no./inflorescence.	Idistance between inflorescences (cm)	The pedicle presence
SIRIANA(control)	SP^{+}	8	26	5	8	Composed	5	20	Present
H 1 S A	SP^{+}	17	20	4	4	Liniar	8	25	Present
H 1 S B	SP^{+}	20	20	5	5	Liniar	9	15	Present
H 2 S	SP^{+}	8	20	3	6	Liniar	11	20	Present
H 3 S	SP^{+}	11	15	5	8	Composed	7	20	Present
H 4 S	SP^{+}	8	17	4	8	Composed	4	15	Present
H 5 S	SP^{+}	9	21	3	5	Liniar	6	30	Present
H 6 S	SP^{+}	13	16	3	6	Liniar	4	30	Present
H 7 S	SP^{+}	15	17	4	6	Liniar	5	25	Present
H 8 S	SP^{+}	17	17	4	6	Bifurcated	6	20	Present
H 9 S	SP^{+}	8	18	5	7	Liniar	8	20	Present
H 10 S	SP^{+}	9	18	3	5	Bifurcated	6	20	Present
H 11 S	SP	4	11	3	4	Bifurcated	5	15	Present
H 12 S	SP	7	11	4	6	Liniar	8	20	Present
H 13 S A	SP	7	21	5	9	Liniar	6	15	Present
H 13 S B	SP^{+}	7	20	5	7	Liniar	5	15	Present
H 14 S A	SP	5	17	5	10	Liniar	8	20	Present
H 14 S B	SP^{+}	6	15	5	8	Liniar	4	20	Present
H 15 S A	SP	9	30	5	10	Liniar	5	20	Present
H 15 S B	SP^{+}	5	16	5	5	Bifurcated	5	20	Present

Phenotypical and biometrical observations were made throughout the vegetation. New hybrids obtained showed distinct characteristics in terms of the type of growth, so 'Siriana' and a total of 14 hybrids showed indeterminate growth while 5 of them showed up semideterminated.

In terms of offspring issuing plant hybrid H1 SB stands with a total of over 20 offsprings / plant and the opposite, with the lowest number of offsprings per plant is H11 S with a total of four offsprings. Regarding of the number of leaves per plant, hybrid H 15 SA ranks first with a total of 30 leaves and last stands hybrids H 12 and H 11 with a total of 11 leaves.

Special attention was paid to the number of leaves below the first inflorescence finding that there is a direct correlation between earliness and number of leaves below the first inflorescence.

Ten hybrids, including 'Siriana' (control) recorded a total of five leaves below the first inflorescence and five of them recorded minimum value of three leaves below the first inflorescence.

In terms of the number of inflorescences per plant was found that hybrids with indeterminate growth recorded a higher number of inflorescences, first hovering hybrids H 14 S and H 15 S with a total of 10 inflorescences and the lowest number inflorescence was recorded hybrid H 11 S , 4 inflorescences per plant.

Determinations on the type of inflorescence revealed three types of inflorescences: linear, bifurcated and composed. Number of flowers per inflorescence varied from H 11 S hybrid flowers up to 4 flowers per inflorescence recorded hybrids H 14 SB, H4 and H 6 S.

The distance between inflorescences varied from 30 cm at H6 and H5 S respectively to the minimum of 15 cm recorded by 5 hybrid combinations. All hybrid combinations showed absence of *Jointless* gene.

Regarding the fruit observations, (table 2 and 3) mainly focused on identifying genes U (immature fruit with green cap), u (whitish fruit without lid) and UG (uniform green fruit). Analyzing mature fruit color, most hybrids showed red H1 except SB which shows yellow fruit. Observations made on the pistilar point form demonstrated that it is a genetic characteristic is greatly influenced by the type of flower, fruit quality and size fertilization. Hybrids obtained showed several pistilar point: star, irregular point. Regarding the weight of the fruit, hybrid H 14 SA ranked first at 234 g and ranked last H1 hybrid SB with 110 g. The number of fruits per plant varies from 45 fruits made of hybrid H 13 SA and 15 fruits at H 15 SB hybrid.

Table 2. The main fruit features of tomato hybrids

Features/hybrids	Immature fruit colour	Riped fruit colour	Pistilar form	Fruit shape	Fruit weight (g)	Absicion diameter (cm)	Fruit no./plant	Total fruit weight /plant (Kg)
SIRIANA(control variant)	Light green with lid	Red	Star	Round	180	0,6	40	4,200
H 1 S A	Whitish green	Red	irregular	Round	125	0,8	24	3,100
H 1 S B	Whitish green	yellow	Point	Round	110	0,8	30	3,300
H 2 S	Green with light lid	Red	Star	Round	150	0,9	30	4,500
H 3 S	Green with light lid	Red	Star	High round	114	0,9	40	4,560
H 4 S	Whitish green	Red	Star	Roound	157	1	28	4,396
H 5 S	Whitish green	Red	irregular	Lightly flattened	232	1,1	25	5,800
H 6 S	Green with light lid	Red	Star	High round	125	0,7	24	3,000
H 7 S	Green with light lid	Red	Star	flattened	198	0,8	24	4,752
H 8 S	Green with light lid	Red	Star	Round	203	1	18	3,654
H 9 S	Whitish green	Red	Point	Lightly flattened	120	1	35	4,200
H 10 S	Whitish green	Red	Star	Round	165	0,6	23	3,795
H 11 S	Whitish green	Red	Star	Heart shaped	155	0,8	34	5,270
H 12 S	Green with light lid	Red	Star	High round	178	0,8	30	5,340
H 13 S A	Green with light lid	Red	Point	High round	120	1	45	6,150
H 13 S B	Green with light lid	Red	Star	High round	170	0,9	35	6,100
H 14 S A	Green with light lid	Red	Star	High round	234	0,7	40	6,100
H 14 S B	Green with light lid	Red	irregular	Round	218	0,8	40	6,200
H 15 S A	Whitish green	Red	Star	High round	212	0,9	40	6,600
H 15 S B	Whitish green	Red	Star	High round	208	0,7	15	6,500

Table 3. The main features of tomato hybrids

Features/Hibrids	Fruit firmness	Seminal lodges no.	Pulp thickness (cm)	Shelf life (days)	Pathogens attack genetical resistance	Genetical stability
SIRIANA(control variant)	good	5	0,7	30	good	Stable
H 1 S A	good	3	0,7	32	average	Segregant
H 1 S B	good	2	1	50	average	Stable
H 2 S	good	4	0,8	26	good	Stable
H 3 S	good	5	0,7	39	good	Stable
H 4 S	average	5	0,8	28	average	Stable
H 5 S	good	5	0,8	39	slabă	Stable
H 6 S	good	4	0,9	28	average	Segregant
H 7 S	good	5	1	38	good	Segregant
H 8 S	good	6	0,7	28	good	Segregant
H 9 S	good	5	0,6	39	good	Stable
H 10 S	good	4	1	63	good	Stable
H 11 S	good	2	0,9	84	average	Stable
H 12 S	good	6	0,7	34	average	Stable
H 13 S A	average	4	0,7	108	average	Stable
H 13 S B	good	6	0,8	63	average	Stable
H 14 S A	good	6	0,8	77	average	Stable
H 14 S B	good	5	0,8	42	average	Stable
H 15 S A	good	4	0,8	42	average	Stable
H 15 S B	good	4	0,9	42	average	Stable

The shape and appearance of the fruit in cross section and longitudinal top hybrids obtained. (fig. 4)

Figure 4. Fruit details of H 13 (left) and H 15 (right) hybrids

In terms of fruit firmness was demonstrated that most hybrids have firm fruit, widely requested feature cultivator. Assessing the number of seminal lodges, lodges lowest number was recorded seminal hybrids H1 and H11 SB S 2 and 4 hybrids seminal lodges recorded a maximum of six seminal lodges. The smallest thickness of the cap was recorded in the hybrid H 9 and 6 mm and hybrids H1 SB, H 7, H 10, S respectively recorded 10 mm.
Special attention was given to the duration of storage after harvesting the fruits are kept in laboratory conditions, in normal room climate without controlled atmosphere. The smallest shelf life was recorded by hybrid H2 S with 26 days and the record was recorded by hybrid H 13 SA in 108 days.
In terms of genetic resistance, most hybrids have resistance recorded and sensitivity to specific diseases recorded species hybrid H 5 S. Regarding genetic stability, although all hybrid combinations showed heterosis phenomenon, in terms of expressiveness uniformity characters behaved differently and H 1 SB, S H6, H7 and H8 S hybrids were uneven (segregant). A total

of five hybrids showed heterosis phenomenon, productions being higher than the parents of maternal and paternal, but to 'Siriana' recorded lower production (Figure 5.) The lowest production was recorded by hybrid H 6 S with 3 kg / plant.

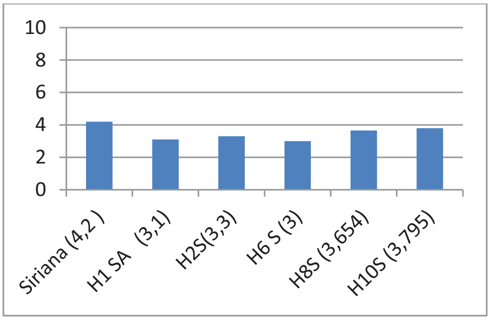

Figure 5. hybrids yield lower than 'Siriana' (kg/plant)

A total of five hybrids recorded a production close to the value obtained by control, showed visible phenomenon of heterosis values oscillating between 4.2 kg recorded by the hybrid H 9 S and 4.752 kg / plant hybrid H 7 S. (figure 6)

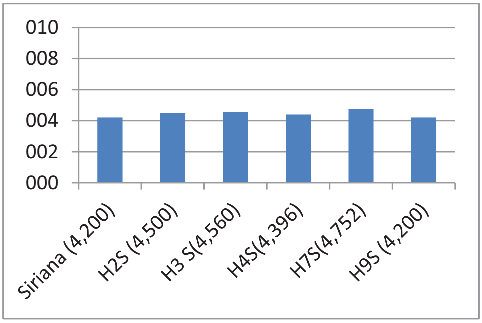

Figure 6. Hybrids yield resembling with 'Siriana' (kg/plant)

Three hybrids obtained higher yield than 'Siriana', with yields of more than 5 kg / plant. Research for these hybrids will continue both in terms of hybridization partners and their cultivation in various technological methods.
Of this group of hybrids, the highest production was recorded by H5 S Hybrid which achieved 5.8 kg yield / plant (figure 7).

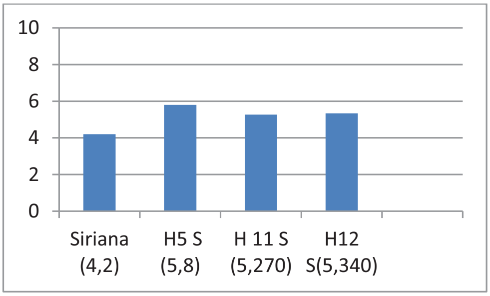

Figure 7. Hybrids with higher yields than 'Siriana' (kg/plant)

Six hybrid combinations productions recorded significantly higher than 'Siriana' (figure 8).

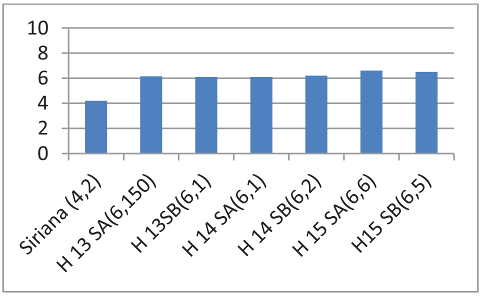

Figure 8. Hybrids with significantly higher yields than 'Siriana' (kg/plant)

They recorded higher output than 6 kg / plant, the record was obtained by hybrid H15 SA 6.6 yield kg / plant.
It should be noted that the hybrid H15 SA is the result 24 x 13 hybridization, which was a consecrated genitor used to obtain the most efficient Romanian hybrid, Export II and also in our research was used as genitor capacity tester for testing combination.
Since 2015, this group of hybrids was introduced in crops on large areas and those that will further demonstrate the performance will be proposed for approval. (figure 9)

H 15 SA H 15 SB

H 14 SB H 13 SA

Figure 9. Crop detail of new obtained hybrids

CONCLUSIONS

The breeding program of tomatoes from VRDS Buzau to date has achieved its objectives: to obtain a solid germplasm collection at this species embodied in genotypes with distinct phenotypical expression.
This evaluation was performed by testing germplasm general collection and specific combinative capacity; they obtained a large number of lines that can be approved as varieties and also a large number of available genitors to obtain new hybrid combinations.
The large number of hybrid combinations made between genitors selected from field work was completed with 19 hybrid combinations showed heterosis phenomenon and 6 hybrids significantly exceeded the control, obtaining 6 kg yield/ plant.
Record yields were obtained using classical crop technology of tomatoes, however by implementing new technologies or technological links (eg - nutrition) yields obtained by these hybrids can increase significantly.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

LOPHANTHUS ANISATUS, A MULTI – PURPOSE PLANT, ACCLIMATIZED AND IMPROVED AT VRDS BUZAU

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Abstract

VRDS (Vegetable Research and Development Station) Buzau has tradition for acclimatization of new vegetable species, there being obtained new varieties of Momordica charantia, Cucumis metuliferus, Cichorium crispum, Cichorium latifolium, Momordica conchinchinensis, etc. Biodiversity conservation and crop extention for the new species through acclimatization and breeding have become a major necessity nowadays. The aim of this study was to give special attention to the acclimatization of a new species, e.g. Lophanthus anisatus. It is a native to Asia, is spread in almost all world crops, known by other names (Agastache foeniculum, Lophantus agastache) and its food, medicinal and melliferous properties are widely recognized by scientists but, however, until now there has not been cultivated in Romania. The research started in 2010 with the documentation and purchase of the basic genetic material (seeds, seedlings). After completing these steps, in 2012 were cultivated the first purchased genotypes. After the first year of study in the crop was observed that there were no major phenotypic differences between cultivars. Genotype L3, from Bulgaria, demonstrated higher uniformity in terms of the main characters expressiveness and high adaptability to environmental conditions. In descending, 2013-2014 was cultivated and studied only this genotype, to avoid contamination by pollination with other cultivars. The results are positive, the species has adapted very well, can be grown successfully in Romania. Research will continue for genetic stabilization and marked characteristics for distinctibility in order to approval and registration at SIVTR (State Institute for Variety Testing and Registration).

Key words: *adaptability, biodiversity, genotype, melliferous, medicinal.*

INTRODUCTION

Lophanthus anisatus study was taken from VRDS Buzau in 2010. In the world is known under several names (*Agastache Foeniculum*, *Lophantus Agastache*) or lofant popular.
"*Agastache* is a small genus of *Lamiaceae*, comprising 22 species of perennial aromatic medicinal herbs. In this article, we review recent advances in phytochemical, pharmacological, biotechnological and molecular research on *Agastache*." (Zielinska, 2014) This is a multi-purpose plant, in the world it is known as a medicinal plant, aromatic, spicy, and even ornamental and melliferous.
"This species is a candidate for large scale, domestic cultivation as a source of nectar for honey bees and as aromatic plant with wide variation in the composition and content of its essential oils." (Fuentes Granados, 1995)
Because of its genetic capacity to adapt to environmental conditions, is cultivated and known worldwide.
"The genus has gained importance in America, Asia, and Europe as a component of tea mixtures and as a flavouring in confections." (Fuentes Granados,1997)
The main objectives of the Laboratory of Genetics Breeding and Biodiversity Conservation from VRDS Buzau are getting new biological creations, competitive, as required by growers and consumers; rehabilitation of neglected plants in culture; acclimatization of new species and promote their culture.
The research undertaken in this species is within the target three priority of the research laboratory.

MATERIALS AND METHODS

The research for this species has been carried out according to an established plan, covering four main stages. The first phase focused on documentation and studies and to obtain basic biological material or seeds from reliable sources and distant geographical areas. The seeds used were from America, Asia and Europe.

In the second stage we worked to acclimate the species in the climatic conditions of our country. In this stage were detained genotypes that have shown adaptability and genetic uniformity descent and those who have demonstrated higher sensitivity and variability of the characters have been removed from the breeding program. Genotypes have passed acclimatization entered the third stage of work aimed at improving the species in order to obtain varieties of genetically stabilized according to international norms.

In the fourth stage has developed specific technology for acclimatization and improved genotypes.

RESULTS AND DISCUSSIONS

Following evaluation, the process of acclimatization acquired genetic material found to L3 coming from Bulgaria best adapted to the climatic conditions of our country and also showed uniformity and genetics. The other origins were removed from the acclimatization process, because this species is entomofila very much preferred by insects, especially bees, contamination risk and prolongation of acclimatization and improvement.

After this genotype has successfully passed acclimatization phase, has undergone extensive improvement works in order to obtain a new variety.

In the process of improvement to follow the main character restriction variability and meeting international standards distinctibility, uniformity and stability (DUS).

Genotype L3 obtained the best results and improvement works ended with getting a new variety and the main features of genotype L3 (table1)

Table 1. The main features of L3 genotype

Studied feature		Variability limit	Average value
Plant height		87-105	90 cm
Shrub diameter		47-55	51 cm
Main shoot no.		10-16	13 buc
Secondary shoot no.		29-38	34 buc
large inflorescences no.		17-24	22 buc
Small inflorescence no.		22-30	26 buc
Inflorescence lenght	large	15-21	18 cm
	medium	9-15	12 cm
	small	4-6	5 cm
Leaf stalk lenght		1.5-2.5	2 cm
Sesil leaf lenght		5-7	6 cm
Leaf diameter		3-4	3.5 cm
Large leaves no/main shoot		11-17	14 buc
Small leaves no./main shoot		35-41	38 buc
Stem lenght		3-5	4 cm
Stem diameter at the basis		13-17	15 mm
Shoots diameter		2.5-3	2.8 mm
Inflorescence diameter		2-2.4	2.2 cm
Floral floors no.	large	14-18	16 buc
	Medium	10-14	12 buc
	small	5-7	6 buc
Flower diameter		1.8-2.2	2 mm
Seed diameter		0.8-1	0.9 mm
Seed lenght		1.4-1.6	1.5 mm
Total weight of the green inflorescence		3.7-4.1	3.9 g
Total weight of dry inflorescence		0.9-1.2	1.1 g

Figure. 1. Crop detail

Leaf sections have edges, sharp tip, slightly porous surface, similar to the *Urtica dioica*. (figure 1 and 2)

Figure 2. Leaves detail

Stems and shoots are grooved with square cross-section (figure 3)

Figure 3. Shoots detail

Nr. stamens in flower- 4 including two long and two short.

The blooming period is very long and is made in instalments from June until the coming of frost and plant specialists is ranked among the top bee plants in the world. Potential production per unit area is very high, of over 600 kg/honey per hectare. (figure 4).

Figure 4. Flower details

After completing the program of improvement, research has been channelled to developing specific technology culture. After research it was found that the species shows great flexibility in terms of culture technology but the best results were obtained from the culture seedling establishment.

It was found that a plant that is highly resistant to cold, frost resistant up to its limits and during periods of heat stress (cold) leaves change colour in green-purple due to anthocyanin pigments accumulation. (figure 5).

The best time for sowing seedlings is after February 20, it is recommended furrow sowing in hard or peat pots or directly in alveolar blades. If the bed is sown, it should work in palaces alveolar subculturing or pots and if is sown directly in pots palaces is recommended to rare the seedlings, leaving one plant in the alveola. Sowing is recommended close to the surface very carefully because the seeds are very small, less than 0.5 mm deep. Sunrise is done in 10-15 days, if factors are insured optimum vegetation.

Planting seedling stage reached after 60 days of emergence (figure 6).

Figure 5. Termic stress, low temperatures

Figure 6. Seedlings details

The establishment of culture are taken into account several factors: the irrigation system used system used for maintenance vehicles that culture and space needed nutrition and development. It was found that the species supports several options for setting up culture technology but the best option checked in the research undertaken (figure 7 and 8) with 70 cm between rows and 30-35 cm between plants / row.

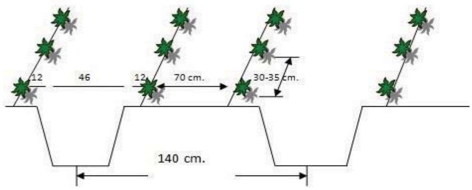

Figure. 7. Open field planting method-shaped soil

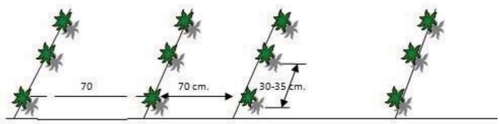

Figure 8. Open field planting method on plan soil

Establishment of culture can be done in a long time, depending on climatic conditions, starting April 15 and ending in late May.

It was found that culture are growing very well in the second and even third year. It can be said that it behaves as a perennial in our country conditions (figure 9).

Figure 9. Crop in the second year

Care works are common to all specific vegetable plant has outstanding technological requirements, no high demands from the ground, can be cultivated throughout the country, it is recommended to perform one or two mechanical hoeing and hand hoeing one or two depending on the physical condition of the land and its degree of weed.

Regarding water supply plant species fall into the group claims to moderate water. In the absence of rainfall is recommended to apply watering rules between 250-350 m3 of water / ha. The absence of water leads to the maturation of the plant and forced induction phenomenon dwarfs.

Research undertaken so far have shown that diseases and pests do not cause significant damage this species was reported only damaging nematode but found that even in areas heavily infested with nematodes, plants have survived, not significantly diminished production (figure 10).

Figure 10. Nematodes attack

Seed maturation is made in stages, starting from the base to the summit blossom. A 2520 gram seed = seed. A 17.5 g plant seeds with a total of over 44 100 units. A well developed and carefully harvested plant can produce one hectare of crop seed required.

Figure 11. Dry inflorescences

Harvesting can be done only once or in stages. If the plants are harvested once mature, production per hectare is 18-22 t vegetative mass but if harvesting is done in stages, by cutting the shoots and regenerating bush, production can increase significantly.

The variety can be grown successfully in the ecological system or to protect other crops that are exposed to rodents (mice, rabbits, deer, etc.) strong flavor nook at the touch of all vegetative parts of the plant creates rodent repellent, protecting crops successfully .

CONCLUSIONS

The research was completed with success. The species can be grown successfully throughout Romania. In the process of breeding a new variety was obtained, which was signed at L3 SIVTR for approval, since 2015, as Aromat de Buzau. To develop specific culture technology has been a significant amount of seeds produced and performed by diffusion and culture.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

TECHNICAL ASPECTS CONCERNING THE PRESERVATION OF PEPPERS IN DIFFERENT STORAGE CONDITIONS

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Abstract

The research concerns the study of the ability to maintain nutritional and commercial quality to peppers in different temperature storage conditions. During the three years of experimentation were used varieties: 'Buzau 10', 'Galben superior' and 'Bianca'. These were stored after proper preparation, at ambient temperature (+20 ... +22°C), refrigerated (+10 ... +12°C) and cold (+3 ... +5°C). The duration of storage, the weight (mass) and losses degradation and evolution of chemical components caused by the 9 variants yielded conclusive conclusions to 'Galben superior' and 'Bianca' cultivars for which experimental three-year cycle. It was found that the losses observed during storage are influenced by storage temperature and climatic conditions for the development of cultivars that have varied significantly in the three years of experimentation. The experimental variants were considered existing conditions in the family farms

Key words: *peppers, quality preservation, storage, family farms.*

INTRODUCTION

Maintaining the quality of horticultural products after harvest, pick still many problems especially for family farms, where the technical knowledge and the material is poor. Research has allowed the determination of the technical aspects of storage cultivar pepper in different storage conditions may be applied in family farms.

Pepper is perishable product storage. Pepper cultivars are grown in almost all households and vegetable farms for their own consumption and / or for sale. The two main factors responsible for maintaining the quality of peppers are: varieties resistance to storage and thermal conditions in storage areas. A series of researchers (Linda J. Haris 1998; Cantwell, I. M. and R.F. Kasmire 2002; Jamba, A. and B. Carabulea 2004; Thompson, F. J. and Crisosto H. C.2002) have studied the behavior of pepper in different storage conditions

Recent research conducted by "Horting" institute has watched highlighting storage resistance of some varieties grown in our country and the influence of temperature on the quality and duration of maintaining quality of peppers. The results may be indicative benchmarks for family farms with peppers in vegetable assortment.

MATERIALS AND METHODS

The study was taken in four varieties of peppers ('Buzau 10', 'Galben superior' and 'Bianca') grown in the same farm and placed in storage. Storing was carried out in three different conditions: ambient temperature (+20…+22°C), refrigerated spaces (+10…+12°C) and cold conditions (+3...+5°C). It covers such major environmental conditions in which the products in question may be kept in the household. Temporary storage after harvesting in different areas is carried out at ambient temperature, keeping the average in refrigerators or refrigerated rooms and long-lasting in cold storage facilities. It were determined the duration of preservation and level of weight (mass) and decay losses and the evolution of some chemical components during storage. The scheme of research organization that included nine experimental variants based on onion varieties and storage conditions is presented in table 1.

Table 1. The organization scheme of research with peppers

Variant	Variety	Storage conditions
V1	Buzau 10	Ambient temp. (+20...+22°C)
V2	- idem -	Refrigeration (+10...+12°C)
V3	- idem -	Cold conditions (+3…+5°C)
V4	Galben superior	Ambient temp. (+20…+22°C)
V5	- idem -	Refrigeration (+10…+12°C)
V6	- idem -	Cold conditions (+3…+5°C)
V7	Bianca	Ambient temp. (+20…+22°C)
V8	- idem -	Refrigeration (+10…+12°C)
V9	- idem -	Cold conditions (+3…+5°C)

The main biometric data of peppers are presented in Table 2 and the appearance of chosen varieties in Figure 1.

Table 2. Biometric data

Variety	Length (height) (mm.)	Width (diameter) (mm.)	Shape index	Average mass (g/pcs)
Galben superior	83,8	64.6	1,30	90,99
Buzau 10	69,10	62,9	1,10	74,66
Bianca	77,3	58,8	1,31	89,16

Figure 1. Peppers appearance at the starting of experiments

The preparing stage of peppers for research purpose is illustrated in Figure 2.

Figure 2. Experience with peppers under preparation

RESULTS AND DISCUSSIONS

The average weight of the fruit is a characteristic indicator for every variety. The level of weight and decay losses and sprouting during storage in different temperature conditions are presented in Table 3.

Table 3. Losses accumulated during storage period (%)

Variety and other	Ambient			Refrigeration			Cold conditions		
	Losses (%)			Losses (%)			Losses (%)		
	weight	decay	total	weight	decay	total	weight	decay	total
Galben superior	18,05	0	18,05	8,28	0	8,28	11,84	0	11,84
Buzau 10	8,91	0	8,91	6,26	0	6,26	6,69	0	6,69
Bianca	13,65	0	13,65	7,29	0	7,29	10,48	0	10,48
Mean	13,54	0	13,54	7,28	0	7,28	9,67	0	9,67
Storage time	5 days			10 days			20 days		

The data presented in Table 3 shows that in conditions of ambient temperatures, peppers can be kept up to 5 – 20 days (depending on variety), with average total losses of 13.60%. Buzau10 variety had the lowest total losses and 'Galben superior' variety showed the highest values of total losses. 'Buzau 10' variety proved to have better resistance to storage mainly because of reduced decay losses. Appearance of 'Buzau 10' variety of storage at ambient temperature is shown in Figure 3.

Figure 3. 'Buzau 10' variety after storage under ambient conditions

In refrigerated spaces peppers was stored for 10 days with 9.85% average total losses. In such conditions 'Buzau 10', was the most resistant cultivar with 8.28% total losses. On second place was situated 'Galben superior' variety, with total losses below the average of the three varieties studied. Last place was occupied by 'Bianca' variety, which cumulated the highest weight and decay losses. Appearance of peppers variety of storage at refrigerated temperature is shown in Figure 4.

Figure 4. Peppers variety after storage under refrigerated conditions

In cold conditions, the average total losses raised to 10.61% after 20 days of storage. Thus the variety ‘Buzau 10’ were recorded the lowest weight anddecay losses cumulating 6.69% total losses, the variety ‘Bianca’ had about 10.61% and the variety ‘Galben superior’ had about 11.84%. Appearance of peppers variety of storage at cold temperature is shown in Figure 5.

Figure 5. Peppers variety after storage under cold conditions

Content and evolution of some chemical components during storage are presented in Table 4. The data presented on Table 4 shows that initially the peppers had 6.5 to 8.0% soluble solids content, from 0.10 to 0.23% treatable acidity, from 1.72 to 3.18% total sugar and from 121.32 to 219.32 mg/100g vitamin C, depending on the variety. ‘Buzau 10’ variety had the highest content of soluble solids, treatable acidity, total sugar and vitamin C, while those of ‘Galben superior’ variety were recorded the lowest values of all components.

Table 4. Level and evolution of chemical components in peppers variety

Var.	Variety	Storage temp. (°C)	Soluble solids (%)	Acidity (%)	Total sugar (%)	Vitamin C (mg/100g)
	Galben superior	initially	6,5	0,15	2,22	121,32
V1		20-22°	6,1	0,14	2,18	36,70
V2		10-12°	5,1	0,13	1,89	19,57
V3		3-5°	4,5	0,10	1,72	16,22
	Buzau 10	initially	8,0	0,22	3,18	219,32
V4		20-22°	7,2	0,22	2,85	144,57
V5		10-12°	6,5	0,12	2,45	140,74
V6		3-5°	6,2	0,23	2,38	157,20
V7	Bianca	initially	6,5	0,19	2,79	168,36
		20-22°	6,0	0,14	2,40	65,20
V8		10-12°	5,5	0,18	2,44	104,32
V9		3-5°	4,7	0,12	2,09	122,97

Main chemical components evolution was different from an experimental variant to another. The content of soluble solids had a downward trend for all the varieties in particular to the peppers stored in cold conditions. Values lower than initial ones have been recorded also by ‘Buzau 10’ variety (V5) and ‘Bianca’ variety (V8) stored under refrigeration conditions. ‘Buzau 10’ variety, considered the healthiest (lowest decay losses) showed a decrease in soluble solids and total sugar content in refrigeration and cold storage conditions. For ‘Buzau 10’ variety the soluble solids content remained high in refrigerated and cold conditions (V5 and V6) and for ‘Bianca’ variety only in refrigerated conditions (V9).

Acidity of peppers presented both slight increases and decreases depending on the variety and on storage conditions. The peppers maintained in general the initial acidity content in ambient and cold conditions and presented mild reductions in refrigerated one, the lowest values being recorded by ‘Galben superior’ variety (V3) and ‘Bianca’ variety (V9).

On ambient conditions total sugar content was maintained at high values at ‘Galben superior’ variety (V1) and ‘Buzau 10’ (V4) and had a decreasing trend at ‘Bianca’ (V7). In refrigerated conditions all varieties of peppers were significant reductions of total sugar content. And in cold conditions peppers from ‘Buzau 10’ variety (V6) and ‘Bianca’ variety (V9) had a total sugar content lower than initially, while the ‘Galben superior’ variety (V3) maintained a high sugar content.

The amount of vitamin C in peppers strongly decreased during storage at all varieties, but bet on in different proportions depending on variety and storage conditions. The sharpest decrease occurred in the ‘Galben superior’ variety of the genus to which vitamin C content decreased by 62-90% depending on storage conditions. Lowest losses of vitamin C were found in peppers of the genus 'Buzau 10' they were 30-50%, depending on storage conditions. Variety 'Bianca' has dropped by 44-74% vitamin C content according to storage conditions. In ambient conditions 'Galben superior' variety had lowest losses of vitamin C, while refrigerated and cold varieties 'Buzau 10' and 'Bianca' showed the lowest losses of vitamin C.

CONCLUSIONS

Maximum storage life of onions was 5 days under ambient conditions (depending on variety), 10 days under refrigeration and 20 days in cold conditions, with average total losses of 13.54%, 7.28 % and 9.67% respectively.

The optimum time to maintain the quality of the sweet is 3 days in ambient conditions, 7 days in refrigerated spaces and 15 days in cold spaces.

Pepper varieties have different behavior in similar conditions of storage. While in variety 'Buzau 10' bet on all storage conditions obtained the best results with the lowest volume loss, 'Galben superior' variety showed great sensitivity higher, posting the biggest losses in both ambient conditions and in cold.

Evolution of the main chemical components (dry matter, acidity, total sugar and vitamin C) of peppers can be an important indicator of the ability to maintain quality of storing bet on different conditions.

The best results maintain the quality of the peppers variety were obtained 'Buzau 10', which proved the most resistant, the best storage conditions are ensured by freezing at 10-12 °C.

The peppers must be checked daily to notice in advance of any change in appearance or quality and to intervene immediately to remove the causes or effects already produced.

The results have confirmed that the cold storage conditions recommended given the lowest loss (mass and impaired), and that increases shelf life, even up to 20 days in the case of peppers have a perishable high.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INFLUENCE OF DIFFERENT ORGANIC MULCHES ON SOIL TEMPERATURE DURING PEPPER (*CAPSICUM ANNUUM* L.) CULTIVATION

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Abstract

The aim of the paper was to present the influence of different types of organic mulch on soil temperature during the cultivation of pepper. The experimental work was carried out in 2012-2013in the experimental field on University of Forestry – Sofia, with pepper cv. 'Sofiiskakapia'. For the purpose of the study were used different available materialsas organic mulches, which were waste products from organic agriculture:spent mushroom compost (SMC),barley straw (BS), grass windrow (GW), weeds. Mulched plots were compared with two control variants – hoed control plots, (HC) and non-hoed control plots (NHC).The mulching materials were spread manually in a 5-6 cm thick layer, after strengthen the seedlings of pepper. The soil temperature was recorded in 7 days, at a depth of 0, 5, 10 and 15 cm, by calculating the average daily temperature, from mulching to harvesting of production. Mulching materials affect soil temperature. Least variation in soil temperature was recorded at a mulch of straw with average temperature 19-22°C during the August, when the air temperature was highest. With the greatest variation in soil temperatures of mulching plots were two variants: with mulch of weeds and with mulch of grass windrow where the green waste materials, used for mulching, started to decompose slowly.

Key words: *soil temperature, barley straw mulch, spent mushroom compost, grass windrow mulch, pepper.*

INTRODUCTION

The optimum temperature for cultivation of bell pepper is between 18 and 25 °C. Extremely high temperatures above 32–35°C, in combination with a low air humidity, cause falling off of the flowers and fruit sets and increase the percentage of non-standard deformed fruits. Root system develops better when soil temperature is between 18–22°C (Panayotov et all. 2006).
In the hot summer days high soil temperatures affect evaporation and soil moisture, and hence the growth and development of pepper (Van Donk et al., 2011). Temperature stress, which is obtained at high soil temperatures at uncovered soil (32 – 34°C) may be minimized by the use of the mulch. (Godawatte et al., 2011; Yordanova and Gerasimova, 2012). Mulching improves plant growth, increased yields and quality (Sharma and Sharma, 2003; Singh et al., 2007). The organic mulches which are recycled into the soil can reduce the cost of production and are useful for the environment (Roe et al., 1992).
One of the best materials for mulching is compost, especially for growing of intensive crops (Vogtman, 1990; Yordanova, 2008). Mulching with grass also has a positive effect on the quality and quantity of the yields in a number of crops (Dvořák et al., 2009; Sinkevičienė, et al., 2009). It degrades faster than other mulch materials, with 10 cm layer of grass windrow is more effective than the 5 cm layer (Jodaugienė et al., 2012). Grass windrow positively affect the activity of soil enzymes and biomass in the soil (Jodaugienė et al., 2010).
It has been found that the mulching with straw has a favorable effect on the growth of pepper (Roberts and Anderson, 1994; Mochiah et al., 2012). This is explained by the preserving and maintenance of the soil moisture, the maintenance of a moderate soil temperature and suppressing the growth of weeds. Use of green stalks of weeds as mulch material only

ismentioned as a method applied in old gardening practices historically. This provoked the decision to explore the possibility of using green weed residues as mulch material and to determine the influence of different types of mulch on soil temperature and crop yields in the cultivation of pepper.

MATERIALS AND METHODS

The experiment was conducted in 2012-2013, in the experimental field of the University of Forestry – Sofia (42°7′ N, 23°43′E and 552 m altitude). The soil is fluvisol, slightly stony, slightly acidic. This area came under a continental climatic sub region, in a mountain climatic region.

The study was performed with bell pepper (*Capsicum annuum*), cv. ‘Sofiiskakapia’, with growing period lasted 116-120 days, with pre-produced seedlings. Planting in the open field wass made on 21-22 May in both experimental years. Each plot was of 1.20 m wide and 3 m long. It contained two parallel rows of plants at 60 cm distance between rows and plants within rows were separated by 20 cm.

The experiment was carried out by randomized complete block design with six treatments and three replications. The tested treatments were: bare soil, maintained weed-free by hoeing – control plot(BSCP); non-mulched and non-hoeing (weeded) control plot (NMCP); mulch from spent mushroom compost (SMCM); mulch from barley straw (BSM); mulch from grass windrow (GWM); mulch from green stalk residues from weeds (WRM).

As weed residues mulch we used widely distributed weeds: common amaranth (*Amaranthus retroflexus* L.), fat-hen (*Chenopodium album* L.), and cockspur *(Echinochloa crus-galli* L.). In 2012 we used them separately, to could check if they will take roots again. In 2013 we used them mixed together as they grew naturally.

The mulches were applied to the soil surface by hands at a thickness of 5-6 cm, after the seedlings of pepper were strengthen – on 11 – 12 of June in both experimental years.

All elements of agrotechnical activities (basic and pre-sowing cultivation, irrigation, etc.) were the same for all treatments. The plants were irrigated by sprinkler irrigation system.

The soil temperature was monitored at soil surface (0 cm depth) and at a depth of 5, 10 and 15 cm, once of week, three times a day, throughout the period from the beginning of July till the end of September. The soil temperature was measured with hand-held needle soil digital thermometer.

Means were separated by application of Duncan’s Multiple Range Test at $p \leq 0.05$.

RESULTS AND DISCUSSIONS

The average mean air temperature during the growing period (June – September) of both experimental years (2012-2013) was within the borders of optimum temperature of pepper cultivation, with one exception – on September, 2013, when the average mean temperature was 16.7 °C.

In spite of the optimum mean air temperature, the maximum air temperature, which was measured during the growing period, was higher than optimum for growing pepper (Table 1.).

Monitoring of soil temperature started in the beginning of July and continued until the end of September. This covered the hot summer period and lasted until the end of harvest. The maximum air temperature had an effect on bare soil temperature.

The average soil temperatures recorded in the middle of the August in all treatments and in four depths are presented in Figure 1. The soil temperature was measured at four depths (0, 5, 10 and 15 cm). We compared them with average daily air temperatures, to present the fluctuation in soil temperatures in different depths.

Table 1 Average air temperature (maximum, minimum, mean) and amount of precipitation during the growing period of the pepper for both years of the experiment.

	Average air temperature (°C)						Amount of precipitation (mm)	
	2012			2013			2012	2013
	max	min	mean	max	min	mean		
May	20.6	9.7	15.2	24.0	11.2	17.6	131.4	31.9
June	28.2	14.8	21.5	24.8	13.0	18.9	8.9	113.6
July	32.1	17.5	24.8	26.6	14.2	20.4	41.2	61.2
August	30.9	15.2	23.1	29.4	15.9	22.6	45.0	13.0
September	26.4	12.2	19.3	23.2	10.2	16.7	48.2	21.0

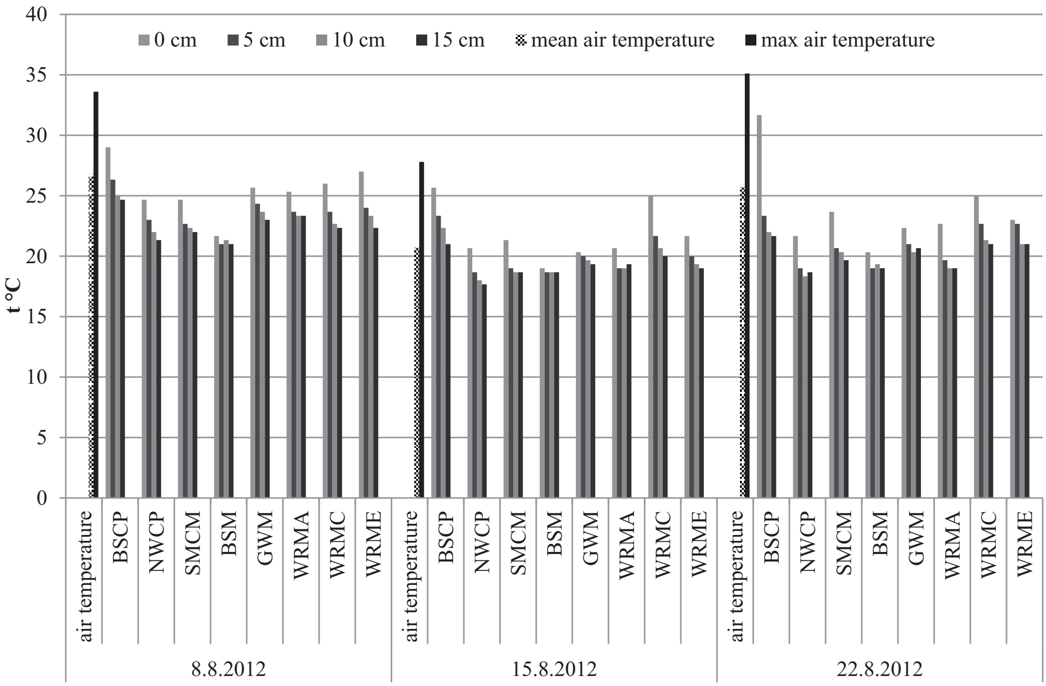

Figure 1 Average daily air temperatures, compared with average soil temperatures recorded in the middle of the August in all treatments and in four depths

The largest temperature differences are recorded at a depth of 0 and 15 cm. The temperature, recorded on the soil surface level of the bare soil control plot (BSCP) was always higher than temperature on the soil surface of the mulched plots (Table 2 and Table 3). However, temperatures of the soil surface of this option was not higher than the average air temperature, which is due to shading of the soil surface by the leaves of pepper.

In BSCP treatment were recorded and the highest temperature amplitudes between average daily soil temperatures on soil surface and at a 15 cm depth, which were significantly higher. The highest temperature amplitude (7.5°C) was recorded in July, 2012 (Table 2), which was the hottest month during the experimental period, the average soil temperature, was also higher (26.5°C) than optimum soil temperature for pepper roots (18-22°C).

The soil surface temperatures, measured at the mulched plots where always lower than the temperatures measured at the bare soil control plot. The soil temperature under different mulches was also affected by the type of used mulch materials.

Lowest soil temperature measured at the soil surface was recorded under barley straw mulch (BSM). This may be due to the fact that mulch of straw has a bright surface and reflects the sun's rays, preventing overheating of the soil surface. On the other hand keeps the temperature in the lower soil layers and was considered the smallest temperature range between 0 and 15 cm depth in the soil. The fluctuation in soil temperature at different levels is between 0.6 °C (in August, 2012) and 1.4 °C (in August and September 2013). Badaruddin et al., 1999, indicates that the use of straw mulch in areas with high temperatures maintaining the temperature in the soil below the day and higher during the night, and thus protects plants from heat stress. At this mulched treatment was recorded and lower average soil temperature (17.2 °C) than optimum soil temperature for pepper roots (18-22 °C).

In the treatment with weed residues mulch temperatures measured on the soil surface and a depth of 15 cm were higher in the first months, compared to other mulch options. This is due to the fact that under the influence of high air temperatures and moisture in the soil, fresh green plant matter begins to decompose, intensifying the microbiological activity of the soil surface. This leads to the maintenance of higher soil temperatures, as compared to other ground cover materials.

In 2012 we used green stalk weed residues (WRM) as mulch separately, to check if they will take roots again and to study them as a mulch material. The mulch from *Amaranthus retroflexus* L. (WRMA), the mulch from *Chenopodium album* L. (WRMC) and the mulch from *Echinochloa crus-galli* L. (WRME) were decomposed almost at the same time. They didn’t take roots again and covered soil surface good in the beginning. The differences in measured soil temperature among these treatments are not significant, with one exception – the temperature amplitude, recorded at WRMA (2.6 °C) in August, 2012 was smaller than at other two treatments. In 2013 we used them mixed together as they grew naturally (Table 2 and Table 3).

At the end of the vegetation of pepper in 2012,mulch from weed residues (WRM) was wilted, was thin and because we used the whole stems, they are no longer covered well the soil surface and because of this the temperature at a depth of 15 cm in September was low and almost close to temperature variations without mulch .

Grass windrow was applied as mulch (GWM) after one – two days, not as fresh as weed residue mulch. The averages mean soil temperatures, which were recorded during the experimental years, were close to the borders of optimum soil temperature levels (17.6-22.2 °C).

Mulch from spent mushroom compost (SMCM)also maintained a higher temperature than barley straw mulch (Table 2 and Table 3). The dark color of this mulch affected the soil temperature and in September the averages mean soil temperatures, for both experimental years, were in the borders of optimum soil temperature levels (18.1-18.2 °C).

Table 2 Average daily soil temperature (at 0 cm and at 15 cm depth), mean temperature and temperature amplitude between two levels ($T_{amp}=T_{0cm} - T_{15cm}$) during growing period of pepper, 2012

	Average soil temperature (°C)											
	July				August				September			
	0 cm	15 cm	mean	T amp	0 cm	15 cm	mean	T amp	0 cm	15 cm	mean	T amp
BSCP	30.2a	22.7a	26.5	7.5a	28.0a	21.4 ns	24.7	6.6a	23.5a	16.8ns	20.1	6.7a
NMCP	22.3b	19.5b	20.9	2.8b	21.8b	19.0 ns	20.4	2.8c	18.3b	16.0 ns	17.2	2.3b
SMCM	23.0b	21.1b	22.1	1.9c	22.0b	19.8 ns	20.9	2.2c	19.3b	17.0 ns	18.2	2.3b
BSM	20.7c	19.6b	20.2	1.1d	20.0c	19.4 ns	19.7	0.6e	18.0b	16.8 ns	17.4	1.2c
GWM	23.2b	21.2b	22.2	2.0c	22.6b	20.8 ns	21.7	1.8d	18.3b	17.0 ns	17.7	1.3c
WRMA	23.4b	20.9b	22.2	2.5b	22.4b	19.8 ns	21.1	2.6c	18.8b	16.5 ns	17.7	2.3b
WRMC	24.2b	21.1b	22.7	3.1b	23.8b	20.4 ns	22.1	3.4b	17.8b	15.8 ns	16.8	2.0b
WRME	23.9b	21.0b	22.5	2.9b	23.4b	20.2 ns	21.8	3.2b	18.3b	15.8 ns	17.1	2.5b

Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

Table 3 Average daily soil temperature (at 0 cm and at 15 cm depth), mean temperature and temperature amplitude between two levels ($T_{amp}=T_{0cm} - T_{15cm}$) during growing period of pepper, 2013

	Average soil temperature (°C)											
	July				August				September			
	0 cm	15 cm	mean	T amp	0 cm	15 cm	mean	T amp	0 cm	15 cm	mean	T amp
BSCP	25.8a	19.0a	22.4	6.8a	27.6a	20.9ns	24.3	6.7a	21.2a	14.6ns	17.9	6.6a
NMCP	19.2b	17.9b	18.6	2.3b	21.2b	18.5ns	19.9	2.7b	18.0b	15.8ns	16.9	2.2b
SMCM	19.8b	18.1b	19.0	1.7c	21.8b	19.6ns	20.7	2.2b	19.1b	17.0ns	18.1	2.1b
BSM	18.2b	16.9b	17.6	1.3c	19.7b	18.3ns	19.0	1.4c	17.8b	16.4ns	17.2	1.4c
GWM	18.7b	17.6b	18.2	1.1c	22.0b	20.4ns	21.2	1.6c	18.2b	16.9ns	17.6	1.3c
WRM	18.8b	17.2b	18.0	1.6c	22.8b	20.1ns	21.5	2.7b	18.7b	16.7ns	17.7	2.0b

Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

The mulch protects the soil from strong overheating during midday hours and cooling at night, which explains the small temperature differences between the measured surface temperatures of the soil in mulched treatments and soil temperatures at a depth of 15 cm. This is in agreement with other researchers: Chen et al., 2004, 2005, 2007 demonstrated a reduction in the maximum temperature of the soil, increase of the minimum temperature, and a reduction in amplitude between day and night temperatures. Pinamonti, 1998, also indicated that mulching reduces fluctuations in soil temperature.

CONCLUSIONS

The bare soil surface is more affected by the air temperature and this is more strongly expressed by temperature fluctuations in the depth of the soil.

Mulches affected the soil surface temperature and keep it moderate. The soil temperature under different mulches was also affected by the type of used mulch materials.

With the least variation in the soil temperature is the treatment with mulch of barley straw, which maintains a temperature in the range of 19-22 °C in August and 17-19 °C during the first two ten-day periods of September.

With the wide variation in soil temperatures of mulch are two treatments: mulch from green weed residues and mulch from grass windrow. It was established in July and August, when the green weed residues and grass windrow used for mulching, decomposed.

Mulch of barley straw maintains moderate soil temperature and protects the soil from rapid temperature fluctuations in depth.

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FLORICULTURE, ORNAMENTAL PLANTS, DESIGN AND LANDSCAPE ARCHITECTURE

EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

ANALYSIS OF ANATOMICAL AND MORPHOLOGICAL CHARACTERS OF THE *SILENE CAPPADOCICA* BOISS. & HELDR. AND *SILENE SPERGULIFOLIA* BIEB. (CARYOPHYLLACEAE) SPECIES

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Abstract

In this study, analysis of anatomical and morphological characters of the Silene cappadocica Boiss&Heldr and Silene spergulifolia Bieb. specie which belong to family of Caryophyllaceae were determined. In morphological studies of these species, parts of stem, leaves, flower and fruit were measured and given as tables. In anatomical investigations of these two species were taken section from root, stem, and leaves by microtom and hand. These sections were painted and were made constant slide. After that, it was taken photograph of these slides with assist of microscope camera. Stomatal characteristics were examined by section taken superficial from these plants leaves and stomatal index was calculated.

Key words: *Anatomy, Caryophyllaceae, Morphology, Silene, Endemic.*

INTRODUCTION

Silene is one of the largest genera of flowering plants in the world consisting of about 750 species with the generality of them distributed in Mediterranean region (Greuter, 1995). In Turkey, the genus is represented by 148 species (Coode and Cullen 1967; Davis et al. 1988, Greuter 1995; Tan and Vural 2000; Özhatay and Kültür, 2006; Özhatayet al. 2009; Bağcı et al. 2007; Aksoy et al., 2008; Bağcı 2008; Tugay and Ertuğrul 2008; Kandemiret al. 2009; Yıldız and Dadandı 2009; Hamzaoğlu et al. 2010; Yıldız and Erik 2010; Yıldız et al. 2010; Hamzaoğlu et al. 2011, Hamzaoğlu, 2012).

Little work appears to have been done on the anatomy of vegetative organs of *Silene* species especially halophytic ones. Anatomical fluctuations about the plants structure are related with the habitats of plants. Millner (2006) reported that the anatomical structures of two *Silene* species is correlated with a wide range of environmental conditions. The high salinity of soils and the soil's moisture has a major impact on halophytes' anatomical structures and has formative effects. Their cumulated action has accompanied the halophytes evolution through time, as an active and dynamic component of the evolutionary "adventure" (Grigore and Toma, 2007). From this point of view, the present study the anatomical and ecological properties of two local endemic species of *Silene* (glikophytic and halophytic ones) have been investigated.

Silene genus is named various names as locally. Usually it is named "nakil çiçeği" in Turkish. The other names are used as *"salkım çiçeği, gıvışgan otu, gıcı gıcı, acı gıcı, gıcime, cıvrıncık, çığıstak, gıvırsık, ecibücü, ibiş gıbış, kıvırşık, kıvışgan, kıvışık, kıvışkan, kıvrışık, kıvşıyık, tavuk yastığı"* for *Silene* genus in Turkish *(Baytop, 1997).*

MATERIALS AND METHODS

Materials

The investigated species have been collected from their natural habitats when they are mature. The localities of species are below:

Silene cappadocica: C4: Konya; Cihanbeyli; Tuz Gölü, Gölyazı, 2 June 2012, 38° 45.672 K, 33°06.801 D, 925 m °28.546 K, 32°43.904 D, 1750-1770 m, Bağcı 4145.

Silene spergulifolia: C4: Konya; Hadim-Taşkent between, 2 June 2012, 38° 45.672 K, 33°06.801 D, 1300 m, Bağcı 4156.

Methods

Morphological method

The species have been diagnosed by Davis (1967) and our observations have been stored in KNYA herbarium. Morphological researches for plant samples were done according to Flora of Turkey and the related articles. The diagnostic parts of *Silene* species such as plant length, basal and cauline leaves, petal, sepal, capsule (fruit) dimensions were calculated on 20 plant samples.

Anatomical method

For anatomical studies, roots, stems and leaves were used in paraffin method. And also some parts of plants were taken by hand with the aid of a razor blade. Paraffin sections were stained with safranin-fast green and hand sections were investigated directly. Canon EOS 450D cameras which attached to Leica DM 1000 light microscope were used for photograph and were calculated the cells dimensions with Cameram 21 programme.

RESULTS AND DISCUSSIONS

<u>S. cappadocica</u>

Morphological characteristics

Perennial. Stems ascending to erect, retroversely puberulent, 10-50 cm. Leaves elliptic to oblanceolate, usually without sterile shoots in their axils, puberulent, less than 5 mm broad. Inflorescence a rather loose though strict panicle. Calyx 3-5 mm in functionally female flowers, 5-11 mm in hermephrodite flowers, puberulent, often glandular. Petals white to grennish yellow, deeply bifid into ± linear lobes. Anthophore (in hermaphrodite flowers) 3-4 mm. Capsule ovoid, trigonous or 3-sulcate, long acuminate, included in the calyx. *Fl.* 5-7. *Steppe*, *slopes, etc. 800-2300 m* (Davis 1967), (Figure 1).

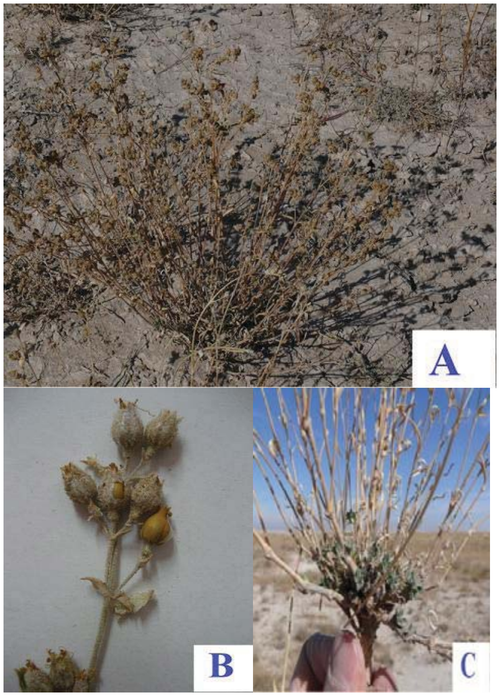

Figure 1. *S.cappadocica*, (A): general view (B): Fruit, (C): Basal leaves

Table 1. Morphological data of *S. cappadocica*

Plant Parts	wide		length	
	MİN	MAX	MİN	MAX
Basal leaf	0.2 cm	0.3 cm	1.2 cm	2.2 cm
Stem leaf	0.3 cm	0.2 cm	1.7 cm	2.3 cm
Calyx	0.3 cm	0.5 cm	0.6 cm	0.8 cm
Corolla	0.1 cm	0.15 cm	0.6 cm	1.2 cm
Fruit	0.2 cm	0.4 cm	0.6 cm	0.8 cm
Calyx teeth length	-	-	0.1 cm	0.1 cm
Bracts	-	-	0.1 cm	0.3 cm
Anthophore length	-	-	0.3 cm	0.5 cm
Plant length	-	-	30 cm	44 cm
Stem diameter	-	-	0.15 cm	0.4 cm

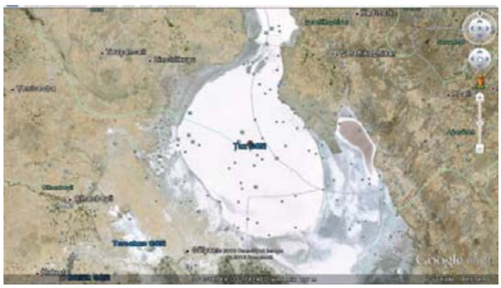

Figure 2. Location of *S.cappadocica* species

Figure 3. Location of *S. spergulifolia* species

Anatomical results

ROOT ANATOMY

Root usuaally comprises of four parts as anatomical; peridermis, cortex, vascular bunds and pith (1, 2 A, B). Peridermis encloses the outermost surface of *S. cappadocica* root cross sections. Below the peridermis, there is 8-10 layered cortex. Vascular system is well developed; there is 2-3 rowed cambium between phloem and xylem. Trachea diameter is 50-100 µm. Pith region is covered with xylem and the pith rays are 1-2 rowed.

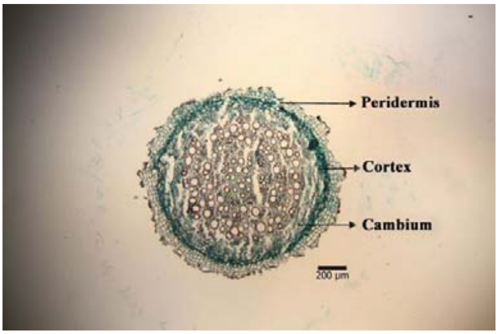

Figure 4. The cross sections of *S.cappadocica* root

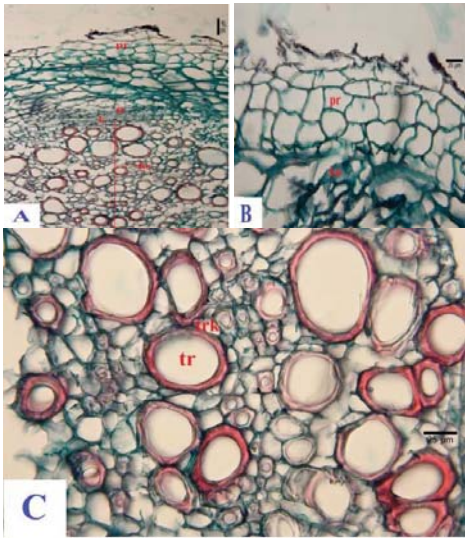

Figure 5. The cross sections of *S.cappadocica* root (A): **pr:** peridermis; ph:phloem; ca:cambium; xy: xylem; (B): pr: peridermis; (C): **tr:** trachea; trk: traceid

STEM ANATOMY

The cross sections of herbaceous stems of *S. cappadocica* have rectangular-oval shaped epidermis on the outermost surface. Under epidermis the 3-5 rowed cortex with chloroplast is located and they have druses in some cells. Endodermis which pentagon shaped and single line lies below the cortex. Sclerenchyma occupies large area (10-12 rowed) under the endodermis as uninterrupted parallel to peripheral. Vascular bundles type is open collateral definitely. Cambium splits up the phloem and xylem. The pith region is composed of parenchymatic cells and contains druses or usually it is empty Figure 3, 4 A-D).

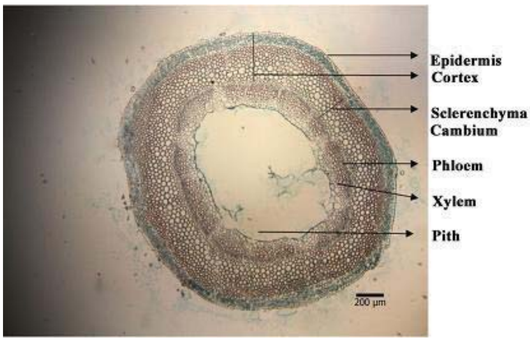

Figure 6. General view of the cross sections of stem parts of *S.cappadocica*

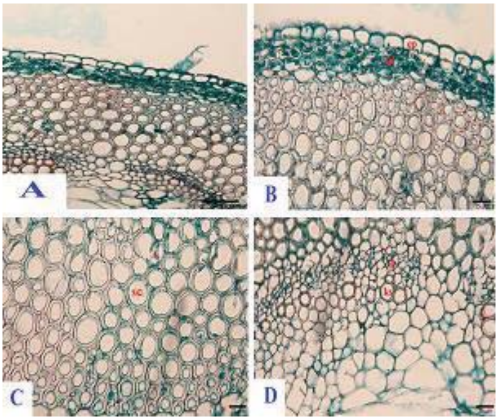

Figure 7. The cross sections of stem parts of *S.cappadocica*, (A): General view of whole parts; (B): **ep:** epidermis, **kl:** klorenkima, (C): **sc:** sclerenchyma rings; (D): **xy:** xylem, ph**:** phloem

LEAF ANATOMY

In cross sections of stem leaves, on the outer surface, there is single row rectangular-oval shaped epidermis. Epidermis is covered by cuticle. Mesophyll is composed of palisade and spongy parenchyma cells (equifacial type). Mesophyll has rarely druses in its large space. Vascular bundles are collateral type and single row bundle-sheath cells are around them. Stem leaves are amphistomatic and stomata of species are diasitic type. The secretory trichomes are abundant in superficial sections of stem leaves (Figure 8, 9, 10).

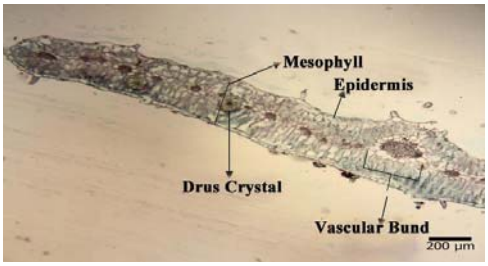

Figure 8. The cross sections of leaves of *S.cappadocica*

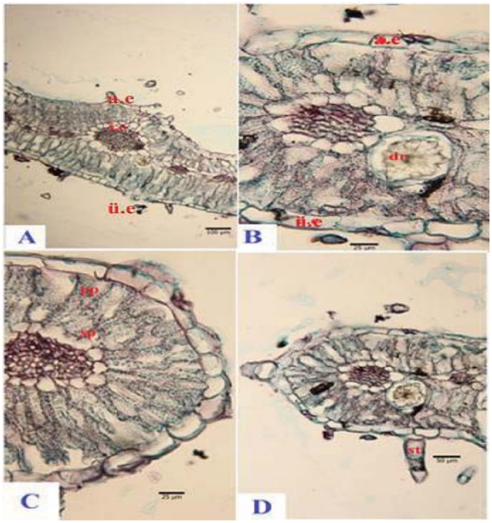

Figure 9. The cross sections of leaves of *S. cappadocica* (A): ie: vascular bund, u.e:upper epidermis, l.e: lower epidermis; (B): u.e: upper eridermis**,** l**.e**: lower epidermis, dr: druses crystal; (C): pp: palisade parenchyma, sp: spongy parenchymas; (D): st: secretory trichomes

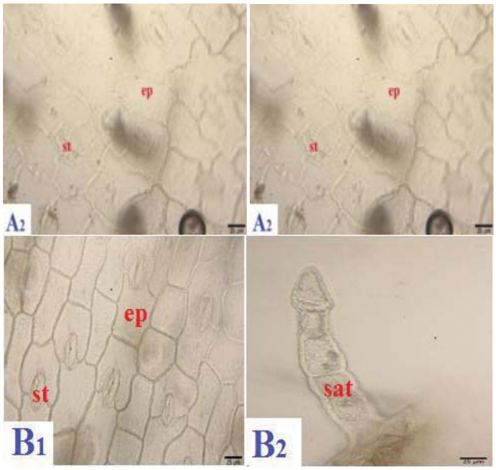

Figure 10. Surface sections of leaves of *S.cappadocica* (A1-A2) lower surface, (A1): Lower surface, sat: secrotery trichome (A2): **ep:** epidermis, **st:** stomata; (B1-B2): upper surface, (B1): upper surface, **ep:** epidermis, **st:** stomata; (B2): sat: secrotery trichome

Table 2. Anatomical data of *S. cappadocica*

Plant part	Item	*Silene cappadocica* Boiss. & Heldr.									
		Wide (µM)			Length Boy (µM)			Diameter / thick (µM)			Number of measurement
		Min	Max	average	Min	Max	average	Min	Max	average	
Root	Peridermis	0.223	0.669	0.37	0.09	0.489	0.24	7413	132.1	1175	110
	Cortex	-	-	-	-	-	-	25.65	75.36	±200	110
	Trachea	-	-	-	-	-	-	50	100	±87.5	110
Stem cortex	Epidermis	9.54	33.07	20.77	9.03	24.58	14.87	-	-	-	110
	cortex	-	-	-	-	-	-	-	-	±225	110
	Sclerenchyma	85.355	256.7	117.9	95.385	260.05	170.15	98.655	353.4	181.25	110
	Trachea	-	-	-	-	-	-	7.96	23.5	21.3±	110
Leaf	Lower Epidermis	12.44	28.53	16.76	14.30	39.73	20.54	-	-	-	50
	Mesophyll	-	-	-	-	-	-	-	-	2.312	50
Upper	Upper Epidermis	14.193	30.105	35.69	13.165	32.22	19.18	-	-	-	50

Table 3. Numerical data of *S.cappadocica* leaves

Leaf	Leaf		
	Min	**Max**	**Ort.**
Number of stomata of lower surface / mm^2	122	204	162
Number of stomata of upper surface / mm2	82	183	144
Number of lower surface / mm2	367	693	482
Number of upper surface / mm2	408	672	591
Stomata index of lower surface	7.95		
Stomata index of upper surface	7.05		
Stoma index ratio	0.886		

Silene spergulifolia **Bieb.**

Morfologic Results

Perennial. Stems ascending to erect, retroversely puberulent, 30-44 cm. Leaves lineare to oblange, usually witht sterile shoots in their axils, puberulent, less than 5 mm broad. Basal leaves 8-16 mm×0.5-1.5 mm. Bract 1-1.5 mm, Inflorescence a rather loose though strict panicle. Calyx 10-14 mm in flowers, puberulent, often glandular. Petals whıte to grennish yellow, deeply bifid into ± linear lobes. Anthophore (in hermaphrodite flowers) 4-6 mm. Capsule roundade, trigonous or not 3-sulcate, long acuminate, included in the calyx. *Fl. 5-7. Screes and slopes*, *steppe, 800-3100 m*, (Figure 11).

Table 4. Morphological data of *S.spergulifolia*

Plant parts	Measurement data			
	wide		length	
	MİN	MAX	MİN	MAX
Basal leaf	0.05 cm	0.15 cm	0.8 cm	1.6 cm
Stem leaf	0.1 cm	0.2 cm	1 cm	1.5 cm
Calyx	0.2 cm	0.4 cm	1 cm	1.4 cm
Corolla	0.1 cm	0.1 cm	0.8 cm	1.5 cm
Fruit	0.2 cm	0.4 cm	0.6 cm	0.8 cm
Calix teeth length	-	-	0.1 cm	0.2 mm
Bracts	-	-	0.1 cm	0.15 cm
Anthophor length	-	-	0.4 cm	0.6 cm
Plant length	-	-	30 cm	40 cm
Stem diameter	-	-	0.1 cm	0.3 cm

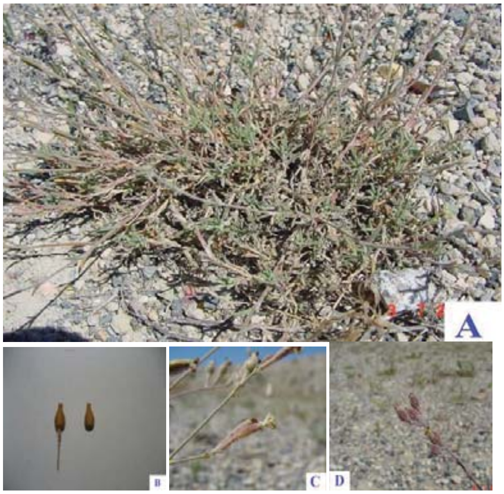

Figure 11. *S.spergulifolia* (A): General view, (B): Mature fruit (C): Young flower; (D) Semi-mature fruit

Anatomical Results

ROOT ANATOMY

Root usually comprises of four parts as anatomical; peridermis, cortex, vascular bunds and pith (Figure 12-15). Peridermis encloses the outermost surface of *S. spergulifolia* root cross sections. Below the peridermis, there is 10-12 layered cortex. Vascular system is well developed; there is 2-3 rowed cambium between phloem and xylem. Trachea diameter is 35-70 µm. Pith region is covered with xylem and the pith rays are 1-2 rowed.

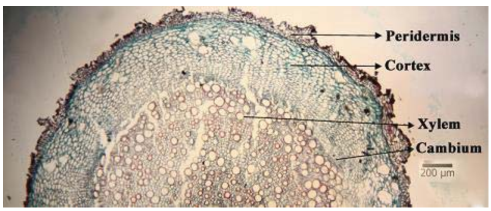

Figure 12. General view; The cross sections of *S.spergulifolia* root

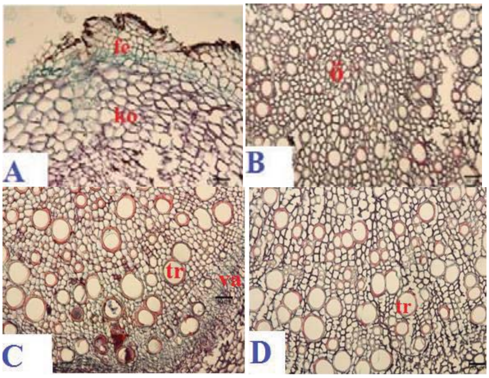

Figure 13. The cross sections of *S. spergulifolia* root, (A): **ko:** cortex, **pe:** peridermis**;** (B): p:pith region parenchyma (C): **tr:** trachea, **va:** vasculer region (D): **tr:** trachea

STEM ANATOMY

The cross sections of herbaceous stems of *S. spergulifolia* have rectangular-oval shaped epidermis on the outermost surface. Under epidermis the 3-5 rowed cortex with chloroplast is located and they have druses in some cells. Endodermis which pentagon shaped and single line lies below the cortex. Sclerenchyma occupies large area (9-10 rowed) under the endodermis as uninterrupted parallel to peripheral. Vascular bundles type is open collateral definitely. Cambium splits up the phloem and xylem. The pith region is composed of parenchymatic cells and contains druses or usually it is empity. Probably pith regioan may be decomposed while it is mature (Figure 14-15).

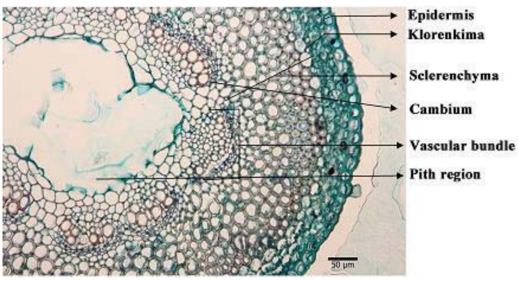

Figure 14. The cross sections of *S.spergulifolia* stem

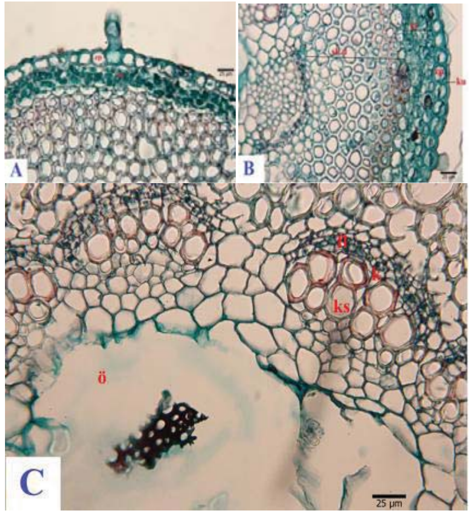

Figure 15. The cross sections of *S.spergulifolia*i stem, (A): **ep:** epidermis, **kl:** klorenkima; (B): cr**:** cycleranchima ring; **kl:** klorenkima; **ep:** epiderma; **ku:** cuticle (C): xy**:** xylem**, ph.**: phloem**,** p: pith region, **k:** cambium

LEAF ANATOMY

In cross sections of stem leaves, on the outer surface, there is single row rectangular shaped epidermis. Epidermis is covered by cuticle. Mesophyll is composed of palisade and spongy parenchyma cells (equifacial type). Mesophyll has druses in its large space. Vascular bundles are collateral type and single row bundle-sheath cells are around them. Stem leaves are *amphistomatic* and stomata of species are *diasitic* type. The secretory trichomes are abundant in superficial sections of stem leaves (Figure 16-18).

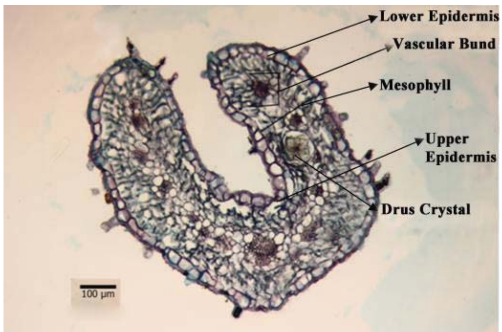

Figure 16. The cross sections of leaf of *S.spergulifolia*

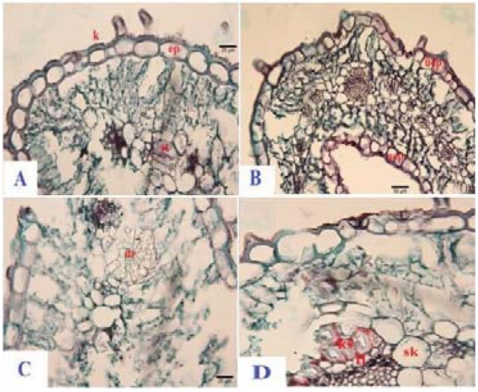

Figure 17. The cross sections of leaf of *S.spergulifolia*, **(A):** ep: epidermis**,** k: cuticle, **st:** stomata**; (B):** uep: upper epidermis, lep**;** lower epidermis**; (C):** dr: druse crystal**; (D):** sk: sclerenchyma, xy: xylem, ph: pholem

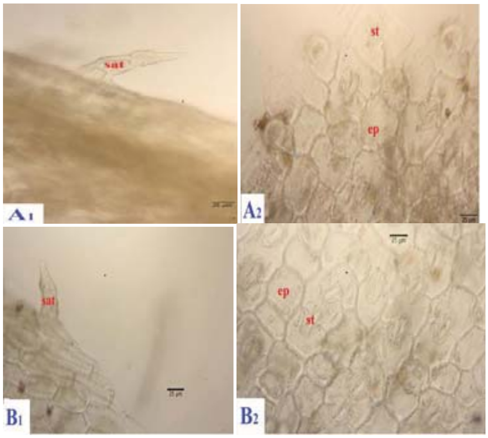

Figure 18**.** Surface sections of leaves of *S.spergulifolia*, (A1-A2) Lower surface, (A1): Lower surface, **sat:** secrotery trichome (A2): **ep:** epidermis, **st:** stomata; (B1-B2): upper surface, (B1): upper surface, **ep:** epidermis, **st:** stomata; (B2): **sat:** secrotery trichome

Table 5. Anatomical measure data of *S.spergulifolia*

Plant part	**Item**	***Silene spergulifolia* Bieb.**									
		Wide (μM)			**Lenght (μM)**			**Diameter/ Thick (μM)**			Number of measurement
		Min	Max	Average	Min	Max	Average	Min	Max	Average	
ROOT	Peridermis	8.612	53.871	22.891	8.824	32.261	16.182	27.848	95.07	175±	110
	cortex	-	-	-	-	-	-	-	-	50±	110
	Trachea	-	-	-	-	-	-	35	70	50	110
STEM	Epidermis	6.07	7.024	22.55	23.87	36.51	20.04	-	-	-	110
	cortex	-	-	-	-	-	-	27.59	50.44	37.45	110
	Sclerenchyma	7.858	28.307	13.53	10.19	29.055	16.845	-	-	-	50
	Trachea	-	-	-	-	-	-	-	-	14.67	110
	Pith	-	-	-	-	-	-	-	-	-	-
LEAF	Lower epidermis	13.54	42.90	21.45	10.53	29.02	20.44	-	-	-	50
	Mesophyll	-	-	-	-	-	-	36.249	202.3	135.81	110
	Upper epidermis	14.56	40.943	24.38	11.92	27.11	19.67	-	-	-	50

Table 6. Numerical datas of leaves of *S.spergulifolia*

Leaf	**Leaf**		
	Min	**Max**	**Ort.**
Number of stomata of lower surface / mm^2	122	306	204
Number of stomata of upper surface / mm2	122	428	329
Number of lower surface / mm2	346	611	491
Number of upper surface / mm2	387	713	532
Stomata index of lower surface	10		
Stomata index of upper surface	15.35		
Stoma index ratio	1.535		

Table 7. The morphological differences between investigated species

Characters	***Silene cappadocica***		***Silene spergulifolia***	
	According to Results of our	**According to Flora of Turkey (Davis, 1967)**	**According to Results of our**	**According to Flora of Turkey (Davis, 1967)**
plant length	30-44 cm	10-50 cm	30-40 cm	30 - 50 cm
basal leaves	12-22×2-3mm eliptice – oblanceolate	Less than 5 mm eliptice – oblanceolate	8-16×0.5-1.5 mm Eliptic-oblanceolate	eliptic–oblanceolate
stem leaves	17-23x2-3 mm eliptic–oblanceolate	30-60x1-3 mm eliptic–oblanceolate	10-15 x 1-2 mm Linear -oblong	Linear - oblong
calyx	6-8×3-5 mm	3-5mm	10-14×2-4 mm	-
anthophore	3-5 mm	3-4mm	4-6 mm	-
stem diameter	1.5-4 mm	-	1-3 mm	-
flowering period	June-July	June-July	June-July	June-July
location	Konya/Tuzgölü	Konya/Hadim	Konya/Hadim	
bract	1-3 mm	-	1-1.5 mm	-

The root, stem and leaf anatomical differences between investigated species are given below in Table 8-10.

Table 8. The root anatomical differences between investigated species

Species tissue	*Silene cappadocica*	*Silene spergulifolia*
peridermis	Average ± 117.5 µm	average ± 175 µm
cortex	150-200 µm / 8–10 layer	400-600 µm/ 10-12 layer
trachea	average : 87.5 µm	average : 50 µm

Table 9. The stem anatomical differences between investigated species

Tissue-species	*S. cappadocica*	*S.spergulifolia*
epidermis	9.03-24.58 x 9.54-33.07	6.07-23.87 x 7.024x 36.51
cortex	±225 µm	27.59-50.44 µm
trachea	average 21.3 ± µm	average 14.7 ± µm

Table 10. The leaf anatomical differences between investigated species

Species tissue		*S. cappadocica*	*S. spergulifolia*
Present of stomata on leaf surface		Amfistomatik	Amfistomatik
According to epidermis position of stomata		Kseromorf	Kseromorf
Type of stomata		Diasitik	Diasitik
Place in druse		Mesophyle layer	Mesophyle layer
Stomata index rate	Upper surface	7.05	15.35
	Lower surface	7.95	10
	Stomata index ratio	0.886	1.535

CONCLUSIONS

Although *S.cappadocica* and *S.spergulifolia* are related species, there are anatomical and morphological different between the two species.

From morphological point of view, *Silene spergulifolia* has leaf narrow than *Silene cappadocica*. *Silene spergulifolia* has different fruit shapes according to fruit of *Silene cappadocica.*

S. cappadocica has 30-44 cm length while *S.spergulifolia* has 30-40 cm length. *S. cappadocica* is taller than *S. spergulifolia*. Calyx is 6-8 mm length in *S.cappadocica* but calyx of *S.spergulifolia* is 10-14 mm length. Anthofor length is 3-5 mm at *S. cappadocica* but calyx length of *S. Spergulifolia* is 4-6 mm

Fruits of *S.cappadocica* are smaller than *S. spergulifolia*. Also, S. *cappadocica* has a split on fruit (capsule) and this feature is a distinct character for this two species.

In anatomical terms, while stomata index rate of *S.cappadocica* is 0.886, iken stomata index rate is 1.535 at *S. spergulifolia.* Leaf of *S. cappadocica* has thinner cuticle layer than leaf of *S. sperguliolia.* While *S.cappadocica* has 4-5 layer peridermis, *S. spergulifolia* has 8-9 layer peridermis.

ACKNOWLEDGEMENTS

We would like to thank to Selcuk University (BAP Project no: **13201051**) for financial support during this study.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

ASSESSMENT OF LANDSCAPE COMPONENTS IN COMANA NATURAL PARK

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Abstract

The approach consists in proposing an assessment method regarding landscape typologies and components, applied in Comana Natural Park, located 20 km south of Bucharest, in Giurgiu County. The research methodology is focused on assessing the share of the individual landscape components in each type of landscape identified. Thus, the components of the landscape are grouped in a tabular analysis into two broad categories: natural and anthropogenic, with specific subcategories: relief, soil, water, vegetation and sunlight for the natural category; infrastructure and architecture for the anthropogenic one. Each subcategory varies depending on the type of landscape, e.g. vegetation varies from forest to agricultural or palustrine. Following the assessment of the components, the anthropic impact level and the diversity index result for each type of landscape. Within the analysis, six types of landscape have been identified: forest, palustrine, agricultural, fallow, old rural, recent rural. After assessing the frequency of the landscape components two categories have been identified: common components (frequently found) and specific components (found only in particular cases). Both groups include natural, anthropic or mixed elements. The study brings in new approaches in identifying and assessing the determining factors in terms of landscape identity and typology, deepening the relations between the different components of the landscape.

Key words: *Landscape Assessment, Landscape Typologies, Landscape Identity, Natural Heritage, Comana Natural Park.*

INTRODUCTION

According to the European Landscape Convention launched in Florence in 2000 and ratified by Romania in 2002, the signatory states are committed to: "a) (i) to identify its own landscapes throughout its territory; (ii) to analyze their characteristics and the forces and pressures transforming them; (iii) to take note of changes; b) to assess the landscapes thus identified, taking into account the particular values assigned to them by the interested parties and the population concerned" (CE, 2000). Unfortunately, the implementation of provisions at national level is deficient and the landscape assessment studies in Romania are isolated, being realized mostly in the academic environment.

In this context, a priority in initiating steps for identifying, mapping and assessing landscapes is researching sites which belong to the natural and cultural heritage. One such case is Comana Natural Park, the largest wetland in Bucharest metropolitan area, which includes valuable landscape both at natural and anthropogenic level.

Comana protected area was declared a natural park in 2004, on an area of 24,963 ha. The park includes 8 communes with a range of cultural and historical heritage objectives, Comana and Neajlov River - a Ramsar and Natura 2000 site, Comana Forest - including 2 floral reserves (Ruscus aculeatus and Paeonia peregrina).

MATERIALS AND METHODS

The methodology is focused on the assessment of the relationship between typologies and the specific components of the landscape. Every landscape typology is assessed in terms of the characteristic components within a tabular analysis.

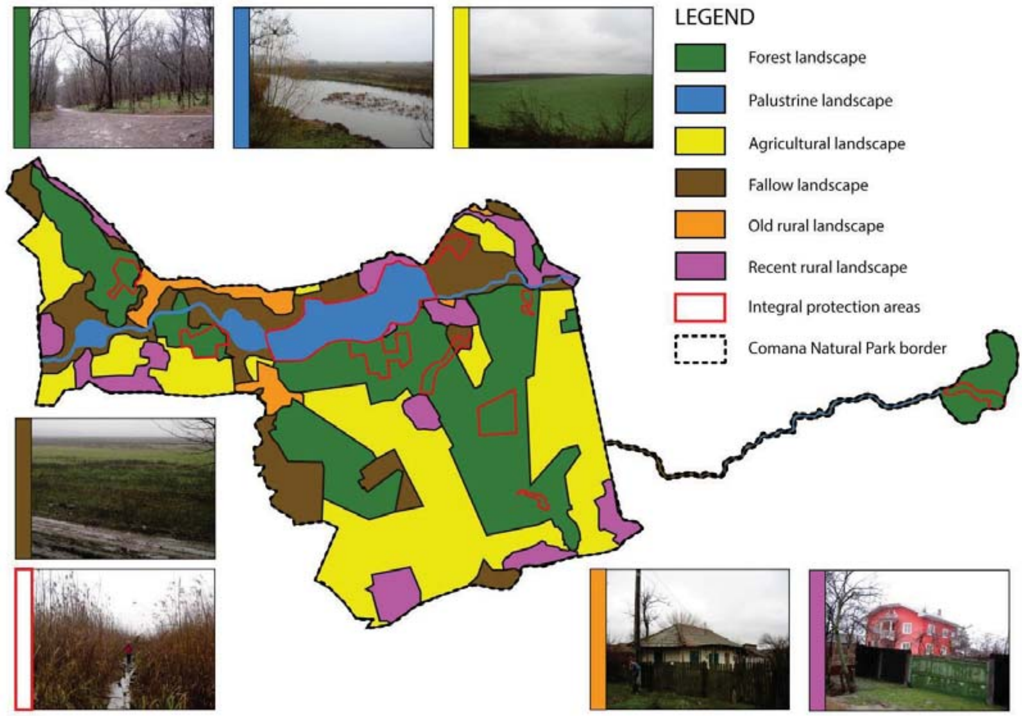

Figure 1. Landscape Typologies in Comana Natural Park

The individual components of the landscape are divided into two broad categories: natural and anthropogenic, with specific subcategories: relief, soil, water, vegetation and sunlight level for the natural category; infrastructure and architecture for the anthropogenic one. Each subcategory contains different components depending on the type of landscape.

Following the assessment of the components for each type of landscape, the anthropic impact level and the diversity index result. The anthropic impact level is determined through the ratio between natural and anthropogenic elements of each landscape. The diversity index results based on the proportion of the components encountered. The last part of the study includes an analysis of the frequency of each component found in Comana Natural Park depending on landscape typologies and on the total area.

The final results concluded two main categories of landscape components: common factors and specific factors. The first category comprises the most frequent landscape elements, while the second one includes the rarest landscape components in Comana Park.

RESULTS AND DISCUSSIONS

Following the site assessment and mapping, 6 landscape typologies resulted in Comana Natural Park: forest, palustrine, agriculture, fallow, old rural, recent rural. Of the 6 landscape types, the forest and palustrine landscape include integral protection areas (flora and fauna reserves within the forest landscape and avifauna reserve within the palustrine landscape) (Figure 1).

After analyzing the landscapes distribution, the agricultural (34%) and forest (28%) typologies resulted as the dominants. The fallow (15%), the new rural (11%) and the palustrine (8.5%) landscapes presented an average share. The lowest share resulted for old rural landscape (3.5%) (Figure 2).

The first step in landscape typologies assessment was to identify the presence of landscape components for each of the 6 cases. In the tabular analysis, for each type of landscape natural components (relief, water, soil, light) and anthropogenic characteristics (architecture and infrastructure) have been identified (Figure 1). Depending on the natural

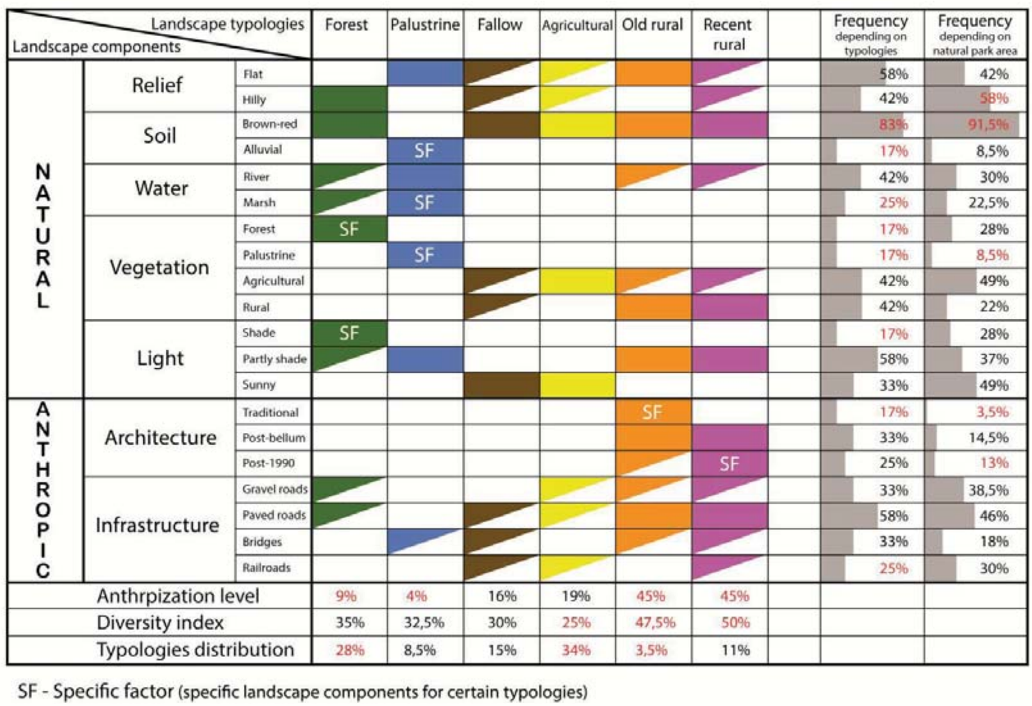

Figure 2. Landscape components assessment depending on landscape typologies

- anthropogenic ratio and on the variety of landscape elements, the diversity index and the anthropic level impact resulted. Thus, the dominant components revealed the following indicators (Figure 2):
- Forest landscape: hilly relief, red-brown soil, forest vegetation, shaded areas, gravel roads; Anthropization: 9%; Diversity: 35%;
- Palustrine landscape: flat relief, alluvial soil, Neajlov River, Comana Marsh, palustrine vegetation, partly shaded areas, wooden decks; Anthropization: 4%; Diversity: 32.5%;
- Fallow landscape: flat and hilly relief, red-brown soil, herbaceous vegetation, sunny areas, paved roads, bridges, railways; Anthropization: 16%; Diversity: 30%;
- Agricultural landscape: flat and hilly relief, red-brown soil, agricultural vegetation, sunny areas, paved roads, railways; Anthropization: 19%; Diversity: 25%;
- Old rural landscape: flat relief, red-brown soil, rural vegetation (orchards, vegetable gardens, etc.), sunny and shaded areas, traditional and post-bellum architecture, paved and gravel roads; Anthropization: 45%; Diversity: 47.5%;
- New rural landscape: hilly and flat relief, red-brown soil, rural vegetation (orchards, vegetable gardens, etc.), sunny and shaded areas, post-bellum and post-communist architecture, paved and gravel roads, railways, bridges; Anthropization: 45%; Diversity: 50%;

The last phase of the study is based on assessing the frequency of components within the 6 types of landscape. Thus, depending on the results, two broad categories of anthropogenic and natural components of the landscape have been identified: common factors – frequently encountered in Comana Natural Park in general and specific factors – rare ones, representative only for certain landscape types within the studied area (Figure 2). The first category includes: red-brown soil, flat and hilly relief, partly shaded areas, paved roads, hilly relief, the Neajlov River, agricultural vegetation, rural vegetation. The second category includes traditional architecture, post-1990 architecture, shaded areas, palustrine vegetation, forest vegetation, alluvial soil, Comana Marsh (Figure 3).

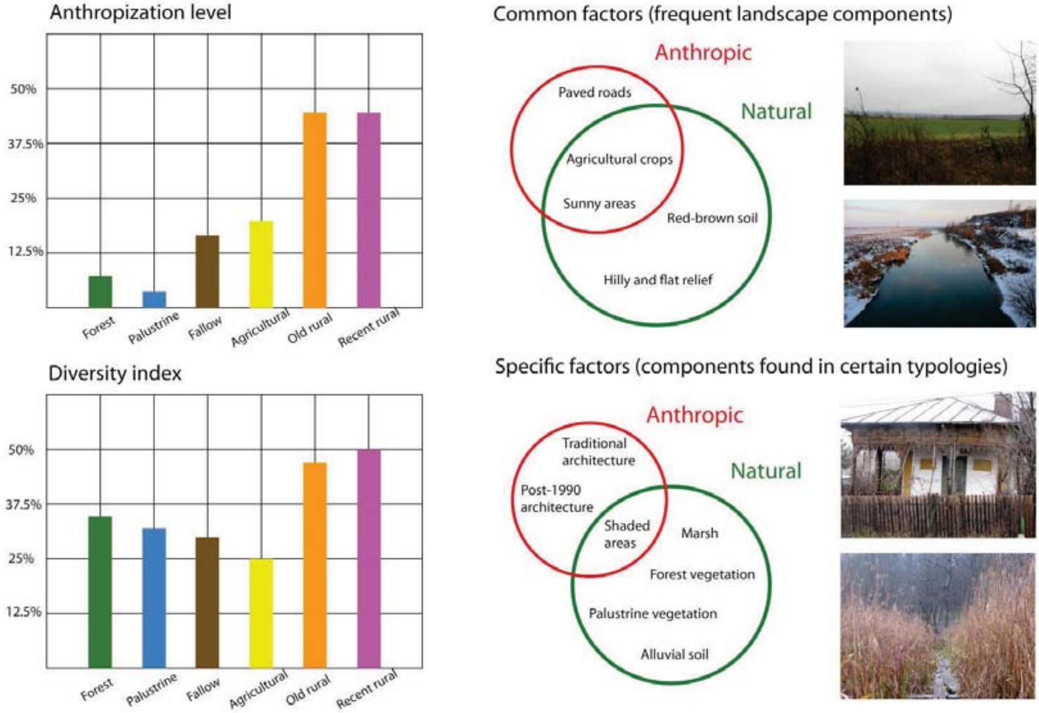

Figure 3 – Common and specific factors in landscape typologies in Comana Natural Park

CONCLUSIONS

The study aims to identify common and specific components of the landscape in Comana Natural Park and proposes a new approach in the assessment of landscape typologies. The importance and originality of the research consist of proposing a comprehensive and integrated analysis method addressing the complex dimension of the landscape. The method complements the sphere of knowledge in the field of landscape assessment by introducing a new approach in quantitative analysis. Its results highlight the qualitative dimension of landscape components. The innovative character of the analysis consists in identifying common and specific factors to certain types of landscapes depending on their frequency within the site, correlated with the spatial distribution of the typologies, the anthropization level and the diversity of landscapes. The results of the proposed method highlight the common elements which define the general character of the landscape in the studied area and determine the particularizing character of typologies. Thus, the results can be integrated into management and local development strategies, including tourism promotion through place branding initiatives. Both specific landscape factors and common ones should be considered within landscape conservation and protection measures for Comana protected area. The presented landscape assessment method can be applied at different scales, from local to territorial level, in both anthropogenic and natural environments. Also, this approach can be developed in order to be integrated in various landscape studies and strategies.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

CURRENT APPROACHES IN METROPOLITAN GREEN INFRASTRUCTURE STRATEGIES

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Abstract

In the last decade, in developed countries the awareness of green infrastructure and its impact on quality of life has increased considerably. Thus, increasingly more cities have initiated development and conservation plans for metropolitan green infrastructure. The research consists of a comparative analysis of a number of green infrastructure strategies from different cities around the world, including major cities such as New York, Sydney, London, and smaller metropolitan areas like Milwaukee (USA) and Cambridge (UK). Within the study, green infrastructure plans are analyzed in terms of structure, underlying studies, visions, objectives, approached themes, complexity, relating to national and international directives, etc. The results reveal the complexity and interdisciplinary character of green infrastructure development plans. The strategies contains various current global issues approached at local level, such as climate change, energy efficiency, pollution reduction, storm water management, biodiversity conservation, public health, etc. The study shows different green infrastructure planning approaches, highlighting an increasingly interest to integrate green areas in urban development strategies and policies.

Key words: *Development Strategies, Green Infrastructure Plan, Landscape Planning, Metropolitan Areas, Sustainable Development.*

INTRODUCTION

The continuous development of the concept of green infrastructure in the last two decades has led international organizations, central and local authorities to develop specific policies and strategies at international, national and local level. Such measures have been initiated especially in the last 10 years, mostly in developed countries such as USA, Canada, Australia or Western Europe. Since 2008 the European Union introduced green infrastructure into its institutional discourse through the European Environmental Bureau (EEB, 2008). Subsequently the concept was taken over by the European Commission (EC, 2012; EC, 2013), which intends to develop a general strategy at EU level on GI (green infrastructure) till 2020. The European documents presents the importance of green infrastructure benefits, particularly for urban areas and their role in combating threats to human security and to the environment (Boc, 2014). Thus, metropolitan green infrastructure strategies can be used to propose natural solutions to various global challenges such as climate change, energy efficiency, urban microclimate conditions, food security, carbon footprint, water management, etc.

MATERIALS AND METHODS

The following comparative analysis illustrates different approaches to green infrastructure strategies for metropolitan areas from Western Europe, North America and Australia, developed in the last 5 years. In the analysis are studied both large cities such as London, New York, Sydney and smaller metropolitan areas such as Milwaukee (USA) and Cambridge (UK). The results of the research are listed within a table, which contains a synthesis of the analysis, and also in a descriptive manner by presenting each criterion gradually according to which the metropolitan green infrastructure strategies have been analyzed (Table 1).

Table 1. Comparative analysis of green infrastructure strategies

	GI Strategies for metropolitan areas				
	Large areas (over 4 million inhabitants)			Medium areas (1,5 mil. inhab.)	Small areas (0,3 mil. inhab.)
	London	New York	Sydney	Milwaukee	Cambridge
Title of the project	Green Infrastructure and Open Environments: the all London Green Grid (ALGG), 2012	NYC Green Infrastructure Plan - 2010 (updated yearly)	Metropolitan Strategy for Sydney, 2012 (Chapters 3.6 Infrastructure, 3.8. Environment)	Regional Green Infrastructure Plan, 2013	Cambridgeshire Green Infrastructure Strategy, 2013 (a review of the 2006 strategy)
Prepared for	Greater London Authority	NYC Depart. of Environmental Protection	NSW Department of Planning and Infrastructure	Milwaukee Metropolitan Sewerage District	Cambridge City Council, Cambridge County Council
Major structure (contents)	1. Introduction 2. Vision 3. Delivery 4. Functions (Benefits) 5. Green grid areas	1. Build cost-effective grey infrastructure 2. Optimize the wastewater system 3. Control 10% of water runoff 4. Management, modeling impact, monitoring 5. Stakeholders	Infrastructure: 1. Planning 2. Funding 3. Social infr. 4. Green infr. Environment: 1. Environment 2. Natural hazard 3. Climate change 4. Waste 5. Sustainability	1. GI in Milwaukee 2. Regional GI Plan Goals 3. Analysis and results 4. GI watershed priorities 5. GI benefits and costs	1. Background 2. Developing the GI Strategy 3. The strategic network 4. GI priorities 5. Delivery of the strategic network
Visions and objectives	A GI network of interlinked, multi-purpose open and green spaces with good connections, the Green Belt and the Blue Ribbon Network, especially the Thames.	Improving water quality that integrates green infrastructure, such as swales, rain gardens and green roofs, with investments to optimize the existing system.	Open space should be treated in a holistic and integrated way as a GI system including parks, reserves, protected lands, landscapes, trails, foreshores, national parks and waterways.	To capture more storm water, harvest more rainwater for reuse, and to provide social economic and environmental benefits for all.	Objectives: 1. Revise the decline in biodiversity 2. Mitigate and adapt to climate change 3. Sustainable economic development 4. Healthy living
Implementation	20 years	20 years	20 years	22 years	15 years (2007-2021)
Approached themes	Climate change, energy efficiency, food security, biodiversity, air quality, water management healthy living, accessibility, sustainable tourism	Storm water management, climate change, air quality, energy efficiency, green roofs, bio-swales	Climate change, energy efficiency, food security, biodiversity, water management, sustainable tourism, healthy living, landscape	Storm water management, climate change, air quality, energy efficiency, green roofs, bio-swales	Climate change, energy efficiency, food security, landscape, biodiversity, air quality, water management healthy living, accessibility, tourism, heritage
Relation to international directives	INTEREG Climate-Change Project	-	-	-	- European Landscape Convention - RAMSAR - SPA, SAC

The criteria included in the analysis are: the general structure of the strategy, vision and objectives, the expected period to implement strategies, main themes, relating to international guidelines and the number of inhabitants of each metropolitan area.
The conclusions show the common elements of the strategies and the main factors which generates different approaches in metropolitan green infrastructure planning.

RESULTS AND DISCUSSIONS

Structure of strategies. The approached green infrastructure strategies have different structures depending on the main themes. In general, the first stage includes a presentation of the current situation of green infrastructure in the overall context of local development strategies and policies. The second part comprises the vision and the main objectives of the GI strategy. Afterwards, the priorities in the development of green infrastructure and the specific benefits are mentioned.
The implementation phase is presented either after vision, in the case of London or at the end of the strategy in the case of Cambridge. The common element encountered in all strategic plans is the development vision, which is designed generally for a period of 20 years (Table 1). The exception is the metropolitan area of Cambridge, where the strategy was developed as a review of the strategic plan from 2006, aimed to be implemented during 15 years (2007-2021). In this case, the main goal was to update the strategic objectives for 2021 and to present programs and projects already implemented or ongoing (CCC, 2013).
Visions. In the UK and Australia the vision and objectives of the GI strategies are approached from an integrated perspective, with a strong interdisciplinary character. The green infrastructure development means to create a complex network of interconnected green areas with ecological, economic, social and cultural role. In the case of the American strategies, the focus is primarily on solving storm-water management issues through sustainable methods in environmental and economic terms.
Approached themes. The strategies from Australia and the UK approach numerous

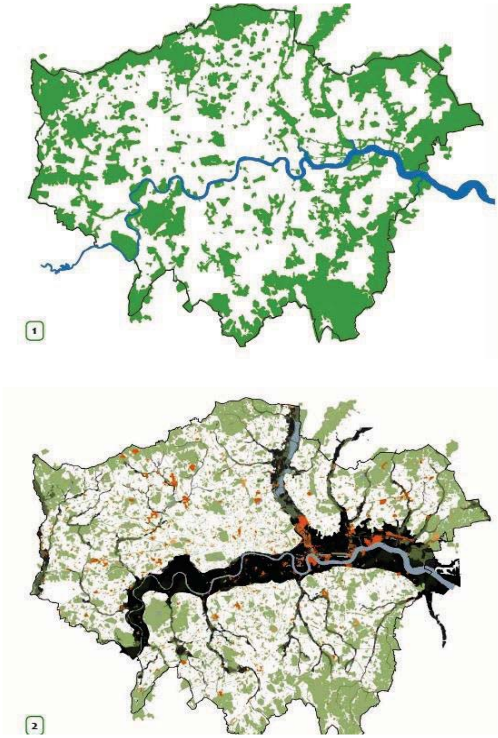

Figure 1. Green infrastructure in London (up), Managing climate change flooding (down), (source: Yurisic, 2014)

topics mentioned in general within the EU directives, such as climate change, energy efficiency, food security, biodiversity conservation, air quality, high accesibility in green areas, encouraging an environment and style healthy living, sustainable tourism development. Regarding the multiplicity of topics addressed, the most complex is the strategy of Cambridge metropolitan area. In this case, in addition to the above mentioned themes, the cultural dimension of green infrastructure is introduced by integrating the concepts of landscape and heritage within the strategic objectives (GLA, 2012). In contrast, US strategies propose an approach based on the role of green infrastructure in storm-water management. Thus, issues such as climate change, energy efficiency and air quality are addressed in the background, especially in relation to sustainable water management. In New York and Milwaukee, strategic plans aimed at developing green roofs, bio-swales, rain gardens, wetlands and green corridors in order to reintegrate the rainwater into the natural biogeochemical circuit (MMSD, 2013).

Relation to international directives. In general, the studied strategies are not related, at least not directly, to international conventions, policies or programs. Such directives are only specified in the strategies from the UK. In the case of London, the INTERREG trans-boundary program, launched by the European Union, is integrated to combat climate change (Figure 1). The objectives of the program include: urban heat island management, flood prevention, reducing CO2 emissions and improving the quality of life through a range of practical activities (GLA, 2012). The GI Strategy for Cambridge metropolitan area has the widest coverage and is strongly related to international directives. The strategic plan integrates principles of the European Landscape Convention. Specific issues as the erosion of the character of cultural and natural landscapes are mentioned. The objectives related to the European Landscape Convention include landscape restoration and creation of new development projects involving the local community. Beside this, the GI strategy for Cambridge highlights the importance of managing natural areas which are protected through international conventions involved in biodiversity conservation, such as RAMSAR – worldwide and SAC and SPA - at European level (CCC, 2013).

The size of metropolitan areas. The main aspect which varies in this regard is the scale and the level of detail in spatial zoning of green infrastructure.

CONCLUSIONS

The comparative analysis is noted that the American GI strategies present a sectorial character, geared mainly towards sustainable storm-water management problem. In the case of strategic plans from UK and Australia, the vision is more comprehensive, addressing numerous issues of contemporary global human security sphere - climate security, energy and food, public health, sustainable tourism, etc. The main common elements in all strategies include an implementation period lasting about 20 years, presenting a general view of the priorities and highlighting the benefits of green infrastructure. At the same time, all GI strategies highlights the importance of green infrastructure to ensure a sustainable future for metropolitan areas. Therefore, the metropolitan authorities foresee increasingly significant investments in GI programs and projects in the coming decades.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

PHENOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF *MELİA AZEDARACH* L. IN KOCAELI CITY IN TURKEY

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Abstract

Melia azedarach L. (Family: Meliaceae), is a perennial, deciduous woody plant and is native in some parts of Asia temperate, Asia tropical, Australasia and Pacific but the tree has been distributed nearly all over the world, including Northern and Southern hemisphere. Every plant tissue or parts of Melia azedarach have bioactive compounds. So its traditional usage or benefit make the plant greatly interesting in science for human, animal and plant health at last decades. The new scientific findings may lead to the plant a part of new generation bio-industry as drug, pesticide etc., and this will cause a demand of raw material without interruption. Due to the geographical differences, the phenological and morphological features can be different more or less. Based on this idea the present study was performed in 2013-2014 (along 24 months) plant growth season in Kocaeli city located in the East Marmara Region in the North-Western part of Turkey. Aims of the study were obtain phenological and morphological characteristics of a Melia azedarach tree. Determined morphological characters were on leaves, flowers, fruits and seeds additionally phenological parameters observed and presented.

Key words: *Melia azedarach, phenology, morphology, features.*

INTRODUCTION

Melia azedarach L. belongs to Meliaceae family and native in some parts of Asia-temperate, Asia-tropical, Australasia and Pacific. The plant naturalized in the other parts of Asia-temperate, Australasia and Pacific in addition with Europe, Northern America, and Southern America (USDA-ARS-GRIN, 2015). Although in most of publications the plant is called as China berry, Persian lilac, Pride of India, Pride of China, White Cedar, it also has common names. Some of the names are; cinamomo in Brasil (Piccola and Gregolim, 1980), zanzalacht in Jordan (Al-Rubae, 2009), mindi in Indonesia (Syamsuwida et al., 2012) and tespih ağacı in Turkey.

The plant helps to improve fertility of soil in agroforestry systems (Patil et al., 2012), adornment of living areas via usage as ornamental plant (Mishra et al., 2013). All part of the plant (roots, stem, bark, leaves, leaf juice, flowers, fruits, seeds) have traditional uses (Mishra et al., 2013). There are some scientific studies focused on importance of some chemical subtances of the plant in medicine (Alché et al., 2002; Saleem et al., 2002; Leelavathi and Doss, 2014; Sen and Batra, 2012) and in plant protection against pests and diseases (Carpinella et al., 2003; Prophiro et al., 2008; Defagó et al., 2009; Cavoski et al., 2012). At the same time the plant is not only important for human and plant health, it also has living and feeding importance for avian (Arslan and Rejmánek, 2010) and primate genera (Das et al., 2014).

Because of the wide range of distribution of the plant, phenological and morphological features expected to change in climatically and geographically different areas. The aims of the study were to obtain some information on phenological and morphological characteristics of a *Melia azedarach* tree under Kocaeli city (Turkey) environmental condition.

MATERIALS AND METHODS

The study was conducted on a tree in Arslanbey Campus of Kocaeli University under Kocaeli City ecological condition from 1st of January 2013 to 31st of December 2014 (along 24 months). Kocaeli City is in the North-Western part of Turkey in the Northern Hemisphere.

In that part of the city summers are hot and mostly dry, winters are mostly cold and rainy (Table 1).

At the experimental area, the altitude was 77.4 m, latitude was 40^0 42' N and longitude was 30^0 01' E.

In the beginning of the study the detected tree was 12 years old, 6.5 m tall and main stem diameter was 22.92 cm.

Its crown-projection area was 28.2 m^2. Soil analysis of the plant site was performed at a depth of 0-30 cm.

According to analysis, the soil is clay, pH 7.4, not salty, slightly calciferous, organic material at medium level, nitrogen content at a good level, slightly phosphoric, potassium is low.

Table 1. Mean of long term (1954-2014) monthly climatic data of Kocaeli City, Turkey

Climatic Data	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Average maximum air temperature(^{0}C)	9.7	10.7	13.2	18.5	23.2	27.5	29.5	29.6	26.2	20.8	16.2	11.9
Average minimum air temperature(^{0}C)	3.3	3.5	4.9	8.9	12.9	16.8	19.1	19.2	16.1	12.5	8.6	5.6
Average temperature(^{0}C)	6.3	6.7	8.6	13.1	17.5	21.7	23.7	23.7	20.4	16.0	11.9	8.5
Average sunny time (hours/day)	2.3	3.0	4.6	5.3	7.2	8.6	9.3	9.6	7.1	4.5	3.4	2.3
Average rainy days	17.6	15.6	14.1	11.9	9.9	8.3	5.8	5.3	7.1	11.8	12.7	16.4
Total rainfall (kg/m^2)	93.2	73.3	73.4	52.3	45.4	52.8	37.6	43.6	52.0	89.9	81.5	108.0
Record in the highest temp.	23.7	26.0	30.8	35.0	36.6	38.7	44.1	41.6	37.8	36.2	29.1	27.4
Record in the least temp.	-9.7	-8.5	-5.7	-0.9	2.8	8.5	11.3	12.4	6.0	2.4	-0.7	-5.7

*The data were obtained from Republic of Turkey, Turkish State Meteorological Service (http://dmi.gov.tr)

In order to characterize the phenology;
1- First bud development date,
2-First-end leaves development dates,
3- First-full-end flowering dates,
4- Fruit maturity dates,
5-First-end leaf falling dates were recorded.

For this purpose; observations were carried on buds, shoots, florescences, fruit stalks from each one of cardinal (East, West, North, South) and ordinal directions (North-East, North-West, South-East, South-West). Each finding was reached from totally 40 formations and avarage dates were presented.

In order to characterize the morphology;
1-Leaflet number/leaf,
2- Flower number/cluster,
3-Petal number/flower,
4- Pistil number/flower,
5-Stamen number/flower,
6- Fruit number/cluster,
7- Fruit width, lenght, weight,
8- Endocarp width, lenght, weight,
9-Seed width, lenght, weight were calculated.

For this purpose; studies were carried on leaves, flowers, fruits from each one of cardinal (East, West, North, South) and ordinal directions (North-East, North-West, South-East, South-West) equally. Each finding was reached from totally 100 formations and average data, with the least and the highest measurements, was presented.

RESULTS AND DISCUSSIONS

Phenological Observations; (Table 2)

1-First Bud Development Date: Based on observation, first bud development initially occured in 15th of March 2013 (Figure 1.A).

2-First-End Leaves Development Dates: First leaf observed in 25th of April 2013 (Figure 1.B) and along the summer new leaf shoots were developed (Figure 1.E) and in 26th of September 2013 development of the new leaf shoots stopped.

3- First-Full-End Flowering Dates: First flower clearly come in view in 25th of April 2013 and was synchronized with leaf development, fully flowering occured 23rd of May 2013 at the same time old fruits from previous year were on the tree (Figure 1.C,H) and in 10th of June 2013 all flowers disappeared.

4- Fruit Maturity Dates: In 2nd of June 2013 first fruit set was come in view. In 30th of June 2013 fully grown dark green fruits clearly observed at the same time old fruits from previous year were still on the tree (Figure 1.D). In 20th of November 2013 the fruits turned yellowish-green, in 8th of January 2014 mostly pale yellow fruits and a few pale green fruits observed even in snowy days (Figure 1.G). In 5th of February 2014 all fruits was pale yellow. The over mature fruits remain the tree until 20th October 2014 together with new generation fruits (2014 spring-formed). In this wise only one term fruit remained on the tree 16 months (from May-2013 to October-2014).

5- First-End Leaf Falling Dates: First leaf falled in 15th of October 2013 and last leaf falled in 10th of November 2014. After the time along the winter the tree was naked, unleafy but only mature and over mature fruits come in sight clearly (Table 2; Figure 1.F).

Table 2. Phenological data from 1st of January 2013 to 31st of December 2014

Year	Date day/month	Phenological observation
2013	15 March	First bud development
	25 April	First leaf development
	25 April	First flower come in view
	23 May	Fully flowering
	2 June	First fruit set
	10 June	End of flowering
	30 June	Fully grown dark green fruits
	26 September	End of new leaf shoots development
	15 October	First leaf falling
	10 November	Last leaf dropping
	20 November	Yellowish-green fruit
2014	8 January	Pale yellow fruit mostly
	5 February	Pale yellow fruit all
	20 October	All fruit dropping

Syamsuwida et al. (2012) reported that flower initiation of *M. azedarach* began in late August, fruits grew in November-December and shedding fruits occured in March-April in West Java, Indonesia. According to Piccola and Gregolim (1980) fully flowering of *M. azedarach* occured from October to May, leaf fall observed two times (July-August and January-February) in Brasil. In another report on *M. azedarach* (Anonymous, 2003), flowering occures from March to June in Hawaii. The differences between the three studies and ours showes there is disparities between hemispheres or climate and region expectedly. In the study of Thakur et al. (2013) this was reported that *M. azedarach* flowering observed in April/May

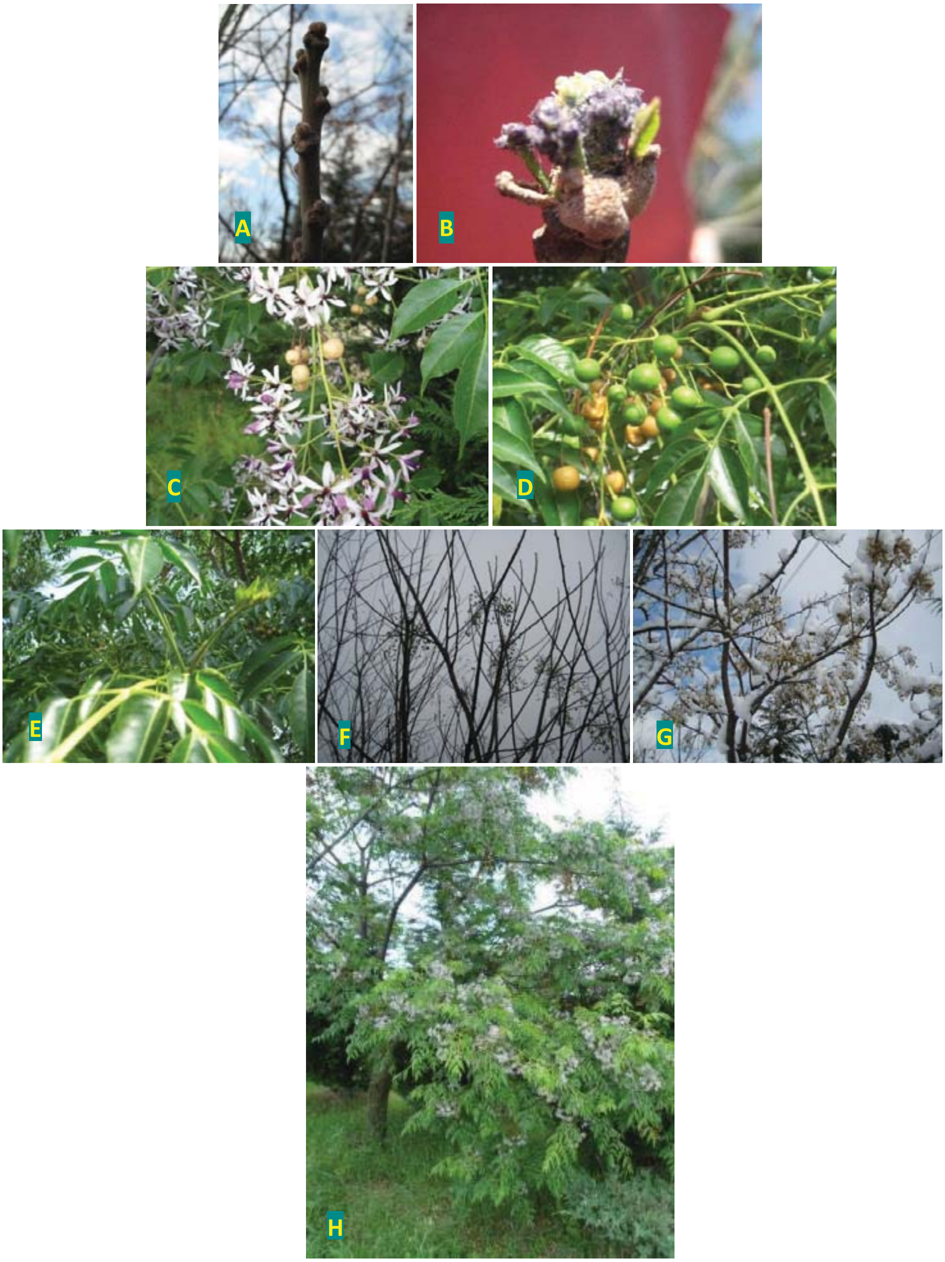

Figure 1. *Melia azedarach* phenological steps; A. First bud development in March, B. Initial leaf and flower development in April, C. Fully flowering in May with old fruits from previous year, D. Dark green fully grown fruits in June with old fruits from previous year, E. New shoots development along summer, F. Leaves fallen tree with mature and over-mature fruit in December, G. Pale yellow fruit even under snow in January, H. A view of fully flowering tree

alongwith fruiting in June/July and seed maturation started from August and continued till October in Himachal Pradesh, India. The data was found more closer than before reports.

Morphological Data; (Table 3)

1-Leaflet Number/Leaf: Melia azedarach leaves are odd bipinnately compound, 17-48 cm long from main petiol basal to leaflets tip. All leaflets was between 26-64 (in average 48.54 leaflets/main petiol). Each main petiol included 5-11 side-divided petiol with the minor leaflets was between 3-9 (in average 5.75 leaflets/side-divided petiol) (Figure 2.A). Abdel-Hameed (2014) also found leaves 20-40 cm long, bipinnated or occasionally tripinnated and leaflets as 3-11. In our study tripinnated leaves were not observed but the other data supported to our findings. This type of leaves were also described in general before; as in the twice pinnate (Singh, 2004) or bipinnate (Toker, 2004) the leaflets of the leaves are also divided into serrate margin opposite leaflets.

Table 3. Morphological data of *M. azedarach* under Kocaeli ecological condition

Plant features	Range of data	Average
Plant age (years old)	12	
Tree height (m)	6.5	
Main stem diameter (cm)	22.92	
Crown-projection area(m^2)	28.2	
Leaf lenght (cm)	17-48	36.5
Side petiol number/main petiol	5-11	6.8
Leaflets number/main petiol	26-64	48.54
Minor leaflets/side petiol	3-9	5.75
Side flower branches/main flower cluster	10-25	17.25
Flower number/main cluster	14-60	32.5
Petal number/flower	5-9	88% 5 petals, 4% 6 petals, 6% 7 petals, 2% 9 petals
Pistil number/flower	1	1
Stamen number/flower	10-11	98% 10 stamen, 2% 11 stamen
6 months old fruit		
Fruit number/cluster	1-17	7.11
Fruit width (mm)	11-53-15.84	13.14
Fruit lenght (mm)	11.15-15.08	13.27
Fruit weight (g)	1.03-2.40	1.55
Endocarp width (mm)	7.49-10.37	8.31
Endocarp lenght (mm)	8.21-12.93	10.27
Endocarp weight (g)	0.25-0.63	0.38
Seed narrow side width (mm)	0.39-2.28	1.84
Seed large side width (mm)	1.15-3.44	2.73
Seed lenght (mm)	6.14-8.26	7.49
Seed weight (g)	0.028-0.035	0.031

2- Flower Number/Cluster: The flower cluster developed from the leaf axils (Figure 2.B) and the cluster also branched into 10-25 side flower branches (in average 17.25 side branches/flower cluster). Each cluster consisted 14-60 flowers (in average 32.5 flowers/cluster). Flowers in an inflorescence bloomed simultaneously. Syamsuwida et al. (2012) also mentioned simultaneously blooming 30-80 flowers in an inflorescence.

3-Petal Number/Flower: The flowers are in a panicle whitish-light purple petales. Flowers were found mostly 5-petaled (88%) but also 6-petaled (4%), 7-petaled (6%) and 9-petaled (2%) were come accross (Figure 2.C,D). Orwa et al. (2009) and Syamsuwida et al. (2012) also

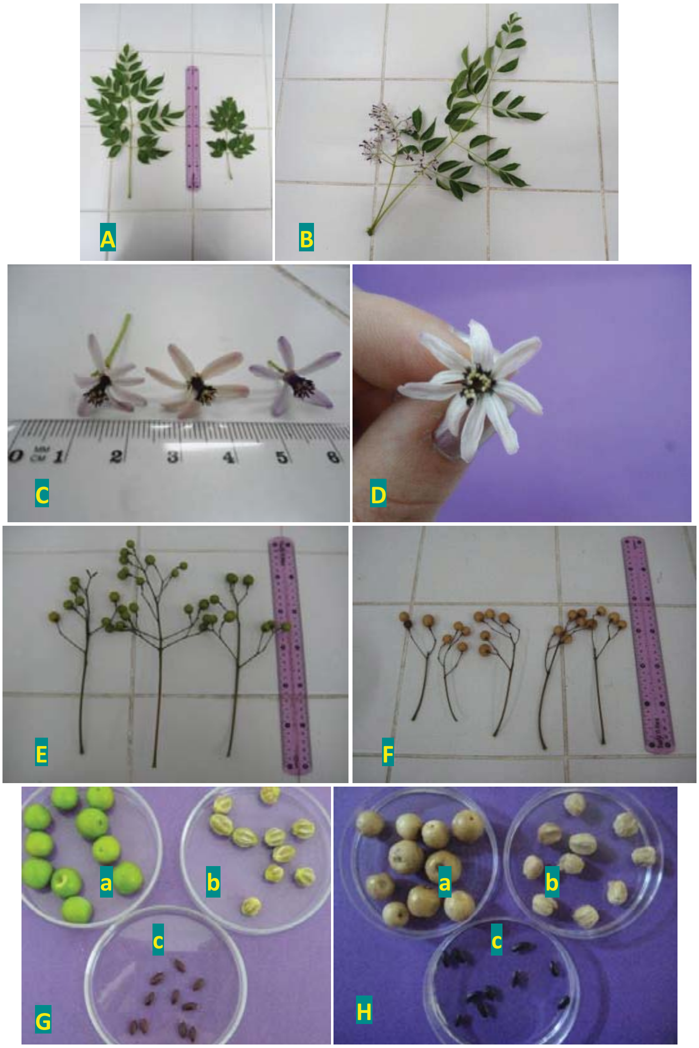

Figure 2. *Melia azedarach* morphological samples; A. Leaves, B. Flower cluster from leaf axil, C. 7, 6 and 5 petaled flowers from left to right, D. 9 Petaled flower sample, E. 6 months old fully grown fruit cluster, F. 12 months old over- mature pale yellow fruit cluster, G. 6 months old fully grown fruits (a), endocarps (b) and seeds (c), H. 12 months old fully grown fruits (a), endocarps (b) and seeds (c).

mentioned white or white to lilac 5 petal respectively. In our study we mostly reached the same data in addition different petal numbers.

4- Pistil Number/Flower: Purple terminale pistil enclosed one stylus (100%). The plant produced hermaphrodite flowers with two gender organs are in the same flower. The data was similar to Syamsuwida et al. (2012) finding.

5-Stamen Number/Flower: Androecium consists mostly 10 yellow stamens (98%) were united to form a tube were found at the outer close to the stigma (Figure 2.D). At 2% rate of stamens were found 11 number happened on interestingly. A tube-like dark purple structure that appears to surround the stamens. Little (1983) also reported 10 stamens. Syamsuwida et al. (2012) reported 8 anthers.

6- Fruit Number/Cluster: Six months after the beginning of the fruit development, in November, 2013 fruits were harvested with clusters. The fruits are drupes, fleshy semi-anhydrous and nearly round. Reports of Anonymous (2003) and Orwa et al. (2009) supported our description. At this stage fruits were mostly yellowish-green, fully grown in shape. Fruit number varied between 1-17/cluster and average fruits number were 7.11/cluster (Figure 2.E). At the same time twelve months after the beginning of the fruit development, in May-2014, old fruit cluster (Figure 2.F) and fruit, endocarp and seed were shown (Figure 2.G; a,b,c)

7- Fruit Width, Lenght, Weight: When fruit measurements were done in November, 2013 on fully grown 6 months old newly harvested fruits (Figure 2.G;a). Width of the fruit varried between 11.53-15.84 mm and was found 13.14 mm in average. Lenght of the fruit varried between 11.15-15.08 mm and was found 13.27 mm in average. Weight of the fruit varried between 1.03-2.40 g and was found 1.55 g in average.

8- Endocarp Width, Lenght, Weight: After fruit flesh removing endocarp was measured in November, 2013 on newly harvested 6 months old fruits (Figure 2.G;b). Width of endocarp varried between 7.49-10.37 mm and was found 8.31 mm in average. Lenght of endocarp varried between 8.21-12.93 mm and was found 10.27 mm in average. Weight of endocarp varried between 0.25-0.63 g and was found 0.38 g in average.

9- Seed Width, Lenght, Weight : After fruit flesh and endocarp removing seeds were measured in November, 2013 on newly harvested 6 months old fruits (Figure 2.G;c). Width of seed from narrow side varried between 0.39-2.28 mm and was found 1.84 mm in average. Width of seed from large side varried between 1.15-3.44 mm and was found 2.73 mm in average. Lenght of seed varried between 6.14-8.26 mm and was found 7.49 mm in average. Weight of seed varried between 0.028-0.035 g and was found 0.031 g in average.

The findings can be useful in studies on agroforestry, agriculture, ornamental and plant physiology subjects in addition with planning raw material flow in bioindustry.

CONCLUSIONS

The study on *Melia azedarach* reached the following findings in the climatic condition;

1- Phenological features was different from the other countries,
2- Observable phenological growth, bud development, begins in March,
3- Leaf growth occures from April to September,
4- Flowering observes from May to June
5- Fruits occure in May,
6- Fruits remain on the tree for a long time (16 months),
7- The tree is deciduous and falls the leaves in October-November in the ecology,
8- To some different morphological data could be reached as being petal and stamen number.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EFFECTS OF GIBBERELLIC ACID (GA_3), INDOLE-3-ACETIC ACID (IAA) AND WATER TREATMENTS ON SEED GERMINATION OF *MELİA AZEDARACH* L.

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Abstract

Melia azedarach L. in addition to ornamental purposes and traditional usage of the plant, some potentially occured bioactive compounds from all parts of the plant that recently studied on can cause an increasing demand of the plant seedling. The present study aims to determine the effects of gibberellic acid (GA_3), indole-3-acetic acid (IAA) and water treatments on breaking seed dormancy, obtaining germination and to reach healthy acclimatized seedlings. The two plant growth regulators, water and different treatment durations have been applied for some plant genus or species as obtaining different germination activities. In the study for germination tests, seeds treated with 500, 1000, 2000, 3000 ppm GA_3 or IAA separately for 6 hours or 24 hours besides water treatments and control in two different seed ages. Among the all treatments in both of the two seed ages (seeds from fresh fruits from tree and seeds from fruits after one year hanging on tree); GA_3 doses gave the best germination and seedling results while controls and IAA treatments had no possitive effects on germination rates. The data was analysed using analysis of variance (ANOVA) of completely randomized block design and the groups that showed variance were then subjected to Duncan's Multiple Range Test with a significance value at P=.05. The percentage data was transformed by Arc Sin √% before carrying out ANOVA.

Key words: *Melia azedarach, GA_3, IAA, seed germination, seed age.*

INTRODUCTION

Melia azedarach L. is a perennial, deciduous woody plant species, belongs to Meliaceae family. The plant has an important role in the nature with valuable fruite, stem, bark, root, leaves, leaf juice, flowers, seeds that used in different purposes in traditional medicine, plant protection and ornamental usage (Mishra et al., 2013). There are some scientific studies (Alché et al., 2002; Saleem et al., 2002; Carpinella et al., 2003; Prophiro et al., 2008; Defagó et al., 2009; Cavoski et al., 2012; Sen and Batra, 2012; Leelavathi and Doss, 2014) which reached positive findings, studied on the plant in last decades related on the mentioned topics.

For the reasons demands for *M. azedarach* would be increased for pharmaceutical and pesticide industries that need raw material without any interruption. For this purposes researhers have worked on clonal propagation or sprouting capacity of the plant with vegetative tissue (Tourn et al., 1999; Scocchi and Mroginski, 2004; Khosh-Khui and Kaviani, 2010; Sen et al., 2010). Furthermore this was emphasized that the plant has very poor seed germination rate due to seed dormancy (Azad et al., 2010) and considerable differences can occure among seed source for growth and yield characters in *M. azedarach* and genetically controlled and selected seed can be an effective tool in the improvement of this economically and ecologically important tree species (Meena et al., 2014).

There are a few reached studies focused on *M. azedarach* generative propagation via seed germination (Banerjee, 1998; Thakur et al., 1998; Sharry et al., 2006; Azad et al., 2010; Khosh-Khui and Kaviani, 2010). During seed germination studies, some external plant growth regulators and another pretreatments like water treatment in different treatment durations are well-known, constantly used and applicable techniques. Especially treatments of GA_3 and IAA are mostly preferred chemicals among all plant growth regulators in seed germination of woody plants because of revealed physiological effects on seed. Some of seeds can be hard to germinate themselves because of external or internal factors (Lang, 1965). The factors well defined and classified in the previous study (Nikolaeva, 1969) and modified by Baskin and Baskin (2004). Physiological dormancy is the most frequent dormancy class (Baskin and Baskin, 2004). The adjustment of physiological dormancy seeds to their external environment is highly specific, and increased germination occurs in response to specific temperature, chemical, or light signals and conditions required for breaking dormancy include application of GA_3 or other hormones such as ethylene, dry storage (after-ripening) warm stratification, and cold stratification (Baskin and Baskin, 2014).

Therewithal, there are some studies conducted on woody species and found positive effects of IAA on seed germination (Mostafa and Abou-Alhamd, 2011; Sinhababu and Banerjee, 2013).

At the same time seed age has an importance on germination rate (Oziegbe et al., 2010).

The study aimed to determine the effects of the GA_3 and IAA concentrations besides water treatment and control on germination rate with two different treatment duration in two different seed ages on germination and seedling capability of *Melia azedarach* seeds under laboratory condition.

MATERIALS AND METHODS

All of the seed materials were collected from a detected single tree which has adapted naturally to Kocaeli City (Turkey) ecological condition. This can be said that the plant is a naturalized species for this area. In the first step of the study *Melia azedarach* seeds from fruits that were gathered at semi-mature yellowish-green step (6 months after the beginning of the fruit development) and called "young seed" in November. In the second step of the study seeds were taken from the fruits that were gathered at over-mature pale yellow step (12 months after the beginning of the fruit development) hanging on the tree called "old seed" in May (Figure 1A,B).

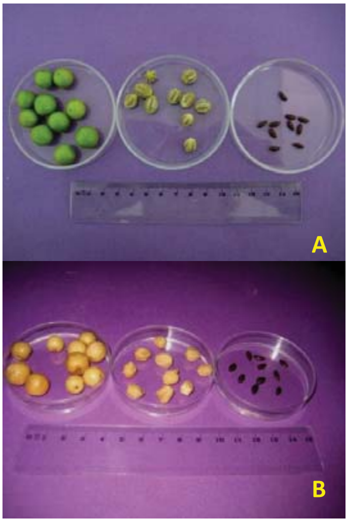

Figure 1. (A) Newly formed fruits, endocarps and seeds; (B) Over-mature fruits after one year hanging on tree, endocarps and seeds

Seeds with the same size selected after fruit flesh and endocarp removing manually without any intermission after fruit gathering in both of the two fruit maturity steps. The experiments (Figure 2A) were conducted during (November, 2013 - August, 2014) at Plant Research Laboratory, Arslanbey Campus (Kocaeli University, Turkey).

After removing, the seed (with seed coat) they were treated with gibberellic acid (GA_3) or indole-3-acetic acid (IAA) one of the concentration of 500, 1000, 2000, 3000 ppm or distilled water under room temperature for 6 or 24 hours. Control seeds were not treated with any chemicals or water. The treated and control seeds were germinated on 6 mm *Petri* plate on moist filter paper beds, irrigated with a fungicide solution once and watered equally in every four days. The step was maintened in an incubator at 20^0C in darkness.

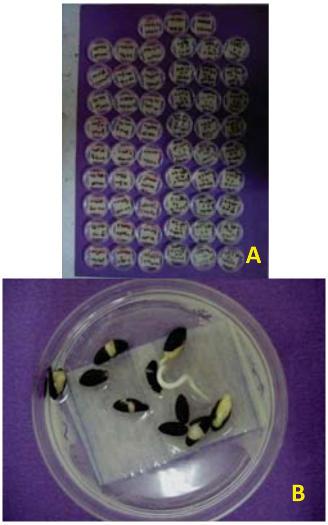

Figure 2. (A) First step of the study in germination experiments; (B) Seed germination in 500 ppm GA_3-6hr treatments in old seed at 21. Day

When root reached 1 cm (more than seed lenght) (Figure 2B), weekly germination percentage (7., 14. and 21. day) and final germination percentage (28. day) were calculated. Final germination anomaly percentage was recorded at 28. day of germination. Following germination, seedling growth was provided in pots consisted peat under day light at laboratory conditions. Seedling survival capability were also calculated as percentage after 2 months acclimatization period of seedlings. In the study each treatment replicated trice, 10 seed were consisted in each replication. The results were calculated as percentage and transformed by Arc Sin √% prior to statistical analysis. Factorial analysis was used based on Randomized Complete Block Design and all data were subjected to analysis of variance (ANOVA). Mean of treatments tested by Duncan's Multiple Range Test. Significance level of source *P*=.05 have been determined.

RESULTS AND DISCUSSIONS

While germination started in the first week in old seeds, young seed gave response to germination in the second week. In the first week, firstly old seeds to which were applied 2000 and 3000 ppm GA_3 for 6 hr and 3000 ppm GA_3 for 24 hr treatments have started to germination. In the second week, young seeds treated with 500 ppm GA_3 6 hr and 2000 ppm GA_3 24 hr showed first germination. There are not significant interaction between the seed age and the treatments in this experiments. In the first 7 and 14 days of germination there were not a clear differences between the mean germination rate of treatments while the differences were statistically important in 21. day of germination. There was any germinated seed in water or IAA applied seeds. Among the GA_3 doses, 3000 ppm GA_3 when treated for 6 hr gave the highest germination rate in mean of seed age but this effect was not statistically significant then other doses of GA_3 (Table 1, Figure 3A).

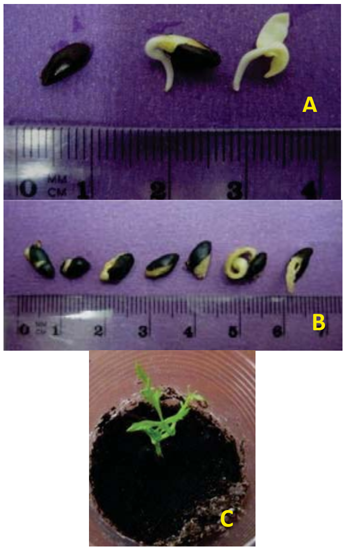

Figure 3. (A) Healty germination steps in 3000 ppm GA_3-6 hr; (B) Different germination anomalies; (C) Seedling acclimatization in peat under lab.condition at day light

Additionally among seed ages, all GA_3 doses showed more germination rates in old seeds than young seeds numerically. Oziegbe et al. (2010) found high percentage germination in six month old seeds as compared to freshly shed seed of some *Ludwigia* species and this was revealed as some degree of dormancy in fresh seeds.

Some germination anomalies were observed during the germination period (Figure 3B). For example, seed coat was cracked and endosperm was observed in some seeds but roots or cotylodone formation did not occure in the later stage. In the other cases cotyledones developed but there were no root development and malformed root developed but there were no arial parts. In these mentioned posture we call them as "germination anomalies" (Pêgo et al., 2012). At the end of the germination period, the germination anomalies were calculated take into account the treatments effects. According to the statistical analysis, being young or old seed were not important but in avarage most of GA_3 concentrations (6 hr or 24 hr) have also responce on seed germination anomalies. In this topic seeds treated with IAA doses, water and control also showed some response. The germination anomalies increased in the old seeds however the difference is not statistically important. The highest anomalies were observed in 500 ppm GA_3-6 hr treated seeds (38.4%) while it was lowest in seeds that was treated water for 6 hr (6.7%).

Germinated seeds and anomaly developed seeds was called as "total vitality". GA_3 concentrations showed higher percentage of total vitality of seeds than control, water or IAA treatments (Table 1).

At the end of the germination period all germinated seeds were transferred in peat media in pots and acclimatized under laboratory condition at day light period. Two months after acclimatization 100% seedling growth observed (Figure 3C).

Banerjee (1998) studied on germination of *M. azedarach* seed with IAA, IBA and GA_3 at duration 24 hr or 48 hr durations. Duration was not found significantly important similarly our result but 200 ppm IAA gave higher germination rate (85.25%) than used GA_3 concentrations showed germination rate between 66.17-74.58%. In contrast to the mentioned results, IAA concentration showed no germination rate in our study. Miransari and Smith (2014) clearly reviewed studies on IAA effects on seed germination and seedling growth. Bialek et al. (1992) and Hentrich et al. (2013) emphasized that although IAA may not be necessary for seed germination, it is necessary for the growth of young seedlings.

Azad et al., (2010) studied on some pre-sowing treatments on seed germination in a mixture media of *M. azedarach*. The treatments were cold water, hot water, scarification and H_2SO_4 concentration besides control. They found that the germination started between 8. and 11. days and 3 weeks after the beginning of the study germination ended in all treatment. Similarly most of germination ended 21. days and after than a few treatments continue to germinate 1 week more in both of seed ages. While the mentioned results supported our germination time, in the study germination rates were found between 39-80% in treated media which is higher than our findings between 0-20% in all treated concentrations or water and control at two seed ages. The seed age, media type and plant origin could be cause the different results. Khosh-Khui and Kaviani (2010) determined that concentration of 800 ppm GA_3 resulted in highest germination percentage (34%) in *Melia azedarach* among all traetments which were water, running water, scarification, dark or light, and 200, 500, 800 ppm GA_3. This findings supported our results that GA_3 effectiveness.

Table 1. Weekly Germination Percentage, Germination Anomalies and Vitality Rate of *Melia azedarach* seed (%)

TREATMENTS	**7. day**			**14. day**			**21. day**			**28. day End of Germination**			**Germination Anomalies**			**Total Vitality**		
	Young seed	Old seed	**Mean of Treat-ments**	Young seed	Old seed	**Mean of Treat-ments**	Young seed	Old seed	**Mean of Treat-ments**	Young seed	Old seed	**Mean of Treat-ments**	Young seed	Old seed	**Mean of Treat-ments**	Young seed	Old seed	**Mean of Treat-ments**
Control	0	0	**0**	0	0	**0**	0	0	**0 b***	0	0	**0**	10	30	**20 abc***	10	30	**20 abcd***
Water																		
Water 6 h.	0	0	**0**	0	0	**0**	0	0	**0b**	0	0	**0**	6.7	6.7	**6.7 c**	6.7	6.7	**6.7 d**
Water 24 h.	0	0	**0**	0	0	**0**	0	0	**0b**	0	0	**0**	3.3	20	**11.7 abc**	3.3	20	**11.7 bcd**
GA_3																		
500ppmGA_3 6 h.	0	0	**0**	3.3	6.7	**5**	6.7	13.3	**10 a**	6.7	13.3	**10**	26.7	50	**38.4 a**	33.4	63.3	**48.4 a**
1000ppmGA_3 6 h.	0	0	**0**	0	0	**0**	3.3	6.7	**5 ab**	3.3	6.7	**5**	30	33.3	**31.7 ab**	33.3	40	**36.7 abc**
2000ppmGA_3 6 h.	0	6.7	**3.4**	0	6.7	**3.4**	0	10	**5 ab**	3.3	10	**6.7**	20	40	**30 ab**	23.3	50	**36.7 abc**
3000ppmGA_3 6 h.	0	6.7	**3.4**	0	6.7	**3.4**	3.3	20	**11.7 a**	3.3	20	**11.7**	20	40	**30 ab**	23.3	60	**41.7 ab**
500ppmGA_3 24 h.	0	0	**0**	0	0	**0**	0	10	**5 ab**	3.3	10	**6.7**	13.3	46.7	**30 ab**	16.6	56.7	**36.7 abc**
1000ppmGA_3 24 h.	0	0	**0**	0	6.7	**3.4**	6.7	13.3	**10 a**	6.7	13.3	**10**	23.3	43.3	**33.3 ab**	30	56.6	**43.3 ab**
2000ppmGA3 24 h.	0	0	**0**	3.3	6.7	**5**	3.3	10	**6.7 ab**	3.3	13.3	**8.3**	16.7	20	**18.4 abc**	20	33.3	**26.7 abcd**
3000ppmGA_3 24 h.	0	6.7	**3.4**	0	6.7	**3.4**	0	13.3	**6.7 ab**	3.3	13.3	**8.3**	13.3	40	**26.7 abc**	16.6	53.3	**35 abcd**
IAA																		
500ppmIAA 6 h.	0	0	**0**	0	0	**0**	0	0	**0 b**	0	0	**0**	6.7	20	**13.4 abc**	6.7	20	**13.4 abcd**
1000ppmIAA 6 h.	0	0	**0**	0	0	**0**	0	0	**0 b**	0	0	**0**	20	26.7	**23.4 abc**	20	26.7	**23.4 abcd**
2000ppmIAA 6 h.	0	0	**0**	0	0	**0**	0	0	**0 b**	0	0	**0**	16.7	16.7	**16.7 abc**	16.7	16.7	**16.7 abcd**
3000ppmIAA 6 h.	0	0	**0**	0	0	**0**	0	0	**0 b**	0	0	**0**	10	16.7	**13.4 abc**	10	16.7	**13.4 abcd**
500ppmIAA 24 h.	0	0	**0**	0	0	**0**	0	0	**0 b**	0	0	**0**	6.7	13.3	**10 bc**	6.7	13.3	**10 bcd**
1000ppmIAA 24 h.	0	0	**0**	0	0	**0**	0	0	**0 b**	0	0	**0**	10	13.3	**11.7 abc**	10	13.3	**11.7 bcd**
2000ppmIAA 24 h.	0	0	**0**	0	0	**0**	0	0	**0 b**	0	0	**0**	10	10	**10 bc**	10	10	**10 bcd**
3000ppmIAA 24 h.	0	0	**0**	0	0	**0**	0	0	**0 b**	0	0	**0**	6.7	10	**8.4 bc**	6.7	10	**8.4 cd**

*Value within the same column (mean of the treatments) with different lowercase letters are significantly different at *P*=.05

In our study different types of germination anomalies were observed. The anomalies types were activation and growth in endosperm and cotyledone development without any roots or without the formation of aerial part with malformed roots. In this respect, GA_3 concentrations gave higher responses than IAA doses in mean and in old seed germination anomalies were observed more than young seeds. Narantsetseg (2014), Queiroz et al. (2000) and Pêgo et al. (2012) studied on seedling abnormalities using seed germination tests in different plants. They emphasized that abnormalities are related with plant region, used chemicals-genotypes or treated temperature respectively.

According to the scientific findings studied by Meena et al. (2014) genotypic correlation coefficient values are higher than corresponding phenotypic values and they emphasized that considerable differences exist among seed sources that they worked for growth and yield characters in *M. azedarach* and appreciable improvement in growth parameters can be achieved by collecting seeds from selected plus trees on a short-term basis.

CONCLUSIONS

The study reached the following findings as follows:

- ✓ Germination has occured in 4 weeks after beginning of the experiments.
- ✓ While GA_3 concentrations were effective on germination; control, water or IAA treatments had no response on germination.
- ✓ Germination rate in old seeds was higher than young seeds so the seed may need a physiologic maturation period.
- ✓ The maximum germination capability was found in 3000 ppm GA_3-6 hr treatment (20%) in old seeds.
- ✓ GA_3 concentrations had more effect on seed vitality.
- ✓ *M.azedarach* seed germination rate was very low and needed forcing with GA_3 under the experimental conditions.
- ✓ The study requires ongoing experiments on this plant at different seed collecting time, different media, pretreatments and environmental conditions.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

AGRICULTURE AS A PROVIDER OF LANDSCAPES, TICVANIU MARE VILLAGE CASE STUDY

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Abstract

Considering agriculture as both a large-scale user of land and a provider of landscapes, this paper aims to present the evolution of landscape in Ticvaniu Mare, Caraş Severin County, located in the Romanian Banat Region due to different agriculture policies. The paper debates on different historical periods: Habsburg Empire (beginning with the 18th century), between the wars (1918-1939) with The Romanian Agricultural Reform (1921), communism and post communism period (1990) until present day. We are interested in how agriculture modified the landscape over time and if there still are landscape elements bearing witness to such changes in the present. The research focuses on different scales: a small scale, the village, its tissue, plots' structure, homestead, specific architecture and a large scale, outside the village, agriculture fields, orchards, meadows/pastures and agriculture infrastructure and buildings. The research data has been obtained through different research methods: archive research (The Romanian National Archives in Timisoara and Caransebeş, Municipality of Ticvaniu Mare archives), map comparing and several field observation. The research on agriculture policies during different periods and landscape changes reveal that the two are well interconnected and that landscape should be taken into consideration by the local/national/European agricultural policy.

Key words: *agriculture, landscape, landscape change, agriculture policy.*

INTRODUCTION

Considering agriculture as both a land user and a provider of landscapes (Lefebvre et. al., 2012) this paper intends to analyse different agriculture policies and the way they changed the landscape in Ticvaniu Mare village. Landscape means an area whose character is the result of the action and interaction of natural and human factors (Council of Europe, 2000) and agricultural landscape is the result of the land use and management system in an area (Kizos et. al., 2006). Also, landscape is considered to have memory, some characteristics we see today come from the past, representing different historical periods and management systems (Haines-Young, 2005). The research on landscape changes in Ticvaniu Mare due to different agriculture policies is part of a wider research dealing with agriculture landscape in different villages in Banat, the historical perspective being the central focus. Agricultural policies applied different on Banat's area during historical periods, in accordance with natural and social conditions. Therefore in some villages the historical periods with agriculture policies are more present than in other and determined different landscape changes. There are typical archaic Romanian villages in Banat, still practicing traditional agriculture where the landscape systematization during Habsburg Empire did not apply, nor communist collectivization (Crivina de Sus in Timiş county or Cornereva in Caraş Severin). On the other hand, Banat plains suffered great landscape changes during Habsburg Empire when a great part of the marshes were drained out with the help of Dutch engineers (Griselini, 1984) and transformed in agricultural land. During this period new villages were settled, following new predefined typology (Buβhoff, 1938) the most common typology being the cess table (Biled and Hatzfeld in Timis County) and the cross shape typology (Bogarosch). This period is also associated with the modernization of agriculture in Banat. Later, probably one of the most important agriculture reforms in Romania is the Agriculture Reform in 1921, that applied a set of laws for each region in Romania, in Banat applied the Law For Agriculture Reform in Transilvania, Banat,

Crişana and Maramureş from the 30th of June 1921. Few of the mutations generated by the agricultural reform were:
-the reduction of big properties and the raise of the percentage of medium and small properties;
-the raising of medium surface of medium and small properties and the reduction of it in case of the big properties;
-the reduction of the bipolarity of the agriculture property in Romania; (Otiman, 2007).
Not in the end, period of the collectivization process during communism starting with the law 187/1945 for the agrarian reform (Otiman, 2006) is probably one of the most intensive reforms with a great impact on rural society and landscape:
-the private property was transferred to the public/governmental property;
-there were organized local centres for agriculture machines (the future SMT);
-the most efficient farms (between 50-100 Hectares) were totally or partially turned into governmental property;
-with the Decree 133 in April 1949 agriculture cooperatives (first named GAC) began to be founded.
Ticavniu Mare the village is mentioned in 1699 to have a majority Romanian population, the property of Petru Macskási and later it appears in official Empire documents (Lotreanu, 1935) and detailed maps. In time the landscape in Ticvaniu Mare suffered radical changes due to agriculture policies and agriculture land management as it was subject of all agricultural reforms.

MATERIALS AND METHODS

The research proposes a historical approach on the village of Ticvaniu Mare (Agnolleti, 2007) and the methodology focuses on two different scales:

- A village scale with its tissue, plots' structure, homestead, circulation and architecture
- A large scale analyse, outside the village (Ticvaniu Mare's territory) with agriculture field, orchards, meadows/pastures agriculture infrastructure and buildings.

The results will be correlated with short references on social impact and changes in social structure.

Research materials are obtained from four main sources:

- Archives study: National Archives in Caransebeş, Municipality of Ticvaniu Mare Archives, National Agency of Land Improvement, Timiş- Mureş inferior Teritorial Branch Archives (ANIF) and personal archives;
- Historical map and plans comparing;
- Studies and research on Banat;
- Field observations and landscape analyse (James et. al., 2008);
- Photographic documentation;

RESULTS AND DISCUSSIONS

1. The village scale analyse

Being a majority Romanian village, Ticvaniu Mare has a typical organic tissue. Usually, Romanian villages structures before Habsburg Empire colonisation are organic, in relation to the landscape and natural conditions, the houses are grouped and the circulation system is not very well developed (Ciobotă et. al., 2014) (Figure 1). Generally, the house is surrounded by a garden or there is a small orchard nearby. In Romanian villages, usually young couples leave their family's home and move out building their own, phenomenon named "roire". (Gheorghiu, 2008). During this period, the houses in Romanian villages were made out of clay, straw and reed or the walls were made out of knitted birches and clay. Usually a house had two rooms, one used as a kitchen and one as a dormitory.

Figure 1 Ticvaniu Mare. The First Military Survey 1763-1787 (http://mapire.eu/)

After Kempelen visited Banat, to observe the colonization process, the Empire ordered a set of regulations for the colonization named "Impopulations-Haupt-Instruktion" (Roth, 1988). This regulation affected not only the new colonized villages but also Romanian and Serbian typical villages. The house was to be placed perpendicular to the street so that the access inside was protected. Not only the house and its relation to the street was affected by the new regulations, but also the village structure, circulations became more coherent and houses got in better relation to them (Figure 2).

Figure 2 Ticvaniu Mare. The Second Military Survey 1806-1869 (http://mapire.eu/)

Village architecture is well related to community occupations and the level of welfare. A quick analyse on Ticvaniu Mare architecture reveals different periods in the village history, most of them connected to agriculture. The analyze of Ticvaniu Mare's Second Military Survey map, reveals a quite dense compact village, with the plots orientated perpendicular to the street (Figure 3), with a very strong axis (the road from Resita to Gradinari). All the houses have small cultivated gardens. Romanian peasant's agriculture techniques are described to be poor, and they cultivate only some roots and few plants for eating (Griselini, 1984).

Figure 3 Typical clay house of a 19th century peasant with later extension at street side (original)

In time, the house typology changes in Ticvaniu Mare. Houses perpendicular to the street are less built and the house parallel to the street begins to be typical. The new house typologies are bigger, more compact and together with its annexes define an interior yard well protected. The crop garden is outside this ensemble (Figure 4).

Figure 4 House No. 342. Typical compact house of a rich peasant 20th century (original)

All these coherent structure and architecture was brutally completed during communism period with technological/urban architecture such as the Machine and Tractors Station (SMT), the Veterinary Centre, animal stables or the engineer's block of flat. In 1971, People's Council of Caraş-Severin County orders a research for architectural solutions in rural areas in Caraş-Severin County. The project No. 255 *Research about housing in rural areas* is accomplished, offering 10 architectural solutions in accordance with different cultural landscapes (Unit for Planning in Caraş-Severin County, 1972). Nevertheless, few years later the project No. 1645 orders the construction of a six apartments block of flat that should be finished until 1979 (Figure 5).

Figure 5 Block of flat for agriculture engineers, 1979 (original)

Part of the communist buildings and farms were put down after December 1989, but few still remained as marks of the period.

Even if the structure typology of Ticvaniu Mare was with the houses facades close to each other, describing a continuous front, street side, the situation has changed in the late years when part of the Romanians, because of economic problems and weak agriculture reform, left the village, selling their houses to gipsy community that built their own typical houses (Figure 6).

Figure 6 Typical continuous house front interrupted by a new out of the scale house, 21st century (original)

2. The large scale analyse (Ticvaniu-Mare territory level)

On the First Military Survey map, agriculture landscape in Ticvaniu Mare is quite modest. There are few gardens or orchards near houses and few arable terrains along Caraş river. For this period, cultivating the land is very well connected to nature and it has a small impact on the landscape. A family produces only for its own needs. Another reason could be the lack of agriculture knowledge, as Romanian peasants don't plough the land or they do it very bad and they don't fertilise the land with compost (Griselini, 1984). Situation changes, the map of The Second Military Survey reveals that the whole village of Ticvaniu Mare is surrounded by orchards, and first lots are noticed. Another sign that the agriculture developed are the two mills along Caraş river, one of them still in the same location, still functioning until modernization and later closing after miller's death. During Habsburg Empire there were several regulations for beautification of villages, but also for planting fruit trees and especially Morus alba for silk production (Griselini, 1984). Therefore, alignments of trees along roads already appear on the Second Military Survey map of Ticvaniu Mare.

The situation of Romanian peasants is not very good during this period. A statistical survey in Transylvania, Banat, Crişana and Maramureş conducted in 1914 reveals the fact that a very important part of the agricultural terrain, 11.283.818 jugăre (1 jugăr= 0,5775 hectares) belonged to minorities (6 jugăre/peasant), meanwhile Romanians had only 1 jugăr/peasant (Georgescu, 1943). This situation, but also agriculture situation in other Romanian regions, was the fundament for an agricultural reform, process started in 1918 and finished in Banat in 1921 with the Law For Agriculture Reform in Transilvania, Banat, Crişana and Maramureş. As an immediate result, there was an excessive fragmentation of land generating a diverse landscape mosaic (a complete plot was of 7 jugăre and a colonisation plot had 16 jugăre) (Law For Agriculture Reform in Transilvania, Banat, Crişana and Maramureş, 1921) and a decrease in production due to poor endowment.

Later, in April 1949, the process of agriculture organising into a system of collective farms, following the Soviet model of *kolkhozes*, started also in Romania. In Ticvaniu Mare the Collective Agricultural Farm (GAC) was founded later in 1952. At first, GAC was founded by 42 families but statistics show that only in 7 years there were already 215 families as GAC members (Collective Agriculture Farm report, 1960). Still GAC Ticvaniu Mare wasn't a very stable organization, dealing with great variations of land use from one year to another as it is revealed in The Annual Production and Financial Plans 1962-1969. The situation turned to be different starting with 1966 (Production and Financial Plan of GAC Ticvaniu Mare, 1962-1969) when GAC was transformed in Agriculture Co-operative for Production (CAP).

In 1976, the Agriculture Co-operative for Production (CAP) Ticvaniu Mare plants the first plot with orchards (P1) (Figure 7) having a total surface of 28 hectares (13.852 trees) and during 1977-1978 plantings in P1 continue and the second plot (P2) is planted with a total surface of 93 hectares (76.500 trees). In 1977 The Economic Inter-cooperative Fruit-growing Association is founded and the orchard surfaces are turned into farms (P1 turns into Farm No.1 and P2 turns into Farm No.5.).

Figure 7 Land preparing for tree planting. Plot P1, 1976 (eng. Costescu G., director of AEIP Ticvaniu Mare personal archive)

In 1978, a plot belonging to Farm No.2 is planted (P3) and later in 1979 and 1981 trees are planted on the last plot of the farm (P4). In 1984 and 1986 the last two small areas are planted in Farm No.1, one with cherry trees and another with raspberry (Figure 8). Even if AEIP was founded in Ticvaniu Mare, only three of the five fruit tree farms owned by the association, were situated on Ticvaniu Mare's territory. Farms No.3 and No.4 were located on Cârnecea and Secăşeni territory.

Figure 8. Fruit trees planting situation at AEIP Ticvaniu Mare between 1976-1986 1. Tree planting in 1976; 2. Tree planting 1977 and 1978; 3. Tree planting in 1979, 1981, 1984 and 1986 (original, after an eng. Costescu G., AEIP Ticvaniu Mare's director situation, dated 1983)

Between 1976 and 1986 a total surface of 406,78 hectares of land were transferred from the Agriculture Co-operative for Production (CAP) Ticvaniu Mare to AEIP Ticvaniu Mare and they were converted into orchards. An analyse on the land use situation before being converted, proves that for parcel P1, a total surface of 100,64 hectares was converted (97 hectares of natural pastures and 3 hectares with other usage). For parcel P2, a total surface of 139,38 hectares was converted (95,64 hectares of arable land, 24,53 hectares of pastures, 7,65 hectares of meadows and 11,18 hectares with other usage). For parcel P3, a total surface of 40,22 hectares was converted (37,92 hectares of pastures and 2,3 hectares with of other usage). For parcel P4, a total surface of 126 hectares was converted (70,59 hectares of arable land, 40,27 hectares of pastures, 9,65 hectares of meadows, 1, 08 hectares of orchards and 4,95 hectares of other usage). (AEIP Ticvaniu Mare, 1980). This land conversions together with land drainage and land erosion control works along Caraş river are maybe the greatest changes in Ticvaniu Mare's landscape since Habsburg Empire. In 1985 the National Agency of Land Improvement (ANIF) starts a large project of erosion control and agriculture land drainage. For better management, the area around Ticvaniu Mare is divided in two subzones, Vărădia-Secăşeni with an impact area of 3.734 hectares and Greoni-Ticvani subzone with an impact area of 7.855 hectares. The channels' total length for Vărădia-Secăşeni subzone has 121.235 meters (73.520 drainage channels and 25.680 meters erosion control channels) and for Greoni-Ticvani subzone the channels' total length is 138.451 meters (122.601 drainage channels and 15.850 erosion control channels). These works had also architectural elements such as bridges, concrete tubes and abrupt discharges (ANIF archives, 1985-1989). Even if all those quantities were not implemented only on Ticvaniu Mares's territory, the impact on the landscape and especially in Caraş flooding valley was quite significant. The marshes here were drained out and their specific vegetation (Salix alba, Salix fragilis, Populus tremula, Populus alba, Sambucus nigra, Rubus idaeus) were cut down. All this natural landscape was transformed in agricultural landscape (Figure 9).

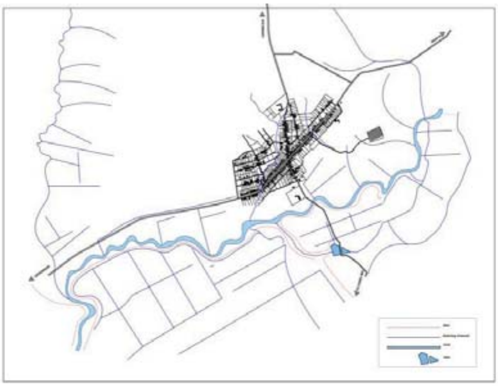

Figure 9. Drainage channels system and flooding protection dike (original, after an ANIF map in archives)

After 1989, together with the transition from communism to capitalism the agriculture situation was not very good. Even if dissolving both AEIP and CAP in Ticvaniu Mare was very well welcomed, the peasants and agriculture situation wasn't getting better. The new Law 18/1991 was applied. Even if the law had two objectives: to give back property to people and to make the agriculture reform, it is proved to be very weak and its impact wasn't the expected one. There were two immediate effects on the situation of Ticvaniu Mare:

-peasants received small properties, maximum 10 hectares (even if they had more before collectivization) and the new farms were very bad endowed.

-the migration of the village population to the city and the aging of the remained population (Otiman, 2007).

As a short term effect on Ticvaniu Mare's agricultural landscape, there was a great fragmentation of the arable landscape and a great diversity of land mosaic with a growing trend in land abandonment because of a weak agricultural reform. As for the great potential of fruit farms (they were in full economic production), even if the land was returned to peasants property, they didn't have the specific technology and knowledge to continue production. As a result, on a medium term, the fruit farms declined and turned into almost forested areas (Figure 10).

Figure 10 In the foreground abandoned apple trees orchard and in the background forested plum trees orchard at Farm No.2 Ticvaniu Mare (original)

From the large surface of fruit trees farms (708 hectares belonging to AEIP Ticvaniu Mare) only a small surface was still maintained (2 hectares of apple trees farm) until 2003.

Because of the Law No.7/1996 of Land Cadastre articles, of the already poor rural communities and of the land low price compared to other EU countries, a phenomenon of large personal farms and large agriculture land property appeared in Romania. In Timiş and Arad counties, in 2007, based on an unofficial data-base, one third of the agricultural surface was already part of this kind of large farms property of foreign companies (Otiman, 2007). In Ticvaniu Mare this phenomenon determined a great landscape change, agriculture landscape mosaic being less diverse (Figure 11).

Figure 11. Large farms on Ticvaniu Mare's territory (Agency of Agriculture Payments and Interventions in Agriculture Caraş-Severin)

Starting with the year 1880 there was a constant decrease in population and in ethnic diversity due to different reasons (Table 1). Between the periods with the greatest impact, besides the two world wars are the communism period and the period after December 1989 until now. The communist period was one of the most tragic periods for Romanian peasants culminating with HCM 308/1953 for the expropriation of land. This was the moment when lots of the peasants in Ticvaniu Mare left their village and moved to industrial places around (Reşiţa, Oraviţa, Ciudanoviţa, Anina) to work in industry or mining. After December 1989, the Ticvaniu Mare's community identity loss process continued because of economic problems and lack of a real agriculture reform with a great impact on landscape and village architecture.

Table 1 Population in Ticvaniu Mare village between 1880 and 2011 (Varga E. Árpád, 2000 (updated in 2008). Nationality and confessional census in Transylvania, III. Arad, Caraş Severin and Timiş Counties between 1880 and 2002, Pro-Print Publishing, Miercurea Ciuc. For 2011 census data from the Municipality of Ticavniu Mare)

Year	Total	Romanian	Hungarian	German	Gipsy	Other	Possible causes of the decrease in population
1880	1844	1775	2	24	-	1	
1890	1871	1834	2	31	-	1	
1900	1832	1761	13	36	-	3	
1910	1684	1589	6	46	-	1	World War I
1920	1422	1348	4	21	-	-	
1930	1452	1388	5	43	13	1	World War II
1941	1262	1095	3	36	-	-	
1956	1054	-	-	-	-	-	
1966	880	698	1	3	175	3	Collectivization process culminating with HCM 308/1953 for the expropriation in industry interest and later Decree No. 115/1959. The moving from the village to industrial areas.
1977	832	652	1	5	173	-	Economic problems, weak agriculture reform and migration to EU countries
1992	782	482	7	10	280	3	
2002	831	470	6	8	342	-	
2011	862	363	3	3	483	-	

CONCLUSIONS

Different policies applied during different historical periods produced dramatic changes into Ticvaniu Mare's landscape along the past centuries.

The application of this historical analyse method shows that there are landscape elements transmitted from the past to the present time. This kind of research should build the basis of a future strategy of management, protection and restoration of such heritage as part of the local identity.

Another conclusion is that agriculture policy did not change only the landscape but it also had a very strong impact on the community. During Ticvaniu Mare's history there are big changes in the community structure.

As a main conclusion, the historical approach studying agriculture policy in Banat and particularly the way they applied and influenced Ticvaniu Mare, reveals a very strong interconnection between policies and landscape dynamic with a great impact on community identity.

ACKNOWLEDGEMENTS

This work was partially supported by the strategic grant POSDRU/159/1.5/S/137070 (2014) of the Ministry of National Education, Romania, co-financed by the European Social Fund – Investing in People, within the Sectorial Operational Programme Human Resources Development 2007-2013.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESTORATION STUDY IN ORDER TO INTEGRATE NEW FUNCTIONS IN THE ACTUAL STRUCTURE OF OROMOLU MANOR

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Abstract

In time mansions and palaces that belonged to nobles and representatives of the Romanian monarchy underwent transformations that were due to changes in the architectural ensemble of dominant functions. Many of them have lost the function of dwelling and turned in office buildings or public interest. Mansion at Pausesti Maglasi Valcea County, which belonged to family can be a model for transforming ancient architectural structures with a single family dwelling leading role in buildings for training and leisure. The methodology to integrate new functions in the context of restoration of built architecture targeting and assembly of garden landscaping related Oromolu Mansion. To conduct the study of landscape restoration has outlined a set of specific analysis of complex landscape that provided information absolutely needed to successfully perform the task of adapting the current functioning of the whole history, atmosphere and ambience of the reference time fall monument, so restoring the whole area is not foreign to the values heads and authentic memoirs. After synthesizing this information it has been generated a series of major strategic directions that underpins the concept development and restoration solution / redevelopment landscaping.

Key words: *restoration, adaptation, refunctionalisation*.

INTRODUCTION

If the restoration of works of art or architecture, the study and intervention aims mainly accurate reconstruction of the original shape and appearance of that object, in the restoration of the historic landscape, the main objective is to reconstruct the atmosphere of that landscape and not necessarily to restore the original state of its component entities.

Garden, as part of the landscape, generates by itself a certain kind of atmosphere and implicitly refers to the archetypal patterns that generated the history of European garden art garden classic or romantic gardens.

Classic garden style praised supremacy of reason, order, geometry and human power to master nature, while romantic garden style rediscovered the beauty, perfection and harmony generated by human relationship with nature, gardens of that time were greatly reflecting natural model as unaltered by man. (Iliescu, 2008)

"The Romanian Garden "takes these features, the two styles of gardens and combines them according to the measure of local understanding, however, beyond simple imitation or use of formal models and principles characteristic of European gardens (Toma, 2001)

The spirit and atmosphere that gives life to Romanian garden is rather a natural space, abundant with fruits, which provides shelter from the scorching sun, path that you refresh in cold and clear water, shining of people cheerfulness, which resounded with music and noise of games and parties.

These are the characteristic features found in most Romanian gardens, which established them authenticity and pragmatic character, inclined to practical use without neglecting the harmonious relationship with European models taken as reference in the way of building the gardens.

MATERIALS AND METHODS

Since the World Heritage Convention drafted in 1972 in Paris, are considered part of the cultural heritage those sites that constitute the work of man or man and nature, serving as a valuable historically, aesthetic, ethnological and anthropological landmarks. Expression of the relationship between civilization and nature, place of leisure and reverie, the garden captures an idealized image of the world carrying over time, culture, style, age and originality of the creator.

In the absence of relevant historical documents and other sources of information today in an effort to restore the garden, were conducted historical research on similar buildings in the same space-time framework – XX century.

The set of analyzes carried out on the site aimed to identify the historical reference period and items of special historical value, assessment and quantification of the existing plant fund value, defining the existing functions, facilities, their current status and the way they relate with each other, the geoclimatic environment that houses the garden and its relationship with the surroundings.

Research has revealed a major empirical and spontaneous landscape design intended to ennoble the buildings constructed at that time.

Regarding the garden of Oromolu there were identified pieces of furniture having a special historical and aesthetic value (two benches carved in natural stone, but placed indiscriminately); plant specimens whose size and approximate age suggests that they are part of the composition of vegetable garden during the early twentieth century (linden - *Tilia platiphillos*, Maple - *Acer platanoides*, Ash - *Fraxinus excelsior*, Oak - *Qercus peduncuIiflora*, pine - *Pinus nigra*, spruce - *Picea abies*, yew - *Taxus baccata*. fir - *Abies alba*) and at the same time revealed a spatial zoning that may suggest how the garden was organized (Figure 1.).

Figure 1. Spatial zoning of the garden (own source)

Certain geometric formations made of vegetal and elements and the vertical systematization of the land, suggested the existence of models using the principles of space organization in landscape architecture: garden's space of honor for the main façade of the manor consists of a sequence of two terraces whose difference is taken over by a slope with two sets of symmetrically placed stairs (Figure 2), on the left and right along the perspective that opens up the windows of the mansion.


Figure 2. Stairs – constructed elements that are part of the garden initial planning (own source).

On the upper terrace there is a spatial formation of circular invoicem made of *Buxus sempervirens* specimens (Figure 3). Specimens phytopathology status is precarious, the entities being aged, unstructured and aesthetically unpleasing. Spatial organization and the use of vegetation in thi area gives the mansion a representation framework that includes overall perspective to and from the edifice (the garden), geometric compositions, symmetrical to the central perpendicular axis for the main façade of the manor.

Figure 3. Circular space shaped by a group of shrubs of Buxus sempervirens the species - the initial arrangement of the garden (own source).

At the top of the forest garden was identified plant specimens arrangement according to principles of landscape architecture, trees and *Tilia* species *Tilia cordata platiphillos* being arranged in an inconsistent alignment, extending throughout the northern side of the garden. The alignment keeps a relatively constant distance to the north fence of the property, suggesting the possible presence of a utility road in this area of the garden (Figure. 4).

Figure 4. Alignment of trees and the utility road, part of the initial planning of the garden (own source).

In the "forest garden type" the spatial arrangement of vegetation and its diversity is an undeniable reference to the characteristics romantic landscape gardening, seemingly natural way through the bush and trees are composed in this area (Figure 5).

Figure 5. Forest garden (own source).

The vegetal spectrum, in this area covers both kind of species: from the local ecosystem, and exotic species such as Platanus acerifolia, Paulownia tomentosa, Acer saccharinum, Ginkgo biloba, Maclura aurantiaca, Sophora japonica, etc. The dominant species are represented by specimens of *Carpinus betulus, Juglans regia, Acer platanoides* and *Tilia platiphillos.*

The significant percentage, the favorable pedo-climatic regime and good status of exotic species in this ecosystem supports the idea of using some species thet are very similar with the existing ones. Also, the spontaneously herbaceous layer identified in the site indicate, in addition to invasive plant groups, a number of perennial grasses category (*Phleum, Festuca, Dactilis Lolium* etc.), possibly favored by soil composition, which is an excellent environment for developing this type of perennial vegetation.

The existing plant fund and the evolutive state in which it is located makes a good relationship with the neighbouring landscape as vegetation having reached maturity, is part of a massive plant extending on several ha. in the north of the property. In contrast, in the southern part of the site passes the National Road 64A, which brings a transport station (a visual conflict with the character and atmosphere of the manor) and noisy traffic. In the distance, a series of hills bring back to sight an image and an atmosphere that is suitable to the dominant character of this historic monument.

In time, however, there is a risk that the image and character of these picturesque surroundings are altered by various elements built that does not fit in a landscape of such invoice. This involves taking measures limiting factor inappropriate assault on the historical monument. Unsightly constructions, noise, visual and air pollution are harmful factors that can be annihilated by legal measures of protection of historical monuments outside localities. This approach requires legal protection zone delineation and establishment of the historical monument (500 m. - Measured from the outer limit of the property), which had already limit accompany the historical and plans should provide for landscaping (Law nr.422 / 2001, art. 8). At the same time, planting trees and shrubs with dense contour perimeter of the property will be a visual and sound barrier that will allow isolation to the historic area in relation with national road.

Accessibility of motor vehicles on the property is made with great difficulty because there is no space to allow a stationary waiting outside the perimeter of national road 64A until the opening of doors by an authorized person (Figure 6).

This issue raises the necessity of establishing functional withdrawals for the purposes of traffic on National Road and the flow conditions in the roadway accesses the property (or a band's speed reduction or an outlet practiced within the property, the input roadway).

Figure 6. Site access (own source).

RESULTS AND DISCUSSIONS

In terms of the concept of landscaping, the solution is focused on highlighting all of the "strong" aspects that characterizes the historic mansion (studied in complex analysis of landscape) and integration of facilities and functions to meet the high requirements of new functional purpose of the building. In this regard were designed multifunctional spaces, areas of interest, objectives and diversified atmospheres which provided perfect relaxation, both active and passive activities that invite and encourage playful, and meditative, providing abundant color, tactile, olfactory and characteristic charm and harmony of the Romanian garden type and to give benefit of the murmur and the cool water, gentle warmth of a clearing or occurring in forest meadows.

At stylistic approach is proposed the mixed style, style that characterizes gardens established during the nineteenth and twentieth centuries, bringing gardens that harmonize the two styles that preceded it; classic and romantic. The area in the vicinity of the manor is treated in a conventional manner using geometric rigor and order to enhance the architectural value of the building.

The main facade is accompanied by a reminiscent circular lawn makink an imaginary circle of buxus species, but the overall appearance, and also in size, obstruct the affirmation of the value of construction in relation to land. The pedestrian walkways stresses the lawn circularity, then backing off two branches that lead to natural stone stairs that go down to the lower terrace. At the end of the path is a decorative pond, also circular in form, a keystone closing the semicircular design of the alleys on the lower terrace. In this space there is the possibility of organizing outdoor group sessions or tea can provide a delightful atmosphere (Figure 7).

Figure 7. The representative area of the garden – virtual simulation (own source).

The transition between the levels of the two terraces is taken by a succession of stairs that are designed to emphasize the geometric nature of this area. The end point of the shaft which is drawn perpendicular to the main facade of the manor, is supported by an end view defined by a group of five pieces of pyramidal oak (*Quercus rubra* "Fastigiata"). This plant is a focus group color and a volume that will serve to structure and prioritize the entire space of representation in the vicinity of the manor.

To the right of the mansion, near the proposed park, a group of three specimens of the *Liquidambar styraciflua* (which turns bright red in autumn) founded another accent color point, making a very interesting contrast, is profiled against a background consisting of pieces of the species *Acer saccharinum* (colored in golden yellow in the same period). All proposed plant composition in the representativeness of the manor offers a varied but unified solution, based on a volumetric decor and color spread and sustained throughout the growing season.

Both species, existing and proposed, with persistent foliage or obsolete offers a harmony of shapes and colors through all the decorative elements: flowers, foliage texture and color coating, architecture and texture stem and canopy.

Moving in the "forest garden type" it has been proposed a number of elements to reinforce the potential landscape of manor garden. After studying topographical plan and following the requirements imposed by the theme launched (so to arrange the existing cave), were able to identify the key points that could be a spring area and a lake area in the garden. The stylistic approach for this romantic area encouraged us to introduce a watercourse in this proposal, the route meandered with stone or earth bank covered with grassland. The role of water in this landscaping proposal is to give life to the space, to reflect and double through reflection the trees verticality, increasing the character, sometimes mystical of the garden, but also to enrich through movement and sound the atmosphere of the place. The river route arise small islands formed almost natural way water finds its way through the forest, river captured by specific vegetation. Aquatic plants and perennial grasses accompanying riverside bring more atmosphere to the texture and color range of the whole arrangement. In the upper course of the river forms a waterfall, such as water around us would find the natural drainage outlet, on its way upstream (north side domain) to downstream, where it meets Olanesti River (south side). Fortunately, the natural existing terrain allows, without major land movements, the potentiation of the garden's space garden and the introduction, almost naturally, an element so much important for a romantic atmosphere in Historic Gardens, namely water (Figure 8).

Figure 8 Waterfall area – virtual simulation (own source).

In the vicinity of this area, with absolute power recharging energy, there could not be another area for passive recreational activities (contemplation, rest, relaxation). At the same time, this space can be a dining area outdoors, near the main access to the historical manor building, this being one of the main arguments underlying the establishment in that area of functions that include relaxation and water. The platform covered with natural stone slabs carved with lawn between joints will create a special atmosphere and the decor will be absolutely delightful. For the furnishing of this platform there will be two options: either use easily removable furniture, allowing its transport inside when the weather conditions are unfavorable, or the option to mount a fixed body of natural stone table, with similar banquets, to provide strength and stability, but in a way that fits perfectly and harmoniously into the special atmosphere of this area. In this case, the decision will be subject to further analysis, together with the client space. The waterfall will become a spectacular element that will transform this dining area into one of the three major areas of interest in the proposed arrangement. The characteristic landscape of the "forest garden" lays the dining platform at the highest point, thus providing an overview of the watercourse of the river. In the forest, the lowest topographical land turns into a special place, by joining three other very important elements - lake, gazebo and lawn (Figure 9).

Figure 9 Lake and gazebo area – virtual simulation (own source).

During the vegetation analysis was identified in this area, one of the most spectacular plant specimens from the entire site. A superb specimen of the species *Platanus acerifolia*, a spatial structuring element is in this area of the garden. The conclusions of the analysis performed on the vegetation proposed to eliminate several common species around the dish to give it a major importance and landscape value.

To emphasize the romantic landscape value and character of the area, the presence of a gazebo situated partly in the console above the lake, and inspired by the traditional romanian architecture (pillars and arches) can complete a picture of romantic garden.

The pedestrian walkways and routes of natural stone thrown into the grass, walk you through this space by passing successively through the brook, forest, and even water, reminiscent of natural bridges, created naturally in natural streams.

At the left and the right access point in kiosk are placed two weeping willows (*Salix alba* 'vitellina") whose role is to enhance the romantic atmosphere and the presence of water in the area.

There were also put into value, view points that open from the enytrance into the property, by marking perspective endpoints with vertical forms like columnar oak (*Quercus rubra* "Fastigiata"), which emphasizes and highlight adjacent items (waterfall, mansion).

The proposal for landscaping will provide solutions to preserve and protect the image and atmosphere of the manor against harmful external factors that might alter the character of the historic and picturesque garden (Figure 10).

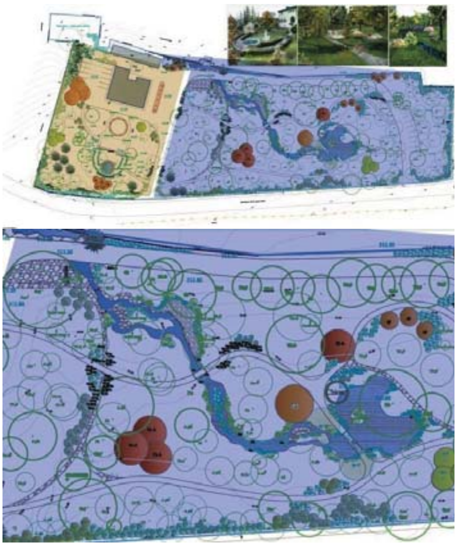

Fig. 10 Plan with the proposed design and detail over the forest garden area (own source)

CONCLUSIONS

Following the synthesis of analyzes it was revealed that the historical reference period to be taken into account in the garden landscape restoration approach is between nineteenth and twentieth centuries, a period in art history that is characterized by a combination of the two gardens reference styles (classic and romantic) and creating mixed style (or composite).

At the same time it is necessary to answer by landscaping restoration to all functional requirements of the new destination of the manor, adapted to current needs of modern society without altering the actual atmosphere, substance and character of valuable historical monument.

Pedo-climatic context favorable and presence in a state of emergency exotic plant specimens encourages the use of decorative species to create an authentic romantic atmosphere.

Auto and pedestrian circulation shall provide a maximum degree of accessibility and to serve the full potential of the area Oromolu landscape.

Landscaping proposal will solve all requirements and problems encountered so successfully to reconstruct the atmosphere of the early twentieth century gardens, and to fall in the current XXI century.

ACKNOWLEDGEMENTS

This research was conducted with support from the central bank, through a pilot project functional restructuring of historic properties.

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***Legea nr.422/2001

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

DECORATION VALUE AND HERBICIDE SENSIBILITY OF SOME EPHEMERAL ANNUAL ORNAMENTAL PLANTS

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Abstract

The main reasons of archaeophytes disappearance are the changing structure of agriculture production and increasing chemicals application. In our investigation we tested the sensibility of four species with using two different modes of action herbicides. In preventive applied broadleaf herbicide (glyphosate) did not have significant effect by comparison with control. However the examined soil herbicide (pendimetalin) was lethal in 100 % in case of Adonis aestivalis, Consolida regalis and Papaver rhoeas. This effect was experienced also by preemergent and by postemergent treatment. This herbicide destroyed every plants and the rate of uncovered soil surface was about 80-90 % even if in the middle of summer. Centaurea cyanus was significant in decoration value. Well useable, but just in windless area. Consolida regalis was weak weed competitor in applied sowing density. It had high decoration value, but the flowering period was much shorter by comparison with Centaurea cyanus. The Papaver rhoeas had a medium flowering intensity, good soil covering ability and it is a strong competitor species. The Adonis aestivalis is not recommended in extensive environmental conditions because it's too small sized. The optimal date of sowing of these four species is early autumn (especially in not irrigated area).

Key words*: archaeophytes, germination, ornamental value, herbicide sensibility.*

INTRODUCTION

Archaeophytes (so called "old adventive" species) are those species, which can be found in flora of scanning area until the end of XV. century (until discovering America). Usually they are identified as epecophytes (their appearance is dependent on the type of cultivated plant). They usually appeared in a given area because some kind of human influence (primarily involuntarily). They are always xenophytes (alien plants), but their appearance and their spreading are largely depending on influence of humans. Because of this reason, they are not dangerous to the natural flora by comparison with the adventive neophytes weeds (THELLUNG, 1919, SCHROEDER, 1968, BALOGH, 2003, PYŠEK et al., 2004). In certain cases – because of the missing information – there can be native also (LAMBDON et al., 2008).

These units of flora were „tolerated parts" of the tillage cultivation. Among archaeophytes we can find ornamental plants, medical plants, vegetables, tinctorial plants and fodder crops. Furthermore they had an important role in biodiversity, in gene preservation, in agricultural-ecological systems (as buffer zone) and as a soil type indicator in the past. However they became insignificant drifted to periphery due to spreading of modern, mechanized cultivation together with the appearance of neophytes (PINKE-PÁL, 2005). For This reason, we examined the sensibility of archaeophytes to herbicides in our research.

MATERIALS AND METHODS

The object and the location of experiments

We investigated four species, which are available in retail sale in Hungary. These are: *Adonis aestivalis* L., *Centaurea cyanus* L., *Consolida regalis* Gray and *Papaver rhoeas* L. The experiment took place in the Corvinus University of Budapest Faculty of Horticultural Science Experimental and Research Farm, which is found next to

Budapest (in Soroksár). In the non-irrigated area only the natural precipitation was accessible to the plants.

The effect of broadleaf herbicide

The method of assessment:

The germinated seedlings were counted once a week. We studied the growing cotyledons, the leafs and the stem by comparison with the control (comparison of distortion, difference in size, growing speed). We investigated soil covering examination and degree the presence of weeds (in per cent). The evaluation was finished in the end of 2013's vegetation period, except the first batch of sowing was kept alive in 2014 as well to evaluate its ornamental value.

Sowing area: 1,5×1,5 m four times of every species (9 m^2).

The soil was strongly infected by perennial weeds and uncultivated in the experimental area (convolvulus, twitch). The soil was sandy poor in humus.

The herbicide treatment was executed on September 16th in fifth percent of the whole area with glyphosate-potassium salt agent Glialka Star in 25 ml/l concentration. We used a small manual vaporization sprayer.

The effect of herbicide became visible two weeks after the treatment (leafs turned into yellow and became dry), so we rotated the soil three times with cultivator.

We marked the sowing area and did the first sowing on October 8th.

One metre wide buffer zone was left blank, to ensure, that the treated zone will be isolated from the control zone. From this buffer zone northwards the treated parcels were marked (1,5×1,5 metre territory). The parcels including the same species were linked to each other (without paths), but a 30 cm wide path were formed between different species. The division of control parcels were the same as the treated parcels. *Centaurea cyanus*, *Adonis aestivalis* and *Consolida regalis* were sowed 1-2 cm deep. 200 seeds from *Centaurea cyanus*, 100 seeds from *Consolida regalis*, 400 seeds from *Papaver rhoeas* and 175 seeds from *Adonis aestivalis* were used. To water the sowed parcels 10 litres of water was used each.

The effect of soil herbicide

The method of assessment and the sowing area were the same as in the previous examination.

The first batch of autumn sowing was kept alive in 2014 as well to evaluate its ornamental value. The other parcels (in total 16) were cleaned up and the weeds were removed on March 27th. At the same time we sowed four control and four treated parcels. The method of sowing was the same as in the previous examination.

The herbicide treatment was applied on March 31th in the same part of the area which we treated in autumn. We used Pendigran 330EC (pendimetalin) in 10 ml/l concentration. We used a small manual vaporization sprayer. We did not find any growing seedlings during the treatment, but the surface of the soil was already cracked by germinating seeds.

We sowed on April 23th for the second time, followed by the precipitation of previous day (5-10 mm). In this case we only used 5 litres water/parcels. We assessed the first sowing in this day.

Determination of the ornamental value

We used ranking once a week from May until July. The categories were:

5. Very decorative, full blooming, healthy wildflower.
4. Medium decorative, begin or finish blooming, healthy wildflower.
3. Slightly decorative, decorated only by vegetative parts or phenological state. Healthy wildflower.
2. No decoration value because of phenological state, or some kind of stress (e.g. sunshine, wind, insects, pathogen).
1. Plant could not be found, or missed from the area.

RESULTS AND DISCUSSIONS

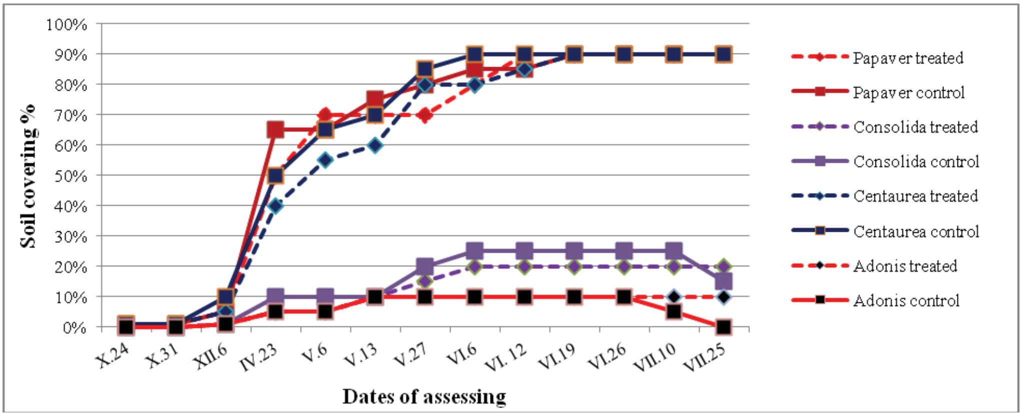
The four examined species could be divided into two parts. The seedlings of *Papaver rhoeas* and *Centaurea cyanus* covered the parcels very well (90 %). In Figure 1 we can see that *Papaver rhoeas* and *Centaurea cyanus* plants developed rapidly in early spring, so they covered the half part

(*Centaurea cyanus*) or two thirds (*Papaver rhoeas*) of the total area, when we began the examination in the end of April. These species were strong competitors against the weeds. At the same time *Consolida regalis* and especially *Adonis aestivalis* covered the soil very poorly (25 % and 10 %), and the plants of *Adonis aestivalis* could not be seen, because of the low height of the plants (20-40 cm). In comparison with glyphosate treated and control parcels no differences could be found in the covering value (Figure 1).

The further sowings (on October 24th, and on October 31th) did not germinate well (the *Consolida regalis* and the *Adonis aestivalis* did not germinated at all, and the parcels of the other two species contained only a dozen of weak seedlings). There was not any differences between the treated and control area.

The spring sowed plants showed more differences. Only the *Centaurea cyanus* could germinate in the eight treated parcels (the soil covering reached 50 % in the pre-emergent parcel, and 15 % in the post-emergent parcels at the end of the experiment). The other three species were killed by the applied soil herbicide. At the same time the degree of weeds presence was not higher than 10-15 % in August (so large not covered soil surface was created – 80-90% in every parcel).

On the control parcels we could generally observe that the sowings germinated better in March than in April. The *Papaver rhoeas* sowed in March was an exception, because these seeds died of the two weeks long dry period after sowing. *Centaurea* showed notable vegetative development and blooming, the flowering period started from the middle of June (end of June by seed sowed in April), but the intensity of blooming and the size of plants were more poor compared to the ones sowed in autumn. We could extend the blooming period of *Consolida regalis* with the spring sowings. The seeds sowed in March began to bloom when the plants of the autumn parcel finished flowering. Thus the decoration period can be extended with one month, but the problems of spring sowings should be taken into consideration. The March sowed *Adonis aestivalis* remained vegetative for a long time, but it was blooming the end of July.



Note: the treatment happened with Glialka Star (glyphosate) soil herbicide

Figure 1. Soil covering of autumn sowed archaeophytes in soil herbicide treatment and control, Budapest, HU, 2014

The highest decoration value was measured in *Centaurea cyanus* among the examined species (Figure 2 and 3). These plants bloomed intensively for more than two months despite the extensive environmental conditions. Aphids attacked the plants before flowering, but the blooming intensity was not impaired. The other problem was the leaning of plants in the middle of summer. The extent of leaning was not high enough to enable a weed infection of the parcel but the leaned plants partly covered the neighbouring species creating a disturbed looking site. The *Centaurea cyanus* was the most strongly growing plant among the examined species. We could count almost 400 flowers at the top of blooming period.

The blooming time of *Consolida regalis* continued from middle of May until first decade of June in this experiment. The number of flowers was also the highest in this period (Figure 3). This species had the highest number of flowers individually. The tallest plant (170 cm high) had 124 flowers at the top of blooming period. The blooming finished at the end of June, and from this time on the plants were not decorative anymore. The stand was very heterogeneous, we could find plants from 15 cm to 170 cm. We could not observe any biotic damage, but a teratomatic plant was developed from one seed, and this plant bloomed 2 weeks later than the others. The flower stems were strong, and the higher plants resisted the wind, but their soil covering capability was minimal.

Papaver rhoeas had moderate blooming intensity compared to the previous species. The plants flowered from the end of May to the beginning of July continuously (Figure 2). We could observe also buds, flowers and fruit in the stand at the same time. We found sign of deer chewing the end of May; this might explain moderate blooming. We did not find other biotic damage during the experiment. The plants were of the same form (60-90 cm), covered the soil well, resistant to wind.

Adonis aestivalis was the last regarding of ornamental value. It had the shortest blooming period, the flowering time lasted from middle of May to beginning of June (but it had a second blooming time in the beginning of September). It had more flowers than the *Papaver rhoeas*, but their significance is smaller because of the short blooming period. The biggest problem was the small size (20-40 cm) because of this the *Adonis aestivalis* cannot decorate under extensive environmental conditions. We could still assess the flowering, but the fertile plants were totally disappeared between the growing neophytes. We did not observe any other biotic damage (neither the wind damage), but the soil covering ability of *Adonis aestivalis* was less than *Consolida regalis* covering (Figure 1).

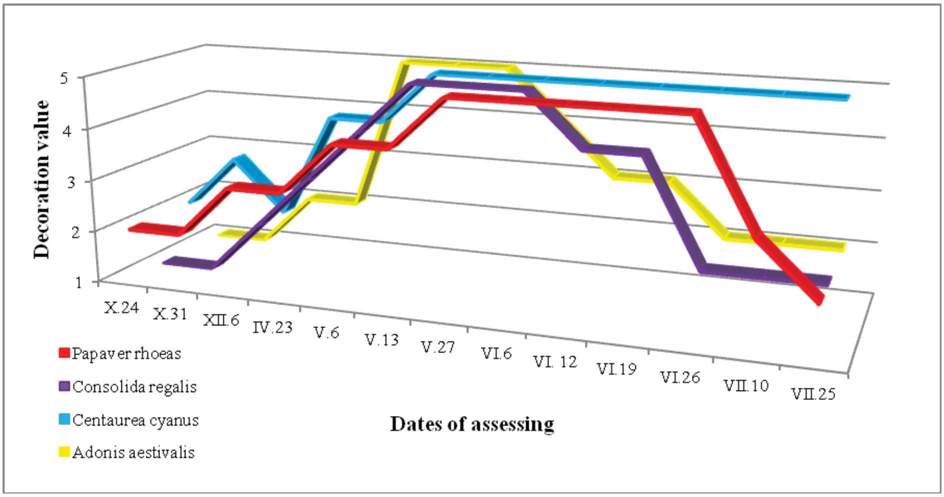


Figure 2. Ornamental value of some autumn sowed archaeophytes from October to July, Budapest, HU, 2014

(Ranking of ornamental value: 5. Very decorative, full blooming, healthy wildflower. 4. Medium decorative, begin or finish blooming, healthy wildflower. 3. Slightly decorative, decorated only by vegetative parts or phenological state. Healthy wildflower. 2. No decoration value because of phenological state, or some kind of stress (e.g. sunshine, wind, insects, pathogen). 1. Plant could not be found, or missed from the area.)

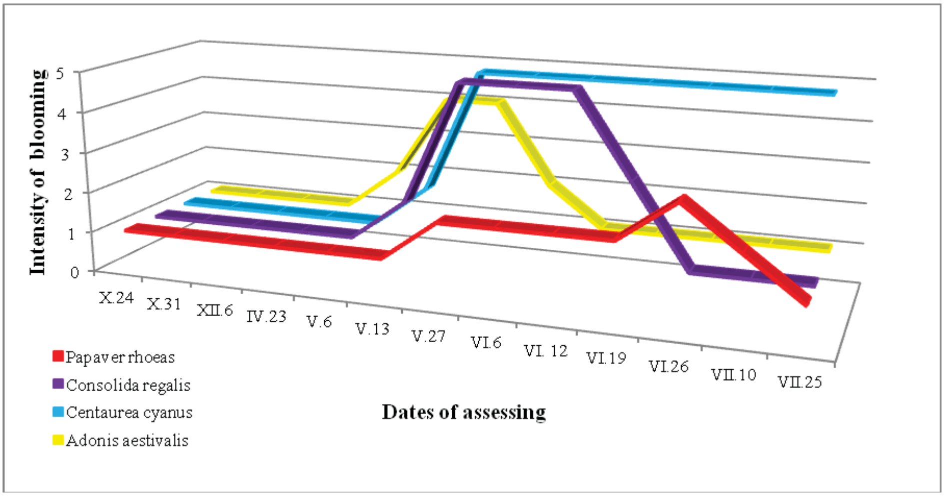


Figure 3. Blooming intensity of some autumn sowed archaeophytes, Budapest, HU, 2014

(Ranking of blooming intensity: 5. More than 50 flowers/parcel. 4. 21-50 flowers/parcel. 3. 11-20 flowers/parcel. 2. 1-10 flowers/parcel. 1. No flowers.)

CONCLUSIONS

The examined broadleaf herbicide did not have any harmful effect to the seeds of archaeophytes. It did not influence the vegetative and generative development. The tested soil herbicide caused total destruction by *Adonis aestivalis*, *Consolida regalis* and *Papaver rhoeas*, and it had partly harmful effect to *Centaurea cyanus* (lately blooming, less flower as control). Because this reason we should not recommend to use it in margins of arable land or gene conservation fields. In these locations we should use a broadleaf herbicide treatment at the end of summer. Thus we can reduce the number of thermophile neophytons and the perennial weeds, but the seeds of archaeophytes do not get damaged. After the pendimetalin treatment a large, not covered soil surface was formed on the treated parcels which is good for the mass-production tillage cultivation, but it has detrimental effect on the biodiversity.

The best sowing date of archaeophytes is early autumn (from middle of September until middle of October), especially extensive application. So the natural soil moisture content is enough for germination and for the growing in early spring. The blooming period lasts in this case from the second half of May until the end of June. *Centaurea cyanus* was especially valuable, because the blooming time lasted until the end of July – the beginning of August in 2014. We can apply it to natural gardens or wildflower meadows. *Consolida regalis* has also significant decoration value, but this species is not as good competitor as the *Centaurea cyanus*. Their blooming time can be expanded with spring sowing, but irrigation must be provided for sufficient development. *Papaver rhoeas* has a short blooming time and strong competition ability. It can be used in extensive environmental areas. *Adonis aestivalis* is suitable to be applied as a border plant, because of its small size.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

SESELI GIGANTISSIMUM CIOCÂRLAN – ANATOMY OF LEAVES

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Abstract

Seseli gigantissimum is a new taxon identified by Professor Vasile Ciocârlan in Şipote Valley (Constanta county). Were performed observations on anatomical peculiarities of the leaves of plants grown in the Botanical Garden of USAMV-Bucharest and were observed some peculiarity of the leaf rachis and ultimate segments that aren't describes in morphological diagnosis.

Key words*: Seseli gigantissimum, secretory ducts, trichome, transversal sections.*

INTRODUCTION

In 2011, V. Ciocârlan describe a new species to the science, found on Şipote Valley (Constanța County), on a rocky substrate, with south-west exposition (Figure 1). Named *Seseli gigantissimum*, this species shows morphological characters similar to *S. tortuosum* and *S. campestre* without, however, to be identified with any of them.
In the sixth volume of Flora of Romania (1958) there are described nine species of the *Seseli* genus,

Figure 1. *Seseli giganitissimum* Ciocarlan - in their natural habitat

including *S. tortuosum* and *S. campestre*. Ciocârlan, in 2009, indicate eleven species in the same genus in Romania and Sârbu et colab., in 2013, included *Seseli gigantissimum* Ciocârlan between the twelve *Seseli* species from our country.
To elucidate some taxonomical aspects, anatomical studies are also important, in addition to those morphological, such as those related to the secretory ducts
of vegetative organs (Coassini et Corsi, 1986; Pimenov et Sdobnina, 1975) or mericarp anatomy (Doğan Güner et Duman, 2013).
In this paper, anatomical characters of the Seseli gigantissimum leaf are presented, in order to highlight some peculiarities of this species.

MATERIALS AND METHODS

Individual plants of *Seseli gigantissimum*, obtained from seeds harvested from Șipote Vally, were acclimatized in the Botanical Gardens of USAMV-Bucharest. Plants form a monocarpic aerial stem which initiate fruits formation in the second life year. For the first life year, on a short aerial stem, arise sessile leaves, 4-6 pinnatisect, the last lamina segments having 0.5-2 cm in lenght and 0.5-1.5 mm in width (Ciocarlan, 2011). Microscopic samples were obtained by cross-section of the leaf at the rachis and lamina level. The cross-sections were clarified with a saturated solution of Chloral hydrate and stained with Alun-Carmine and Iodine Green to highlight the cell wall structure. Images were obteined with a digital camera (Panasonic DMC-LZ7) at an optical microscope (Optika DM-20).

RESULTS AND DISCUSSIONS

The rachis structure

Rachis, in cross-section, is winged, with edges (Figure 2).

Figure 2. Rachis (general view, in cross-section)

From species diagnosis, leaves are glabrous (Ciocarlan, 2011). So are described leaves of the Seseli tortuosum and S. campestris in Romanian Flora (Todor, 1958). But, in our sections, it may observed, on the abaxial side of the rachis, an unicellular, epidermal trichome. Thus, to the morphological description, on may add the presence of rare bristles on the underside of lamina rachis.

Figure 3. Unicellular, epidermal trichome on the abaxial side of the lamina rachis

The internal structure of the rachis is intermediary between the stem and the leaf lamina structure; it can discern the following sequence of tissue (Figure 4 and 5):

- The epidermis: a row of cells protected by a thick cuticle on the outside walls; cells have obvious external and internal walls, thickened with cellulose. The description of two *Umbelliferae (Apiaceae)* species - *Angelica archangelica* and *Eryngium plan*um, shows that their epidermal cells have only external walls thickened (Toma and Rugina, 1998). Stomata are observed and they are at the level of the epidermal cells.
- 3-4 rows of angular collenchyma appears below the epidermis, at the edges level; beneath epidermis is formed a layer of parenchymatous cells, followed by the palisade tissue, bistratified; the assimilation tissue is continuous arranged around the section, interrupted only by the collenchyma layers on the adaxial side.

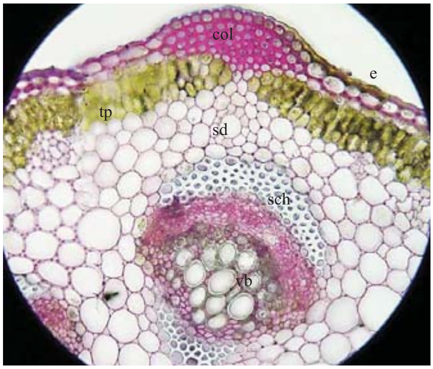

Figure 4. Rachis cross-section detail: e – epidermis, col.- angular collenchyma, t.p.- palisade tissue, s.d. – secretory ducts, v.b. – vascular bundle, sch. - sclerenchyma

- The center of the section is occupied by a fundamental parenchyma; vascular bundles, of different size, are arranged in semicircle: three large bundles are on abaxial side and two smaller are on each lateral sides; ursini can be found in some parenchymal cells (Figure 5).
- Vascular bundles are delimited by two arcs sclerenchyma - one higher, above the phloem zone, and the second, less developed is beneath xylem; vascular tissues are of primary origin, although between the phloem and xylem tissues fascicular cambium can be observed (collateral bundles with open structure).
- Secretory ducts are arranged in fundamental parenchyma, on an outside circle from vascular bundles and inside bundles, in phloem area -

identified also in archangelica Angelica archangelica species.

Figure 5. Ursini in parenchyma cells

<u>The lamina segments structure</u>

In cross-section, the median vein is prominent on the abaxial side of the lamina segments; a sclerenchyma bundles support the main vein; secondary veins are without sclerenchymatous tissue (Figure 6).

Figure 6. The main vein prominate on abaxial side

Epidermis is formed by a layer of cells with external walls thickened; stomata are at the same level as the epidermal cells.

The mesophyll is differentiated in a palisade tissue, compact arranged around the section and a parenchymatous tissue in the center, where the vascular bundles and secretory ducts are included (Figure 7).

Vascular bundles are small, with the phloemic zone more developed as the xylem.

Secretory ducts are evident in the outer part of the parenchymatous tissue.

Figure 7. The lamina segments structure (detalied)

CONCLUSIONS

Microscopic observations showed the presence of unicellular trichome on the abaxial face of Seseli gigantissimum leaf rachis, unlike morphological descriptions.

Secreting ducts are both in the rachis and the terminal segments of the lamina. they are arranged in the fundamental parenchyma, on an outside row of vascular bundles.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

UNASPIS EUONYMI (COMSTOCK), A PEST ASSOCIATED WITH DAMAGING THE PARKS AND ORNAMENTAL GARDENS OF BUCHAREST

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Abstract

Euonymus scale is a pest that has been frequently encountered in the recent years in parks and gardens on such ornamental host plants as Euonymus spp., Syringa vulgaris and other. Following the attack, plants are completely defoliated or dried. The attack is more likely to occur on the plants located near buildings, or where air does not circulate and there are water stress conditions. This paper presents observations on the pest presence in the ornamental parks and gardens of Bucharest, its attack mode and possibilities of attack limitation.

Key words**:** *pest, control, ornamental plants, attack.*

INTRODUCTION

The euonymous scale is a frequently ecountered pest in dendrological nurseries, but also in parks and ornamental gardens.

As it is also the case for other pests which are specific to dendrofloral plants from urban areas, this species' combat is special because it has a series of difficulties. It is to be preffered that biological, physical, cultural are to be used at maximum, in order to protect the native useful fauna and to reduce the impact upon environment.

When a problem occurs, the management programme needs to be reevaluated in order to prevent future apparition of viral or harmful organisms.

The combat possibilities are limited, taking into consideration the plants' placement (parks, public areas, playgrounds, rest spaces, isolated bushes, green fences, private gardens), the lack products with reduced toxicity or biological products, usage method difficulties and treatment costs.

MATERIALS AND METHODS

A hard to combat pest due to its protection shields, *Unaspis euonymi* Comstok is met more frequently on de *Euonymus* sp. plants in landscape maintenance activities (Brewer and Oliver, 1987). This pest's spread is favoured also by the verminous plants' merchandising.

Tracking this pest has been realized by observing *Eounymus* plants from Herăstrău park, Kiseleff park, Cişmigiu park, Nicolae Iorga park, the Patriarchal Residence park.

The combat methods we've used consisted in taking prevention and remedial measures curative (Table 1). These have been applied only in private ornamental gardens or closed-circuit public gardens (the Patriarchal Residence park).

The experimental combat variants have had at their basis this species' biology, the larvas apparition moment (before the protection shields' formation) The chemical products' efficiency has been settled 48 h after using the treatment by ascertaining the individuals' death rate (adults and larvas) on leaves, under the binocular magnifying glass.

Table 1. Experimental variants of combat of *Unaspis euonymi* Comstok

Variant	Landscape maintenance
V_1 – witness	Kiseleff Park
V_2 – cutting the attacked branches +gathering the fallen leaves+spraying a powerful spurt of water	Private garden
V_3 – chemical treatment on larvas appearance (Confidor Energy – 0,13 %)	Private garden
V_4 – chemical treatment on larvas appearance (Proteus OD 110 – 0,1%)	Private garden
V_5 – chemical treatment on larvas appearance (Oleosan APG – 1,5%)	Private garden
V_6 – treatment in vegetative repose (Nuprid Oil 004 CE – 1,5%)	Private garden

RESULTS AND DISCUSSIONS

Euonymus scale is a frequently encountered pest throughout the last years in dendrological nurseries, but also in parks and ornamental gardens (Figure 1). Favourite host plants are *Euonymus* spp*.*, *Syringa vulgaris, Hedera helix, Hybiscus* spp., *Catalpa bignonioides*, *Lonicera* spp. After the attack plants are completely exfoliated (through leaves falling) or might even perish. Plants living in hidric stress conditions and near buildings or in areas where air stream does not circulate very well are more prone to the attack.

On a soft attack leaves with yellow stains are noticed, with specific larvas and adults along the nerves, on branches and on the plant's basis stem. When infestation is powerful, plants lose their leaves, scions and branches dry out and plants eventually die.

The insect presents three development stages: egg, larva and adult. Eggs are deposited in early spring under the female's body. After a certain period of time the yellow-orange larvas appear, which migrate on other parts of the plant or are carried away by the wind on nearby plants. After a few days these become motionless, they fix themselves on the plant's tissues and start to secrete the secretion shields. The larvas which will grow into males present white longitudinal knolls, and the larvas which will grow into females are bigger, grey and in the shape of an oyster. Adult males have wings, and females keep their protective shield (Cockfield and Potter,1990).

Figure 1. *Unaspis euonymi* Comstok – euonymus scale

Following observations made this species has been found in many public and private landscaping (Table 2).

Results regarding this pest's combat are shown in Table 3. Variant number 2 is applicable to a reduced number of plants (isolated plants), having as a result population reduction, without setting an exact death rate. In the case where chemical treatment has been used, the death rate was of 65% at V_3 and 89% at V_4. Along with sistemic insecticides, another product has been used. It belongs to the mineral potasium salts and fatty acids group (potasium oleate) – Oleosan APG (V_5) where detah rate was of 60%. Mineral salts and fatty acids soap-based pesticides (potasium laureate, miristate potasium, potasium oleate and potasium ricinoleate) are used in order to combat insects, but also thews, seaweeds, orchils and herbs. Due to their reduced toxicity, they situate themselves in the IV-th group and are not toxic for birds in our ecosystem (Tudose et al., 2008). For this product, mortality rate for larvas and adults was of de 60% on a single treatment used. Treatment usage in vegetative repose using with horticultural oil (Sadof and Sclar, 2000) - Nuprid Oil 004 CE (V_6) product has led to a 80% mortality rate in hibernal stages.

Table 2. The evonimous scale's presence in landscape maintenance

Ornamental garden	Pest presence/absence (+/-)
Kiseleff park	+
Herăstrău park	+
Cişmigiu park	-
Nicolae Iorga park	-
The Patriarchal Residence park	+
Private garden from northern Bucharest	+
Private garden from northern Bucharest	+
Private garden from northern Bucharest	+
Private garden from Bucharest's center	+

Table 3. Experimental combat variants of the *Unaspis euonymi* Comstok

Variant	Lanscape maintenance	Mortality rate (%)
V_1 – witness	Kiseleff park	0
V_2 – cutting the attacked branches +gathering the fallen leaves+spraying a powerful spurt of water	Private garden	-
V_3 – chemical treatment on larvas appearance (Confidor Energy - 0,13 %)	Private garden	65
V_4 – chemical tratment on larvas appearance (Proteus OD 110 – 0,1%)	Private garden	89
V_5 – treatment on larvas appearance (Oleosan APG – 1,5%)	Private garden	60
V6 – treatment in vegetative repose (Nuprid Oil 004 CE – 1,5%)	Private garden	80

Coccinelide have been noticed in the case of euonymous scale population (Figure 2), their presence representing a guide in combat possibilities. Plants upon which no combat measure was taken (V_1) have become frost sensitive and have dried out during winter time (Figure 3).

Figure 2. *Coccinellidae* inside *U. euonymi* colonies

Figure 3. Dried plants after attack

CONCLUSIONS

While managing this pest's monitoring and combat, a series of curative and prevention measures can be applied:

Cutting and destroying infested plants is beneficial before young larvas start migrating.

Plant trimming, as a guidance and maintenance method, reduces the supply of pregnant females, although this issue can become difficult when the plant is already exfoliated.

Manually removement of infested areas in motionless stages. It is valid at weak plagues and on a small plant number. By removing them, the oral apparatus is affected and thus, the insect cannot establish a new feeding position.

Vigorously upkeeping the plant. Dousing and fertilising the plants contributes to a better attack resistance, as it is a pest wich stinges and sucks the sap.

Insecticides usage. It is efficient if systemic products are used during the larvas appearance, before the protective shields are formed. It is right for nurseries and less for parks and gardens.

Mineral potasium salts and fatty acids based. These are non-persistent, the halving time being less than a day in the environment. This creates the usage premises in combating pests in parks and ornamental gardens.

Horticultural oils usage. They can be used in winter time and aim for the hibernant stages' destruction through contact, through insertion and by respiratory pathway. It is necessary that a large solution quantity must be used, so that the stems are properly bathed.

Useful fauna preservation of *Coccinellidae* species and neuropteras in the case of *U. euonymi* population suggests this species' biological combat possibilities.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

CISMIGIU GARDEN IN BETWEEN ORIGINAL DESIGN AND FURTHER TRANSFORMATIONS – A COMPARATIVE STUDY ON A CONTINUOUSLY REDESIGN PROCESS

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Abstract

Cismigiu garden was designed in 1845 by Karl Friederich Wilhelm Meyer according to the requests and needs of the mid 19th century urban society of Bucharest. However, the original design and composition of the garden is now lost due to a series of successive transformations undertaken on both the architectural layout and components of the garden as well as on its planting design and composition; thus transforming the romantic 19th and 20th century romantic landscape into a contemporary livable but "adorned public space ruin". To this end, this paper aims to compare and analyze the historical transformations that successively altered and reinvented Cismigiu garden's overall image and composition, in the hope of understanding how and why did the garden had to be redesigned and, to a certain extent – reinvented, so many times in its history. The study is based on field research as well as on comparative analyses in both archive images and on contemporary "in situ" photographs.

Key words: *Cismigiu, composition, patrimony, transformations.*

INTRODUCTION

Representing the second public garden opened in Bucharest, Cismigiu first designed by the Austrian landscape architect Karl Friederich Wilhelm Meyer according to the specificity of the mid 19th century society of Bucharest. However, Meyer's designed was reinterpreted and to this end, the entire garden was redesigned many times during its relatively long history. Thus, Meyer's work was successively carried out, improved but mostly reinterpreted, after his premature death (1852) by engineer Lalanne and architect Seminet; gardener Frei; botanist gardener Hoffman (1855), architect Al. Orascu and engineer Gilbert (1860); Swiss horticulturalist Louis Leyvraz (1863); botanist engineer W. Knechtel; architect Joseph Hartl (*apud*. El-Shamali, 2011). However, the most important transformation took place at the beginning of the 20th century when architect Friedrich Rebhun (1910) drastically modified the original design of the garden both adding and eliminating different features of the garden.

To this end, this paper aims to show how the garden changed over time, both in what concerns the visual and physical transformations and also in what represent the formal and informal use of the garden by nowadays society. The study will thus focus on both the interpretation of several historical images of the garden as well as on written documents that offer both a physical and a social description of the second public garden in Bucharest.

MATERIALS AND METHODS

In the effort of showing the scale of all the transformations the garden has suffered since the middle of the 19th century up to the present day, this chapter will focus on analyzing both literally brief descriptions of both the entire complex and of its components as well as on overlaying plans and image comparisons.

Short history - predating the design of the Cismigiu garden.

In order to understand how Meyer designed Cismigiu as a public garden fitted for the traditional population of 19th century Bucharest, one has to understand the image of the city at middle of the 1800's.

Bucharest represented "a city built heterogeneous over the Dambovita river" (Parkinson, 2014), but was seen by most foreign travelers as a city of contrasts. To this end, Bucharest was a city of both western and oriental urban textures, a city where often described as a "garden-city", but a "garden-city" misinterpreted due to the fact that the green image of the city was due to the numerous private houses with relatively large garden and not due to a specific public concern for green public spaces. The strange outline of the western-oriental city was however changed after the adoption of the Organic Regulation in July 1831 and January 1832. Along with the Regulation, the idea of a public garden was more popular and, in 1843, Gheorghe Bibescu commissioned Austrian landscape architect Karl Friederich Wilhelm Meyer and his collaborator Franz Horer to design the first public garden in Bucharest. Thus, the two landscape artists continued the work on the "Baneasa promenade" or "The big/grand alley" and, in between 1843 and 1847, designed the first public garden of the city - "Grădina de la Şosea" (future Kiseleff garden). The garden was designed according to western romantic principles and, but due to the fact that the Romanian society was not used to use public spaces as the western societies did the garden was improperly used by the local population. This was due to the "more «wild» landscape that the society was used with for daily activities, totally different from the rest of Europe […] the contact between the Romanians and the green spaces was more tactile than visual" (El-Shamali, 2011), meaning that the society was used to use outdoor green spaces for religious procedures, parties, barbeques etc. However, Meyer started analyzing the habits and way of life of the society of 19th century Bucharest and, when he became commissioned with the design of a second public garden to be planned over the Cismigiu swamp, he adopted a style more closer to the Romanian model and way of using public spaces and he designed Cismigiu garden as a garden of western inspiration fitted for the semi-oriental society of Bucharest.

Short history - the specificity of the mid 1800's Romanian society.

In terms of the use of green spaces, the Romanians were used to a more practical and very religious way of seeing and using nature. To this end, the Romanian folklore associates almost every type of plant with a Christian story, considering that Nature is created by God, and every aspect of nature is of divine influence (apud. Simion-Florea, 2010). To this end, water was perceived as a divine element as well, and as sociologist Dolores Toma states, "water is found in the Romanian view of Paradise […] Not by chance the church, the garden and the well were next to each other, both real and imaginary, in the heavenly space given by God" (Toma, 2001). Thus, the Romanians were used to a more practical and pragmatic way of using green outdoor spaces, and they perceived that and planted space is a garden (El-Shamali, 2011).

In terms of the way of life of the Romanian society, many foreign travelers offered detailed descriptions of how the population of Bucharest was used to living. English author Rea Maude Parkinson summarizes the specificity of the late 1900's society, considering that, when it comes to outdoor living, Romanians like to "see and be seen by others" (Parkinson, 2014).

Designing Cismigiu garden - original image and future transformations

Taking into consideration all the aspects of the daily life, habits, superstitions and religious symbols of the Romanian population, Meyer came up with a very interesting design for the Cismigiu garden. One of the advantages of the site where the garden was proposed to be designed was that the specific area was already considered by the local population as a "garden" in the sense that the wild swamp was already used by the locals for recreational activities such as fishing. Furthermore, an 18th century well inserted in the proximity of the swamp and two churches (Sarindar and Schitu Magureanu) built near the future garden represented helped the 19th century society of Bucharest to more easily appropriate Meyer's landscape design. However, while his original design was highly appropriate for the urban society of Bucharest, the future transformations that the garden suffered due to many aspects, both technical and social-political, forever altered the original image of the second green public space in Bucharest. To this end, the following subchapters aim to show different parts of the garden, briefly describing their history and offering details on how they evolved and also on their current state of preservation.

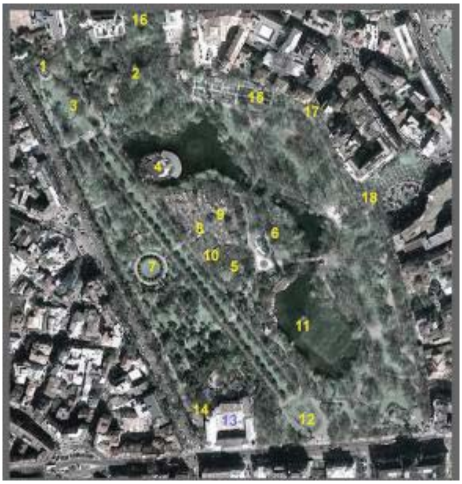

Figure 1. Garden components - dating (1. False ruin, aprox. 1910; 2. Former Cretzulescu garden, design by Rebhun 1910; 3. Former (lost) Semicircular Pavilion; 4. Monte Carlo island and restaurant; 5. Elizeu hillock; 6. Former flower beds, current French Monument, 7. Romanian Writer's Rotunda, former Music Pavilion; 8. Sissi spring (beginning of the 20th century); 9. The gazebo, former Mineral Water Pavilion; 10. The log (beginning of the 20th century); 11. The fountain - 1860; 12. Main entrance - design after Rebhun 1910; 13. Gheorghe Lazar high school (1891-1910); 14. Former entrance according to Meyer's original design; 15. The roses parterre per. Rebhun 1910; 16. Main entrance at the beginning of the 20th century; 17. Entrance, aprox.1850; 18. Main entrance according to Meyer's design, aprox. 1850) (El-Shamali, 2011)

A. The main axis

As stated before, Meyer begun to observe and better understand the habits and way of life of the local population shortly after designing Kiseleff garden. To this end, after observing that the Romanians used *The Road* (Kiseleff avenue) "to see and be seen"(Parkinson, 2014), the Austrian landscape architect designed a large straight axis within the garden, an axis which he divided into 3 parallel "corridors" - the central corridor for walking and the lateral for sitting and observing (El-Shamali, 2011). Meyer alternatively planted the three corridors with alignments of white poplars (*Populus alba*) visualizing the "cathedral effect" that the tree crowns will create. This particular design represents and adaptation of Karl Friederich Wilhelm Meyer of the western landscape architecture ideas in the Romanian traditional usage of the garden. The two ends of the main axis were represented by a *round-point* with a opened gazebo surrounded by acacia trees designed for the stationing of carriages and by a semicircular pavilion surrounded by poplars and elms and the other end of the promenade. The axis did not physically connect the two ends - the road was interrupted by an extension of the lake but the visual field extended up the water to the semicircular pavilion. Due to some probably technical problems, William Knechtel extends the axis over the lake and thus unites the lake's shore with the island Meyer designed for a statue of the goddess Diana with the deer. (Apud. El-Shamali, 2011) (figure 2).

Figure 2. Knechtel's modifications over Meyer's design (El-Shamali, 2011)

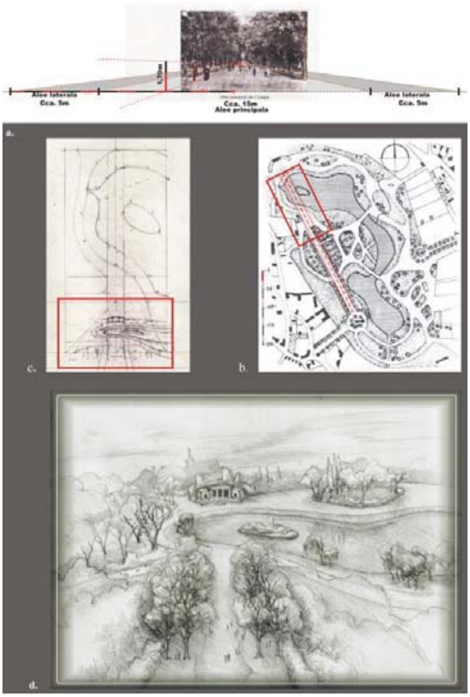

Figure 3. Image graphic restitution of Mayer’s original design – Island of Diana (hypothetical statue), the lake and the Semicircular pavilion (El-Shamali, 2011)

During Rebhun's redesign plans, he changes Meyer's view of the main axis as he eliminates the central corridor in favor of a geometrical French style series of green parterres. He also cuts the white poplars and plants linden trees (*Tilia tomentosa*) and yews (*Taxus baccata*). The new formal, geometrical design is unappreciated both by the society and by the media (Apud. El-Shamali, 2011). The same architect also eliminates the *elm round-point* due to the construction of the Queen Elisabeth avenue and the Gheorghe Lazar high school and demolishes the semicircular pavilion on the other end of the garden and places a false ruin instead.

Figure 4. The main axis - original 19th century design (www.googleimages.com; www.orasulluibucur.blogspot.com)

Figure 5. The main axis between designs (www.only-romania.com; www.only-romania.com; www.only-romania.com)

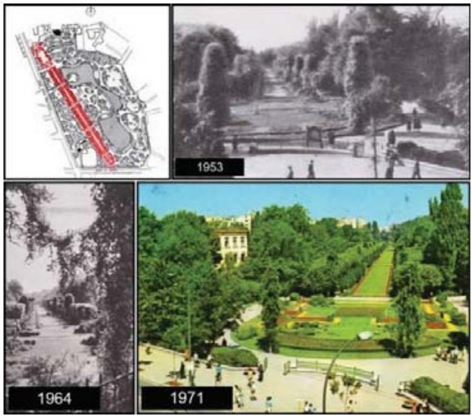

Figure 6. The main axis ends (www.googleimages.com; www.sanuuitam.blogspot.com; www.sanuuitam.blogspot.com; www.sanuuitam.blogspot.com)

Figure 7. The main axis - the false ruin (https://www.facebook.com/bucuresti.minus.50?fref=ts; www.googleimages.com)

B. The lake

The main lake of the garden may be divide into three major sections according to their limits - the stone and concrete bridges: the lake with the fountain, the intermediary lake (in between the two bridges) and Monte Carlo restaurant's lake.

When commissioned with the design of the garden, Meyer has dried up the swamp and re-planned the margins of the future lake.

Although the original outline of the lake is not the same today due to both technical and urban-architectural transformations undertaken both inside and outside the garden's limits, the romantic display of vegetation around the lake's shores still remind of Meyer's design.

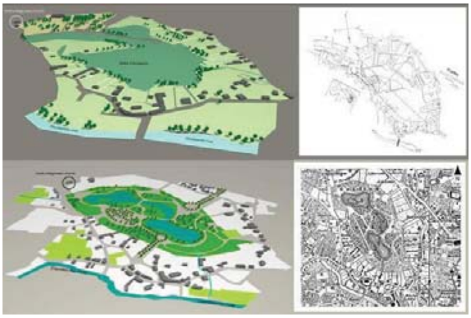

Figure 8. The swamp (1844) and Meyer's garden and lake (1852) (El-Shamali et. al., 2010)

The first segment - the fountain

The first segment was provided by Meyer with a wharf (on the southern side of the lake) which would be decommissioned alter after his death and changed with a new one which would be placed on the western side of the lake. Moreover, the lake will be later provided with another important feature that will come up to represent one of the main symbols of the garden - the rock fountain (approximately 1890).

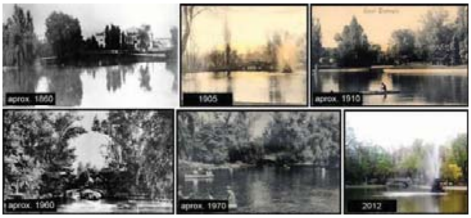

Figure 9. The fountain and the surroundings - before and after (www.googleimages.com; www.googleimages.com; www.googleimages.com; www.sanuuitam.blogspot.com; www.sanuuitam.blogspot.com; www.romaniapozitiva.ro)

Figure 10. The fountain and the surroundings (www.orasulluibucur.blogspot.com; www.only-romania.com; www.only-romania.com; www.pexacons.ro; www.only-romania.com; photo by iuliano www.googleearth.com)

Figure 11. The first wharf (www.googleimages.com; www.googleimages.com; www.only-romania.com; www.only-romania.com; www.only-romania.com)

Figure 12. Future wharfs (www.miscarea.net; www.only-romania.com; www.only-romania.com; www.fiveprime.org; photo by iuliano www.googleearth.com; www.amfostacolo.ro)

Figure 13. The lake's margins - views and vegetation (www.sanuuitam.blogspot.com; www.sanuuitam.blogspot.com; www.viabucuresti.ro www.sanuuitam.blogspot.com; http://only-romania.com; www.googleimages.com; http://only-romania.com)

The second segment - the intermediary lake

The intermediary segment of the lake is, as mentioned before, bordered by two stone bridges - the large bridge and the walnut tree-like bridge, both the work of Swiss artists (built at the beginning of the 20th century).

Figure 14. Views over the intermediary section of the lake - before and after (www.googleimages.com; www.googleearth.com; photo by Al. Mexi)

Figure 15. The walnut tree-like bridge - before and after (www.googleimages.com; www.infopensiuni.ro)

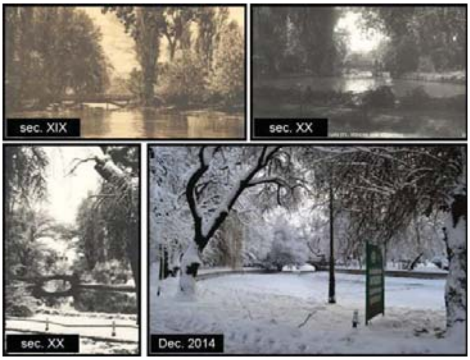

Figure 16. The large bridge - before and after (www.googleimages.com; www.only-romania.com; www.googleimages.com; photo by Al. Mexi)

Figure 17. The intermediary section of the lake - before and after (www.vederiro.blogspot.ro; photo by Ioan Manoliu www.googleearth.com)

Figure 18. The intermediary section of the lake - before and after (www.romania.ici.ro; photo by Al. Mexi)

Figure 19. The intermediary section of the lake - before and after (www.anticariatplus.ro; photo by Al. Mexi)

Figure 20. View from the walnut tree-like bridge towards the intermediary section of the lake (www.only-romania.com; www.panoramio.com)

Figure 21. View from the walnut tree-like bridge towards the 3rd section of the lake (www.only-romania.com; www.googlearth.com)

The third segment - the Monte Carlo island

The final segment of the lake is probably the one with the longest history of both outline and architectural transformations. To this end, whilest in Meyer's age, the lake should have held an island with a white marble-like statue of Diana with a deer, during Knechtel's transformations, the island becomes conected by a stone bridge with the lake's shore while the entire western outline of the lake is transformed and brought closer to the island. Moreover, at the begining of the 20th century, a new restaurant wih a floating island, designed by famous Romanian architect Ion Mincu is built on the island. However, the restaurant burned and several new restaurant designs took over the island.

Figure 22. Monte Carlo Restaurant - first models (www.centenarcaragiale.radio3net.ro; www. stiri.tvr.ro; www.googleimages.com; www.only-romania.com; www.googleimages.com; www.only-romania.com)

Figure 23. Monte Carlo Restaurant - before and after
(www.sanuuitam.blogspot.com;
www.only-romania.com; www.only-romania.com;
www.sanuuitam.blogspot.com)

C. The hill, the flower beds and the French monument

The original design of the garden consisted in numerous romantic spaces distributed around the garden. One of those subspaces was composed of a small hill of approximately 7 m, placed near the first segment of the lake and just above a flower parterre. The hill should have been provided an artificial grotto and a small waterfall. This original composition was supposed to offer wide perspectives over the flower beds up to the lake and to the dense plantation on the other side of the intermediary segment of the lake. Due to the nearby water (lake and waterfall), the intensity of the flowers' perfume would have been increased (El-Shamali, 2011). However, the original design is now lost, as the hillock was over-raised and a monument dedicated to the French Warrior stands it what should have been the flower beds and the newly (approximately 1961) planted vegetation enclose the original widely planned perspectives. The monument itself does not represent a contradiction of style but rather the coniferous trees planted behind the monument, as well as many other trees and shrubs planted on the Elizeu hillock do.

Figure 24. The hillock and view from the hillock towards the flower beds
(photo by L. Angerer, Biblioteca Academiei Romane)

Figure 25. The intermediary section of the lake - before and after
(www.googleimages.com; www.only-romania.com;
www.only-romania.com; www.googleimages.com;
www.panoramio.com; www.googleearth.com)

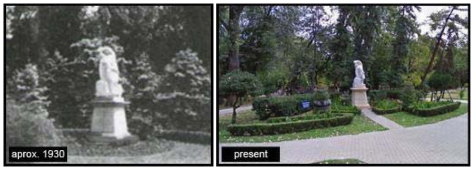

Figure 26. The French monument - before and after
(www.romania.ici.ro; www.googleimages.com)

D. The central area and the gazebo

Located in the center of the garden at the base of the hillock, the area surrounding a gazebo is the only flat geometrically planted matrix-like *Platanus* sp. grove. From Meyer to Rebhun, this area has been not been severely transformed. The main feature of this *Platanus* sp. "grove" is represented by the central gazebo. This building initially served as a mineral water pavilion and it is now used occasionally for small concerts given by the military orchestra.

Figure 27. The mineral water pavilion (the gazebo) - before and after
(www.smaraldelebucurestiului.wordpress.com;
www.googleimages.com; www.hailabord.com)

E. Cretzulescu palace and the small lake

At the beginning of the 20th century, the Cismigiu garden is expanded to the north by incorporating new grounds from the nearby Cretzulescu palace. Thus, the private palace gardens are redesigned and become public. Rebhun designs a new interesting area consisted in a small lake and zoo and a rose parterre. Other features introduced in this "annex" are represented by a new fountain placed nearby the former well from the

1800s - Eminescu's fountain, a frog-like fountain and a statue of Atlas. The new grounds are quickly appropriated by the society as the amaze mostly due to the exotic features represented by the birds and small mammals exhibited at the zoo. However, the new formal-classical design of the northern end of the garden is totally opposite to the romantic style imposed by Meyer at the middle of the 19th century.

Figure 28. Cretzulescu palace - view from the garden - before and after (www.jurnalul.ro; www.orasulluibucur.blogspot.com; www.googleimages.com; dumbrava laur on www.googleeath.com)

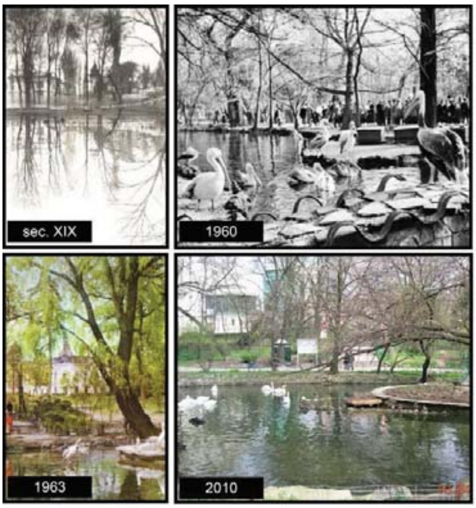

Figure 29. The zoo - before and after (www.only-romania.com; www.googleimages.com; www.googleimages.com; raduconstantin on www.googleearth.com)

F. The Romanian Writer's Rotunda

In the former placement of the Music Pavilion, a new formal landscape architectural design is planned. To this end, the decommissioning of the pavilion at the end of the 1800s offered the room for the construction of the Romanian Writer's Rotunda. However, the Rotunda's image will be fulfilled only after Italy, during the 1940's, will present Bucharest with a gift consisting in a series of 12 Carrara marble statues representing some of the most renowned Romanian writers. The specificity of this particular feature of the garden consists in the geometrical pattern in which geometrical clipped yews and hedges intersect with architectural elements such as marble statues, stone benches, columns, iron pergolas, stone and concrete vases etc. (Mexi et. al, 2013)

Figure 30. The Rotunda - (yews) before and after (www.googleimages.com; www.povestidinbucu resti.ro; www.googleimages.com; www.sanuuitam. blogspot.com; www.okazii.ro; www.sanuuitam.blogspot.com)

Figure 31. The Rotunda - before and after (www.googleimages.com; www.googleimages.com; www.googleimages.com; www.googleearth.com)

Figure 32. The Rotunda - before and after (www.googleimages.com; www.googleimages.com; www.googleimages.com; www.googleearth.com)

Figure 33. The Rotunda - before and after (www.googleimages.com; www.miscarea.net; www.googleimages.com; https://www.facebook.com/bucuresti.minus.50?fref=ts; photo by Al. Mexi; photo by Al. Mexi)

G. Pergolas alley

The Pergolas alley is situated at the western side of the garden and it owes its history to Rebhun's design from the beginning of the 20th century. Since then, the only modify-cation stands in the redesign of the pergolas.

Figure 34. Pergolas alley - before and after (www.googleimages.com; AlexRo on www.googleearth.com)

RESULTS AND DISCUSSIONS

Though numerous transformations were undertaken in Cismigiu garden, this city center green public space in Bucharest was massively used by the city's inhabitants. Today, the garden is probably even more crowded than it used to be during the 19th and 20th century and this is due to many public manifestations that take place within the garden. While some activities such as ice-skating may be seen as traditional, others such as fairs are totally both historically and practically inappropriate to be hosted in an A class outdoor green public space monument. Moreover, some other massive public manifestations such as concerts may be seen as partially traditional according to the original plans developed by Meyer for the garden - the music pavilions or the concert grotto - but are highly inappropriate today due to improper and misplaced concert scenes and large crowds of people that take over much of the already improper managed and uncared for planted space. To this end, while the former main chapter offered and insight in terms of historical design transformations undertake in the architectural layout of the garden, this chapter aims to show how Cismigiu is currently used by the public. The following analyses will focus on both traditional and modern ways of today's society's garden use.

Traditional activities

Since 1853-1856, both foreign travelers and local writers describe different relaxing activities and sports competitions held in the Cismigiu garden. If activities such as swimming competitions or *oina* games (traditional Romanian sport), winter ice-skating is still appreciated today. However, some esthetically improper technical solutions for freezing the lake's water took place of the original natural way of creating an ice rink and creates a very rigid and manufactured image that alter the overall romantic design.

Figure 35. The lake - skating - now and then (www.vechiul-regat.blogspot.com; www.orasulm.eu; photo by Al. Mexi; www.vechiul-regat.blogspot.com; www.libertatea.ro)

Figure 36. The lake - skating - now and then (www.vechiul-regat.blogspot.com; photo by Al.Mexi; www.pexacons.ro; photo by Al. Mexi)

New improper (semi/non)traditional public manifestations

Due to mostly economical and political reasons, numerous fairs and both rock and traditional music concerts take place within the garden. Both the large crowds that take over the already improper managed planted space and the high noise alter both the visual image of the garden and the romantic, wild mood created by different areas from Cismigiu.

Figure 37. Fairs in Cismigiu garden (www.rasunetul.ro; www.sorinoprescu.ro)

CONCLUSIONS

Cismigiu garden is a historical piece of urban landscape architectural design of Bucharest that has witnessed many different modifications undertaken by different specialists. Though not discussed in this article, none of the aforementioned transformations did affected the overall image of the garden as the last 70 years did, as both during communism and the last 25 years only a handful of poorly trained specialists ever took care of the garden and, instead of conserving its plants and architectural components, most of the garden's “masters” often tried to add new features that they believed will make the garden more beautiful and interesting.

From a romantic garden designed by Meyer to Rebhun's drastically transformations, few planting, architectural or layout modifications have been as damaging as today's improper actions that aim to "beautify" the already beautiful and coherent garden landscape. To this end, the current politics, though probably unconscious, continue the destructive actions firstly undertaken by the communists, and while before 1989, the actions aimed to exaggerate the romantic design of the garden, nowadays transformations mostly consists in the addition of several discordant design elements such as benches, banners, lighting poles, flower vases etc. and on the incoherent new planting design.

Figure 38. Protecting the garden - today's reality between signs and framings (Photos by Al. Mexi)

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INTERPRETING THE GARDEN SALOMON DE CAUS'S *HORTUS PALATINUS* – HISTORY, DESIGN, COMPOSITION, ARTS AND PHILOSOPHY

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Abstract

The Palatine g\Garden at Heidelberg was designed at the beginning of the XVIIth *century by Salomon de Caus for the royal couple Frederich V and Elisabeth Stuart. Though never finished due to the beginning of the 30 Years War, Hortus Palatinus is seen as the best example of a Renaissance and both Mannerist garden in nowadays Germany.Though never finished, the Palatine Garden at Heidelberg holds a series of secrets, signs, and symbols hidden in Salomon de Caus's book – Hortus Palatinus (1620). To this end, this paper aims to represent an interpretation of the gardens's design and components by confronting the author's text and drawings with the research in the field of visual arts, architecture and landscape design history and philosophy.*

Key words: *interpretation, Hortus Palatinus, palatine garden, Salomon de Caus, symbols*.

INTRODUCTION

Started but never finished, Hortus Palatinus, the garden from the Heidelberg Castle, was conceived as a landscaping complex full of symbols and a tribute to the palatin elector Frederick V, paid by the polymath architect Salomon de Caus. Together with the neighbouring castle, this allegorical garden should have represented the centre of the imperial couple's power- Frederich V and Elizabeth Stuart- but the beginning of the Thirty Years' War stopped the landscaping work at the garden, which later served as an outpost and a bombing space of the castle. Although the today's ruins do not tell much about the designed allegory, Solomon deCaus's work –Hortus Palatinus (1620) - as well as Jacques Fouquier (1620)'s paintings offer a complex base for researching and analysing the palatine garden from Heidelberg.

In this sens, this paper aims to provide a short history and a description of the garden as well as criticism and interpretation of the architectural and vegetal symbols designed by Salomon de Caus in order to be integrated into this particular landscape design of the 17th century.

MATERIALS AND METHODS

This chapter will focus on a brief history, personal comments and mostly on a comparative analysis of both historical and contemporary texts and images of the Palatine Garden at Heidelberg.

Brief History

Using the image employed by the poets, we may think of Jacobean Heidelberg as arising from the marriage of the Thames and the Rhine.(Yates, 1998)

The history of the palatine garden from Heidelberg represents an artistic product, the result of an important event from Central and Western Europe at the beginning of the 17th century. Therefore, Hortus Palatinus represents a project begun almost simultaneously with the wedding of the elector prince of Rin, Friedrich V and princess Elisabeth Stuart, the daughter of James I of England and suddenly interrupted by the political and military failure of Frederick V's resistance battle against the Habsburg Empire.

Representing the palatinate's capital, the Heidelberg defined itself as an outpost of culture, a centre "whence strange and exciting influences were to emanate"(Yates, 1998). In this respect, the gardens whose construction started on July 14th, 1614 represented an artistic current in itself - a three-dimensional allegory, a story in images and perspective shapes. Unfortunately, several historical events such as the election of Frederick V as King of Bohemia (August 1619) and the military defeat from the White Mountain (November 1620) discontinued and subsequently permanently closed the garden's landscaping work.

Although unfinished, Hortu Palatinus was considered an eighth wonder of the world; the Heidelberg castle's gardens are thought to have been the inspiration for a number of important texts such *The Chemical Wedding of Christian Rosencreutz*. Thus, Frances Yates considered that Hortus Palatinus as a separate architectural, landscaping, mythical and mystical entity is in the centre of Johann Valentin Andreae's description of the Rosincrucian Manifest *The Chemical Wedding of Christian Rosencreutz* (1616):

The Chemical Wedding introduces us into a vast castle, full of wonders, and with a marvellous garden—Heidelberg castle and gardens full of the wondrous works of Salomon de Caus. There is a Lion at the gate and a very prominent Lion fountain in the gardens, emphasizing that we are in the domains of the Palatine Lion. Castle and gardens are full of movement, they are inhabited by members of a wealthy court whose life centres on a married pair, a King and Queen, a sponsus and sponsa, who are both emblems of marriage as a mystical experience, and of the alchemical sponsus and sponsa spiritually interpreted, and also have a real basis in history as the Elector Palatine and his wife Elizabeth Stuart (Yates, 1998).

Salomon de Caus's Personality and Frederick V's cult.

The design of the famous palatine gardens of Heidelberg is especially due to the polymath architect, landscape architect and hydraulic engineer Salomon de Caus. This genius of French origin was raised in the spirit of the Renaissance and was noted in particular for his many hydraulic works made for various nobles or even royal houses from Italy, the Netherlands and England. It should also be mentioned that his works and texts about hydraulics represented "the base of the hydraulic works of the Baroque" (Kluckert, 2007).

Salomon of Caus's relationship with the royal family of England is due to Elizabeth's brother - Prince Henry. As Frances Yates also stated, "prince Henry, had been deeply interested in Renaissance gardens' design, in mechanical fountains which could play musical tunes, in speaking statues and other devices of this kind [...]. In his employment, as his surveyor, was Salomon de Caus, a French Protestant and an extremely brilliant garden-architect, and hydraulic engineer" (Yates, 1998). The premature death of Prince Henry and Frederick's wedding with Elizabeth sent de Caus to Heidelberg, him being responsible for the design and execution of the palatine gardens. As the royal wedding brought great hope to those who wanted the Habsburgs removed from Europe, the universe accompanying the couple was supposed to represent a strong message in itself sent through different symbols. Thus, Hortus Palatinus being part of this universe was endowed by Salomon de Caus with a series of symbols which make allusions to ancient mythology and glorify Frederick V's personality. In this regard, Salomon de Caus designed the gardens according to the Vitruvian principle of "true architecture" (arts and sciences based on numbers, proportions, music, geometry and perspective, mechanics, etc.)(Yates, 1998) and aesthetic and compositional principles of the Renaissance offering the architectural and landscaping complex from Heidelberg an aura of mystery fueledby magic-mechanical "wonders" found in caves and hydraulic works.

Through "Frederick's cult" I will refer to the trust shown by his subjects to remove the Habsburgs from Europe, trustmani-fested through a sum of symbols and titles granted to the palatine elector. Excluding for the moment alchemical symbols designed by de Caus and found at Heidelberg, "Frederick's cult" was powered by granting the title "Order of the Garter", depicting him as a contemporary Saint George about to behead the Habsburg dragon or as a Jason of the Golden Fleece when, travelling on water to Heidelberg, the garter was hung from the ship's mast (Yates, 1998). On the other hand, regarding Hortus Palatinus, this garden has been endowed with a number of alchemical symbols that glorify through their shape or mythical substrate, Frederick V's personality as well as his relationship with Elizabeth and implicitly with James I's England.

***Hortus Palatinus* – Examining Salomon de Caus's Print.**

As discussed above, investing Frederick as king of Bohemia interrupted work on the gardenfrom the Heidelberg palace and the military failure at the White Mountain in 1620 ended any hope of resuming the work at Hortus Palatinus. Undescouraged and confident in the possibility of completing the workat Heidelberg, Salomon de Caus began in November 1619 to describe literary and graphically the garden's composition editing in 1620, shortly after the aforementioned battle, a paper entitled *Hortus Palatinus – a Frederico Rege Boemiae Electore Palatino Heidelbergae Extructus*. This volume contains a series of brief, literary and graphic descriptions of the already carried out, as well as of the works that were going to be included in the garden. This print is thus the most valuable historical source based on which one can make a criticism of gardenswhich unfortunately for the modeling landscaping art's history could never be completed.

The document begins with a brief description of the topography and vertical systematization work (the detonation of the slope adjacent to the medieval castle and building terraces) and continues with a brief presentation of the architectural, horticultural and landscape components that will characterize the garden. At the end of the text, the print includes a plan and a general outline as a *perspectiva cavaliere* as well as a series of descriptive quasi-random concatenated drawings per-taining to Matthaeus Merian (McIntosh, 2005). In addition to the text and the des-criptive drawings, the printalso hasa cover full of alchemical symbols closely related to the Rosincrucian program of the seventeenth century. Thus, the garden is presented as a way of interpreting the "Book of Nature", an important element of the Rosincrucian program (the divine truth can be discovered in nature as in the Scripture)(McIntosh, 2005) and tries to mimic the Garden of Eden (artistic motif and a landscape specific to the Renaissance) by using sacred proportions that „vibrates with divine harmony" (McIntosh, 2005).

If the criticism of the text and the description of the gardens represent the subject of the next chapter, the current chapter should be concluded with a brief description of the allegory of the alche-mical symbols that make up the cover (figure 1). Therefore, this "Book of Nature" / *Carta Mundi*is flanked by two satyrs with goat legs - demons of Dionysus, the god of wine and vegetation. These two creatures represent, in Christopher McIntosh's view, "nature in its primal state of rawness and innocence" (McIntosh, 2005). The same mythological creatures are accompanied by the two gods of the exoteric wisdom and implicitly of the esoteric hermeneutic tradition, Pallas

Athena and Hermes. Between the two deities one can see the five geometric figures of Plato's Timaeus’s: the tetrahedron, the cube, the dodecahedron, the icosohedron and the octahedron. Above mythology and ancient sciences there are four angels. If the two central cherubim support a sphere of stars that is described by McIntosh as consistent with the verse "as in heaven, so on Earth" - everything on Earth has a correspondent in heaven – the cherub situated on both sides of the sphere support astock of scientific knowledge suggested by the mathematical tools they keep hang on a string. Also, these two angels hold a torch in the other hand which can be interpreted as a flame of wisdom and respectively a mirror, an alchemical symbol possibly interpreted as suggesting that "human arts are merely a reflection of divine creation"(McIntosh, 2005). To summarize, the cover of Salomon de Caus’s print can be interpreted as representing the Book of Nature’scover in itself.

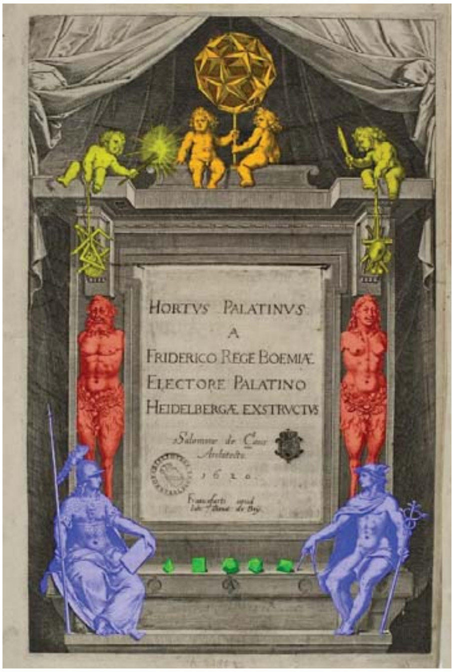

Figure 1. Cover symbols
(deCaus, 1620)

Describing the Palatine Garden

Salomon de Caus concentrated on garden design, which, in the Renaissance, was closelyrelated to architecture, dependent, like the queen of the mathematical sciences, on proportion, perspective, geometry, and employing the newest refinements in mechanics for its decorative singing fountains and other embellishments (Yates, 1998).

Initiated in the art of gardens in Italy, Salomon de Caus drew inspiration from the model of Renaissance gardens in Italy to design the palatine gardens. Thus, it seems that Renaissance villas like Villa D'Este, Villa Pratolino, Villa Lante or the Boboli Gardens served as architectural, engineering and artistic models for the architect in drawing the sketches and plans for Hortus Palatinus. Regarding the text, it is considered that works such as of Heron of Alexandria’s pneumatics and hydraulics treaties, Francesco Colonna’s *Hypnerotomachia Poliphili* (Poliphilus' dream), Vitruvius or Pliny the Elder’s textswere the basis of the project for the gardens in Heidelberg. Forced to move to Prague after Frederick was elected King of Bohemia, Salomon deCaus started working on a text describing the garden’s composition so that it can be completed in the future, but due to the military failure at the White Mountain, the entire cultural-architectural project was abandoned and the garden was never finished. Although the palatine garden remained in an intermediate stage, being quite badly damaged by the Habsburgs shortly after the victory against Frederick, thanks to de Caus’s print, it went down in the history of landscape architecture as a landscaping complex of mixed styles, both Renaissance and Mannerist, a garden of alchemical symbols, a *statement* of the Palatinate’s power. In this respect, the following subchapters will provide a brief description, interpretation and critique of the landscape design.

The Insertion and the Connection to Topography

De Caus had blasted away the rocky hillside to form a flat surface on which he developed geometrical garden designs of great complexity.(Yates, 1998)

A fundamental characteristic of the Renaissance and Mannerism gardens is represented by the planimetric and level structure of the landscape - terraces with parterres. Thus, because of the rocky terrain adjoining the medieval castle of Heidelberg did not allow people to immediately start the landscape design, Salomon de Caus had to propose detonation of a big slope near the architectural complex so that they can build, according to the Italian model, a series of intercomnected terraces at varying altitudes. These works are alsobriefly mentioned in Salomon de Caus's print – Hortus Palatinus (1620). The vertical systematization work is supposed to have been completed around 1618 as in that year a gardener was employed to take care of planting (www.heidelberg-fruehe-neuzeit.uni-hd.de). Thus, before the second decade of the seventeenth century, the medieval castle and adjacent gardens occupied a dominant position over the city and the Neckar.

The Connection to the Castle

Although he followed quite attentively the compositional structure of the Renaissance villas in Italy, Salomon de Caus did not create a direct link, on the same line with the castle. Thus, the garden's transition from medieval architecture to the Renaissance garden composition should have been done through an annex which was never built.

This relationship of independence between the castle and gardens is one of the major pieces of criticisms brought to de Caus'sprojec. However, I think that the lack of a direct connection between the architecture and the landscape is a "strong point" of the project as the garden represents a message made up of alchemical symbols that glorify Frederick's personality, a "green" message attached to an already existing architecture. Therefore, the absence of a perfectly synchronized link with the old castle would have been a message in itself, and given the fact that Friedrich had to create a new future by changing the political map of Europe, an axial connection to the past (the castle) could alter the alchemical message of the garden – the continuity of the past in the future versus a new future rooted in the past.

The Connection to the City

As I previously mentioned, the garden and the castle levitated above Heidelberg, being located at a considerable height over the urban constructions. As people thought that the "castle of Heidelberg will become a center whence[...] strange and exciting influences were to emanate" (F. Yates), thisphysical and psychological levitation can be regarded as a *statement*, as a foundation of the royal couple's universe's philosophy. Along with the separation between the oldmedieval architecture and the new Renaissance-Mannerist landscaping, the relationship between the architectural complex and the urban constructions reinforces the idea of a Heidelberg which is an outpost of culture and of the fight against the Habsburgs.

The Analysis and Criticism of the Terraces' Composition

The detonation of the eastern slope allowed Salomon deCaus to design a series of four terraces. Each terrace contains a number of "green" parterres where one can often find architectural objects which form alchemical symbols that glorify the royal couple - Frederick V and Elizabeth Stuart. In the following chapters I will try to make a description of the terraces and green parterresand interpret the design of some more or less architectural elements.

A. The Main Terrace

The main terrace is the most complex of all 4 terraces, having the most vegetalized parterres and architectural objects. This terrace was accessed through that annex attached to the medieval castle and was followed by aseries of 8 square or rectangular parterres, each having at least one alchemical symbol.

The parterre with the Fountain with a Grimace

This parterre is described in de Caus's print, being assigned the drawing number 16 in Hortus Palatinus (1620). Thus, this square parterre, divided into 4 congruent surfaces, but with different vegetal composition, bordered both inside and outside by a series of architectural hedges, coupled with small trees, surrounded by an architectural element shaped as an octagonal basin with a grimace fountain. Finally, the inner alleys had on the outside an arch made of wooden lattice and probably covered with climbing plants.

According to online descriptions, it seems that the smaller parterres were made up of herbs (thyme, lavender or rosemary) inserted on a bed of clay or colored sand; and the fountain would have been an area adorned with stones, shells and tuff (www.heidelberg-fruehe-neuzeit.uni-hd.de).

The Parterre with Pergola

This parterre, briefly described by de Caus, is believed to have been made up of 8 square partswith hornbeam *(Carpinus* sp.*)* planted in the grid, squares separated by pergolas and hedgerows with roses *(Rosa* sp.*)*, Jasmine *(Jasminum officinale)* or vine*(Vitis vinifera)*. In the center of this predominantly vegetal composition a pavilion with bells was in plan to be constructed.

The parterre of the 6 Squares

Similar to the pergola parterre, this component was not described in detail by Salomon de Caus. However, from studying Matthäus Merian's perspective and plans and from Jacques Fouquieres's perspective, one can see that these parterres consisted of vegetal-architectural compositions - probably made up of thyme, rosemary, sage or lavender (www.heidelberg-fruehe-neuzeit.uni-hd.de) and laid on beds of clay or colored sand. Like the other parterre previously mentioned, these were alsobordered by anarchitectural hedge doubled by small trees, similar to the one at thefountain with a grimace.

The Parterre with the Obelisk-Fountain

Very similar from the point of view of the composition with the fountain with a grimace parterre, this parterre was built around an octagonal basin in the center of which is an obelisk decorated with fantastic sculptures out of which water gushed and which had a tip made as a Ionic capital thatsupported a sphere. This *Globus cruciger*, symbol of the Christian monarchy, located on top of an obelisk - the archetypal symbol of creation and masculinity, can be another alchemical symbol which might be translated as a leader (men / male) - Frederick V - master, God willing, over the esoteric legacy, ancient knowledge about the world, etc.

Unlike the parterre at the fountain with a grimace, this parterre is described by architect through two figures (numbers 3 and 4) in *Hortus Palatinus* (1620).

The parterre of the Muses

Divided into four semi-parterres, similar to those previously mentioned, this parterre is distinguished by the vegetal and architecttural design, as well as by the ornaments inserted round its compositional center. Thus, the four squares surrounded by architectural hedges intertwined with deciduous trees of different sizes, have a number of embroiderie swhich make up the following message: *FRIDERICVS V COMES PAL (ALTINUS) EL (ECTOR) D(UX) BA (VARIEAE) 1619- Frederick V, Electoral Palatine, Duke of Bavaria 1619*. This parterre contains, as its name states, a series of nine statues that embody the arts and science muses of Greek mythology. Of the 9 muses, the statue of Urania, the muse of astronomy, is the one which stands out. It's placed in the compositionalcenter of the parterreand it is equipped with a wand which according to de Caus serves as a sundial.(www.heidelberg-fruehe-neuzeit.uni-hd.de) The online documents of the University in Heidelberg interprets this parterre as hiding the following alchemical message- Frederick V, ruler endowed with a comprehensive humanities education (www.heidelberg-fruehe-neuzeit.uni-hd.de).

The Parterre with the Orangery.

Thisparterre is described in de Caus's print is made up of a complex composition of circles and octagonal stars completed by vases with citrus fruits, especially orange trees. Besides the special architecture, this parterre contains some hidden symbols specific to both the Renaissance as an artistic phenomenon and Salomon de Caus, in terms of his passion for music. Thus, using constantly multiples of 8 in the planimetric architecture of this parterre is in the opinion of Christopher McIntosh that a musical symbol is embedded in the architectural composition (McIntosh, 2005). On the other hand, while the architecture replaces music, the vegetable composition made up especially of exotic trees of the citrus family substitutes the general theme of the *orangery*.

Since plants are rarely used strictly for decoration, the citrus trees used in *Hortus Palatinus* are part of the landscaping patterns of the Renaissance, these representing *green* alchemical symbols. Thus, the lemon tree, symbol of redemption, harmony and fidelity along with the orange tree, symbol of Paradise, chastity, purity and marriage (Impelluso, 2004), and also the musical architecture creates a complex scenography that can be interpreted as the very marriage of Frederick and Elizabeth. Also, since the ancient mythology associates the two citrus species with symbols of the marriage between Jupiter and Juno, I think that a symbolic comparison between Jupiter and Juno and Frederick V and Elisabeth Stuart is plausible, at least in terms of the decor and alchemical allegory from Hortus Palatinus.

Father Rhyne's Basin

This basin is right outside the entry into the "Great Grotto" and includes a statue which embodies the Rhine. The plan and the outline for making the basin are graphically described by Matthaus Merian and inserted, along with Salomon de Caus's literary description, in the volume *Hortus Palatinus*.

Probably inspired by the model of statues in the gardens of the Italian villas like the Statue of the Apennines (Villa Castello, 1563) or the Pegasus' basin (Villa Lante), the fountain of Father Rhine appears as an old bearded character, resting among a number of small rocks out of which water jets gushes. This piece of decor can be interpreted as a new alchemical symbol. Although we found no information to confirm or refute my personal hypothesis, I believe that this statue facing the obelisk with a sphere is a promise of Frederick - *son of the Rhine* - as a defender and winner of Protestants (Anglo-Saxons and Germans) against the Catholic Habsburgs.

The Great Grotto

The great grotto consisted of two main rooms and several annexes. This cave was accessible via a portal of red tiles decorated with an array of wild, indigenous and exotic animals, such as deers, lions, monkeys and on the inside it was decorated with mosaic floors and wall covered with limestone and tuff. Regarding the objects which could be found in these rooms, we have to mentione a table used for *water arts* and a sphere floating over a waterfall illuminated through a slot in the ceiling. All these descriptions of the cave are accessible through three drawings (numbers 21, 22, 23) attached to Salomon de Caus's volume.

Regarding the interpretation of the components of this suite of underground rooms, I believeone can mention a hidden message - nature (as defined by the multitude of statues of wild animals and the false stalactites) can be tamed through knowledge (the table of hydraulic works) and also through divine illumination (suggested by the sphere which levitates above a waterfall illuminated through the slot in the ceiling). Also, the physical lighting of the cave can represent an allusion to the Rosincrucian Manifesto *Fama Fraternitas* - Christian Rosencreutz' scriptand the alchemic sun which “artificially” illuminated the room (Andreae, 2013).

The Water Parterre

The water parterre is described in detail, both from the point of view of the text and graphically in *Hortus Palatinus* (Figures 7 and 8). Thus, its composition is formed by a series of basins, bridges and circular alleys which surrounds five statues - three nymphs and 2 children. Since this garden was begun shortly after the royal wedding of Frederick and Elisabeth and on the adjoining parterre, there is a basin with the statue of the Rhine, I believe that these nymphs must also be integrated into the alchemical allegory. In this respect, I believe that the central nymph represents the Thames, alluding to the marriage of the Rhine (German states) and Thames (England). This nymph can be seen as being the king’s ally in the battles that he had to win.

My statement is supported by the fact that the central nymph – Thames, the Palatinate’s ally - supports a lance in the tip of which there is a small sphere with a cross - symbol of the Christian monarchy - possibly interpreted as "God's will". Also, the nymph, protected by a thin layer of water gushing from under the Christian sphere and the group of statues surrounded by water may represent the British Isles and the protection offered by the sea water.

The Orangery

This part of the garden is described in detail in Salomon de Caus’s print and in two drawings (number 9 and 10). The architect relates how they had brought over 30 trees from a specific garden, on water, to Heidelberg and describes in some detail the way the orange trees will be protected during winter by covering them with a wooden construction richly decorated on the outside.

The Seasons’ Parterre (figure 2)

Named by de Caus the "Flower’s Garden", this parterre has a complex architectural composition made up of a series of plane geometricalfiguresin which various species of plants are included. Thus, if the extremities of the parterreare designed as embroidery of small plants, aligned in front of some wooden gazebos, the radial strips from the central area of the parterreare described by the architect as planted along with species of flowers to make a "floral calendar” based on a chromatic sequence. (www.heidelberg-fruehe-neuzeit.uni-hd.de)

The compositional center consists of a circular basin in the middle of which there is an area with stones and species of small conifer trees out of which thin jets of water gush through a series of slots. Since the whole Renaissance program embedded in landscape architecture revolves around the idea of finding the Garden of Paradise, it is assumed that the area from the centre of the floral parterreis meant to be an allusion to Paradise Mount (McIntosh, 2005). Also, this complex composition may have roots in the Persian philosophy, philosophy that describes the *"Paradise Garden"* (Iliescu, 2014) as being divided into four squares symbolizing the four corners of the world and having in the middle a vase or a basin with water which suggests Earth’s navel (Foucault, 2001) (in the palatine garden’s case - a basin with a "*mountain of Paradise"*). Therefore, this floral calendar representa sum of allegories and alchemical symbols which are wrapped in a chromatic spiral of a magical time.

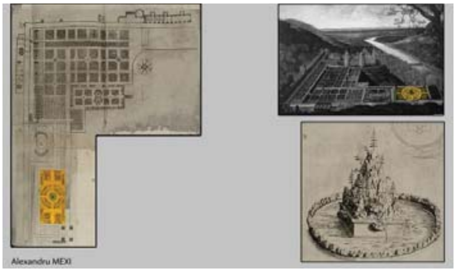

Figure 2. The Season's Parterre and the Paradise Mount (after de Caus, 1620)

The RearCabinets
These constructions are not described in any historical document; however, they might have served as a cabinet of curiosities. This is purely speculative, but it is possible and actually probable that given the fact that these cabinets represent a fashion of that time, and the garden is fundamentally an area of exhibiting works of art (architectural or topiary) I think it would have also accommodate other art objects placed in such rooms which were easily accessible through the garden.

The Greenhouse Tower
Located in the northern extremity of the garden, this annex is believed to have been started but not completed because of the war. Briefly described, both in writing and graphically (Figure 13 in *Hortus Palatinus* 1620) by the architect, this architectural volume would have provided a panoramic view over the palatine garden, the medieval castle and the Neckar valley.

B. The Upper Terrace
This terrace in the shape of a longitudinal promenade host 2 of the 3 gallery-caves designed by Salomon deCaus–the "large safe" and the small gallery/grotto as well as a number of other architectural components and plant covered in mysterious alchemical symbols.

Frederick V's Portal (figure 3)
In the western end of the upper terrace an architectural portal was designed above which there should have been placed a statue of Frederick V dressed in the royal cloak and the war armor, holding in his left hand a sphere and a sword, and around the neck - a medal. In the centre of the portal there can be found an image of a fountain with the statue of Neptune, god of the seas, leaning triumphantly gainst his trident and a sea creature. Also, this architectural structure, described from a graphical point a view in the architect's writings (Figure number 20) also contains a Latin inscription which can be translated as:
"Frederick, King of Bohemia, Elector of the Palatinate of the Rhine, count over the Diana's former Holy Land, now ordered by the leveling of the mountains slopes and the coverage of the valleys in honor of the garden god and by incorporating water channels, caves - fountains, statues, plants, flowers and tall trees in a topiary art of bushes. This was continued until the year of God 1619" (www.heidelberg-fruehe-neuzeit.uni-hd.de).
I believe that this portal can be interpreted as representing an alchemical message that glorifies the Elector Palatine as being that Man that connects the wild landscape of ancient mythology and nature's metamorphosis through the science of the Renaissance and Mannerism. Thus, by brute force (the sword) and knowledge (the sphere), Frederick manages to tame Diana's realms and master Neptune's waters, and through the waters of Neptune, I think we can refer to both the Rhine and Neckar, as well asto the British Thames.

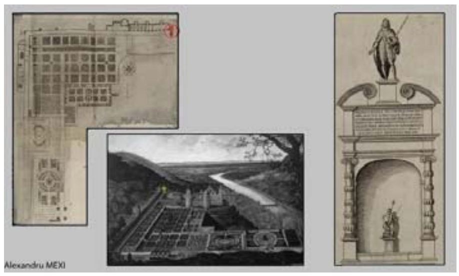

Figure 3. Friedrich's Portal (after de Caus, 1620)

The Big Seif
This first cave on the upper terrace is described in some detail by the architect,

both literary and graphic (Figures numbers 28, 29 and 30). The "vault" was divided into three rooms that had different functions. The west room served as an orangery –a storage space of the vases with citrus trees in winter; the central chamber had a series of "water machines" (www.heidelberg-fruehe-neuzeit.uni-hd.de); and the third room functioned as a royal Terme heated by ovens. In this thermos one was supposed to find a statue of a satyr playing the flute (by means of machines to make sounds) and two statues – perspective heads located along the thermal spa. Thus, one end was made in the shape of a cave in the middle of which, floating on a circular platform, there was the figure of a child with two domestic dogs; while the opposite end was designed as a grotto with a waterfall which integrated two characters - a creature which comes out of a rock and spreads water through a series of holes found in the eyes, mouth, nose, ears, phalanges, belly or breasts and a young man who pours water from a kettle on a platter.
Regarding a critical approach to this safe-cave, I do not think that this is a complex or a conglomerate of alchemical symbols, but rather, a series of rooms designed to provide entertainment especially in winter.

The Gallery and the Small Grotto
This gallery impresses the public through the architectural embroideries of the facades and through the 10 reliefs showing the glorious deeds of Hercules, and also through the rich interior decorated with mosaics, stone carvings, coral and shells (Figures numbers 25, 26, 27 - HortusPalatinus 1620). These interiors do not lack mythological reinterpretations or hydraulic artworks. Thus, in the gallery's annex – in the small cave – one can find bass reliefs showing a number of sea creatures, nymphs and gods, as well as a basin with fountains of coloured coral lit through a slot in the ceiling. This basin of corals can be interpreted, as Frances Yates also suggests, as an alchemical symbol depicting the Philosopher's Stone.
Unlike the "large safe", I think that this gallery with grotto hides many alchemical symbols camouflaged in mythological reinterpretations and engineering works. But perhaps the most impressive symbol is represented by Hercules's allegory – an allegory specific to the "royal motifsof the seventeenth century Europe" (www.heidelberg-fruehe-neuzeit.uni-hd.de) - a tribute to that cult of Frederick.

The gardiner's Annex
This construction attached to the upper terrace is not described by the architect, but it appears both in Matthaeus Merian'splan and perspective and in Jacques Fouquieres's perspective drawings. The architecture of this building is, however, similar to the one of the "greenhouse-tower".

Venus's Basin
This pool is situated above the Great Grotto and as Salomon of Caus also states, it would provide water for the cave, thus representing a quasi-water tank. In the compositional center of the fountain there was a statue of Venus, the goddess of beauty, love and prosperity, accompanied by Cupid, the god of attraction, affection and erotic love. These two deities were projected on a pedestal supported by four sea creatures and four reliefs from which water jets were gushing. I believe that this mythical-erotic duality can represent an alchemical symbol that completes the message and promise supported by "Friedrich's Portal" - a mystical realm, ruled by feelings and reason.

The Oval Stairs (figure 4)
The stairs represent an architectural element designed according to the principles of Renaissance perspective geometry. Also, the sequence of basins' model which accompany the stairs can represent a reinterpretation of some architectural patterns similar to those of

Villa Lante, Villa D'Este, Palazzo Farnese in Caprarola etc. I believe that this part of the garden can also be interpreted as an alchemical symbol. Thus, this architectural vision requires a distortion of the de Caus'sprojected image and transforms the geometrical circularity of the stairs into an apparent hourglass that together with the water's kinetic gravitational movement can give the impression of the "passage of time".

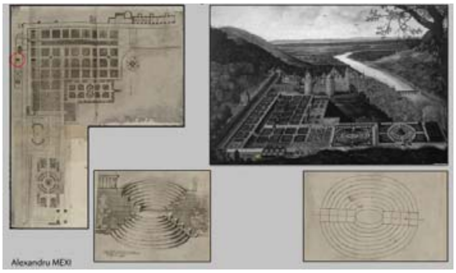

Figure 4.The Oval Stairs
(after de Caus, 1620)

The Cabinets

Unlike the "back chambers" on the main terrace, these cabinets are described by Matthaeus Merian in Figure 17 of Hortus Palatinus. These areas enclosed by hedges, accessible through some architectural carved stone gates, should have incur-porated a wellwhich would ensure the water supply necessary for a number of fountains in the garden, but also provide ample views of the castle and the palatine gardens. On the other hand, although their design and location differ from the cabinets on the main terrace, it can be assumed that they would have also served as a cabinet of curiosities. Given the absence of a direct conncetion with the medieval castle, I believe that these cabinets could represent a true *piano nobile* through their location and panoramic openings on the garden.

The Labirinth with a Sundial

Undescribed in Salomon de Caus's writings, but present in Jacques Fouquires's perspective drawings, it appears that the labyrinth should have been made up of concentric hedges which would have surrounded the compositional centerwhere an obelisk bordered by a basin of water would be placed – possibly a sundial. Perhaps this circular maze could have been designed so as to represent "a green miniature" of the road to enlightenment, but this aspect can only be presupposed as the information about this part of the garden is insufficient.

C. The Intermidiate Terrace

The intermediate terrace consists of 8 architecturalparterres–covered with plants, each of them different from the point of view of the vegetal embroidery, but similar in terms of compositional symmetry. Moreover, besides the 8 parterres,one can also find a basin in the shape of a square adorned with a central piece which wasn't described in any historical document.

D. The Inferior Terrace

The lower terrace is described in de Caus's volume both through the textand especially through two figures (numbers 14 and 15). This lower part of the garden appears as a semi-independent courtyard with two squares decorated in palmettes and a central basin guarded by the architectural figures of the Main and Neckar rivers and of the nymphs Flora and Ceres. The garden is accessible via a series of three pyramidal stairs which go down from the main terrace. Regarding the author's literary descriptions, he proposes that the two sides with embroidery in palmettes be equipped with a number of vases with Seville Orange Trees *(Citrus aurantium)* and as for the central basin, Salomon of Caus designed it so that it collects water from all the fountains in the garden. (www.heidelberg-fruehe-neuzeit.uni-hd.de)

RESULTS AND DISCUSSIONS

Complex Alchemical Symbols

De Caus's intention in the garden was to present the visitor with a vision of this *divine order operating within nature, but a nature refined and uplifted – in a sense, a paradise regained. And, since nature is so diffuse and multifarious, he used certain standard images from mythology to illustrate its various aspects. Thus the garden combined music, mathematics, geometry, architecture, mechanics and mythological iconography. In a richly detailed analysis of the garden's symbolism, Richard Patterson has written that 'in the Hortus Palatinus de Caus was concerned to articulate a path which would reconnect humanity to Nature in some absolute sense.*(McIntosh, 2005)

We believe that this Palatine Garden offers not only punctual alchemical symbols (statues, topiary art, engraved texts) but also complex messages, messages which make up the magic of this garden. I will therefore list four complex symbols that I believe Salomon de Caus inserted through architectural, horticultural, landscaping or engineering artifices as well as mathematical means - symmetry, perspective, repetition etc. I will define the four "magical arts" the following way: musicology; architecture, religion and mythology; reason and feeling; tempology.

Musicology (figure 5)

Soon after entering the garden one comes upon an octagonal stone basin, which is all that remains of a fountain. However, the octagonal form immediately gives us a clue to the message of the garden, for eight, the octave, is the number of musical completion and wholeness, and the musical theme is one that is repeatedly taken up in de Caus's design (McIntosh, 2005).

Salomon de Caus is known to have been not only an incredible engineer and architect, but also passionate about music. He managed to endow numerous statues with the ability to sing through the hydraulic techniques. To this end, Chirstopher McIntosh relates about a machine designed by de Caus that it was able "the three models of ancient music, the diatonic, the enharmonic and the chromatic" (McIntosch, 2005) and about another one, seen as a satirical statue of the god Pan playing the flageolet, that it was able to play a kind of nature's music - „the passionate, rude and inarticulate origin out of which refined melody might emerge" (McIntosh, 2005).

Moreover, his music was not only acoustic but also but also architectural / compositional - symbolic. Thus, besides the statues endowed with voice, the garden's symbolic music also consisted of a series of objects related to the number 8, objects designed based on an ordonate geometry ranked by multiples and divisors of the figure 8: the statue with a grimace's basin, the obelisk-statue's basin,the mountain basin's vases etc. Also, the figure 8 is also found in the planimetric geometry of the garden and parterre models: the intermediate terrace (Annex 26) comprises an amount of 8 parterres described by Christopher McIntosh as having the shape of a musical theme of the AABAABAA type „in the form of a modal scale or an octave of dimensions which complete one harmonic interval (McIntosh, 2005); The main terrace with the pergola parterres (parterre subdivided into 8 squares), the 8 squares parterre and the orangery parterre (designed as a star with eight corners); as well as the lower terrace which consists of two parts situated symmetrically to a central basin and summing eight squares. Although I haven't found any information to confirm or refute my personal opinion, I believe that the palatine garden from Heidelberg could be read as a mystical musical stave as it brings together music in its classical auditory form, and also the visually and tactile through the architectural-vegetal composition. As a matter of fact, Frances Yates himself compares Heidelberg with a garden of sounds similer to those on Prospero's island (Yates, 1998).

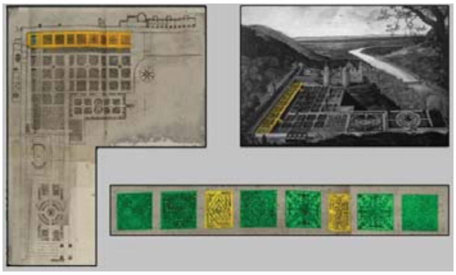

Figure 5.Musiology - AABAABAA
(after de Caus, 1620)

Architecture, Religion and Mithology

Not incidentally, the statue of Friedrich is placed in the highest point of the garden –it watches everything that happens in the scenography of the garden, in its alchemical microcosm. This is so because of the symbolism in the architecture and fine arts in the garden, a messenger of religion and divine creation on Earth (see details of the construction of the statue of Frederick: the sphere with a cross, the medal and the conquering sword) but also a master over the mythology, culture and knowledge of the antiquity (locating the statue of the elector above that of the sea god- Neptune). In this regard, the mythological allegory contains ancient nymphs and goddesses (Venus - beauty, love, prosperity, Cupid - attraction, affection, love, erotic, Urania - astronomy; Neptune - waters; Pan - pasture and orchard, Flora, Ceres, etc.) but also deities who embody Frederick's familiar geographical frame (Neckar, Main, Rhine, etc.), all of which follow each other in a well defined order in front of the statue of the elector palatine on Frederick's portal. I believe that all this alchemical scenography exalts the future King of Bohemia and puts him forward as a monarch who will conquer and rule in the name of God, but not so much by the sword, but especially through culture and knowledge.

Reason and Feeling

The notion of 'reading the book of nature' was an important element in their programme, as they believed that divine truth is revealed in nature as clearly as in scripture. The whole universe, in this view, is constructed according to sacred proportions and vibrates with divine harmony.(McIntosh, 2005)

The entire Renaissance garden art, as presented by Tom Turner, revolves around the idea of a mathematical nature, a nature created by a *Deus Geometer*, that landscape architects and artists have to render in their designed compositions. To this end, since the garden was supposed to be an exact copy of the Garden of Eden, it had to be equipped with a range of architectural or vegetable artifices to inspire different feelings or to appeal to the human conscience and reason. Although we can confidently state that the garden in Heidelberg was created around the "cult of Friedrich", it does not lack some components to "deify" compositional parts which make the transition from art to divine art. Architectural components such as The Basin with Mount Eden gives the garden this "divine nature", while other architectural and vegetal elements stimulates the human senses and offer different sensations (basins, water organs, singing statues, herbs, etc.).

Tempology

Time plays a fundamental role in Frederick's mission. Thus, to implement the Garden of Paradise summarized as a mythical – religious heterotopia in the reality of the 18th century Western Europe, Frederick's Palatinate had to overcome a series of obstacles that could be surpassed only by enlightment, and this process was directly proportional to time. If the enlightment can be read in the garden by studying the architectural composition or vegetal symbols, time is visible in the garden through the Oval Staircase, through the Floral Calendar, but especially through the Maze with a Sundial. The latter one probably best describes this race against time to attain enlightenment - a mythical religious enlightment - which can not be personified other way than as an obelisk lit by sunlight.

Hortus Palatinus in the present

As we gaze at Matthieus Merian's fascinating engraving of the Heidelberg gardens, we may reflect that here, perched on this hillside in the heart of Germany, was:

"[...] *an outpost of Jacobean England, a citadel of advanced seventeenth-century culture. But this most promising new growth, fertilized by the marriage of the Thames and the Rhine, was to have no future. The date, 1620, of the publication of the engraving, is the year of the brief reign of Frederick and Elizabeth in Prague as King and Queen of Bohemia, the year which ended with the events leading to the outbreak of the Thirty Years War which was to devastate the Palatinate and destroy the splendours of Jacobean Heidelberg. The Palatinate was in the front line of the battle and the devastating impact of the reaction can be clearly seen in the fate of Heidelberg."*(Yates, 1998)

Unfortunately for history, the magic of the palatine was interrupted by the war's curse, but despite these adverse events, HortusPalatinus survived due to Salomon de Caus's drawn print.

Currently, a number of reconditioned ruins can be seen in Heidelberg. The castle's ruins, the incomplete construction of terraces, Father Rhine's Basin, The Big Gallery remind us of the designed scenography and of the architectural-vegetal alchemical allegory, underlining "Frederick's cult". On the other hand, although in ruins, the former palatine garden is a living space; a public garden that offers a beautiful view of the castle and of the old town and which through some reconditioned elements pertaining to the original design, is a portal that connects contemporary reality to 17th century magic.

CONCLUSIONS

The Heidelberg garden was therefore a complex visual text, designed to convey its message on many different levels (McIntosch, 2005).

Whether it's about "Frederick's cult", or about allusions to his marriage with Elizabeth, the heterotopic allegories which recreates a mythical and utopian microcosm, Hortus Palatinus (the print and the garden) is a codex (Clavis Universalis – the universal key) that can be deciphered and read as required by the Renaissance ideal, as a "Book of Nature", but a book that involves nature and mythology to create a scenography that revolves around the royal couple made up of Frederick V and Elizabeth Stuart. The rosincrucian program from the palatine garden amazes even today through its complexity and alchemical compositional depth, but at the same time, the real depth of the message which Salomon de Caus wanted to convey through the architecture, engineering and horticulture can be only partially deciphered and interpreted as real history did not allow it to be really truly implemented.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

CORRELATIONS BETWEEN THE VEGETATIVE AND DECORATIVE INDICATORS IN *CALLISTEPHUS CHINENSIS L.* BY TYPE OF CULTIVATION

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Abstract

Callistephus chinensis is widely used variety of species for the production of cut flowers and shaping of colorful annual groups in landscaping. The control of plant height, size and number of clusters are the basis of a large number of studies. The objective of this article is to trace the correlation changes of these and other groups of vegetative and decorative indicators according to the way of plant cultivation. The analysis of the correlations shows that they have highly interrelated variable values . With their help we can predict the changes in the key indications depending on the change of the correlative related indicators.

Key words: *Callistephus chinensis, China asters, correlation analysis, farming.*

INTRODUCTION

The rich colour range, interesting configuration of clusters and varying amount of flowering stems determine the annual asters *Callistephus chinensis* an attractive species both for the production of cut flowers and for landscaping. The establishment of an optimal way of growing is basic prerequisite for manifestation of the morphological and productive capacities of the plants. In our country there are no systematic studies in this direction. The recommendations of our authors (Vitanova et al., 2011; Nikolova, 1999) are based on own research, practical and foreign experience. According to them the seedlings way is most common in the practice. In her study Varbanova (1994, 1995) defines the direct way of growing as better to the growing of asters through seedlings, because plants are characterized by a prolonged period of flowering and the best quality of the cut flowers. Results obtained by Wegfrass (1982) show that with direct sowing a larger number of cut flowers of asters is obtained and it prevents the occurrence of fungal diseases. In our other studies (2011) plants grown by direct sowing are characterized by more compact dimensions of the bush, a smaller diameter of inflorescences and lower productivity expressed by the number of standard inflorescences in comparison to the plants grown through seedlings. The study of the correlation between the main vegetative and decorative signs of China aster enables an adequate planning of the technology for growing plants and in particular, their method of cultivation.

The objective of the study is to establish the existence of correlations between basic morphological characteristics in annual asters.

MATERIALS AND METHODS

During the period of investigation (from 2010 to 2012 year) in the Institute for Plant Genetic Resources (IPGR) - Sadovo, two varieties of asters (Princess sylvis and Harzyrus) were tested. Plants are grown by pre-production of seedlings in unheated greenhouses and direct sowing of seeds in the adopted country for technology (Nikolova, 1999). Plants are grown by pre-production of seedlings in unheated greenhouses and by direct sowing of seeds according to the technology adopted by the country (Nikolova, 1999). The experience is set in the block method in 4 repetitions with size of the test plot 3.5 m^2. The reported parameters are for plant height, length of 1st order branches, number of leaves, volume of the root system, etc. The data are processed through a correlation analysis, as its reliability is assessed by criteria t on the table of Student (Zapryanov and Dimova, 1995).

RESULTS AND DISCUSSIONS

Tables 1, 2 show all the possible correlation coefficients between the parameters plant height, length of 1st order branches, number of leaves, volume of the root system, the diameter of the inflorescence and number of 1st order clusters of the variety Princess sylvis. No significant differences can be observed in the values of the correlation coefficients according to the method of growing plants. Regardless of the growing the height of the plants is highly correlated (0.84^{+++}; 0.839^{+++}) in relation to the length of the 1st order branches, as a result of which it can be assumed that the higher plants respectively form longer flowerings.

Table 1. Correlation coefficients of the variety Princess sylvis in seedling growing of plants
GD (95% - 2.447; 99% - 3.707 and 99.9% - 5.959).

Parameters	Plant height	Length of 1st order branches	Number of leaves	Volume of the root system	Diameter of the inflorescence	Number of 1st order clusters
Plant height	-	0.84^{+++}	0.842^{+++}	0.718^{+}	0.892^{+++}	0.628^{+}
Length of 1st order branches		-	0.881^{+++}	0.441^{ns}	0.724^{++}	0.533^{ns}
Number of leaves			-	0.527^{ns}	0.676^{+}	0.829^{+++}
Volume of the root system				-	0.515^{ns}	0.629^{+}
Diameter of the inflorescence					-	0.44^{ns}
Number of 1st order clusters						-

Table 2. Correlation coefficients of the variety Princess sylvis in direct sowing cultivation
GD (95% - 2.447; 99% - 3.707 and 99.9% - 5.959).

Parameters	Plant height	Length of 1st order branches	Number of leaves	Volume of the root system	Diameter of the inflorescence	Number of 1st order clusters
Plant height	-	0.839^{+++}	0.84^{+++}	0.85^{+++}	0.925^{+++}	0.876^{+++}
Length of 1st order branches		-	0.844^{+++}	0.778^{++}	0.971^{+++}	0.94^{+++}
Number of leaves			-	0.745^{++}	0.918^{+++}	0.89^{+++}
Volume of the root system				-	0.856^{+++}	0.759^{++}
Diameter of the inflorescence					-	0.969^{+++}
Number of 1st order clusters						-

A very strong positive relationship is detected with provability GD-0.01% between plant height and number of leaves per plant, with correlation coefficients 0842^{+++} in seedling growing of plants and 0.84^{+++} in direct sowing cultivation. Analogous proportion dependence and high correlation is revealed between plant height and diameter of clusters. This shows that higher plants form larger clusters. Plant height is also positively correlated with the number of 1st order clusters and the volume of the root system, as the obtained coefficients in direct sowing cultivation has the highest level of provability (GD - 0.01%, respectively 0.876^{+++} and 0.85^{+++}), while in seedling cultivation the provability is at GD - 5%.

Well to very well proven is the correlation between the length of the 1st order branches, the number of leaves per plant and the diameter of clusters, which is completely logical and determines the quality of the cut flowers. In plants grown through direct sowing the length of the 1st order branches is from moderate to high correlation with the volume of the root system (0.778^{++}) and with the number of 1st order clusters formed (0.94^{+++}) while the plants grown through seedlings in these indicators the correlation is moderate and unproven.

Unproven and moderate is the relationship between the number of leaves and the volume of the root system. It is found that through seedling plants cultivation the formed foliage is slightly influenced by the volume of the root system (0.527ns), while plants grown by direct sowing form more foliage in greater volume of the root system as the correlation coefficient for this type of growing has high values - 0745^{++} and provability at P1%. The larger amount of leaves has a proven high dependability and a larger number of inflorescences of 1st order plants, regardless of the type of growing.

For the first time in asters, this study observes the impact of the lower volume of the root system on the formation of a smaller number of clusters in a direct way of cultivation. In confirmation, highly positive is the relationship -0.759^{++} between the two indicators, proven with a high level of GD - 0.1%. A strong correlation is observed in the direct sowing and between the volume of the root system and the diameter of the clusters (0856^{+++}), and between the diameter and number of 1st order inflorescences of (0969^{+++}).

In seedling plant cultivation there is a moderate to significant correlation between the volume of the root system, the diameter of the clusters and the number of 1st order inflorescences, but it is unproven to poorly proven at P5%.

Similar in magnitude are also the calculated correlation coefficients between the said signs and in the variety Harzyrus (Table 3, 4).

Table 3. Correlation coefficients of the variety Harzyrus in seedling growing of plants
GD (95% - 2.447; 99% - 3.707 and 99.9% - 5.959)

Parameters	Plant height	Length of 1st order branches	Number of leaves	Volume of the root system	Diameter of the inflorescence	Number of 1st order clusters
Plant height	-	0.654^{+}	0.966^{+++}	0.632^{+}	0.982^{+++}	0.99^{+++}
Length of 1st order branches		-	0.76^{++}	0.269^{ns}	0.618^{+}	0.605^{ns}
Number of leaves			-	0.645^{+}	0.974^{+++}	0.967^{+++}
Volume of the root system				-	0.668^{+}	0.63^{+}
Diameter of the inflorescence					-	0.995^{+++}
Number of 1st order clusters						-

Table 4. Correlation coefficients of the variety Harzyrus in direct sowing cultivation
GD (95% - 2.447; 99% - 3.707 and 99.9% - 5.959)

Parameters	Plant height	Length of 1st order branches	Number of leaves	Volume of the root system	Diameter of the inflorescence	Number of 1st order clusters
Plant height	-	0.967^{+++}	0.937^{+++}	0.599^{us}	0.98^{+++}	0.983^{+++}
Length of 1st order branches		-	0.851^{+++}	0.537^{ns}	0.914^{+++}	0.98^{+++}
Number of leaves			-	0.808^{++}	0.965^{+++}	0.888^{+++}
Volume of the root system				-	0.646^{+}	0.53^{ns}
Diameter of the inflorescence					-	0.932^{+++}
Number of 1st order clusters						-

In seedling plant cultivation the plant height correlates strongly with the number of leaves, inflorescence diameter and number of 1st order inflorescences. The larger number of leaves is in a strong positive correlation with the diameter and number of 1st order inflorescences, as it provides greater feeding (photosynthesizing) surface. Characteristic of the variety are the large flowers and large number of 1st order inflorescences, which is also reflected in the established strong positive correlation coefficient of the relationship between them. The height of the plants grown in a direct way has a strongly expressed proven correlation with the length of the 1st order branches (0.967^{+++}), number of leaves (0.937^{+++}), diameter of clusters (0.98^{+++}) and number of 1st order clusters (0983^{+++}), and moderately expressed with the volume of the root system (0.599ns).
Longer 1st order flowerings determined a large number of leaves, a larger number of 1st order clusters, and clusters with a greater diameter and vice versa. Such relation is established by the coefficients in the studied indicators. Low proven is the influence of the length of flowering on the volume of the root system. It is rather highly determinative of the number of leaves and diameter of clusters. In the seedling cultivation as well as in the direct sowing, the greater mass of the leaves is in a very high correlation with the diameter of the inflorescence (0.965^{+++}), and the number of 1st order clusters (0.888^{+++}). The change of the indicator diameter of the cluster will lead to a change in the number of 1st order clusters, because between them there is very high correlation dependence, proven at the highest level of GD - 0.01%, with a coefficient of 0995^{+++}.

CONCLUSIONS

Plant height is highly correlated to the length of the 1st order branches, the diameter of the clusters and the number of 1st order inflorescences of a plant, as a result of which it can be assumed that the higher plants respectively form a greater number of longer flowerings with larger clusters.
The larger amount of leaves has proven to be in high correlation with the larger number of 1st order clusters of plants, regardless of the type of cultivation.
The smaller volume of the root system affects the formation of a fewer clusters in a direct way of cultivation.
Similar in magnitude are also the calculated correlation coefficients between these indications of plants of the variety Harzyrus.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

CAROL I PARK IN BUCHAREST IN THE SECOND HALF OF THE 20TH CENTURY

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Abstract

Carol I Park is the oldest park of Bucharest (est. 1906) and is representative of the evolution of the Romanian landscape architecture. Its history is comprised of three main phases of development, which reflect different political, cultural and social contexts, the first one at the beginning of the 20th century and the second in the '30s. This paper is the third in a series documenting and analysing the development of the Carol I Park's and covers the second half of the 20th century, which is politically characterised by a communist regime in Romania. The ideological communist vision, as in other totalitarian systems of different ideology, aimed to use public space and national symbols as poster icons. As a consequence, in 1960, Carol I Park underwent radical modifications, being cut apart by the Communist regime's approach to public spaces. The park lost its original character and became a platform for Socialist propaganda. Stylistically, this translated as a strong monumentalism typical for totalitarian architecture, which was based around vast empty spaces, designed for large crowds. The 1960 project brutally transformed the layout of the park. Its original mixed style, with its Romantic French landscape garden dominant, became geometrically-oriented. However it was not the classic geometrical style representative of the Royalty designed at the human scale, but instead a monumental geometrical design erasing human scale. In spite of the subsequent changes and evolutions during different periods, the Carol I Park remains an incontestable gem of Romanian cultural heritage.

***Key words**: public park, geometrical style, monumental style, totalitarian landscape architecture, communism.*

INTRODUCTION

Carol I Park is the oldest park in Bucharest. It is located in the city's southern part amongst the hills on the way from the Cotroceni to the Văcăreşti districts. It was conceived in 1906 to host the *General Romanian Exhibition* and to celebrate 40 years since Carol I became king of Romania, 25 years since the proclamation of an independent Romanian Kingdom and also 1,800 years since Trajan's conquest of Dacia (Parusi, 2007 and Potra, 1990). The French landscape architect Édouard Redont designed this elegant Belle Époque park in a mixed style with predominant French Romantic motifs, as explained in earlier published paper *Carol I Park in Bucharest at the Beginning of the 20th Century* (Pantu, 2011). Most of its many expo pavilions disappeared over time, but in 1935 the park experienced a renaissance for another exhibition event. In this second phase of development, there were a few modifications which I analyzed in *Carol I Park in Bucharest in the '30s – Celebrate Bucharest Month* (Pantu, 2011). Once the Communists came to power, the park was renamed Liberty Park - a kind of dark irony - and was radically transformed. Most of its monuments vanished or were relocated in order to erase all remnants of royal symbolism.

STATE OF THE ARTS

In 1960 Carol Park was radically restructured in order to fit the new program of Communist propaganda, which sought to appropriate all public space and national symbols. In terms of style, this translated into a pronounced monumental character, typical of Soviet totalitarian architecture, with its vast empty spaces designed to accommodate the crowds, "the people" (Pantu, 2012).
The project was conceived by a collective from the *Proiect Bucuresti* Institute, led by the city's chief architect, Horia Maicu (Studiu privind grădinile istorice din R.S.R., 1973). They spared no effort in this unprecedented uprooting of the park's compositional structure. Its style went from predominantly French Romantic to geometrical and orderly (Figure

1). Classical geometry did exist before, but the totalitarian take on it deprived it of all human warmth by favouring exaggerated monumentalism. The latter geometric style received a share of 55% of the park's total surface, as opposed to the initial 42%, according to my calculations based on specialized maps and surveys (Pantu, 2012). Thus the park was given a new guise and a new fate.

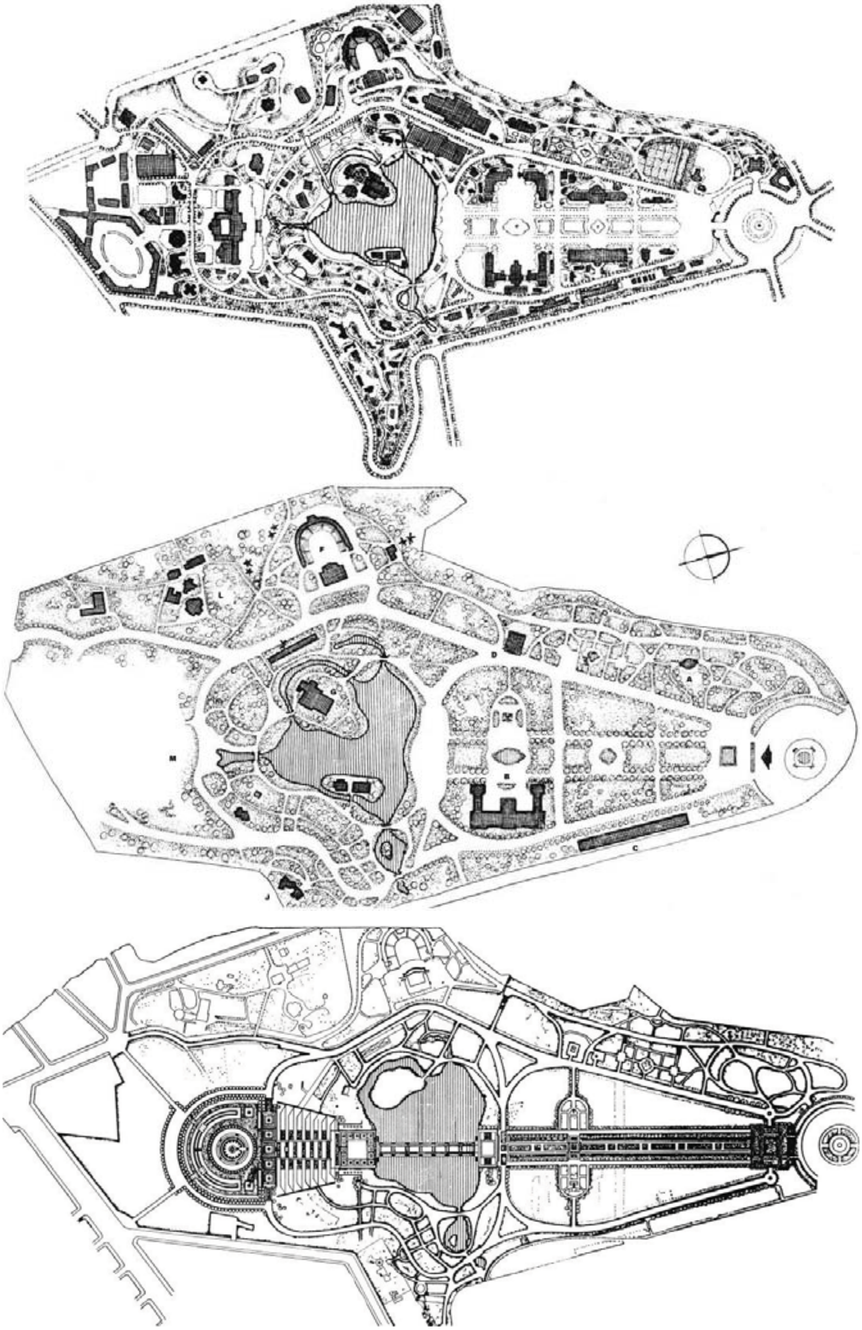

Figure 1. Carol I Park – phase 1, 2 and 3 of development – plans from 1906, 1957 (Marcus, 1958) and 1963 (Arhitectura R.P.R. journal, 1964; Răducan and Pantu, 2004)

The dramatic changes involved the amplification and extension of the main axis, both transversally and longitudinally, adding a monumental bridge extending over the lake, and ample stairways and esplanades reaching up the slope to the new end focal point. The previous focal point used to be the Palace of the Arts, a valuable building from an architectural standpoint (built in the Art Nouveau style and a symbol of the Royalty at the time), which was replaced with an elegant, streamlined mausoleum dedicated to the heroes of Communism (Figure 1). Its planners were architects Horia Maicu and Vasile Cucu (List of Historical Monuments, 2004). The monument is 48 metres in height, which was also - probably coincidentally - the length of King Carol's reign (Majuru, 2007). It is gracefully proportioned, which matches its role as an end focal point to the great axis: while the original element dominated by its mass, the one replacing it dominates by its height (Figures 2-5).

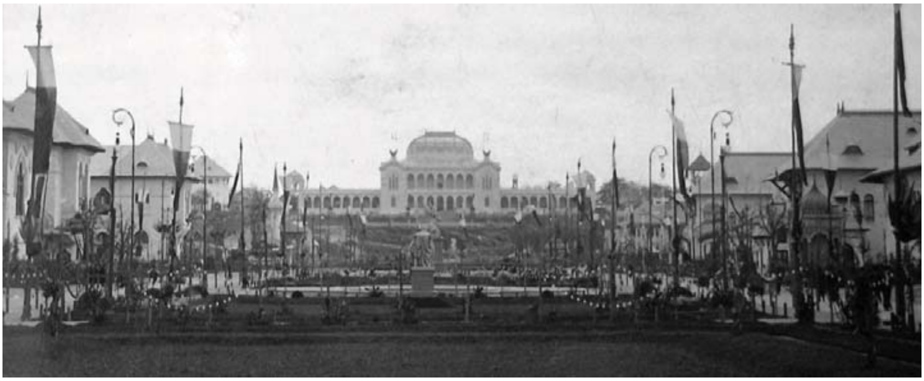

Figure 2. The main axis towards the slopes in 1906 (Zaharia, 1906) and august 2012

The sloping area was thus severed from its Romantic concept, Redont's original thoughtful design of its waterfall grotto and statuary group (Figures 3-5), and turned into a monumental, geometric space lacking in human scale (Figure 3). The waterfall grotto was destroyed, the rock garden earth mounds were replaced by an ample stairway, and the sides of the terrain were terraced into a trapezoidal planimetry. Here the disruption of the Romantic image was the most brutal, as the landscape style was eliminated from the most important and visually accessible area in the entire park. The statuary group was dispersed, and therefore lost both its unity and coherence and its significance.

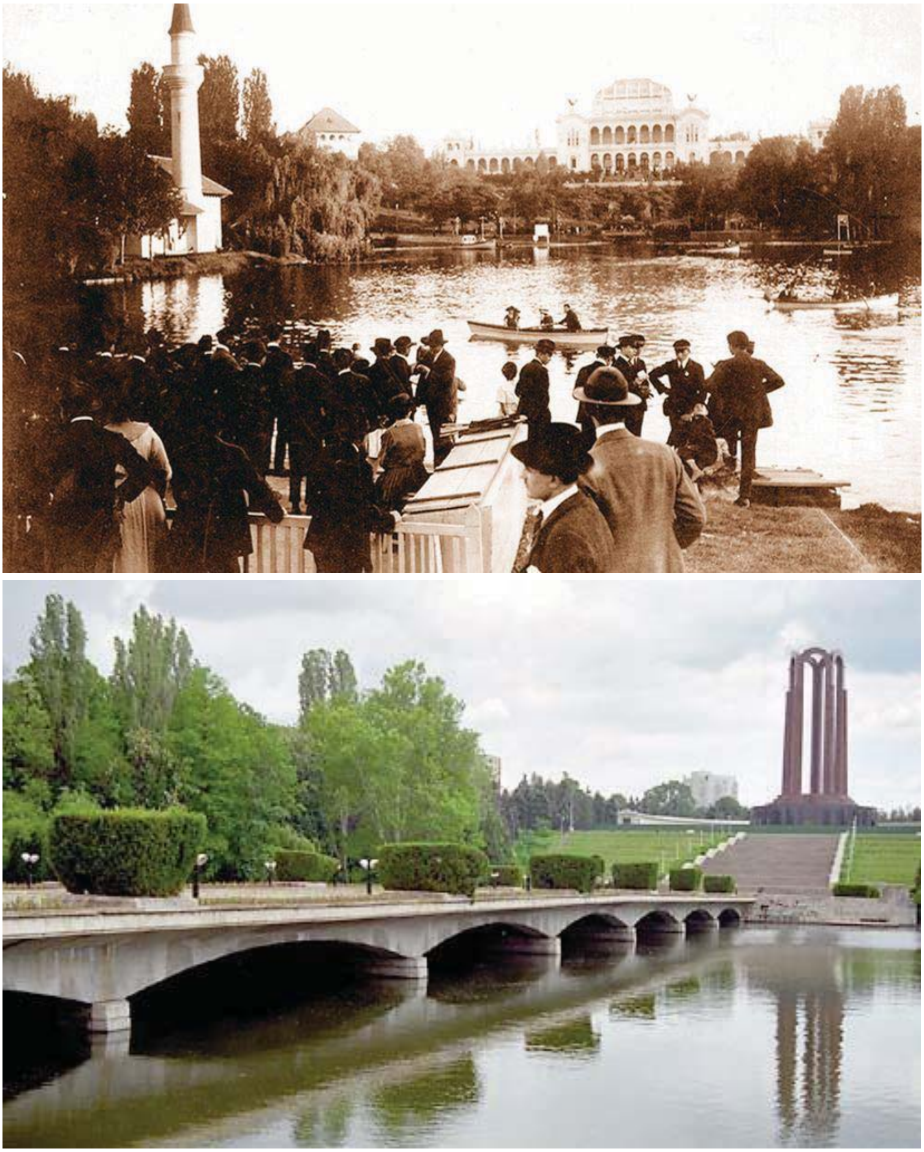

Figure 3. View towards the slopes (between the wars – National Romanian Library Archives and sept. 2004)

The main axis was widened, its central parterre discarded, so it was made into a pedestrian walkway along its entire width, to which two additional, narrower lanes were added, separated by tree alignments. The axis was also punctuated by ample esplanades which highlight its importance (Figures 1, 3, 6,7).
This is a statement of power expressed in the public space. Just like Louis XIV used the spectacular grandeur of his gardens at

Versailles to make such a statement, so did the Romanian Communist dictators use Carol I Park to make theirs. However, the result itself is nowhere near as brilliant as that found in France: the pedestrian walkway is monotonous, lacking animation, the proportions are clumsy when compared to the original version, while details like materials used, lighting fixtures, etc., are inadequate.

Figure 4. The Palace of the Arts in 1906 (Noica, 2007)

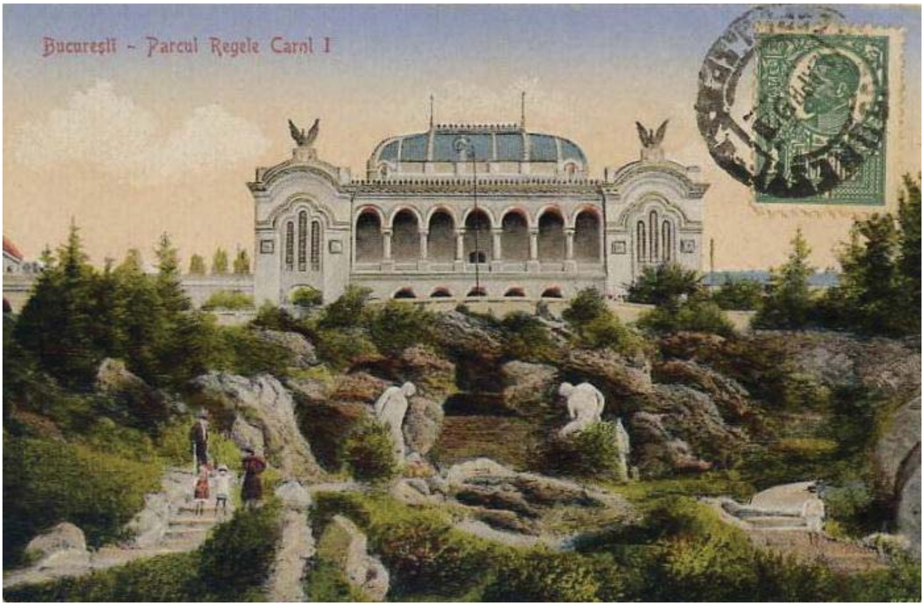

Figure 5. Palace of the Arts and the waterfall with grotto and statuary group in the twenties (postal cards)

The pedestrian walkway can accommodate up to 13 rows of visitors, being 10 meters wide. It has become a largely shadeless path, lacking human perspective (Figure 6-7). Unfortunately, it is not even used for walking. Visitors prefer the more protected, shaded lateral lanes (Pantu, 2012).

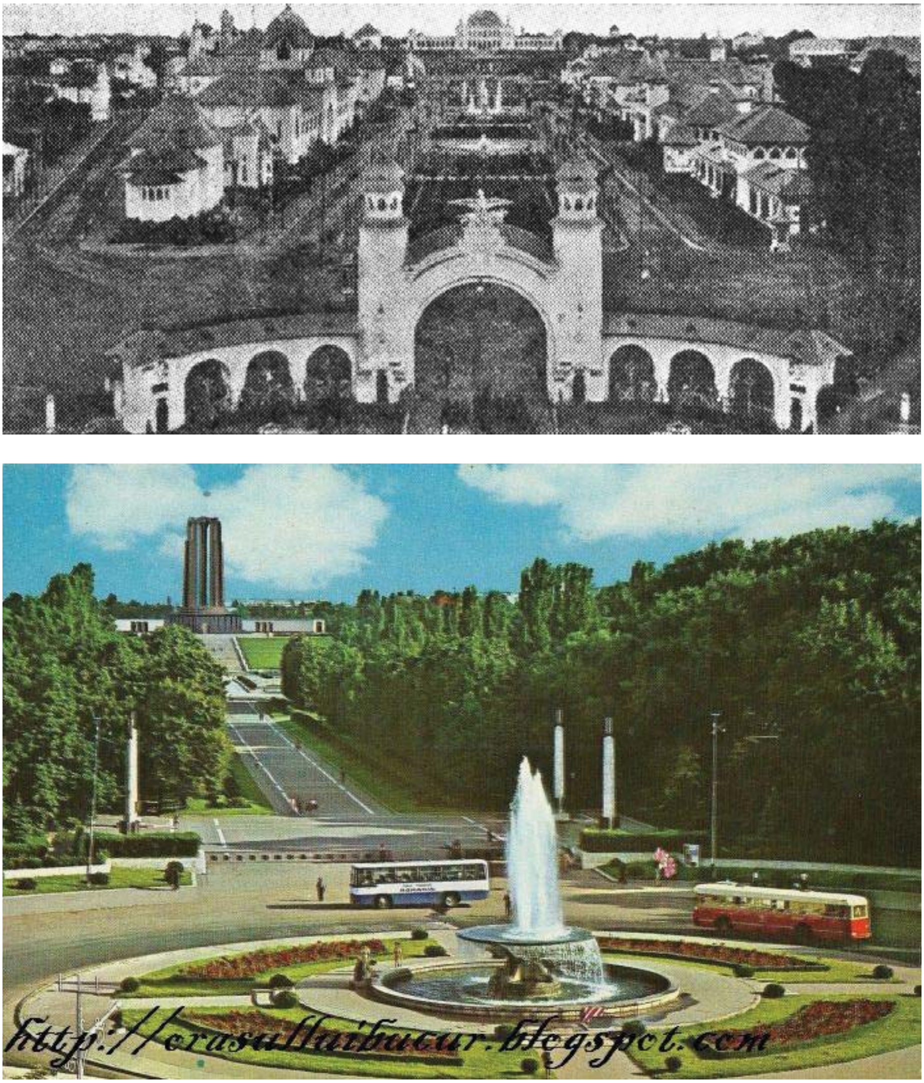

Figure 6. The main axis from the entrance in 1906 (Răducan, Pantu, 2004) and 1977 (postal card)

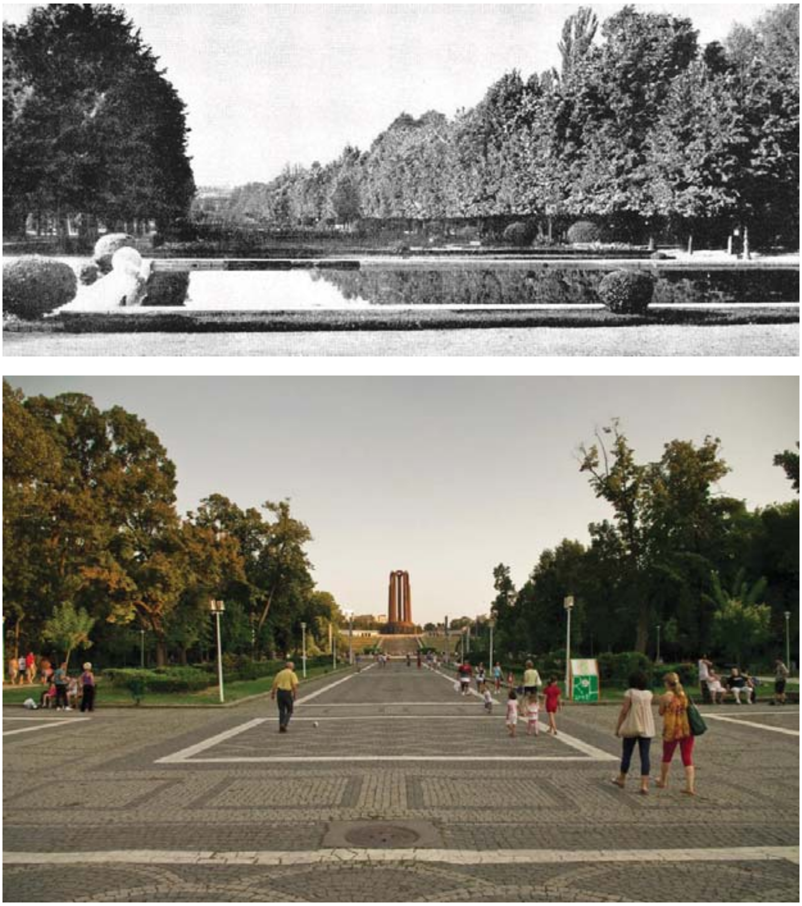

Figure 7. The main axis from the entrance in 1957 (Marcus, 1958) and in 2012

The monumental bridge severs the lake in two. Raised over 10 metres above the water, it excessively diminishes the lake's importance and visual access to the water surface, which likewise subdues its original Romantic concept (Figure 8).

Figure 8. The monumental bridge and geometrical vegetation in the '70 (Donose archive)

Throughout its evolution, with every transformation, Carol I Park served as a tool for advertising power, for propaganda. At the beginning of the century it was the royal business card - created to display the accomplishments of King Carol I during his 40 years of reign. Up to the Communist period, the park played this role in royal publicity, by hosting various events which celebrated Romanian kings, whether directly or indirectly. *Bucharest Month* was also an event which celebrated this type of power, in this case Carol II, though indirectly. After the war, its publicity value was seized violently by the Communists. In 2004, the park was singled out as a site for erecting a monumental Cathedral of the Nation. Fortunately, this decision was revoked; but had the plans gone through, the park would have become the propaganda tool for the Romanian Orthodox Church. Thus, the fate of Carol I Park was never separate from the publicity of power.

CONCLUSIONS

Even though the Carol I Park was violently restructured in its third phase of development, it remains an indisputable gem of landscape architecture, steadily breathing both direct and indirect French influences: Redont, the park's creator, was one of the most important French landscape architects from the beginning of the twentieth century, while interwar approaches included the use of Art Déco by Romanian architects. Even the Communists' rigorous geometry was originally based off French Neoclassicism.

Due to its complex history, Carol I Park exhibits all the stylistic changes that were happening in the twentieth century, in one place. It is a perfect recording of the park urban program evolution in Romania and, at the same time, a witness to the upgrades in Romanian landscape architecture during the twentieth century.

During its evolution, Carol I Park was permanently loaded with historical and political symbols. These were influential in the radical transformations to which it was subjected over time. Most of these symbols are those of the monarchy versus the socialist republic, as could be observed in the replacement of the old Palace of the Arts with a Communist mausoleum. Although the system and its symbols appeared to change, the park itself maintained its overall political role as propaganda.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

NEW TRENDS IN URBAN PUBLIC PARKS - THE FRENCH POST WAR PERIOD AND ITS INFLUENCE IN ROMANIA

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Abstract

In France, the period after the Second World War represents an important phase in the evolution of public parks. This paper analyzes this period and its influence in Romania. After the long stagnation caused by the Great Depression and the world wars, French landscape architecture recovered during the time known as the Glorious Thirties (1945-1975). On account of re-assigning urban parks and gardens as "green space", urban landscape projects suffered from an acute lack of specific planning. As a result, new city parks displayed merely the attempt to green up interstitial "open space", by working around the general city plan. The most important French park from this period is the vast Floral Park in Bois de Vincennes, Eastern Paris. It was designed by Daniel Colin as a large flower expo, within the new French landscape garden style established by Alphand. In spite of the prestige and artistry of the project, Floral Park remains a display of spectacular flower species, closer to a botanical expo. However, its resounding success set a new trend in landscape design worldwide: the floralies. Romania also knew this influence, which led to the display of extensive floral designs in public parks.

Key words: *public park, trend, French post war period, floralies, Romania.*

INTRODUCTION

After a period of stagnation caused by the great financial crisis and the Second World War, the practice of landscape architecture in France recovered via Le Corbusier's line of progressive urbanism. The recovery went on during the thirty “glorious” years, *les Trente Glorieuses* as they were termed by French demographer Jean Fourastié, meaning the 29 years between 1945 and 1974 (Pawin, 2012; Price, 1993; Fourastié, 1979). Le Corbusier appealed for “green space” in the notorious Athens Charter of 1933, and no more for parks and urban gardens, in a free, neo-romantic style to accompany the geometry of the architecture, a “greeneing” (Le Corbusier, 1971).

STATE OF THE ARTS

Following this mutation of gardens and urban parks into "green space" per Le Corbusier, urban landscape planning suffered from an acute lack of design. The most affected were the areas next to the large housing complexes that were being built heavily in that time due to population growth. Urban parks were likewise approached with the thought of merely greening up leftover space, or urban interstitial space in an overall plan (Pantu, 2012).
The most important creation in this vein in the Glorious Thirties’France was the Parc Floral in the Bois de Vincennes, East Paris, designed by landscape engineer Daniel Collin and inaugurated in 1969 (Figures 1-5). There had not been any other park of this scope conceived since the time of Alphand (Le Dantec, 2002).
The Parc Floral’s style is French neo-picturesque style, via Alphand's line, obvious at a glance over the park's layout (Figure 1), as the Athens Chart imposed. The well-drawn curves of alleys speak for themselves, as do the soft earth mounds seen throughout the park, the elegant flexuosity of lake shape as well as the vegetation massifs.

Figure 1. Parc Floral, Paris – plan displayed in the park, april 2007

Figure 2. Parc Floral, Paris – earth mounds with cedar groups, april 2007

Figure 3. Parc Floral, Paris – Flowers Valey, april 2007

Figure 4. Parc Floral, Paris – detail plan of Flowers Valey (Google Earth)

Figure 5. Parc Floral, Paris – Flowers Valey, central lake shore, april 2007

This project was co-ordinated by Daniel Collin, an emblematic figure of the 60s in French landscape design, and involved other designers that were to become famous over the next few decades. Of these, Jacques Sgard and Alain Provost distinguished themselves by creating important public parks or conducting more complex territorial studies. For the Parc Floral, Sgard designed the Sculpted Garden and Provost conceived the Water Gardens. The Valley of Flowers was created by Caroline Stefulesco and Leandro Silva Delgado (Figures 3-5) (Le Dantec, 2002; Barozzi, 1989).
The context in France at the time saw the era of famous writers Sartre and Roland Barthes, psychoanalyst Lacan, anthropologist Levi-Strauss, philosophers Deleuze and Foucault. Unfortunately, the Parc Floral did not record much at all about those times, about the specifically French cultural ebullience taking place. Despite the great variety of plant species, the park lacked a sense of temporal placement, as was the case with the rest of green spaces designed in Le Corbusier's manner (Le Dantec, 2002).
Notwithstanding its great prestige due to designer Daniel Collin's and the others' show of mastery and workmanship, the Parc Floral in Paris remained a mere display of spectacular floricultural species - almost a botanical exhibition.
This type of decorative floral thinking achieved great public success and developed widely in French landscape design. As a result, many events called *floralies* were organized, for the purpose of exhibiting stunning flowers.
Other countries' landscape design was influenced also by this trend. It was also the case of Romania which was ruled by a communist regime at the time. For this

ideology, Romanian public space needed to change in order to support its propaganda. New urban parks were designed in a monumental spirit, with large open spaces in order to accommodate the crowd, "the people" and these vast areas welcomed the wide flower arrangements specific of the French Glorious Thirties. Other reasons for adopting this floral tendency in Romanian were: the immediate effect (no need to wait long time for the plant to grow up), seasonal change of those compositions (annual plants were predominantly used) and, more important of all, their adaptability to propagandistic spectacular purposes (like an enormous ephemeral national flag or the communist national coat of arms designed in flowers).

A telling example is Tineretului Park, the vastest of Bucharest, designed by a team of Proiect Bucureşti Institute lead by architect Valentin Donose and opened in 1974 (Figures 6-10). Together with Circului Park, created also by Donose, and other after the wars urban public spaces, Tineretului Park sustained the mutation in Romanian urban planning and landscape design in the second half of the 20th century. It was conceived to recreate and relax the population leaving in the new large collective housing in south Bucharest. In spite of the housing architecture's poor quality and its high density of population, this park improved people's living by ameliorated neighbourhood's microclimate and city's green space balance (Pantu, 2012).

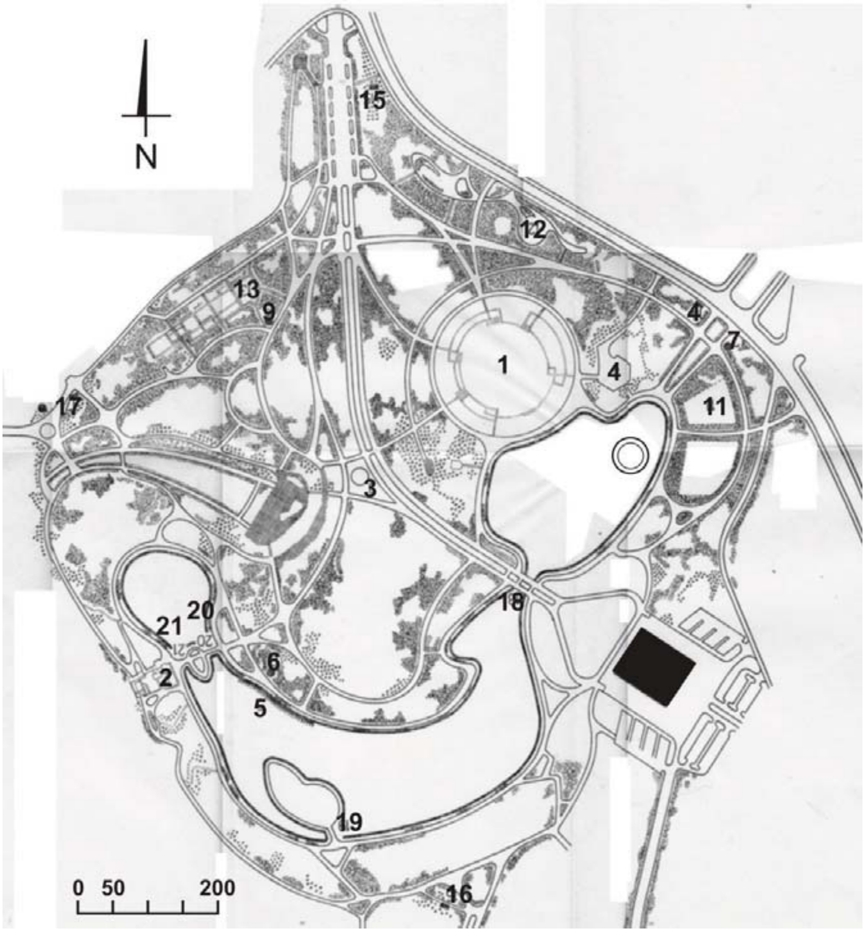

Figure 6. Tineretului Park – plan; equipments: 1. rosarium, 2. waterfall, 3. fountain, 4. restaurant, 5. warf, 6. box office, 7-9. refreshment booths, 10-11. sport grounds, 12-13. playing areas, 14-17. public toilets, 18. main bridge, 19-21. bridges. (Sonea, Palade, Iliescu, 1979)

Donose created this park for youth (*tineret* in Romanian) with the ideas of creativity and confrontation as concepts. His main design approach was to highlight the natural terrain configuration (16 m level difference) and to model it in order to create harmonious volumes and various interesting scenery (Figure 7). This is basic for all Donose's many landscape design creations. Alongside the elegant curves drown by the circulation and the vegetal massifs outlines, the lake's sinuosity, planting composition with colour accents are all elements of this unitary park to show the French Gloroius Thirties (neo-Alphand) style influence and also Donose's creativity and ability in landscape design (Pantu, 2012).
Furthermore, as a good example for the influence of the French Glorious Thirties *floralies* in Romania, Tineretului Park abounded in floral arrangements: on the slopes and on the lawns in a free manner, in organic shapes, (Figure 7) and geometrical in accompany of the main circulation or architectural equipments (Figures 8-9).

Figure 7. Tineretului Park – floral composition on the slopes in the eigthies (arch. V. Donose archive)

Tineretului Park's main circulation is a wide longitudinal open space with two alleys one side and the other of a large axial red roses parterre (Figure 8).
Roses were by far the preferred flowers of Ceauşescu couple, in power at the time.
For this reason also, one of Tineretului Park's major compositional elements was a vast circular rosarium (Figure 9).
Foreign leaders who visited the Romanian capital were given a tour of the park simply to admire these flowers. Unfortunately, the rose garden was deteriorated and eventually lost its initial function (Pantu, 2012).

Figure 8. Tineretului Park – Main circulation with large axial red roses parterre, 2003 - photo by C. Enăchescu

Figure 9. Tineretului Parc – the circular rosarium in the time of its construction (arch. V. Donose archive)

Typical for the Romanian Communist era were the seasonal floral tapestries. These arrangements were used to amplify the monumental character of buildings in parks such as Sala Polivalenta (Figures 10) or Palatul Copiilor in Tineretului Park or in the city, such as Sala Palatului in Bucharest (Figure 11).

Figure 10. Parcul Tineretului – Sala Polivalentă with geometrical floral arangements in the eighties (postal card)

Figure 11. Central Bucharest - Monochrome flower carpet in front of Sala Palatului in 1964, photo George Damian

During the Communist regime, vast floral arrangements were seen in parks all over Romania, such as Theatre Park in Constanța (Figures 12), the park of Roman (Figures 13) and Liberty Park in Bacău (Figures 14).

Figure 12. Theatre Park in Constanța – floral tapestries, 1970 (postal card)

Figure 13. The Park of Roman – floral composition in the seventies (postal card)

Figure 14. Liberty Park in Bacău – floral composition, 1974 photo A. Comănescu (postal card)

CONCLUSIONS

As part of the evolution, in theory and practice, of French urban public parks in the 20th century, it is possible to discern many influences and trends disseminating in Romania, modelling the topical ideas and achievements in its cities. After the wars, in this country, new additions to urban parkland were conceived in a mixed style with French neo-Alphand style as dominance with their extensive floral areas, while pre-existing locations were embellished with such floral compositions, as a French Glorious Thirties influence. Those flower compositions were adopted very fast there in the communist era because of the perfect compatibility with large open areas characteristic for this period. Moreover, those elements were also easy adaptable to propagandistic spectacular purpose, fitting the research of a new landscape design language for the communist architectural style. The fast impressive effect obtained was also associated with progress and efficiency in the new era like a power demonstration of the working class ideology.

As an example the Tineretului Park tells us a lot about the Romanian park style in the communist era, it preserves its spirit in the large open spaces in the monumentality of the architecture.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

GREEN ROOF VEGETATION POSSIBILITIES

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Abstract

The aim of this article is showing few ways how to make green roofs. The difference between intensive and extensive green roof, plant establishment and choice of plants is described. Aim of this article is showing the best combination of designed roof construction, designed thickness of soil and designed vegetation. Types of soil, depending on intensive or extensive green roof are described. Types of vegetation, depending on intensive or extensive green roof are described.

***Key words**: establishment, green roof, medium, plant.*

INTRODUCTION

In just few years, green roofs have gone from a historical curiosity to a booming growth industry – primarily because the environmental benefits of extensively planted roofs are now beyond dispute, whether for industrial or governmental complexes or private homes in urban or suburban settings. This paper deals with extensive green roofs. Nature helping the body, views offered for people living near green roofs, relaxant attributes of wildness in built environment. In bigger detail it focuses on its plants and vegetation, its construction, attributes and best use and choice of plants.

Medium depth and its greater depth means more diversity of used plants because of more options for growing roots of used plants. Composition of the underlying medium influences load of soil. This also means influencing plant specification in terms of weight, water absorption capacity, drainage rates etc. The ideal medium is lightweight, retaining water well, also porous and freely draining. The more water the medium retains, the more weight is being added to the roof. The medium supplies and absorbs nutrients, anchors the plants, provides enough weight to avoid floating when wet and avoids being flown off during establishment (Dunett, 2004).

Extensive green roofs are lightweight veneer systems of thin soil or substrate layers of drought tolerant self-seeding vegetated roof covers. Extensive green roofs require special types of plants. Also, they can be constructed on existing structures with little, or no additional structural support.

Generally, extensive green roof medium is a blend of sandy or granular materials that balances water absorption with adequate porous surface. A variety of natural and unnatural materials can be used to achieve balance. Lelite, pumice, diatomaceous earth, sand, expanded and active clays, expanded shale, gravel, bricks and tiles. And vermiculite or perlit can be used in conjunction with other materials (Snodgrass, 2006). But we need to face the fact that using these kinds of materials the green roof is going to be less environmental and more expensive than purely natural medium.

Intensive green roofs are designed to look like gardens, landscapes. They need similar management as ground gardens. Contemporary technological conditions allow many things. Waterproof membranes help to capture water for irrigation, drainage support growing medium and resist invasion of roots of plants. During the day, temperature of asphalt roof is unbelievably high. On green roof, soil mixture and vegetation act like an insulation. Reducing heating; cooling the building. When it is raining, water floods down to city´s artificial canyons. A living roof absorbs water, filters it and slows it down.

More organic medium, more planting options are available. Predominantly organic medium is not recommended for extensive green roofs.

Because of decreasing of pore space, higher water retention and increasing nutrient loading, reducing medium depth over time may be caused. Changing of medium depth may cause change of the designed roof, adding the substrate and changing environment of planted vegetation. Depth of medium should be constant over a long period of time and highly organic medium makes it impossible.

MATERIALS AND METHODS

Plant establishment is the key to green roof´s longevity. If the establishment in the beginning is unsuccessful, time of the return of investments is going to be lengthened. It is very important and also much cheaper to ensure the plant establishment in the beginning or even before the realization of the roof. First weeks after installation are crucial. It is prudent to plant the plants early enough to allow plants to root in before the first frost. Trials performed at Penn State University on plant establishment showed that well-established plants were much more likely to survive winter and drought than plants that were poorly established (Thuring, 2014).

Proper care during establishment will provide achieving coverage in earlier date. Planting occurs regular irrigation. If planting occurs in areas with natural rainfall that is regular, irrigation may not be needed. On many installations on US East Coast, plants require no supplemental irrigation at all, not even upon planting. On the other hand, parts in North require care and every day irrigation. Irrigation can be achieved through several methods: built in irrigation systems, lawns sprinklers, garden hoses. Irrigation need should be ascertained and used for the specific plants, location and time of year when the roof is being installed (Snodgrass, 2006).

Seeds are first way of installing green roof. No wholly seeded green roof installations exist in North America, but it seems likely that they will eventually appear. Market pressures to decrease installation costs by direct sowing on green roofs that could become more viable and the least expensive method (Snodgrass, 2006).

Seeded green roof takes the most time to mature, generally two to three years for coverage. Limited numbers of species can reliably germinate on a roof. All require some supplementary irrigation during germination and establishment phase. Seeds are best sown in spring or fall, depending on climate. To achieve full coverage of a roof in a short time period, quicker maturing annuals could be mixed with perennial seeds.

Cuttings are the most used plants installed on green roofs. They are viable and increasingly popular method for establishing. They are quicker than seeds and depending on climate, place and time, they may not need any supplementary irrigation to help them to establish. Cuttings are more expansive than seeds, but they achieve coverage much earlier. They can cover the roof within a year after planting (Nakano et al. 2014).

Plugs are cuttings with established root system. They offer a compromise between cost and flexibility. They offer greater diversity, because fully rooted plugs store sufficient energy to allow for easy establishment. They are easily packed in boxes (Nakano et al. 2014).

Nursery containers are occasionally specified for extensive green roofs when more established plants are needed from the beginning. Where the medium is deep enough to accommodate the root system, vegetation will spread more quickly than of plugs. If the depth of the root ball is bigger than depth of soil, root ball needs to be broken, roots need to be shortened to fit into soil (Nakano et al. 2014).

Vegetative mats are long rolls of pregrown plants set in a thin layer of mesh and medium. They are fully mature upon installation. They are installed in strips on top of a base substrate, which provides eventual root support. Mats are heavy and bulky to transport, must be grown at least one year before installation (Snodgrass, 2006).

Modules are discrete vegetative systems of black plastic squares or rectangles. They are the most expensive green roof planting option. They share all advantages and disadvantages of mats, but they include more medium. They can be installed like pavers (Snodgrass, 2006).

RESULTS AND DISCUSSIONS

The most influential parameter on vegetation layer is the leaf area index (LAI) that depends basically on the foliage density, the foliage geometric characteristics and on the plant height. Thus, the most important contribution of the vegetation layer to the thermal behaviour is shadow effect, both by the interception of solar radiation and reduction of roof surface temperatures (Theodosiou, 2003). Vegetation cover (LAI) and consequently the ability to produce shade can become reduced in certain periods of the life of the extensive green roof, for example during the plant growth period, which can last up to two years, or in water shortage periods, disease, or even because the type of plants, etc. Also it is known that because the type of plants and the low maintenance levels, extensive green roofs hardly reach 100% of the vegetation cover.

Figure 1: Sempervivium

Hardy succulents are the workhorses of extensive roofs and the primary plants for systems using a medium of 10, or less centimetres. Plants are native from dry locations, semi-dry locations, stony surfaces such as alpine environment. These kinds of plants have typical mechanisms to survive extreme conditions. Mechanisms like water storage organs, thick leaves, thick leaves surfaces, narrow leaves etc. They have unsurpassed ability to survive drought and wind conditions, store water in their leaves for extended periods and conserve water through a unique metabolic process. Hardly succulents like Sempervivum Fig. 1, Sedum, Talinum, Jovibarba, Delosperma are the only choices for thin substrate, non-irrigated, extensive green gardens with the greatest survivability (Snodgrass, 2006).

Figure 2: Phacelia Campanularia

Annuals should not be the dominant plant selection for extensive green roof, because they do not offer longevity required to make a project cost effective. They can be used as seasonal accents. They are required in places with regular rainfall, or in places with irrigation system. Annuals like Phacelia Campanularia Fig. 2, Portucala, Townsedia Eximia may be used on extensive green roofs as filters to provide quick colour during first grown season (Snodgrass, 2006).

Figure 3: Dianthus Dianthus Prairie Pink

Herbaceous perennials are the most desired plants for aesthetic reasons. They offer great colors, textures and season variability. On the other hand, they require deeper substrate and moisture than are found on most extensive green roofs. Some of them work very well on extensive roof installations. Dianthus Fig. 3, Phlox, Campanula Garganica, Teucreum, Allium, Potentilla, Achillea, Prunella, Viola, Origanum and some other low growing and shallow rooted perennials can be used, however, medium depth must be greater than 10 cm and has to have adequate water source. Few herbaceous perennials are evergreen, so if winter interest is a major design consideration for a roof, alternative must be provided so the brown vegetation is not so visible during its dormant period (Snodgrass, 2006).

Figure 4: Carex

Figure 5: Salvia

Short grasses are mostly popular for traditional intense green roofs and landscaping, but they still have their place in extensive green roofs. They do not have colorful bloomers like annuals and perennials, but they do have a lot of offer. They are more vertical, they add a texture and motion into a picture of roof, offer birds, insects habitat. They do need deeper depth of soil to accommodate their root system, some of them may have a Durant period during summer what means having a brown spot on the roof some time. Short grasses like Carex Fig.4, Festuca, Deschampsia are appropriate for extensive roofs.

Herbs as Thymus, Origanum, Salvia Fig. 5 and Allium have mostly their selected use on green roofs because of depth of soil that has to be more than 10 centimetres. On the other hand, their use is very specific because of their aroma, what is commonly used on buildings like restaurants, hospitals, residences, institutional buildings, they can be harvested for culinary, aromatic, therapeutic or educational purposes (Snodgrass, 2006).

CONCLUSIONS

Groundcovers like hardly succulents should be predominant plants used on extensive green roofs with a limited amount of accent plants. Groundcovers provide a rapid, reliable and cost-effective spread over the roof.

Accent plants like annuals, perennials, herbs and grasses while spectacularly during bloom, may not live more than five years on the roof.

In addition, they do not spread as rapidly as groundcovers, more plants are required to cover an area, but they offer seasonal interest. They may be replenished by periodic re-sowing.

Combination of these types of plants is the best way to come to this state. These combinations offer solution to make roof green all year long but with some colourful spots according to designed and used plants.

ACKNOWLEDGEMENTS

This work was supported by: VEGA 1/0202/15 Bezpečné a udržateľné hospodárenie s vodou v budovách tretieho milénia/ Sustainable and Safe Water Management in Buildings of the 3rd. Millennium.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

PAR ABSORPTION ABILITY OF THE CANOPY OF YOUNG LINDEN (*TILIA* SP.) TREES

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Abstract

*The rate CO_2-fixation of the plant depends significantly on the absorption of available photosinthetically active radiation (PAR). The PAR absorption ability is determined by the size and shape of canopy and by the position of leaves. In this context, there may be notable differences between species and moreover varieties. The aim of our work was to compare the PAR absorption ability of different Tilia varieties. Our measurements were done in Soroksár, Budapest with AccuPAR LP-80 linear ceptometer in an experimental linden alley. Beside leaf area index (LAI) the instrument is able to calculate the ratio of photosinthetically active radiation (PAR) above and below the canopy, which is the PAR transmission ability of foliage (τ). With this information the PAR absorption ability of the canopy can be easily calculated. Measurements were done monthly in 2013 (March-September) and 2014 (March-October). In the sprouting period of 2014 – to ensure better traceability – measurements were done every two weeks. From among the 13 varieties which are in the experimental alley the results of 6 varieties (*Tilia americana *'Redmond',* T. cordata *'Greenspire',* T. c. *'Savaria',* T. platyphyllos *'Favorit',* T. tomentosa *'Szeleste',* T. t. *'Zentai Ezüst') will be presented in this paper. In 2013, the PAR absorption of investigated varieties reached their maximum in the early July (68-84 %). T. americana 'Redmond' was exception, because its maximum was in the middle of June (85 %). Then the light absorption ability of canopies decreased gradually. In 2014, after initial growing of values in the case of every varieties slight decreasing was found in early June, which reason lies in the end of blooming. Then, till the middle of June increasing values were measured again. The foliage development was monitored till the end of July, and the declining of PAR absorption was sensible in September caused by reduction of leaf area.*

Key words: *light absorption, linden varieties, PAR.*

INTRODUCTION

Linden species (*Tilia sp.*) represent an important genus in Central Europe (Radoglou et al., 2008) and are widespread planted under urban conditions in form of different cultivars. The following species are commonly planted for urban forestry in Hungary: *T. cordata* Mill. and *T. platyphyllos* Scop., (native to Europe forming climax forest); *T. tomentosa* Moench, (native to Southern Europe and Asia); *T. americana* L. (cultivars were introduced recently).

However, Schmidt (2003) reckons *Tilia* species as deep shadowing trees, there are little and inconsistent data on PAR absorption ability of linden cultivars.

PAR absorption ability depends first of all on leaf area index (LAI). LAI influences photosynthetic and transpiration capacity of the whole tree (Oyarzun et al., 2007, Olchev et al., 2013), and in urban condition the air pollution on leaves as well (Mori et al., 2015). The PAR absorption ability effect on plants, which might be planted under the tree (Schmidt, 2003) and moreover on microclimate close to the tree and hereby it influences the human thermal comfort conditions, too (Lakatos et Gulyás, 2003, Kántor et al. 2009).

This is why we aimed in this work to evaluate this phenomenon on different linden taxa in order to gain information on the annual course of PAR absorption.

MATERIALS AND METHODS

In Central Hungary at the Experimental Farm of Corvinus University of Budapest Faculty of Horticultural Science in December 2009,

using multiple *Tilia* taxa an experimental alley was planted with the aim of comparison of Hungarian and foreign cultivars occurred in Hungarian nurseries. The orientation of the alley is N – S, the location is: N 47°22’, E 19°09’, elevation above sea level 103 m. The climate is typical of the central Hungarian flatland; yearly average temperature is 11.3 °C, total sunshine is 2079 hours per year, and precipitation is 560 mm per year. The soil type is light sandy, lime content is around 2.5 %, soil organic matter is low (0.8 – 0.9 %), pH is 7.7 - 8.1.
Our measurements were done with AccuPAR LP-80 linear ceptometer (Figure 1). It consists of an integrated microprocessor-driven datalogger and probe. The probe contains 80 independent sensors, spaced 1cm apart. The photosensors measure PAR in the 400-700nm waveband between 0 and 2500 μmol m^{-2} s^{-1}.

Figure 1. Measuring with AccuPAR LP-80 linear ceptometer (12.03.2014., Soroksár)

Beside leaf area index (LAI) the instrument is able to calculate the ratio of PAR above and below the canopy, which is the light transmission ability of foliage (τ). With this information the PAR absorption ability of the canopy can be calculated by the following equation:

$$\text{PAR absorption (\%)} = (1 - \tau) \cdot 100.$$

Measurements were done monthly in 2013 (March-September) and 2014 (March-October). In the sprouting period of 2014 – to ensure better traceability – measurements were done every two weeks.

The trees were planted with 12/14 cm trunk circumference size in autumn 2009. From among the 13 cultivars which are in the experimental alley the results of 6 cultivars will be presented in this paper, 8 trees from each cultivar.
Short description of the investigated Tilia taxa, in alphabetical order:

Tilia americana 'Redmond': Conical canopy, dense and compact growth. Young shoots are red. The leaves of T. a. ‘Redmond’ are slightly lighter green than the leaves on T. a. ‘Nova’ (Ifju, 2009-10., Krüssmann, 1986, Schmidt and Tóth, 2006).

Tilia cordata 'Greenspire': Straight trunk, 15-20 m high tree. Regular cone-shaped crown. Leaves are rounded and 6-10 cm in size, shiny dark green (Izer, 2010-11.; Krüssmann, 1986; Retkes and Tóth 2005, Tóth and Schmidt, 2006).

Tilia cordata 'Savaria': Hungarian selection. Conical canopy. The tip of young shoots slightly reddish, later turns brownish red. Characterized by many fragrant flowers (Izer, 2010-11.; Retkes and Tóth 2005, Schmidt and Tóth, 2006).

Tilia platyphyllos 'Favorit': Hungarian selection. 10 to 15 meters high, medium growth vigor, tall slender tree. Autumn leaves are yellowish (Schmidt, 2008).

Tilia tomentosa 'Szeleste': Old Hungarian selection. A vigorous growing variety, narrow oval, then expanded tree canopy, 20-25 m height. Young branches are greenish gray. The leaves are more or less rounded (Izer, 2010-11, Retkes and Tóth 2005, Schmidt and Tóth, 2006).

Tilia tomentosa 'Zentai Ezüst': Hungarian selection. In the first years very slender with conical canopy, later columnar shaped variety. Conspicuously silvery leaves, tolerates polluted environment (Retkes and Tóth, 2005; Schmidt and Tóth, 2006).
Under our investigations we could compare two years as well, when rainfall was very different in vegetation period (Figure 2).

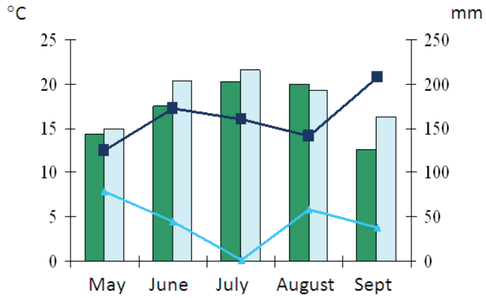

Figure 2. Temperature and rainfall in 2013 (dark column, light line) and 2014 (light column, dark line), Soroksár (Budapest)

Data were evaluated using Microsoft Excel software. One-way analysis of variance (ANOVA) was carried out in SPSS 18 (PASW 18) to see significant differences between the cultivars.

RESULTS AND DISCUSSIONS

In 2013, measurements were done monthly and started on 20th March, when the trees were still leafless (Figure 3). PAR absorption increased in every cultivar continually during the spring until the middle of summer then it started to decline. The maximum was detected in the early July (68-84 %) expect *T. americana* 'Redmond', because its maximum was in the middle of June (85 %). *T. americana* 'Redmond', *T. platyphyllos* 'Favorit' and *T. tomentosa* 'Zentai Ezüst' had the highest PAR absorption maximum (84-85 %), while the lowest top value was measured on *T. cordata* 'Greenspire' specimens (68 %)., In 2013, significant differences were found between above-mentioned cultivars only in summer time.

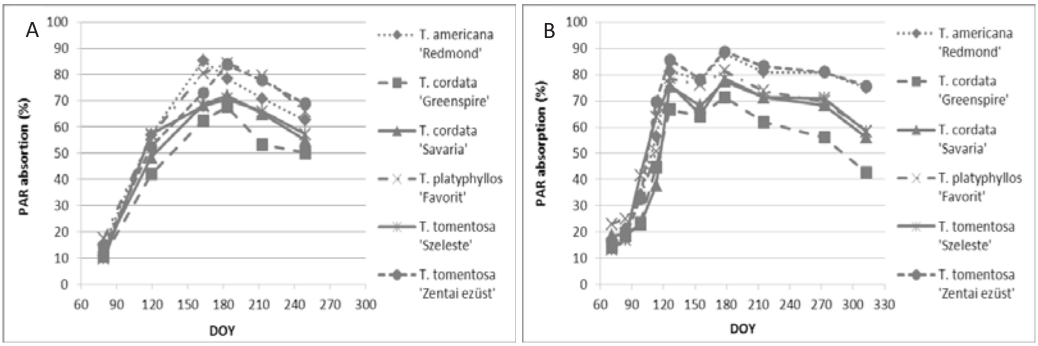

Figure 3. Annual changing of PAR absorption on different *Tilia* cultivars in Soroksár (Budapest), in 2013 (A) and in 2014 (B). DOY: day of the year

To ensure better traceability, measurements were done every two weeks in the sprouting period of 2014 (Figure 3). Similarly to 2013, it was a quick growing in PAR absorption in the spring. However, slight decreasing was found in early June in every cultivar, which reason lies in the end of blooming. It was able be detected because of the more frequent measurements. Significant difference was detected firstly between cultivars in the end of April. In this time the highest PAR absorption was measured on the two *T. tomentosa* cultivars ('Szeleste' 64 %, 'Zentai Ezüst' 70 %), while the lowest on *T. cordata* 'Savaria' (38 %). Maximum values were detected on every cultivar in the end of June (71-89 %). However, differences were not justified statistically there was notable variance in PAR absorption between the lowest (*T. cordata* 'Greenspire') and the highest (*T. tomentosa* 'Zentai Ezüst') cultivars.

CONCLUSIONS

The significant higher precipitation in 2014 causes some differences in the two examined years. The foliage of water-consuming *T. americana* 'Redmond' fell down slower in 2014 compared to 2013 when the weather was dry and hot. Leaf falling was similar on the other species in both years expected *T. cordata* 'Greenspire', which leaves fell down faster in 2014, due to supposedly a hard *Mycosphaerella microsora* infection.

ACKNOWLEDGEMENTS

Our research was supported by Hungarian Scientific Research Funds OTKA 109361.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE LANDSCAPE OF PARKS IN THE MUNICIPALITY OF BAIA MARE FROM AN AESTHETIC-URBAN PERSPECTIVE

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Abstracts

Green spaces have beneficial effects on human ecosystem and maximizing the people human health quality. As a result of urbanization, green spaces were created by fragmentation of natural habitats. A major problem faced by contemporary civilization is environmental degradation and therefore the quality of life. Urban green spaces can be a solution to improving ambient environmental conditions. They are an essential utility category role in the functionality of a localitys being represented by a complex system of architectural elements (the part that is built) and landscape (design of green spaces through the use of vegetation). Urban green spaces as a result of the smaller spread of peri-urban ones require certain landscaping techniques. This study focused on the analysis of existing green areas in Baia Mare in a European context. With a view toward finishing the study we proposed, we drew up an urban and landscape design plan of Baia Mare's extant parks (Mara Central Park, Park of the Monument to the Romanian Soldiers and Queen Mary Park), describing their principal characteristics (functions, landscaping style, extant facilities). Notably, we performed a study that involved monitoring extant vegetation in the parks and classified the vegetation according to categories (deciduous trees, evergreen trees, deciduous bushes, evergreen bushes, hedges, annual flowering plants, aromatic and decorative species). Thus, we were able to determine the extant quantity of plant material and to gauge its uses. Thus, this study offers new instructions for refurbishing the parks analyzed through another process of landscaping.

Key words: *urban green spaces, landscape management, population.*

INTRODUCTION

Green urban infrastructure represents a medium in which human life interacts with natural and artificial elements, (Simonds, 1967) stimulating a feeling of social, intellectual and affective living. However, it has been observed that urban green architecture is situated within optimal parameters only in high-income countries, and that it can function as an indicator of development (Florincescu, 1999). Urban green spaces take advantage of the city's biological (Preda-Godeanu, 2013) and aesthetic potential. Likewise, they influence the population's health by improving air quality, moderating thermal variations and sonic pollution (Cândea, Bran and Cimpoeru, 2006; Ciupa and collab., 2010). Moreover, urban green spaces also influence the interior thermic environment (cooling or warming the interior microclimate) (Wang and collab., 2014). Thus, in keeping with principles of durable development, the characteristics of vegetation in a public space may contribute to reducing inhabitants' stress (Muja, 1994) and, implicitly, ensure quality of life. Urban development follows the creation of structures able to transform an "agglomeration" into a "complex of settlements" partly freed of stress (Rădulescu, 2007). Moreover, cities should be planned as spaces for durable communities (Antohi, 2012).

In urban areas, green spaces tend toward insularity. Under conditions of reduced biodiversity, linking green spaces and re-establishing links with natural habitats (Vădineanu, 1999) become necessary actions when it comes to preserving species of interest to conservationists. Thus, a heterogeneity of biotope conditions is ensured, as well as, implicitly, more ecological niches as trophic and spatial support.

Green spaces represent land managed within a constructible perimeter or outside it, covered in vegetation, that can be utilized directly (for recreation) or indirectly (through moderating and remodeling) by the human population (Negruțiu, 1980; Baycan - Levent, Vreeker and Nijkamp, 2009).

According to the World Health Organization (WHO), an optimal level of human activity takes place within 50m^2 (at a minimum, 9m^2/inhabitant) of green space/inhabitant within the city and 300,000 m^2 outside the city (Muja, 1994 cited by Constantinescu and Szilagyi, 2002). At the European Union level, green space standards indicate a minimum of 26m^2/inhabitant. In Romania, urban green space does not meet European standards, the average being 18m^2/inhabitant (Chiriac, Humă and Stanciu, 2009). The majority of Romanian cities have recreational spaces below the cumulative area recommended for green space in our country (14.0-32.5m^2/inhabitant) (Cândea, Bran and Cimpoeru, 2006).

In 2011, the north-west region held second place in terms of urban green spaces (3.164 ha), behind Bucharest-Ilfov (4.921 ha), with a growth rate in green spaces of 35.8% (the national average being 9.7%) (www.adrvest.ro). In 2013, Maramures Country had some 342.8 ha of urban green space, which comes to an average of 11.2 m^2/inhabitant (PLAM, 2013). Maximal European norms provide that green space in Baia Mare be extended to 40m^2/inhabitant, or 598 ha by 2015 (Bolea and Chira, 2009). Thus, in order for quality of life to improve in Baia Mare, urban renewal is needed. This would entail adopting complex principles that regard the use of space in harmony with the population's demands, the aestheticization of the environment and the highlighting of the landscape through architecture. Understanding the landscaping and ecological importance of aestheticized landscapes in urban life impelled the undertaking of this study.

MATERIALS AND METHODS

In realizing this study, we consulted extant documentation in libraries and at the Ambient Urban Public Space (SPAU) Baia Mare, as well as direct observations in the field.

We prepared an urban plan of extant green spaces in Baia Mare (Figure 1, Table 1) map shows the three city parks: Queen Mary Park (1), Park of the Romanian Soldier's Monument (2) and Mara Central Park (3), green spaces of major interest to the city and to our study due to their complexity and surfaces.

Additionally, direct observations were undertaken in 2009-2010 regarding the structure of decorative species and the landscape method in the three parks (Queen Mary Park (1), Park of the Romanian Soldier's Monument (2) and Mara Central Park (3). The observations lasted for two years (2009-2010), while monitoring took place during the vegetation period.

Starting with the European norms regarding growth and development of urban green spaces in Baia Mare, and based on the results obtained following observations undertaken and data gathered on repeated occasions during 2013-2014, we drafted proposals for landscape management of the green spaces in each park analyzed for improving the quality of the urban environment.

Baia Mare, the capital of Maramures County, is located in northwest Romania, along the 47°39' - 47°48' parallel of northern latitude and along the 23°10' -23°30' meridian of eastern longitude (Tache, 2014).

Table 2 presents a few of the elements regarding climate conditions in Baia Mare.

Table 1. Main characteristics of green spaces analyzed in Baia Mare (original)

Name	*Surface (*ha*)*	*Position:* [1] *GPS coordinates* [2] *Geographic orientation in urban space* [3]*Address*	*Vegetation characteristics*
Queen Mary Park	8	[1]N:47° 66' ' ; E:23° 57' ' [2] N Strada Valea Roș ie	Forest species dominant
Park of the Romanian Soldier's Monument	2.41	[1]N:47° 66' ' ; E:23° 57' ' [2] NE [3]Str. Valea Roș ie	Grass and flower species dominant
Mara Central Park	1.45	[1]N:47° 65' ' ; E:23° 56' ' [2] SV [3]B-dul Unirii	Grass species dominant

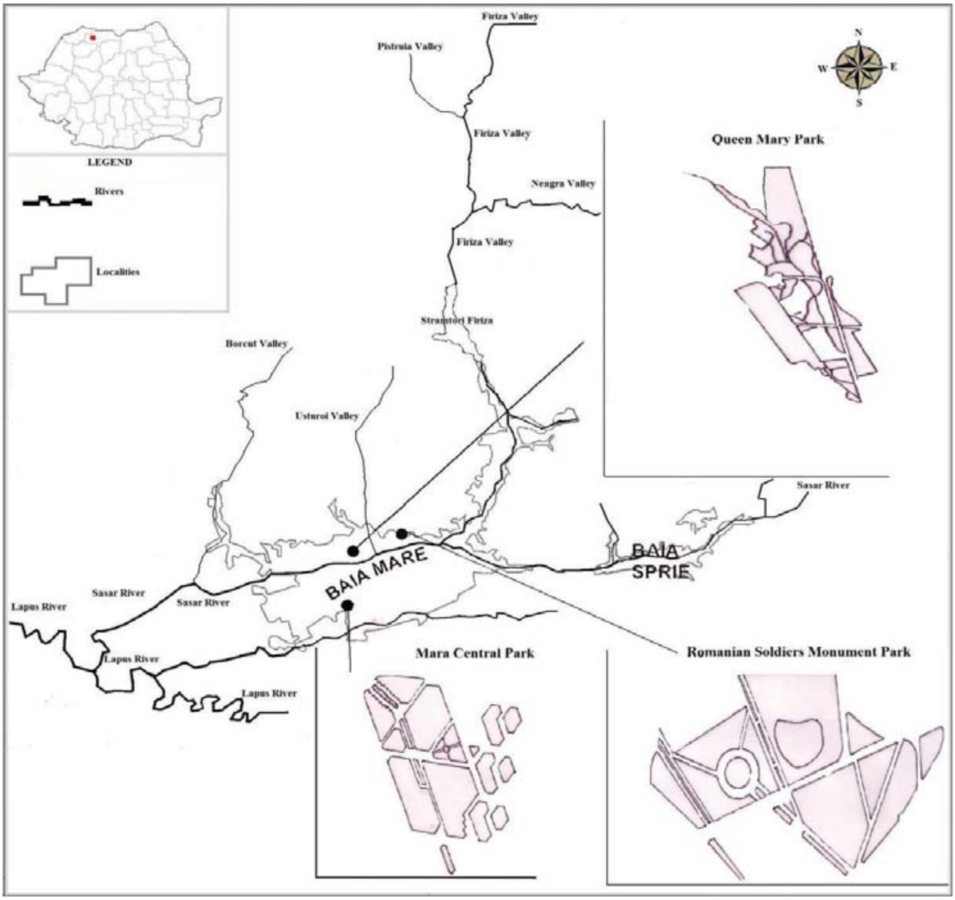

Figure 1. Location of green spaces analyzed in Baia Mare (original)

Table 2. Elements of climate conditions in Baia Mare

Analyzed elements	Caracteristics
Altitude	➢ 235 m
Microclimate and topoclimate	➢ hills and low plateaus, city situated in sub-mountainous depression
Ecological sector	➢ oak forests
Atmospheric pollution	➢ atmosphere polluted with sulfur and nitrogen oxides, heavy metals, dust
Annual precipitation	➢ 976 mm
Average annual temperature	➢ 9.4° C

RESULTS AND DISCUSSIONS

The administrative surface of Baia Mare covers 23,363.81 ha, of which 3,170 ha are agricultural land, 18,599 ha are forested land and 1,804 ha are construction sites or used for other purposes.

The built-up area comes to 3,563.58 ha, of which the total green space is 141 ha or 3.95% (Table 3) (Statement PUG, 2012). The amount of green space per inhabitant is 15.34 m^2, under the national average of 18/m^2 (Chiriac, Humă and Stanciu, 2009) and far below the optimal level of 50 m^2/inhabitant recommended by WHO. The most extensive green spaces are Queen Mary Park, the Park of the Romanian Soldier's Monument and Mara Central Park.
The main activities in Baia Mare that represent the main criterion of marking the land use zones and implicitly the types of landscape are (after PUG, 2012): dwellings of all types, industrial and storage activity, public institutions and services, communication and transport links, services, green spaces, government equipment, communal agriculture, special use, other (built-up areas, forests, water, unproductive land) (Table 3).

Table 3. Land use in built-up area of Baia Mare (Memoriu PUG, 2012)

Functional zones	Sub-functional zones	Extant	
		ha	%
Dwellings and associated circulation arteries		**1,208.97**	**33.93**
Industrial units and deposits		**296.09**	**8.31**
Public institutions and services		**531.39**	**14.91**
Communication and transport routes	**Road transport**	**362.31**	**10.17**
Green spaces, leisure, sport areas	**Roads, parks**	**23.16**	**0.65**
	Leisure/sport areas	**92.42**	**2.59**
	Specialized	**11.06**	**0.31**
	Other green spaces	**14.36**	**0.40**
	Total	**141**	**3.95**
Forests		**49.82**	**1.40**
Lands with special destination		**20.95**	**0.59**
Technical and government buildings		**97.72**	**2.74**
Communal agriculture, cemeteries		**40.03**	**1.12**
Other areas (unusable land, waterways)		**815.30**	**22.88**
	Total	**3,563.58**	**100.00**

Information about the structure of decorative species, the type of management and the main functions of the parks in Baia Mare are synthesized in Table 4 and Table 5.
Given the objective of expanding green spaces in Baia Mare, in the context of European norms, we recommend that when landscaping is performed, that decorative species be selected according to the following criteria:
- adaptability of ornamental vegetation to the pedoclimatic conditions of Baia Mare;
- fulfillment of ecological conditions for attracting pollinating insects;

Table 4. Characteristics of certain parks in Baia Mare (adapted from Radu, 1984)
- classification based on categories of vegetation: trees, shrubs and bushes potential species

Decorative totality / Characteristics	Queen Mary Park (1)	Park of the Romanian Soldier's Monument (2)	Mara Central Par (3)
Functions	Recreation/Playground	Cultural/Recreation	Transit/Recreation/Playground
Landscaping style	Natural	Mixed (landscaping and geometric)	Mixed (landscaping and geometric)
Vegetation appearance	Kept up	Needs upkeep	Need landscaping
Abies alba	solitary	N/A	N/A
Chamaecyparis lawsoniana	solitary	N/A	solitary
Larix decidua	solitary	N/A	N/A
Phellodendron amurense	solitary	N/A	N/A
Picea abies	solitary	N/A	solitary
Pinus nigra	N/A	solitary	solitary
Pinus strobus	solitary	N/A	N/A
Pinus sylvestris	solitary	N/A	N/A
Pseudotsuga menzienii	solitary	N/A	N/A
Tsuga canadensis	solitary	N/A	N/A
Acer globosa	N/A	solitary	solitary
Acer negundo	N/A	solitary	solitary
Acer platanoides	N/A	N/A	solitary
Acer pseudoplatanus	solitary	N/A	N/A
Betula pendula	N/A	N/A	solitary
Carpinus betulus	N/A	solitary	solitary
Castanea sativa	solitary	N/A	N/A
Catalpa speciosa	solitary	N/A	N/A
Elaeagnus angustifolia	N/A	N/A	solitary
Fraxinus excelsior	N/A	solitary	solitary
Juglans regia	solitary	solitary	solitary
Magnolia kobus	solitary	solitary	solitary
Malus sylvestris	N/A	solitary	solitary
Prunus cerasifera pissardi	N/A	solitary	solitary
Quercus petraea	solitary	N/A	N/A
Quercus robur	N/A	plant associations	solitary
Robinia pseudocacia	N/A	solitar	solitary
Salix babylonica	N/A	N/A	solitary
Salix matsudana "tortuosa"	N/A	N/A	solitary
Sorbus aucuparia	N/A	solitary	solitary
Tilia cordata	solitary	N/A	solitary
Ulmus minor	N/A	N/A	solitary

Legend: N/A- missing species

- size, position and use of landscaping points of interest created through diversity of vegetation, play of water and light effect;
- introducing non-allergenic double-flowered plants;
- assuring a year-round plant decor;
- diversifying vegetation so that it includes both deciduous and evergreen trees and bushes, as well as perennial and annual species;
- selecting ornamental species based on type of decor (decorative through shape, flowers and leaves, or arrangement on twigs of fruits).

Table 5. Characteristics of certain parks in Baia Mare (adapted from Radu, 1984)
- classification according to categories of vegetation: bush species, annual flowering species and aromatic species

Decorative totality / Characteristics	Queen Mary Park (1)	Park of the Romanian Soldier's Monument (2)	Mara Central Park (3)
Functions	Recreation/Playground	Cultural/Recreation	Transit/Recreation/Playground
Landscaping style	Natural	Mixed (landscaping and geometric)	Mixed (landscaping and geometric)
Vegetation appearance	Kept up	Needs upkeep	Need landscaping
Juniperus horizontalis	N/A	plant associations	plant associations
Thuja sp.	solitary	N/A	N/A
Thuja columnaris	N/A	solitary	solitary
Thuja orientalis	N/A	N/A	solitary
Amorpha fruticosa	N/A	N/A	plant associations
Berberis thunbergii	N/A	N/A	hedges
Berberis vulgaris	N/A	N/A	hedges
Buxus sempervirens	N/A	alignment	hedges
Chaenemeles japonica	N/A	plant associations	plant associations
Cotoneaster dammeri	N/A	growth in pots	N/A
Cotoneaster horizontalis	N/A	alignment	hedges
Euonymus fortunei	N/A	plant associations	plant associations
Forsitia intermedia	N/A	plant associations	alignment
Hibiscus syriacus	N/A	N/A	solitary
Ligustrum vulgare	N/A	alignment	Hedges
Phyladelphus coronarius	N/A	plant associations	plant associations
Rosa sp.	N/A	solitary/ plant associations	solitary/ plant associations
Sambucus nigra	N/A	solitar	solitary
Spiraea vanhouttei	N/A	plant associations	plant associations
Symphoricarpus sp.	N/A	plant associations	plant associations
Viburnum carlesii	N/A	solitary	solitary/ plant associations
Hedera helix	N/A	Narrow band	N/A
Begonia semperflorens	plant associations	plant associations	Narrow band
Canna indica	N/A	N/A	Narrow band
Dhalia sp.	N/A	N/A	Narrow band
Gazania splendens	plant associations	N/A	Narrow band
Iresine lindenii	N/A	plant associations	N/A
Lavandula angustifolia	N/A	plant associations	N/A
Rosmarinus officinalis	N/A	plant associations	N/A
Thymus vulgaris	N/A	plant associations	N/A
Viola tricolor	plant associations	N/A	Narrow band
Zinnia elegans	N/A	N/A	Narrow band

Legend: N/A- missing species

Following an analysis undertaken in Queen Mary Park (Figure 2), the Park of the Romanian Soldier's Monument (Figure 3) and Mara Central Park (Figure 4) we determined the landscaping values of each park as it currently exists as well as proposals for improving quality of life in Baia Mare through landscaping techniques (Table 6.).

Table 6. Proposals for landscaping of green spaces in Baia Mare (original)

Location	Current use	Landscaping proposals
Queen Mary Park	• represents a recreation area for adults and seniors; • a network of pedestrian paths equipped with wooden benches, surrounded by deciduous and evergreen species, both trees and bushes; • play areas, specially cared for and carefully marked, exist.	• redoing the play area; • using extant vegetation to create special effects at night. These are obtained through artificial illumination of ornamental plants in various chromatic shades; • enclosing the recreation benches located on the main alleys in coverings of cast iron decorated with liana species and climbing roses.
Park of the Romanian Soldier's Monument	• serves as a meeting point between various educational centers and areas near the sports center; • connects the new and old centers of Baia Mare.	• landscaping geared toward a younger population (14-20 years); • creating landscape effects through lianas, bushes and flowering plants; • including rocks with an alpine type landscaping; • introducing water play that will have a cooling effect on sunny summer days.
Mara Central Park	• has a functional purpose, serving as a connecting node between the main commercial, administrative and educational centers.	• Surrounding with curtains of decorative vegetation that is soundproofing, resistant and non-allergenic; • landscaping an area set aside for walking and activities of the 0-3 age group; • landscaping a play space for the 4-8 age group; • setting aside a miniature garden with traditional, representative Maramures elements.

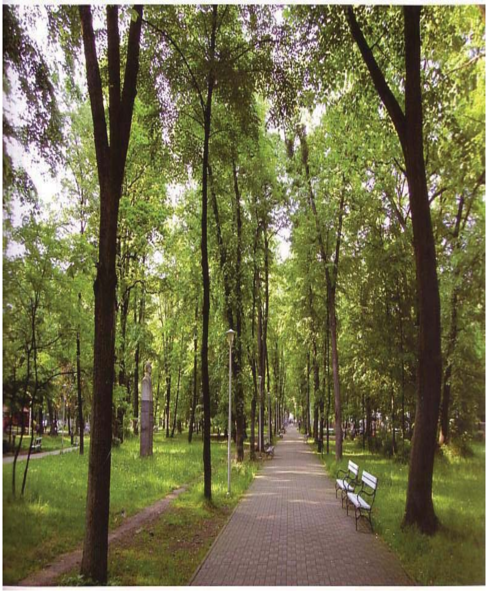

Figure 2. Alley with Small-leaved Lime in Queen Mary Park, Baia Mare, Maramures

Figure 3. Arrangement with annual flowering and aromatic species, in the Park of the Romanian Soldier's Monument, Baia Mare, Maramures

Figure 4. Bush species arrangement in Mara Park, Baia Mare, Maramures

CONCLUSIONS

Information presented in this study is a novelty of being so far reported in other publications.
After the assessment were established the most important characteristics of public parks from the city of Baia Mare (Maramures County), located in the north-west part of Romanian country. It was also drafted a first classification of vegetation in species categories arbustoide and bushes, annual flower and aromatic species; it was described the current destination of each park and there have been made new proposals for landscaping to improve the space for the three municipal parks in modern European context.
When applying these proposals for landscape management, the daily needs of the population of Baia Mare will be met; green spaces will be beautified in three locations: Queen Mary Park (1), the Park of the Romanian Soldier's Monument (2) and Mara Central Park (3) and the quality of the urban environment and the population's life will be improved.
Comparing the recorded data (Table 4) to the 3 parks in Baia Mare found that the park with the highest number of species of solitary willing shrubs were recorded in Mara Central park (21 species) followed by Queen Mary Park (16 species) and only 12 species Park of the Romanian Soldier's Monument (arranged solitary and in associations with 2-4 species);
For the shrubbery and flower decoration the most representative parks are Park of the Romanian Soldier's Monument for the diversity of plant arrangement (Table 5) such as:
- plant associations between deciduous and softwood species (*Juniperus horizontalis Amorpha fruticosa Chaenemeles japonica, Phyladelphus coronarius* and others) exist in 2 parks (Mara Central Park and Park of the Romanian Soldier's Monument);
- hedges with *Berberis sp. Buxus sempervirens Ligustrum vulgare* exist only in Mara Central Park;
- solitary plant species there are planted in all 3 parks (Figure 4);
- alignment with trees, shrubs and bushes potential species in 2 parks (Mara Central Park and Park of the Romanian Soldier's Monument);
- flowers it was organised in narrow band association in the Mara Central Park (*Zinnia elegans*, *Canna indica, Gazania splendens, Dhalia sp*) or simple plant association (*Begonia semperflorens, Gazania splendens, Viola tricolor*) in the Park of the Romanian Soldier's Monument;
- medicinal plant species was used only in Park of the Romanian Soldier's Monument organised in plant association with 4 species: *Iresine lindenii, Lavandula angustifolia, Rosmarinus officinalis, Thymus vulgaris*.
The landscaping solutions for the parks analyzed will ensure the reorganization of extant plant groups, the improvement in appearance of the green spaces studied and the creation of points of interest around certain themes. Moreover, they will permit the realization of landscaping solutions and the grouping of vegetation around traditional themes.

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EX·TERRA·AVRVM

Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EFFECTS OF DIFFERENT IRRIGATION TREATMENTS ON QUALITY PARAMETERS OF CUT CHRYSANTHEMUM

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Abstract

This study was carried out to determine the effects of different irrigation intervals and water amounts on yield and quality parameters of cut chrysanthemum. Spray cut chrysanthemum (cv. 'Bacardi') plant was used as a plant material. Class A pan was placed in the greenhouse to determine the amount of irrigation water values. Irrigation treatments consisted of three irrigation intervals (I_1: 2-, I_2: 4-, and I_3: 6-day) and four crop-pan coefficients (k_{cp1}: 1.20=T_1, k_{cp2}: 0.90=T_2, k_{cp3}: 0.60=T_3, and k_{cp4}: 0.30=T_4). The irrigation water amounts applied to the experimental treatments ranged from 249.7 to 517.9 mm, and seasonal evapotranspiration ranged from 340.9 to 560.5 mm. Different irrigation water amounts and irrigation intervals had statistically significant effects on flower stem length, stem diameter, stem weight, the number of flowers, the vase life and root length of chrysanthemum. Stem length varied between 52.36-79.81 cm, stem diameter varied between 4.62-7.69 mm, stem weight varied between 32.48-123.61 g and root length varied between 18.88-24.22 cm. The optimum irrigation scheduling was T_1I_1, in which the longest flower stem and the highest stem weight were obtained.

Key words: *Chrysanthemum, Class A Pan, Evapotranspiration, Irrigation interval, Water deficit.*

INTRODUCTION

The total production area of ornamental plants worldwide is 1.573.167 ha according to the data of 2013. Some 651.800 ha of it is composed of cut flowers and pot plants. The important production regions according to land areas are Asia, North America, Europe, South America, Africa, and the Middle East. The continent with the largest production area for cut flowers and pot plants worldwide is Asia-Pacific (468.000 ha) (Anonymous, 2013). Chrysanthemum is one of the major cut flowers in the world. The demand for the flower reached 35% of the overall market request, second only to roses (Steen, 2010).

As in all plants, irrigation is an essential practice for chrysanthemum growing, but its adequate handling has been neglected by growers, resulting in growing loss and consequent productivity and quality decreases in the final product (Farias et al., 2009). In order to irrigate more extensive areas with the available water resources, such factors as soil, plant, and water resource must be taken into consideration. In addition, the values of plant water consumption under either sufficient or deficient water conditions should be known throughout the growing season of plants and water-yield relationships should be formed accordingly. These data can be obtained by making a large number of investigations for each plant (Doorenbos and Kassam, 1979). To generate the data concerned, Conover (1969), Harbaugh et al. (1985), Parnell (1989), Kiehl et al. (1992), Schuch et al. (1998), Rego et al. (2004), Conte e Castro et al. (2005), Fernandes et al. (2006), Budiarto et al. (2007), Farisa et al. (2009), Waterland et al. (2010) and Villalabos (2014) made investigations on irrigation and flower quality in the chrysanthemum plant. The majority of the investigations concerned are in the form of pot studies, and they are studies in which the plant quality was determined in different soil moisture tensions. Unlike the above-mentioned studies, this study aimed to determine the effects of different irrigation intervals and water amounts on yield and quality parameters in the chrysanthemum plant under greenhouse conditions in the Mediterranean climatic zone.

MATERIALS AND METHODS

The research was conducted in a polyethylene-covered greenhouse of 255 (6 m x 42.5 m) m^2 on the Research and Application Farm of the Faculty of Agriculture at Süleyman Demirel University (lat. 37.83° N, long. 30.53° E, altitude 1,020 m) in 2011 (in Isparta, Turkey). Some characteristics of the greenhouse soil (in 0- to 50-cm depths) were as follows: texture: clay loam; bulk density: 1.32-1.41 g cm^{-3}; field capacity: 24.80-27.01%; permanent wilting point: 7.08-8.51%, and total available water holding capacity in 0- to 50-cm soil depths: 123.6 mm (Table 1).

Table 1. Some Properties of the Soil in the Greenhouse Soil

Soil Depth	FC		WP		BD	AWHC	
cm	%	mm	%	mm	g cm^{-3}	%	mm
0-25	24.80	81.8	7.08	23.4	1.32	17.7	58.4
25-50	27.01	95.2	8.51	30.0	1.41	18.5	65.2
Total		177.0		53.4			123.6

FC: Field capacity, WP: Wilting pointh, BD: Bulk Density, AWHC: Available water holding capacity.

The mean daily temperature ranged from 20 to 30°C in the greenhouse but from 15 to 25°C outside the greenhouse in 2011. The relative humidity was 70-80% in the greenhouse but 50-70% outside the greenhouse (Figure 1) (DMI, 2011). Spray cut chrysanthemum (*Chrysanthemum morifolium* cv. 'Bacardi') was used as the plant material in the research. Uniform rooted cuttings were planted on 20 June 2011 into plots (1-m length, 1-m width) with five rows (20×12.5 cm spacing, 40 plants/m^2), and each plot contained 40 plants. Plants were grown under long day (LD) conditions until the plant height reached 0.3 m, followed by short day (SD) period up to harvesting. SD (08:00-17:00) period was enforced by using a blackout screen (Kofranek, 1980; Kazaz et al., 2010; Lin et al., 2011). Fertilization was applied to each treatment at equal amounts as follows: (ppm): N: 200, P: 20, K: 150, Ca: 80, Mg: 25, Fe: 3.0, Mn: 0.5, Cu: 0.02, Zn: 0.05, B: 0.5, Mo: 0.01 (Yoon et al 2000). Standard cultivation practices for flower bud removal, supporting system, disease and pest control as used for commercial standart spray cut chrysanthemum production in Turkey were employed for growing the crops during the experiment. The practice of pinching was not applied to the plants in the study.

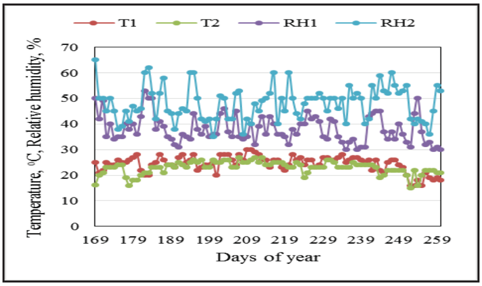

Figure 1. Temperature and relative humidity values at inside and outside of greenhouse. (T_1 and RH_1: Temperature and relative humidity at inside of greenhouse, T_2 and RH_2: Temperature and relative humidity at outside of greenhouse)

All the water which evaporated from Class A Pan (CAP) for 25 days after planting (DAP) was applied equally to all the treatments as irrigation water to ensure the root development and full survival of seedlings. The application of different irrigation intervals and irrigation water amounts was initiated 25 days after planting (DAP). The irrigation treatments were arranged as three different irrigation intervals (I_1:2-, I_2:4-, and I_3:6-day) and 4 different crop-pan coefficients (T_1:$k_{cp}1$=1.20, T_2:$k_{cp}2$=0.90, T_3:$k_{cp}3$=0.60, and T_4:$k_{cp}4$=0.30). The experiment was conducted according to the randomized plots experimental design with 3 replications.

The CAP placed in the greenhouse was utilized to determine the irrigation water amounts (Allen et al., 1998). Irrigation treatments were based on the evaporation data (Ep, mm) obtained from a CAP located inside the greenhouse. Irrigation water amount was calculated using Equation 1. Irrigation water was applied to each irrigation treatment by measuring it with a water meter.

$$IW = A \times E_{pan} \times k_{cp} \quad [1]$$

In the equation, IW denotes the irrigation water (mm), A the plot area (m^2), E_{pan} the amount of cumulative evaporation at the irrigation interval (mm), and k_{cp} the crop-pan coefficient.

The irrigation applications were carried out with the drip irrigation method. The dripper and lateral space was 20 cm, whereas the dripper discharge was 2 l/h (Uçar et al., 2011). The soil water content in the root zone of the plant was measured by means of watermarks (Irrometer, Model; Watermark200SS, USA). The watermarks were placed in the depths of 15 and 40 cm from the soil surface, with each experimental plot containing 2 watermarks. The watermarks were calibrated, and the calibration equation was found as $Pw=48.626\times kPa^{-0.302}$ ($R^2=0.97$) (Pw: Soil moisture as the percentage of dry weight; kPa: Watermark readings).

Plant water consumption was computed by using Equation 2 according to the fundamental principle of water budget by considering the soil moisture values measured before each irrigation application (Allen et al., 1998):

$$ET= I + P - RO - DP + CR \pm \Delta SF \pm \Delta SW \quad [2]$$

In the equation, ET denotes plant water consumption (mm), I the irrigation water applied (mm), P precipitation (mm), RO surface runoff (mm), DP deep percolation (mm), CR capillary rise (mm), ΔSF subsurface runoff (mm), and ΔSW the change in the moisture content of the root zone (mm). Precipitation (P), surface runoff (RO), capillary rise (CR) and subsurface runoff (ΔSF) were neglected in the calculations. The chrysanthemum plant is shallow-rooted, and its effective root depth is about 30 cm. Thus, the values of the watermark placed at the 15th cm were taken into consideration in the computations of plant water consumption, while the deep percolations were examined from the watermark at the 40th cm in depth. The moisture values above the field capacity in the root zone of the plant were considered deep percolation. When the watermark reading limit was exceeded (199 kPa), soil samples were collected from the experimental treatments and the soil moisture content was determined with the gravimetric method.

The flowers were harvested on September 15, 2011, when the flower in the middle opened completely and the surrounding flowers displayed full development. Stem length, stem diameter, stem weight, the number of flowers, vase life and root length were determined.

The obtained data were subjected to an analysis of variance by means of MINITAB 16 computer software, and the LSD Multiple Comparison test was applied by means of MSTAT-C computer software in order to compare the averages.

RESULTS AND DISCUSSIONS

Irrigation Water and Evapotranspiration: The values of irrigation water, percolated water, and plant water consumption applied according to the experimental treatments are provided in Table 2. All the water which evaporated from CAP for 25 DAP (160.3 mm) was applied to all treatments as irrigation water to ensure the root development and full survival of seedlings. During the growing period, 517.9, 428.5, 339.1 and 249.7 mm of water was applied to treatments T_1, T_2, T_3, and T_4, respectively. The total amount of evaporation was 458.3 mm (Table 2).

Table 2. Evaporation and irrigation water values in the treatments

Treatments	Evaporation (from CAP)	IW_1	IW_2	IW
T_1		160.3	357.6	517.9
T_2	458.3*	160.3	268.2	428.5
T_3		160.3	178.8	339.1
T_4		160.3	89.4	249.7

*: 160.3 mm of evaporation had been measured before making a transition to scheduled irrigation. IW_1: The irrigation water amount applied to the experimental treatments before making a transition to scheduled irrigation (mm), IW_2: The irrigation water amount applied according to the k_{cp} coefficients after making a transition to scheduled irrigation (mm); IW: Total irrigation water (mm).

The values of evapotranspiration measured according to the experimental treatments are presented in Figure 2. The highest evapotranspiration took place in T_1 treatments, where 1.2 times the water which evaporated from the evaporation pan was applied as the irrigation water (I_1T_1: 560.5 mm, I_3T_1: 553.4 mm, and I_2T_1: 552.7 mm), followed by T_2 (I_1T_2: 504.6 mm, I_2T_2: 491.3 mm, and I_3T_2: 486.7 mm), T_3 (I_1T_3: 427.4 mm, I_2T_3: 423.1 mm, and I_3T_3: 415.2 mm), and T_4 (I_1T_4: 345.7 mm, I_2T_4: 342.5 mm, and I_3T_4: 340.9 mm). In the study, it is seen that the evapotranspiration varied at different irrigation intervals even if the same amount of irrigation water was applied. Since the soil surfaces of the treatments with short irrigation intervals were continuously wet, the values of plant water consumption measured in these treatments were higher. The deep percolation values ranged from 27.72 to 18.90 mm according to the experimental treatments. Since the irrigation water amount applied at the beginning of the experiment was higher than the values of plant water consumption, the majority of deep percolation (18.90 mm) had taken place before making a transition to scheduled irrigation. After making a transition to scheduled irrigation, no deep percolation occurred in treatments T_3 and T_4 (Figure 2).

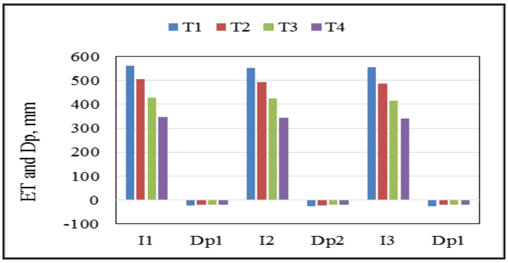

Figure 2. Evapotranspiration and deep percolation values according to the experimental treatments (T_1, T_2, T_3 and T_4: The level of irrigation water amount; I_1, I_2 and I_3: Irrigation interval; Dp_1, Dp_2 and Dp_3: Deep percolation; ET: Evapotranspiration)

Quality Parameters: Different irrigation intervals and irrigation water amounts significantly affected stem length, stem diameter, number of flower, stem weight, and root length at %1 level, and affected vase life at %5 level (Table 3).

Stem length: Growing conditions (temperature, light, photoperiod, relative humidity, CO_2, and planting density) have significant effects on plant height, the number of flowers per plant, and flower size that are among the important quality criteria in chrysanthemum (Carvalho & Heuvelink, 2001). The main climatic factor used to control plant height is temperature (Carvalho et al., 2002), and the optimum temperature requirement of chrysanthemum is 18-20^{o}C (van der Ploeg & Heuvelink, 2006). In this study, however, the temperature of the interior of the greenhouse ranged from 20 to 30^{o}C.

The increased irrigation water amount caused significant increases in stem length. The longest stem (75.03 cm on average) was recorded in T_1 treatments, to which the largest amount of irrigation water was applied, followed by T_2 (70.99 cm), T_3 (65.21 cm), and T_4 (57.22 cm) with the smallest amount of irrigation water application. The highest stem length in T_1 with the largest amount of irrigation water application was obtained from I_1 (79.81 cm). Stem lengths were 73.75 and 71.52 cm in I_3 and I_2, respectively (Table 4). The differences between I_1 and I_2 and between I_1 and I_3 were statistically significant, while the difference between I_2 and I_3 was insignificant. Likewise, the longest stem in T_3 treatments was determined in I_2 (67.93 cm), followed by I_1 (67.18 cm) and I_3 (60.52 cm). Although there was a difference between I_1 and I_2, it was not statistically significant. In T_2 and T_3, the highest stem length was obtained from I_1. When the same amount of water was applied at different irrigation intervals, its effect on stem length was not the same. This led to an interaction between the irrigation intervals and irrigation amount. The longest stem (70.96 cm) was recorded in I_1 with a 2-day irrigation interval, followed by I_2 (67.44 cm) and I_3 (62.94 cm). It was also stressed by Harbaugh et al. (1985) that stem length generally increased with an increase in the irrigation water amount applied. In the study concerned, they stated that the plant height was 62 cm in the treatment of 0.16 cm/day, 76 cm in the treatment of 0.24 cm/day, 86 cm in the treatment of 0.31 cm/day, 92 cm in the treatment of 0.40 cm/day, and 97 cm in the treatment of 0.47 cm/day. These data are in agreement with our results. Stem length is one of the most important indicators for the market value in chrysanthemum, as in the other cut flower species. Although varying by country, the branches which are 70-80 cm long are generally preferred in chrysanthemum (Kazaz, 2010). Chrysanthemums are classified when their flower stem lengths are 60-75 cm according to the classification in the USA but when their flower stem lengths are 50-70 cm according to the classification in England (Mengüç, 1996). All experimental treatments according to the English classification and all treatments other than I_2T_4 and I_3T_4 according to the American classification are included in the good class.

Table 3. The results of variance analysis of mean values of spray cut chrysanthemum quality parameters

Variation Sources	Mean square error						
	df	Stem length	Stem diameter	Stem weight	Number of flower per plant	Vase life	Root length
Replication (R)	2	19.45	0.16	74.70	6.02	5.86	0.10
Irrigation Interval (II)	2	194.22**	4.31	552.40**	54.28**	12.19*	2.96**
Irrigation water amount (IW)	3	537.44**	5.37**	8211.40**	440.99**	10.74*	38.09**
II*IW	6	22.60**	0.13**	191.80*	13.43**	4.05**	0.26
Error	22	6.03	0.12	60.0	4.00	1.89	0.41
Total	35	2307.86	28.49	28358.90	1612.22	106.22	130.97

df: degrees of freedom,*P<0.05 and **P<0.01

Stem weight: Stem weight ranks first among the most important quality criteria which are taken as the basis in the marketing of chrysanthemums worldwide. At the flower auction of the Netherlands (FloraHolland), the stem weights range from 45 to 105 g depending on the stem length (65, 70, and 72 cm) in spray chrysanthemums. In addition, the optimal stem weight is 70 g (Anonymous, 2010).

In terms of the irrigation water amounts, the highest stem weight was found in T_1 (108.72 g on average), followed by T_2 (83.79 g on average), T_3 (60.09 g on average), and T_4 (38.67 g on average). In terms of the irrigation intervals, the highest stem weight was obtained from I_1 (78.89 g on average), followed by I_2 (74.07 g on average) and I_3 (65.49 g on average). I_1 and I_2 were not statistically different in either T_1 or T_2, ranking first and second in terms of stem weight, while I_3 was different (P<0.05). In a study reported concerning stem weight, Harbaugh et al. (1985) determined the plant stem weight as 93 g in the treatment of 0.16 cm/day, 127 g in the treatment of 0.24 cm/day, 138 g in the treatment of 0.31 cm/day, 149 g in the treatment of 0.40 cm/day, and 168 g in the treatment of 0.47 cm/day in different daily irrigation water applications. Higher stem weights were obtained in the treatments treated with a large amount of water in our study, which is similar to these results. It was reported that the stem weight of a chrysanthemum of a high quality ranged from 25 to 105 g according to the classification criterion of the Dutch flower auction (Anonymous, 2010), while it was reported in Japan that the chrysanthemums which were 80-90 cm long should weigh 55-100 g (Yoon et al., 2000). Even though the stem weights in all experimental treatments are included in the good class according to the Dutch classification criterion, the stem weights of the flowers obtained from the experimental treatments other than T_4 are included in the good class according to the Japanese classification system.

Number of flower per plant: There were differences in the number of flowers in terms of both irrigation intervals and the irrigation water amounts applied. The difference between T_1 (28.60 flowers/plant) and T_2 (26.99 flowers/plant) was statistically insignificant. On the other hand, T_3 (20.19 flowers/plant) and T_4 (13.31 flowers/plant) were statistically different from each other. The differences in the number of flowers per branch between I_1 (24.64 flowers/plant) and I_2 and between I_1 and I_3 were significant, whereas the difference between I_2 (21.65 flowers/plant) and I_3 (20.53 flowers/plant) was insignificant (P<0.05).

Vase life: Irrigation interval and irrigation water amount had significant effects on vase life (P<0.01). The longest vase life among the irrigation intervals was determined in I_3 (17.82 days on average). However, the difference between I_1 (16.00 days) and I_2 (16.42 days) was insignificant. Although the difference among the irrigation water treatments was significant, there was no linear correlation either between the decrease and increase in irrigation water or between the increase and decrease in vase life. The longest vase life among all experimental treatments was recorded in I_3T_1 (19.67 days).

Table 4. Mean values and significance groups of quality parameters of spray cut chrysanthemum

Treatments	Stem length, cm			Average	Stem diameter, cm			Average
	I_1	I_2	I_3		I_1	I_2	I_3	
T_1	79.81 a	71.52 bc	73.75 b	75.03 A	7.69	6.77	6.68	7.05 A*
T_2	74.29 b	73.57 b	65.12de	70.99 B	7.10	6.73	5.98	6.61 B
T_3	67.18 d	67.93 cd	60.52 fg	65.21 C	6.74	5.78	5.72	6.08 C
T_4	62.58 ef	56.73 g	52.36 h	57.22 D	6.11	5.03	4.62	5.25 D
Average	70.96 A	67.44 B	62.94 C		6.91 A	6.08 B	5.75 C	
$LSD_{0.01}$	LSD_I:2.079, LSD_T:2.401, LSD_{IxT}:4.158				LSD_I:0.295, LSD_T:0.340			
	Stem weight, gr				Vase life, day			
T_1	123.61a	101.00b	101.54b	108.72 A	16.00 de	17.67a-d	19.67 a	17.78 A
T_2	85.82 c	95.24bc	70.31 d	83.79 B	14.00 e	16.33 cd	17.00 b-d	15.78 B
T_3	60.27 d	62.36 d	57.64 de	60.09 C	18.33 a-c	16.00 de	18.67 ab	17.67 A
T_4	45.86 ef	37.69 fg	32.48 g	38.67 D	15.67 de	15.67 de	16.33 cd	15.89 B
Average	78.89 A	74.07 A	65.49 B		16.00 B	16.42 B	17.82 A	-
$LSD_{0.01}$	LSD_I:6.558, LSD_T:7.573, LSD_{IxT}:13.120				LSD_I:1.158, LSD_T:1.337, $LSD_{I\ x\ T}$:2.317			
	Number of flower per plant, numbers				Root length, cm			
T_1	29.41ab	26.30bc	30.09 a	28.60 A	18.93	18.57	19.54	19.01 D
T_2	29.24ab	26.29bc	25.44 c	26.99 A	20.67	21.14	21.82	21.21 C
T_3	23.38cd	21.20 d	15.98 ef	20.19 B	21.71	22.68	23.07	22.49 B
T_4	16.53 e	12.80 fg	10.60 g	13.31 C	23.40	23.93	24.22	23.85 A
Average	24.64 A	21.65 B	20.53 B	-	21.18 B	21.58 B	22.16 A	
$LSD_{0.01}$	LSD_T:1.693, LSD_T:1.955, $LSD_{I\ x\ T}$:3.387				LSD_I:0.5429, LSD_T:0.6268			

*The difference among the averages is significant at 5% level.

Stem diameter: Stem diameter is an important criterion for determining the resistance of a branch. In terms of the irrigation water amounts, the thickest stem occurred in T_1 (7.05 mm on average), followed by T_2, T_3, and T_4. The stem diameters in these treatments were 6.61 mm, 6.08 mm, and 5.25 mm on average, respectively. When the irrigation intervals were examined, the thickest stem as found in I_1 (6.91 mm), followed by I_2 (6.08 mm on average) and I_3 (5.75 mm on average). The thickest stem was recorded in I_1T_1 (7.69 mm), to which the largest amount of water was applied at a 1-day interval, whereas the thinnest stem was obtained from I_3T_4 (4.62 mm) with the smallest amount of water application at a 6-day interval.

Root length: The longest root length was determined at T_4 (23.85 cm) which was applied the least irrigation water and also the lowest root length was determined at T_1 (19.01 cm) applied highest irrigation water. When the consideration irrigation interval, the highest root length was measured I_3 (22.16 cm). On the contrary, other quality parameters, when the irrigation water amount and irrigation interval increased, the root length was reduced. In other words, the lowest root length was obtained from T_1 which had the most irrigation water amount and highest irrigation interval. It is thought, due to the plants had not water stress and could easily get water from soil, the root growth in T_1 was better than applied less irrigation water such as T_4 or T_3.

CONCLUSIONS

The irrigation water amounts applied under experimental conditions ranged from 249.7 to 517.9 mm, while the plant water consumption varied between 340.9 and 560.5 mm. The large amount of irrigation water applied increased the plant water consumption, and its effect was reflected positively on the quality parameters;

hence, a longer stem and a higher stem weight were obtained from the treatments with a larger amount of water application and high plant water consumption accordingly. In the study, the longest stem (79.81 cm), the thickest stem diameter (7.69 mm) and the highest stem weight (123.61 g) were obtained from combination I_1T_1, while the largest number of flowers per plant (30.09 flowers/plant) and the longest vase life were determined in combination I_3T_1 (19.67 days). When stem length and stem weight are particularly considered in terms of marketable products, the optimum irrigation scheduling is I_1T_1. When it is intended to save water, treatment I_1T_2 or I_2T_2 might be selected as the irrigation scheduling. In this case, the reduction in flower quality will be minute.

ACKNOWLEDGEMENTS

This research was supported as a Master Thesis by Suleyman Demirel University Unit of Scientific Research Project (Project No: 2934-YL-11).

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

CHARACTERISTICS OF INVASIVE TAXA OF *PARTHENOCISSUS* IN THE BUDA ARBORETUM, HUNGARY

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Abstract

There are 15 species in the genus of Parthenocissus (Krüssmann, 1989), some of them (Parthenocissus inserta, P. quinquefolia, P. tricuspidata) were used as hardy, decorative outdoor ornamental climbing shrubs in Hungary (Priszter, 1997; Tóth 2012). These invasive plants can spread spontaneously and cause ecological, maintenance problems in several gardens and public parks, among others in the Buda Arboretum, were different kind of characteristics of four Parthenocissus taxa were examined during two years (2012 and 2013). Biological features of reproduction (crop yield, seed viability, germination capacity), aptitude of spontaneous spreading (ground-space and number of plants, density of seedling under the mother plant) and maturation (coloration, shedding and soluble dry weight of fruits) were examined to determine their invasion capacity. P. tricuspidata produced the highest and P. inserta developed the lowest number of fruits. Seed viability was the largest in the case of P. quinquefolia (100%), and every taxon has got high capacity of germination (especially if the soft part of fruits – which usually contain germination inhibitors – was removed). The highest numbers of individuals were obtained on the case of P. quinquefolia (35 plants), this species covered 499 m^2 horizontal and 157 m^2 vertical area. The second was P. tricuspidata with 17 individuals, 158 m^2 horizontal and 2603 m^2 vertical area, followed after the other 2 species (P. inserta, P. tricuspidata 'Veitchii') with 143 and 32 m^2 ground-space covered by 17 and 4 plants. Fruits of P. tricuspidata 'Veitchii' were colored the earliest and fallen the latest (unlike P. inserta, which produce the latest fruit-colorization and the earliest shedding). There were not significant differences between soluble dry weight of every Parthenocissus fruits (6,3-7,6%).Taxa with more individuals and ranges were qualified as more invasive than the other ones with lower values. This qualification was directly proportional to the number of seedlings under the originally planted parents as well as the fruit quantity and the germinable of seeds, but not correlated with soluble dry weight and taste of fruits (in which there were not significantly differences between the taxa).

Key words: *invasive, Parthenocissus, Buda Arboretum.*

INTRODUCTION

Invasive species can spread aggressively in new habitats, and ecologically, economically damage native biomes (Mihályi and Botta-Dukát, 2004), probably thanks to the climate change and human impacts (Csiszár, 2012).

Not every introduced species can invade new areas; most of them are not dangerous for endemic floras or faunas (Mihályi and Botta-Dukát, 2004). At the same time; more and more researchers execute studies and publish results about invasive taxa. Nowadays, a special journal is available connected with invasive species: Biological Invasions (Dancza, 2012). Bulletins, regulations pertain to invasive plants were included in international environmental agreements and internal law (Genovise and Shine, 2007).

Parthenosissus (with 15 species) belonged to the *Vitaceae* family (Krüssmann, 1989). In Hungary, *Parthenocissus inserta, P. quinquefolia, P. tricuspidata* species and its cultivars were used as outdoor ornamental climbing shrubs (Priszter, 1997; Tóth, 2012). We can find them in the Buda Arboretum, where spontaneous invasion of *Parthenocissus* taxa often cause difficulties in horticultural works. There is no concrete data about introducing; perhaps these vines were firstly planted at the beginning of 19 century.

Parthenocissus quinquefolia is native to East part of North America. It is a strong climbing shrub with palmately compound leaves (which contains 5 leaflets), bifurcated tendrils and adhesive disks at the end of the tendrils. This species was come to Europe in 1887.

Parthenocissus inserta is very similar *to P. quinquefolia* (with the same origin and without disks). It was transferred to Europe in 1922.

Parthenocissus tricuspidata is originated in Japan, China and Korea. Juvenile leaves are 3-lobed, adult forms has trefoil ones. There are several varieties of this species, one of the most widespread and old-established, Japanese cultivar is 'Veitchii', a juvenile type (Krüssman, 1989).

The aim of our study was to examine invasion capacity of *Parthenocissus* taxa in the Buda Arboretum.

MATERIALS AND METHODS

Experiments were carried out in the Buda Arboretum of Corvinus University Budapest during 2012-2013. Separation of *P. quinquefolia* and *P. inserta* individuals was unambiguous but in the case of *P. tricuspidata* only grafted, older plants or seedlings with more intensive autumn-coloration were registered as cultivar 'Veitchii'. The other ones (non-grafted or less colourful seedlings) were recorded as the original species named *P. tricuspidata*. There were 3 main groups of the examinations according to the reproductive capacity, spreading and fruit maturation.

1. Examination of reproductive capacity

Yield, seed viability and germination were investigated.

To determine of yield (with a scale division from 1 to 5), fruits number/1 m^2 area of mother plant was estimated. The values of scale were: 1=0-20 fruits/m^2, 2=20-40 fruits/m^2, 3=40-60 fruits/m^2, 4=60-80 fruits/m^2, 5=80-100 fruits/m^2.

20-20 seeds were randomly collected from every taxon (before assessing of germination) and after peeling of the seed coat, rate of viable/unviable seeds was determined visually.

For examining germination, in 2012 (October) 20-20 seeds were gathered again from all taxon. As stratification, 10-10/10-10 seeds with/without pulp were sown into trays filled with sand. Furthermore, every trays were recessed and covered by Raschel net and leaf-litter (stratification procedure was placed in outdoor). After stratification, all seeds were transferred to chernozem soil with lime deposit in 2013 (April). Irrigation and examinations were done weekly. The last time of monitoring was at 3rd May (2013), after it every seedling were eliminated.

2. Examination of spreading

During examination of spontaneous spreading of *Parthenocissus* taxa in the Buda Arboretum, monitoring of occurrence, measuring of covered areas and determining of density of seedlings (under their mother plant) were done.

In the case of monitoring of occurrence, originally planted (usually elder) specimens were marked by the help of the map of the arboretum. After this, the other (e.g. newly hatched, young, spontaneously appeared) plants were counted and registered. Results of this monitoring were recorded on the map (with colourful spots), and all plant were photographed. Horticultural works (e.g. weeding, wood-cutting) and constantly varying stock made our research more difficulties were. Some specimen (which was registered in 2012) was resected in 2013.

During measuring of covered areas, plants were measured horizontally and vertically (with a metric rod) so thus their covered areas were calculated. In addition, age of plants was appreciated (if precise data were not found about it).

To determine density of seedlings, we used a 1 x 1 m sized frame (which was placed under the chosen mother plants), and all seedlings were counted within. Counting was repeated 3 fold (namely 3 different part under the mothers). Total number of seedling was calculated by the following formula:

Total number of seedling=total covered area of seedlings (m^2) x (seedling number/m^2).

3. Examination of fruit maturation

Coloration, dropping, taste and soluble dry weight of fruits were examined.

Monitoring (and photographing) of fruit coloration and dropping was done weekly, from 24th August 2012 to 14th December 2012. Results were illustrated on Figure 4.

In order to ascertain bird's choice (i.e. which *Parthenocissus* produce the best fruit for birds), soluble dry weight of collected fruit was determined in the laboratory of Department of Applied Chemistry (Faculty of Food Science, Corvinus University Budapest) in 2013 (November). For measuring, PAL-1 (Atago Corporation, Tokyo, Japan) portable digital refractometer was used. Soluble dry weight (%) is current for defining sucrose contents of solutions (Fodor, 1971; Kovács, 2012). During the examination, 2 g fruits (from all taxa) and equal quantity (Milli-Q 18.2 MΩcm) distilled water (DV) was measured by Precisa 40MS-200A analytical balance. After it, fruits (mixed with DV) fractured and homogenised in braying mortar. Finally, filter-liquor was separated from the homogenous suspension, and 3 drops were used for refractometric analyses.

In 2013 (autumn) we degusted the fruits, and tastes (sweet, bitter, acidic) were recorded with a scale range from 1 to 5 (Table 3). Range 1 was: the less sweet or bitter or acidic, range 5 was: the sweetest or bitterest or the most acidic.

RESULTS AND DISCUSSIONS

1. Examination of reproductive capacity

Results were shown on Table 1. *Parthenocissus tricuspidata* produced the highest and *P. inserta* the lowest number of fruits. It is an important factor, because plants with higher yield commonly produce more seedlings. Moreover, birds (which are often take part in spreading plants) often prefer plants taxa with more fruits or seeds.

In 2012, rate of viable seed was the highest (100%) in the case of *P. quinquefolia* (in 2012), and 20 % of *P. tricuspidata* 'Veitchii' seeds were unviable. Next year, all (100%) seeds of *P. inserta* and *P. quinquefolia* was viable, and 90% in the case of the others (*P. tricuspidata* and *P. tricuspidata* 'Veitchii'). Not only higher yield, but producing more viable seeds is important for successful spreading.

Viable seeds germinated fast and well in the case of every *Parthenocissus* taxa. Although there were not significant differences between the groups, germination ratio was higher if pulp (which probably contained inhibitors) was removed from fruits.

Table 1. Values of reproductive capacity of *Parthenocissus* species and cultivars (Buda Arboretum, 2012)

Taxon	Yield (estimated values)	Seed viability (%)	Germination capacity of seeds (with pulp) (pcs/20pcs)	Germination capacity of seeds (without pulp) (pcs/20pcs)	Endurance of fruits (days)	Seedling number under their mother plant (pcs)
P. inserta	3	100	11	12	56	5
P. quinquefolia	4	100	10	15	63	10
P. tricuspidata	5	90	14	18	70	20
P. tric. 'Veitchii'	4	90	12	14	77	10

2. Examination of spreading

a) Spreading in the Buda Arboretum

As we can see on Figure 3, every *Parthenocissus* taxa widespread all part of the Buda Arboretum and numerous seedlings were found mainly on the wall of the buildings, on the retaining walls, on the surface of larger rocks and on the fences.

In the bottom part of the arboretum, mostly *P. quinquefolia* and *P. tricuspidata* plants were found. In particular, the latter species grown on the wall of buildings, on the other hand, *P. quinquefolia* mainly crept up the trees, shrubs or the retaining walls (but sometimes grown horizontally on the grass).

P. tricuspidata 'Veitchii', *P. inserta* and *P. quinquefolia* covered large areas in the upper part of the arboretum. For example *P. tricuspidata* 'Veitchii' mainly grown on the building 'E' (Figure 1),

Figure 1. *Parthenocissus tricuspidata* 'Veitchii' on building 'E' (Buda Arboretum) (photo: Végh, 2012)

P. quinquefolia preferred fence near Ménesi Street (Figure 2), and on the grass, trees and shrubs mainly *P. inserta* plants were found.

Figure 2. Information board and fence was covered by *Parthenocissus quinquefolia* (Buda Arboretum) (photo: Végh, 2012)

Taxa with larger areas (and longer spread distances) have higher capacity of invasion. However, if spread distances of (invasive) mother plants were increased, the new plants (seedlings) were not always their offsprings.

The number and composition of invasive plants is continuously change due to the reserving works in the Buda Arboretum. Some cases, new plants were not found at the next occasion (probably these plants were weeded out).

Even so, all plants were registered on the map. By the way, some specimens of *Parthenocissus* can develop new shoots next year in the case of unsuccesful weeding.

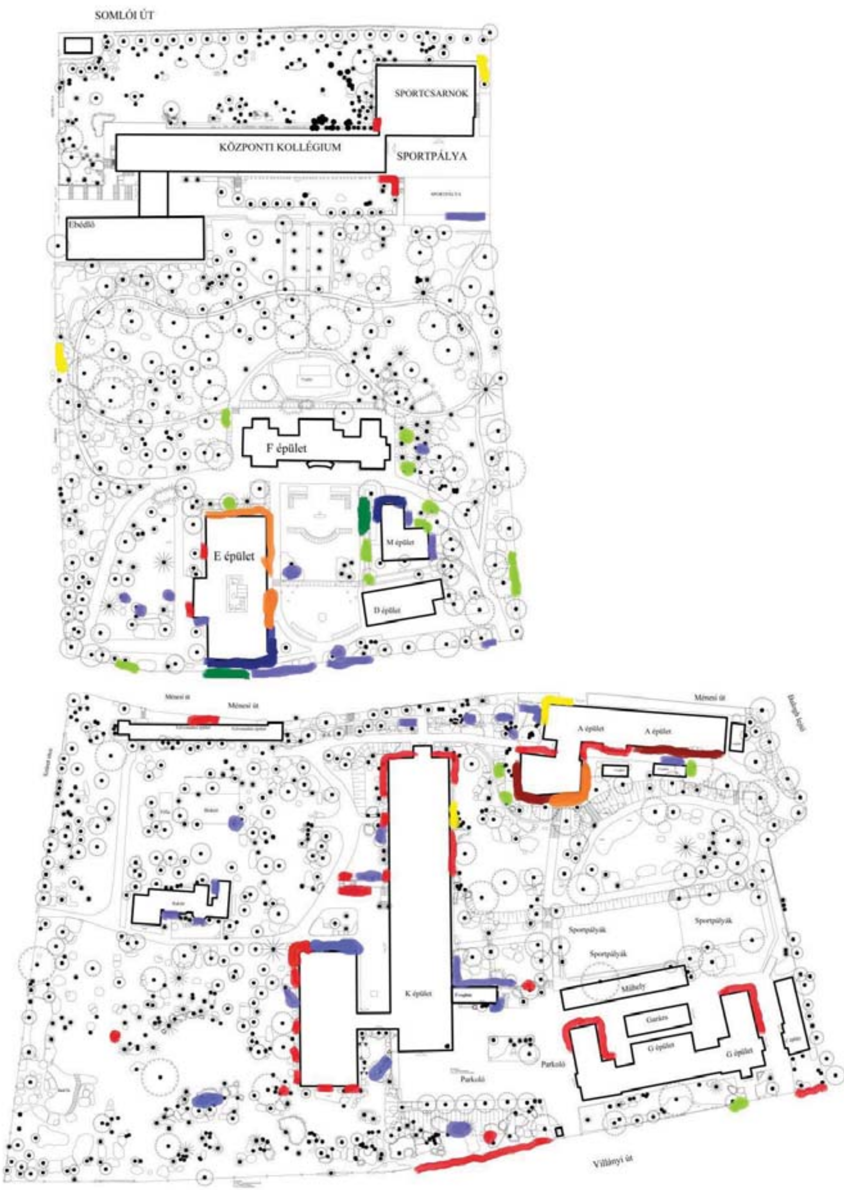

Figure 3. Spread of *Parthenocissus* genus in the Buda Arboretum (2013)
(map: Schmidt and Czigány, 2013)

Colour codes: *P. quinquefolia*: dark blue=original plantation, pale blue=spontaneous occurrence
P. inserta: dark green= original plantation, pale green= spontaneous occurrence
P. tricuspidata: dark purple= original plantation, red= spontaneous occurrence
P. tricuspidata 'Veitchii': orange= original plantation, yellow= spontaneous ccurrence

b) The number of individuals, sizes of covered areas

The number of individuals and sizes of covered areas were shown on Table 2.

Most plants (35: 6 elder and 29 young) were found in the case of *Parthenocissus quinquefolia*. This species mainly grown vertically (499 m^2) and the size of horizontal area was 157 m^2. The largest specimen covered almost 140 m^2 on a wall

17 *Parthenocissus inserta* plant was registered, mostly youngs (15) and only 2 elder. The largest *P. inserta* had almost 48 m^2 covered area on the wall (and the smallest: less than 5 m^2). Considering the whole arboretum, this species covered nearly 143 m^2 on horizontal spaces and vertically overgrown 219 m^2 on the walls.

23 specimens were found in the case of *Parthenocissus tricuspidata*. But this species had got the largest vertical covered area, approximately 2603 m^2 (Table 2), and the largest plants grown vertically almost 1248 m^2 and horizontally 52 m2 (all plants: 158 m^2).

Only 4 *P. tricuspidata* 'Veitchii' were in the arboretum (most of them originally planted). The total size of their horizontal spaces was 346 m^2, and 32 m^2 regarding vertical areas.

Summarizing, *P. quinquefolia*, covered the largest areas, and spread more aggressively than the other taxa (probably due to the adhesive disks on the strong tendrils which are absolutely suitable for climbing everywhere). On the other hand, *P. tricuspidata* and especially its cultivar named 'Veitchii' was the weakest invader, because these plants easily damaged by hard frost (Schmidt and Tóth, 2012) and only spread on the building/retaining walls, sometimes on the bark of wide tree trunks.

Table 2. The number of individuals and size of covered area of *Parthenocissus* taxa (Buda Arboretum)

Taxa	No of individuals (pcs)		Horizontal (ground) space (m^2)	Vertical space (m^2)
	Original	Total		
Parthenocissus inserta	1	17	219	143
Parthenocissus quinquefolia	2	35	499	159
Parthenocissus tricuspidata	1	17	2603	158
Parthenocissus tricuspidata 'Veitchii'	2	4	346	32
Total:	**6**	**73**	Average: 916	**490**

3. Examination of fruit maturation

a) Coloration of fruits

P. tricuspidata 'Veitchii' fruits gained their mature colour firstly, and the last were *P. inserta* and *P. quinquefolia* (figure 4). Fruit endurance (from the beginning of coloration till the end of dropping) was the longest on individuals of *P. tricuspidata* 'Veitchii' and the shortest in the case *P. inserta*.

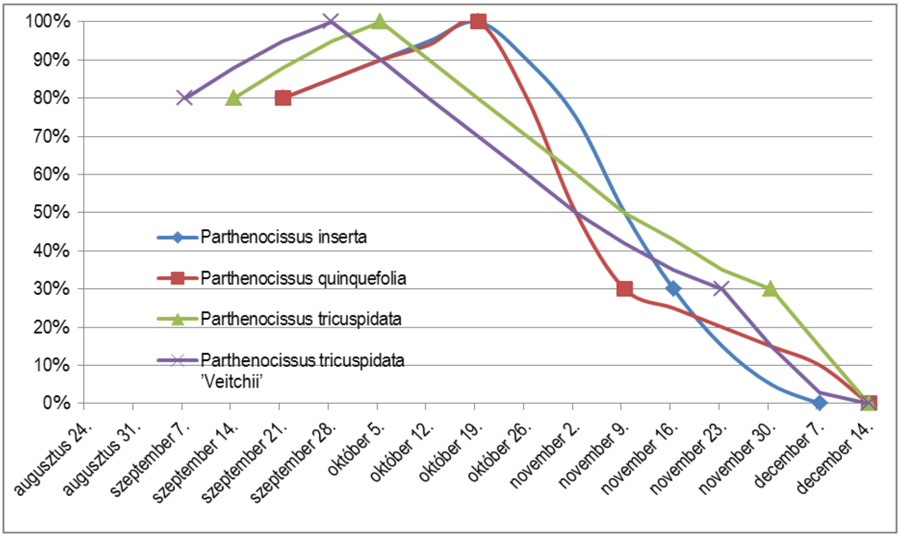

Figure 4. Coloration and dropping time of *Parthenocissus* fruits in the Buda Arboretum (2012)
(80%= beginning of fruit coloration, 100%= total coloration,
30%= beginning of fruit dropping, 0%= end of fruit dropping)

b) Soluble dry weight and taste of fruits

Soluble dry weight of *Parthenocissus* fruits were almost equal with fairly low variations (7,6-6,3%) (Figure 5).

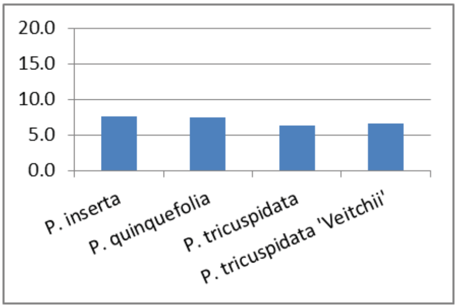

Figure 5. Soluble dry weight of fruits of *Parthenocissus* taxa in the Buda Arboretum (2013)

Not significantly higher values were obtained in the case of *P. inserta, P. quinquefolia*, and the other 2 taxa produce fruits with slightly lower dry weight. Also, there were not significant differences between the tastes of fruits of every taxon of *Parthenocissus*. (Table 3).

Table 3. Taste of fruits of *Parthenocissus* taxa (Buda Arboretum, 2013)

Taxa	Taste of fruits		
	Sweet	Bitter	Acidic
P. inserta	2	3	1
P. quinquefolia	3	2	1
P. tricuspidata	3	2	1
P. tricuspidata 'Veitchii'	2	2	1

Note: range 5=the sweetest or bitterest or the most acidic, range 1=the less sweet or bitter or acidic

Birds usually help for spreading *Parthenocissus* fruits and seeds; however, some species/cultivars of this genus were proved to be more aggressive than the others. Probably soluble dry weight and taste of fruit could affect the capacity of spreading, although statistically differences were not detected between them.

CONCLUSIONS

Invasion characteristics of four kinds of *Parthenocissus* (3 species and 1 cultivar) were examined during 2012 and 2013 in the Buda Arboretum. The highest number of individuals (with the largest ground area) were found in the case of *Parthenocissus quinquefolia*, followed by *Parthenocissus tricuspidata* (17 plant, covered 158 m^2 horizontal and 2603 m^2 vertical area) and *Parthenocissus inserta*, *Parthenocissus tricuspidata* 'Veitchii' (17 and 4 plant with 143 m^2 and 32 m^2 ground place). Taxa with more individuals and larger covered area were pronounced as more invasive than the others with less number of plants and overlaid area. Positive correlation was detected between the invasion capacity and the number of seedling, fruits and germination capacity of seeds. Nevertheless, there were not significant differences between *Parthenocissus* taxa in according to the soluble dry weight and taste of fruits.

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MISCELLANEOUS

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

HPTLC FINGERPRINT USE, AN IMPORTANT STEP IN PLANT-DERIVED PRODUCTS QUALITY CONTROL

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Abstract

Romanian flora comprises a significant number of vegetal species, some of these already established in terms of chemical composition and pharmacological potential. Also, currently on the national profile market there are many plant-derived products for internal or external use that contain standardized extracts or herbal powders. So, it is very important for the plant-derived products production process to have quality control methods for raw materials and for finished products. In the context of complex chemical composition of vegetal raw material, depending on the cultivating region, the climate (temperature, humidity, light and wind), the harvest time and plants part used, the chromatographic fingerprint can certify the species, chromatographic fingerprint of vegetal products being one of the most simple and feasible method of quality control. Accordingly, High-performance thin-layer chromatography (HPTLC) has become one of the most important tool for quality control of plant-derived products on basis of its simplicity and accurately, as well. It can serve as a tool for instance, depending on the chromatographic conditions, HPTLC method can identify numerous classes (16) of vegetal compounds. Given these, this paper was aims at presenting HPTLC chromatographic phenolic fingerprint of some valuable Romanian vegetal species as follows: Juglans regia L. - walnut, Morus nigra L. - mulberry tree, Althaea officinalis L.- marshmallow, Carum carvi L.- caraway, Crataegus monogyna Jacq. - hawthorn, Tilia cordata Mill. - linden, Achillea millefolium L. - yarrow determined by HPTLC, species present in many plant-derived products.

Key words*: chromatographic phenolic fingerprint, HPTLC, Romania, vegetal species.*

INTRODUCTION

Romania has different bio-geographic regions and ecosystems, being considered a link between Europe and Central Asia. The flora and fauna of Romania represent a renewable resource of significant value if protected and exploited on a sustainable basis. Romania possesses about 50 % of Europe's flora and fauna with more than 3,500 plant species (Pârvu, 1997).

With this abundance of resources, the local producers that uses native flora as raw material, are in a continuous expansion. In the same time, the interest of the consumers for the plant-derived products is increasing, given the fact that these products have a lower price and no side effect comparable with synthetic drugs (Stoia and Oancea, 2013).

On the national market there is an important number of plant derived products for both internal and external administration. For the producers is very important to have reproducible raw material in the terms of chemical composition.

Therefore, is very important for the production process to have simple and feasible quality control methods for raw material and for finished products. In the context of complex chemical composition of vegetal raw material, depending on the cultivating region, the climate (temperature, humidity, light and wind), the harvest time and plants part used, the chromatographic fingerprint can certify the species, being an important step in plant-derived products quality control.

The High performance thin layer chromatography (HPTLC) has become one of the most important tools for quality control of plant-derived products on basis of its simplicity and accurately, fingerprint chromatography being accepted by the World Health Organization as an identification and quality evaluation technique for vegetal raw material (Alaerts, et al 2007).

Through, HPTLC technique, depending on the chromatographic conditions, can be identify numerous classes (16) of bioactive compounds. These bioactive compounds are often secondary metabolites, commercially important and find use in numerous plants - derived products. Among these, phenolic compounds occupy one of the first places due to their health promoting properties (Ghasemzadeh and Ghasemzadeh, 2011). The consumption of products that contain phenolic compounds has been often associated with decreased risk of developing several diseases. Phenolic compounds are known for their action in an important number of biological activities with antibacterial, antioxidant and anti-inflammatory properties. Most of the literature data regarding the biological activity of phenolic compounds refers to antioxidant properties witch may be due mainly redox properties, that allow them to act as a reducing agent and as a hydrogen donor (Kamatou et al 2010; Samec, et al 2010; Rice-Evans al 1996).

Given the importance of the these compounds, HPTLC chromatographic fingerprint of raw material can be an important step in quality control of production process.

The species selected for this study are some of the most valuable Romanian species, which are present in the plant derived products (Table 1).

Table1. Plant material

Latin name	***Common name***	***Family***	***Part used***
Juglans regia L	walnut	*Juglandaceae*	*Juglandis folium et pericarpium*
Morus nigra L.	mulberry tree	*Moraceae*	*Mori folium*
Althaea officinalis L	marshmallow	*Malvaceae*	*Althaeae folium*
Carum carvi L.	caraway	*Apiaceae*	*Carvi fructus*
Crataegus monogyna Jacq.	hawthorn	*Rosaceae*	*Crataegi folium cum flores*
Tilia cordata Mill.	linden	*Tiliaceae*	*Tiliae flores*
Achillea millefolium L.	yarrow	*Asteraceae*	*Millefolii flores*

MATERIALS AND METHODS

Raw material - was purchased from the local store in the form of tea products.

Sample preparation: the samples were prepared by extraction with ethanol 50 % (v/v) - vegetal material/ solvent rate -1/15 m/v for 5 minutes at boiling temperature of the solvent. The solution was filtered and frozen until analysis.

HPTLC Analysis for phenols: According to TLC Atlas - Plant Drug Analysis (Wagner, H. and Bladt S. 1996) was performed a densitometric HPTLC analysis for the development of characteristic fingerprint profile for phenolic compounds. 3-3.5µl of the samples and 1-3µl of references substances (10^{-3} M quercetin, rutin, hyperoside, chlorogenic acid, caffeic acid, rosmarinic acid, ferulic acid, apigenin - 7-glucoside - Sigma-Aldrich) were loaded as 10 mm band length in the 20 x 10 Silica gel 60F254 TLC plate using Hamilton-Bonaduz, Schweiz syringe and CAMAG LINOMAT 5 instrument. The mobile phase was constituted of ethyl acetate-acetic acid-formic acid-water 100:11:11:27 (v/v/v/v). After development, plates were dried and derivatized in Natural products–polyethylenglycol reagent (NP/PEG) (Sigma-Aldrich) reagent. The fingerprints were evaluated at 366 nm in fluorescence mode with a WinCats and VideoScan software.

RESULTS AND DISCUSSIONS

Figure 1 shows chromatographic phenolic fingerprint of S1-*Juglandis folium et pericarpium,* S2-*Mori folium,* S3-*Althaeae folium*, S4-*Carvi fructus,* S5-*Crataegi folium cum flores*, S6-*Tiliae flores,* S7-*Millefolii flores* and references substances, S8-ferulic acid, S9-hyperoside, S10- apigenin-7- glycoside, S11-caffeic acid, S12-chlorogenic acid, S13-rutin, S14-rosmarinic acid, S15-quercetin.

Juglans regia, walnut, is a large, deciduous tree that grows to 25-35 m in high. *Juglandis folium et pericarpium* consists in the leaves of the tree and the green husk of the nuts of *Juglans regia.* The tree was brought from Persia by the Romans. Now, grows in the South-East Europe, East Asia, Himalaya and China. The chemical composition of the leaves and green husk includes phenolic compounds and juglone. The active principles have bactericidal, astringent, slightly hypotensive, hypoglycemic, soothing, healing, emollient, antidiarrheal properties (Istudor 1998; Pârvu, 1997; Cosmulescu and Trandafir, 2011). All parts of *Juglans regia* specie (as green walnuts or husk, shells, kernels, seeds, bark and leaves) are used in plant-derived products, for healthcare improvement (Stampar, et al., 2006).

In this study, the HPTLC fingerprint (S1) of *Jugladis folium et pericarpium* revealed the presents of flavonoid glycosides as orange spots, with hyperoside (rate of flow values Rf~0.67) and avicularin (Rf~0.89) as major compounds. Neochlorogenic acid, as blue spot (Rf~0.58) and kaempferol-3-arbinoside (Rf~0.92), as green spot were also present. (Figure 1, Figure 2). The obtained results were compared with literature data (Wagner and Bladt, 1996).

Ten phenolic compounds contained by leaves, determined by High-performance liquid chromatography with photodiode, were reported: 3- and 5-caffoylquinic acids, 3- and 4-p-coumaroylquinic acids, p-coumaric acid, quercetin 3-galactoside, quercetin 3-pentoside derivative, quercetin 3-arabinoside, quercetin 3-xyloside and quercetin 3-rhamnoside, (Pereira et al., 2007).

Morus nigra, mulberry tree, is a large, deciduous tree that grows to 12-15 m in height. *Mori folium* consists in the leaves of the tree. It is found in East, West and South East Asia, South Europe, South of North America and in some areas of Africa. In medicinal, economical, industrial and domestic fields, mulberries have enormous importance. *Mori folium* is commonly used for sudorific, antidiarrheal, adjuvant in the treatment of diabetes, myocardial dystrophy activities (Watson and Dallwitz, 2007; Pârvu, 1997).

This qualitative study determined that *Mori folium* chromatographic profile (S2) shows the presence of rutin as orange spot (Rf~0.41), chlorogenic acid as blue spot (Rf~0.51), hyperoside as orange spot (Rf~0.68), apigenin-7-glycoside as orange spot (Rf~0.75) (Figure 1, Figure 3).

Mori folium phenolic compounds identify by HPLC are p- hydroxybenzoic acid, vanillic acid, chlorogenic acid, syringic acid, p-coumaric acid, m-coumaric acid (Memon et al., 2010).

Althaea officinalis, marshmallow, is a perennial plant with erect, woody stems, 60-120cm high. The plant is indigenous to western Asia and Europe, and is naturalized in the USA. *Althaeae folium* are the leaves of marshmallow that contain as major chemical compounds, phenols. The leaves are used for emollient, antidiarrheal and soothing actions (Pârvu, 1997; WHO Monograph, 2003).

In our study, in marshmallow leaves (S3) were identified apigenin-7-glucoside (Rf~0.75), ferulic acid (Rf~0.94) and another two blue major spots that according to Wagner and Bladt, (1996) and based on the relationship spot color - Rf are caffeic acid derivates (Figure 1).

Carum carvi L. is one of the oldest spices cultivated in Europe. Caraway is growing on 20-30 cm stems. *Carvi fructus* are the fruits of the plants that have as active principles volatile oils and phenolic compounds. Carvi fructus acts as a carminative, against spasmodic gastro-intestinal complains, irritable stomach, indigestion, lack of appetite and dyspepsia and relieving flatulent colic (Pârvu 1997; Thippeswamy, et al., 2013).

In our results phenolic compounds revealed in *Carvi fructus* (S4) are chlorogenic acid (Rf~0.51), rosmarinic acid (Rf~0.89) as blue spots and hyperoside (Rf~0.67) as orange spots (Figure 1, Figure 4).

Determined by HPLC, caraway contained a mixture of phenolic acids including gallic acid, catechuic acid, caffeic acid, cinnamic acid, ferulic acid and flavonols such as quercetin and kaempferol (Thippeswamy and Rajeshwara 2014).

Crataegus monogyna Jacq., hawthorn, is a shrub or a small tree of 5-14 m height. It is found in Europe, North Africa and western Asia. *Crataegi folium cum flores* are the leaves and flowers of the hawthorn that have as active principles phenolic compounds. The plant is used for cardiac insufficiency (Pârvu, 1997).

On our hydroalcoholic extract (S5) only vitexin -2-O-rhamnoside (Rf~0.43) as yellow - green spot, hyperoside (Rf~0.68) as orange spot, caffeic acid (Rf~0.93) as blue spot were identified.

Methanolic extracts of hawthorn were reported to have as phenolic compounds rutin, vitexin - 2-O-rhamnoside, caffeoyl quinic acids, hyperoside, luteolin-5-O-glucoside, vitexin and cafeic acid, determined by TLC (Wagnera and Baldt, 1996). The different results between the extracts may be due to the different extraction solvent and also because of the extraction time (Figure 1).

Tilia cordata, linden, is a deciduous tree that grows to 20-40 m in height. Linden is found in Europe from England to Scandinavia, Russia, Spain, Italy, Greece, Romania, Bulgaria, Turkey and western Asia. *Tiliae flores* are the flowers of the tree, having as major active principles volatile oil and phenolic compounds. Flowers have diaphoretic, antipyretic, emollient, expectorant, sedative, anxiolytic, decongestant, anti-inflammatory and diuretic activities (Rodriguez-Fragoso et al., 2008; Pârvu 1997).

In Figure 1 (S6) - fingerprint of *Tilia cordata* flowers are present flavonoids as rutin (Rf ~0.41) and hyperoside (Rf~0.68) as well asflavonoid glycoside derived from quercetin, myricetin and kaempferol (Wagner and Bladt 1996) and ferulic acid (Rf~0.94) (Figure 5). The major flavonoids found in the flowers extract by HPTLC were: quercetin-3,7-di-O-rhamnoside, kaempferol-3,7-di-O-rhamnoside and kaempferol 3-O-(6”-p-coumaroyl glucoside) or tiliroside (Negri et al., 2013).

Achillea millefolium, yarrow, is a perennial herb, 30–90 cm in height, with aromatic odor and grayish- green colour. *Millefolii flores* consists in the dried flowering tops of *Achillea millefolium L*. The plant is Native to Asia, Europe and North America, now being widely distributed and cultivated in the temperate regions of the world. Major chemical constituents of the flowers are essential oil (0.2-1.0 %) and phenolic compounds.

It is used for internal administration for loss of appetite, dyspeptic ailments, common cold, such as mild spastic discomfort of the gastro-intestinal tract, as a choleretic and for the treatment of fevers and for external administration for skin inflammation and wounds (WHO Monograph, 2003; Pârvu, 1997).

In (S7) we have found the following compounds: rutin (Rf~0.41), hyperoside (Rf~0.68), as well as flavonoid glycoside (yellow - orange spots Rf~0.19-0.25) and chlorogenic acid (Rf~0.51) (Figure 1, 6).

Eight phenolic compounds were identified by HPLC in extracts from yarrow flowers: chlorogenic acid and flavonoids, namely vicenin-2, luteolin-3',7-di-O-glucoside, luteolin-7-O-glucoside, rutin, apigenin-7-O-glucoside, luteolin, and apigenin (Benetis et al., 2008).

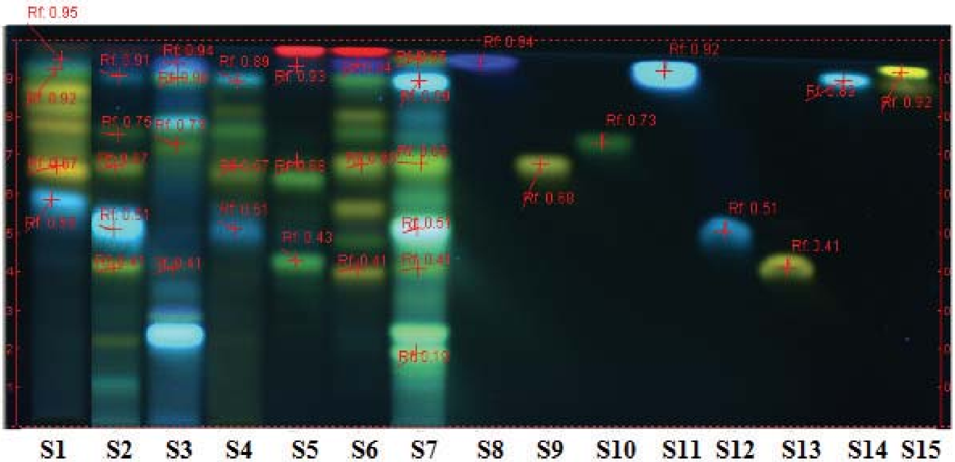

Figure 1. Chromatographic fingerprint of the species comparative with references substances

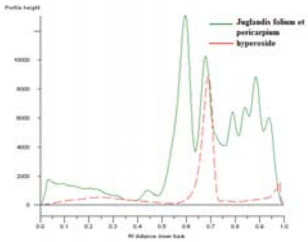

Figure 2. Profile comparison *Juglandis folium et pericarpium*/references substances

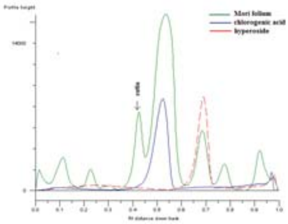

Figure 3. Profile comparison *Mori folium*/ references substances

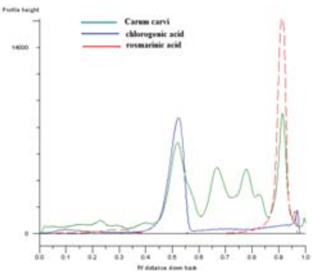

Figure 4. Profile comparison *Carum carvi*/ references substances

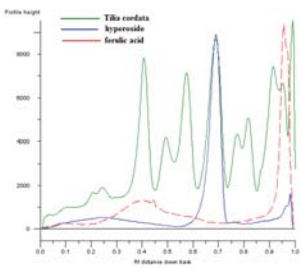

Figure 5. Profile comparison *Tilia cordata*/ references substances

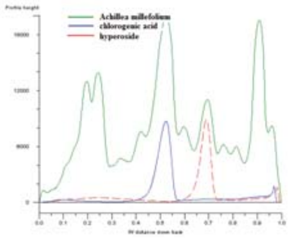

Figure 6. Profile comparison *Achillea millefolium*/ references substances

CONCLUSIONS

To ensure consumer health protection, the quality and safety of vegetal raw material, particularly those used for plant-derived products, must be determined.
With a market in continuous expansion, the competition between the producers is getting stronger every day. Therefore, in quality control management are needed safe, easy and not very expensive methods as HPTLC, especially as this method is accepted at international level.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESEARCHES REGARDING THE IMPLEMENTATION OF FOOD SAFETY MANAGEMENT SYSTEM ON THE FRUIT DRYING PRODUCTION PROCESS

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Abstract

HACCP was originally developed as a microbiological safety system in the early days of the US manned space programme in order to guarantee the safety of astronauts' food. Up until that time most food safety systems were based on end product testing and could not fully assure safe products as 100% testing was impossible. A pro-active, process-focused system was needed and the HACCP concept was born. HACCP is a system that identifies evaluates and controls hazards which are significant for food safety. It is a structured, systematic approach for the control of food safety throughout the commodity system, from the farm to the plate. It requires a good understanding of the relationship between cause and effect in order to be more pro-active and it is a key element in Total Quality Management (TQM). This paper aims to address this subject, basing the approach as closely as possible on the Codex Code of General Principles on Food Hygiene on the fruit drying production process, which emphasises the importance of GMP/GAP/GHP as sound foundations to incorporate the HACCP approach and develop a user friendly Food Safety Management System. The main identified hazards are moulds and mycotoxin, which can keep under control by adequate monitoring of CCPs – fruit drying and the end storage product.

Key words: *CCP, HACCP, food safety*.

INTRODUCTION

On the producer-user line (from manipulation to processing) there are a high number of factors that can affect fruits quality (Bonsi R., 2001).

Considering these products as primary product for the fruit dried products or as finite product in the case of their fresh consume, the major preoccupations are in relation with pesticides level and others chemical contaminants (fertilisers), as well as to preserve the hygiene during harvesting, manipulation, processing and storage.

To reduce these risks, it is necessary that the small producers, as well as the high-specialised companies, to apply prevented methods as HACCP type and not those based on the end control of products (that can affect the consumer healthy) and can induce significantly economic losses (Aversano, F 2006).

MATERIALS AND METHODS

The fruit dried product has been obtained in the Technological laboratory of the Faculty of Horticulture Bucharest, using an electrical oven and fresh fruits (apples from cultivars: Jonathan and Golden Delicious).

A HACCP study was performed based on the following working stages:

1. the presentation of the specifications about product;
2. the production technological flow description;
3. the potential risk identification and evaluation;
4. the critical control points (CCP) determination;
5. establish the critical limits ;
6. the monitoring of the CCP parameters;
7. corrective actions, implemented if the critical limits in CCP have been excelled;

The laborious study was finished by elaboration of the HACCP Plan, a base document, which represents a guide to follow, with a view to keep under control the relevant risks that could affect the safety of fruits dried products.

RESULTS AND DISCUSSIONS

Risk identified during the processing of fruit dried products is concerned especially to: pesticides residue provided from the fruits, as a consequence of the chemical treatments, nitrates provided by the excessive fertilization and micro-organisms (yeast, moulds) presented on the fruits or on the technological equipment, because of the inadequate hygiene (Table 1).

As a consequence of this study, there were identified two Critical Control Points:

- Primary matter reception, for the risks generated by the pesticides and nitrates;
- Fruits drying, for the risks generated by yeast and moulds;

Table 1. Hazard analysis

Processing step	**Fruit dried products**				**Preventive /Control measures**
Fruit reception	HAZARD				- Training of the workers - Supplier assessment - Analytical analysis
	KIND OF HAZARD	**G**	**P**	**RC**	
	B) Clostridium sp.	high	low	3	
	B) E. Coli	medium	low	2	
	B) Aspergillus flavus	medium	low	2	
	C) pesticides residue	high	low	3	
	C) heavy metal	medium	low	2	
	C) nitrit, mycotoxin	medium	low	2	
Fruit drying	B) Salmonella sp.	high	low	3	- Training of the workers - Analytical analysis - Process monitoring
	B) Clostridium	high	low	3	
	B) E. Coli	medium	low	2	
	B) Aspergillus flavus	medium	low	2	
	B) Bacillus sp	medium	low	2	
	B) Staphyloccocus	high	low	3	

Legenda:
B = biological C = chemical P = physical G = gravity
P = probability RC = risk class

Data presented in Table 2, emphasis that for these risks, there were established the critical limits and the specifically parameters (product content of pesticides, nitrite and mycotoxin, temperature or NTG) were controlled.

HACCP system, predicts also the critical limits surpass situation, therefore, there were predicted the corrective actions too, to determine the effect removing and the elimination of the causes which generated the manifested risk.

To assure the product traceability on all the production and selling process, it acts to register in specifically forms, which are useful as well to HACCP system revision.

To apply the HACCP Plan, as it was realized, determines to maintain under control the relevant risks, for the food safety of the fruit dried products and to grant an adequate product for the people consume.

Table 2. HACCP Plan

Nr crt	Pro-cess step	Relevant hazard	Control measures	Criti-cal con-trol point	Criti-cal limits	Monitoring			Correction/ Corective actions	Re-cords
						Responsa-bility	Frequency	Method		
1	Raw mate-rial recep-tion	Pesticide residues Myco-toxin Nitrate	Supplier assess-ment Labora-tory analysis	CCP 1	According Reg UE 1881/2006	Laborato-ry technician	2 weeks before purchasing	Cromato-graphic	Fruits rejection Supplier selection Personnel training	Test report
2	Fruit dry-ing	Yeast Bacteria Mould	Drying schedule	CCP 2	T= 60 –70 C degrees Product water content – max 12%	Drying operator	Continuous	Drying diagram	Product rejection Process resume Personnel training	Drying report

CONCLUSIONS

On the fruits dried products technology, there have been identified two Critical Control Points: at primary raw material reception and at the drying step.

The established monitoring system allows maintaining the relevant risks under control, for the hygienically quality of the analysed product.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INSIGHTS INTO MICROGREENS PHYSIOLOGY

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Abstract

In recent years people have a substantial interest for the consumption of fruits and vegetables characterized by a high content of bioactive substances. It is known that these are beneficial not only because they provides the necessary nutrients for human body, but, also have important effects on health. From this point of view, microgreens represent a new class of vegetables that can be considered as "functional foods". Although they have a short life cycle, one of the possibilities of manipulation of the bioactive compounds biosynthesis is to know that species physiology during germination, during the growth, as well as during postharvest. This review presents a general overview on some technological measures that may influence microgreens physiology, based on few recent research works carried out on these topics. There are reviewed data on: 1. beneficial effects of pre-sowing treatments; 2. the lights effects on microgreens physiology (in terms of quantity, but mostly quality of light) concerning the growth process, as well as accumulation of bioactive compounds; 3. measures to influence microgreens post-harvest physiology, to avoid the incidence of some microorganisms, to extend shelf life and to maintain their nutritional quality. Despite microgreens short life cycle, technological measures applied based on species physiology understanding are undoubtedly intended to result in increased the productivity, to obtain healthy products, with lower prices.

Key words: *microgreens, physiology, bioactive compounds.*

INTRODUCTION

In recent years people have a substantial interest for the consumption of fruits and vegetables characterized by a high content of bioactive substances. It is known that these are beneficial not only because they provides the necessary nutrients for human body, but, also have important effects on health (Beceanu, 2008; Galaverna et al., 2008; Mahima et al., 2013).

Microgreens are a new class of edible vegetables (Pinto et al., 2015), a very specific type which includes seedlings of edible vegetables, herbs or other plants, ranging in size from five to ten centimeters long (including stem and cotyledons) (Xiao et al., 2012).

Over the past few years, microgreens have gained popularity as a new culinary trend, being served as an edible garnish to embellish a wide variety of others dishes or a new salad ingredient (Frank and Richardson, 2009; Hedges and Lister, 2009; Chandra et al., 2012; Xiao et al., 2012; Kou et al., 2013; Pinto et al., 2015) thanks to their greater nutritional benefits (Chandra et al., 2012; Pinto et al., 2015).

Today, more attention is given to a healthy nutrition to prevent certain diseases (Márton et al., 2010). Microgreens are considered as "functional foods" which are food products that possess particular health promoting or disease preventing properties, that are additional to their normal nutritional values (Xiao et al., 2012). Nowadays, demand for these products is growing rapidly (Janovská et al., 2010; Samuoliené et al., 2012) and consumption is growing given their particular characteristics: unique color, rich flavor and appreciable content of bioactive substances (Brazaitytė et al., 2013; Kou et al., 2014; Sun et al., 2014; Brazaitytė et al., 2015a). These are also classified as a good source of minerals in the human diet (Pinto et al., 2015). However, it should be noted that due to the high price and high perishability, microgreens are not currently available to commercial terms in chain stores.

This crop has a quick production cycle (two to three weeks) and occupies very little space in greenhouse production (Kopsell et al., 2012;

Viršilė and Sirtautas, 2013). However, shorten the production cycle and thus reduce greenhouse production cost is one of the major goal of the current researches (Murphy and Pill, 2010). Another issue addressed was that the impact of the biotic stress agents on sprouts and microgreens, through the necessity of obtaining disease-free products (Pill et al., 2011; Xiao et al., 2014). The need to extend their shelf life is also a recent concern to researchers (Berba and Uchanski, 2012; Sasuga, 2014). Preharvest (Kou et al., 2014) or post-harvest (Lee et al., 2009) treatments can be effective means to achieve this objective (Kou et al., 2014).

The purpose of this review is to make a brief insight into microgreens physiology based on the recent research works carried out in this field. There are reviewed data on : 1. pre - sowing applied treatments as beneficial effects for seeds germination physiology; 2. lights effects on microgreens physiology (in terms of light quantity, but mostly light quality) referring to growth process, as well as accumulation of bioactive compounds; 3. measures to influence post-harvest physiology, to avoid the incidence of some microorganisms, to extend shelf life and to maintain microgreens quality.

MEASURES TO INCREASE GREENHOUSE PRODUCTION AND REDUCE COST PRICE

Growing microgreens is a relatively simple process, which does not require much time, energy and experience (Franks and Richardson, 2009). However, attention should be given to each step and besides there are necessary research to improve this type of culture, in terms of productivity, nutritional quality and last but not least the cost of production. Even if microgreens life cycle is very short, certain applied measures for improving seeds germination (as germination faculty, as well as germination velocity) are welcome, to determine a more rapid stabilization and to promote vigorous seedlings. To shorten the greenhouse production and thus the production cost, Murphy and Pill (2010) conducted a series of experiments on microgreen arugula (*Eruca vesicaria* subsp. *sativa*) grown in peat -lite (a soilless medium). Regarding pre-germination treatments results have revealed that seed incubation in exfoliated vermiculite (1.12 g seed in 157 g vermiculite) moistened with 2 g H_20 g $^{-1}$ dry weight vermiculite for 1 day at 20 ^{0} C resulted in a 21% increase in shoot fresh weight by 14 days after planting, as against untreated seed before sowing. Pre-germinated seed germination was 81.5% and at the time of sowing the radicle already had an average length of 2 mm. In terms of sowing density it has proven that high density caused an increase in shoot fresh weight m $^{-2}$ at 10 days after planting, compared to using a lower density. Regarding fertilization, the experiments showed that the most economical measures that have induced an increase in fresh weight m^{-2} were those based on daily use of 150 mg N L $^{-1}$ or daily solution fertilisation that contained 75 mg N L $^{-1}$ plus a pre-plant media incorporation of 1,000 mg N L $^{-1}$ from $Ca(NO_3)$;

Impact of seed treatment was experienced as well for others species: radish (*Raphanus sativus*), kale (*Brassica napus* var. *pabularia*), and amaranth (*Amaranthus tricolor*) (Lee and Pill, 2005). Pretreatment for 3 days in vermiculite (at 12 ^{0} C and -1.0 MPa), removing from the vermiculite and then dried the seeds to the initial weight (before sowing) although not greatly influenced germination faculty, had a positive impact on germination velocity at all studied species. The emergence of radish and kale was faster than untreated seeds although 13 days after planting there has not been an increase of shoot dry weight. In contrast, the amaranth shoot dry weight was increased. If seeds have been exposed to a two-step primed treatment: 3 days at 50% H_20 and then germination 1 day in vermiculite at 150 % H_20, the shoot dry weights increased by 20, 49, and 84% for radish, kale, and amaranth, respectively, as against to those from non-treated seeds.

Also, Lee et al. (2004) examined some possibilities to advance the establishment of table beet or chard (*Beta vulgaris* L.) for greenhouse microgreens production. Germination of seeds in fine grade vermiculite and sowing the germinated seeds with vermiculite mixture caused a more rapid seedlings emergence. If before this process seeds were primed and soaked with hydrogen peroxide, there has been no progress in terms of emergence advancement or growth. On the other hand, germinating the seeds in shallow (4 cm deep) vermiculite (150% initial water, 1 seed : 3 vermiculite dry weight ratio, 27 ^{0}C) for 2 days (table beet) or 3 days (chard) resulted in 0.33-fold and 2.79-fold greater shoot fresh weight, respectively, at 11 days after planting than was achieved by sowing untreated seeds.

LIGHT INFLUENCE ON MICROGREENS PHYSIOLOGY AND THEIR NUTRACEUTICAL QUALITY

One of the possibilities to manipulate the physiology of the plant, including bioactive compounds is controlling environmental conditions (Murchie et al., 2011; Jones, 2014).

Light is one of the main external factors absolutely necessary for the photosynthetic organisms, as it is a source of energy and information from the environment (Murchie and Niyogi, 2011; Fortunato et al., 2015). All oxygenic photosynthetic organisms need strategies for maintaining the balance between efficient light harvesting, photochemistry and photoprotection from excess light (Goss and Lepetit, 2015; Quaas et al., 2015). Light intensity and its quality not only influence the rate of photosynthesis in plants, but also the accumulation of different organic compounds (in terms of their quantity and quality), including production of secondary plant compounds (Murchie et al., 2011; Brazaitytė et al. 2015 a,b).

Vegetables are designated as healthy foods of the millennium or nutraceutical foods of the century (for reviews see Rahal et al., 2014). Microgreens contain higher concentrations of bioactive compounds such as vitamins, minerals, and antioxidants, than mature greens (Janovská et al., 2010; Xiao et al., 2012).

According to Kopsell and Kopsell (2006) one important class of phytochemicals is the carotenoids. Recent studies of Brazaitytė et al. (2015) from the view point of light intensity and its quality influence emphasized that *Brassicaceae* microgreens accumulated more total carotenoids in the case of 330–440 μmol m^{-2} s^{-1} wavelengths levels, as against to 220 μmol m^{-2} s^{-1} , considered as a normal one.

On the other hand, changes of carotenoids content can be achieved by changing of the light spectral composition, relative to the species. Thus, in mustard, supplementation with green light determines an increase in lutein / zeaxanthin and beta- carotene. In the case of other species (red pak choi and tatsoi), the standard blue, red, and far- red light are favourable.

As stated Brazaitytė et al. (2015b), additional application of UV-irradiation for basal lighting with light emitting diodes may lead to an improvement in antioxidant characteristics at microgreens depending on the species. A significant beneficial effect was induced in the case of wavelengths of 366 nm and 390 nm at a photon flux density of 12.4 μmol m^{-2} s^{-1}.

Short-term pre-harvest supplemental 638-red lighting on *Perilla frutescens* (L.) Britton (an annual herbaceous edible and medical plant of *Lamiaceae* Lindl. family naturally growing in the East Asia) on the one hand may reduce the quality of plants, due to the increase in major antioxidants content (e.g. anthocyanins and acid ascorbic) and on the other hand the decrease of nitrate (Brazaitytė et al., 2013). The authors did not show any effect of treatment on DPPH (1,1-diphenyl-2-picrylhydrazyl) free radical scavenging activity and flavonols index, while α-tocopherol content decreased.

Sirtautas and Samuoliené (2013) noticed that the red light-emitting diode (LED) and 24 h photoperiod effect for nitrate and antioxidant contents red baby leaf lettuce is variety – dependant and proper lighting strategies should be selected seeking to cultivate lettuce with optimal contents of phytochemical compounds. However, light spectra and photoperiod are suitable tools seeking to create mild photo stress for plants, with the aim to enhance the contents of antioxidant phytochemicals. In the case of borage (*Borago officinalis* L.) Viršilė and Sirtautas (2013) showed that 440 μmol $m^{-2}s^{-1}$ LED illumination is a recommendable light intensity for microgreens production with optimal growth and nutrient contents. Lower irradiance levels result in significant accumulation of nitrates, decreased fresh weight and elongated hypocotyls, when the highest investigated 545 μmol m^{-2} s^{-1} photosynthetic photon flux density level exceeds plant tolerance and is associated with the decreased growth parameters and slightly lower antioxidant phytochemical contents.

As regard as the impact of supplementary short-term red LEDs lighting on the antioxidant properties of microgreens, Samuoliené et al. (2012) established that natural antioxidant compounds varied in function of the studied species. Thus, the gradual decline of this activity was registered, from a maximum value determined at pea (then lower values for broccoli, borage, mustard, amaranth, basil, kale, beet, parsley, in the order presented here), to very low values for tatsoi. Differentiation was recorded in terms of content in phenols due to additional red light assuring, so variable content was noticed, with an increase (from 9.1% to 40.8% in the tatsoi mustard) or a decrease (with 14.8% at amaranth) .

An obvious variability was also noted in terms of ascorbic acid and anthocyanins content. For example, ascorbic acid in amarantus increased by 79.5%, while in basil it decreased by 53.9%. The amount of anthocyanins increased significantly in broccoli (45.1%), decreased markedly in borage (51.8%), while in basil it was not significantly influenced.

For *Brassicaceae*, Samuoliené et al. (2013) noticed that, the best conditions for growth and nutritional quality (higher leaves, higher content of anthocyanins, phenolics, antioxidant activity, lower nitrate content) were at 320-440 μmol cm $^{-2}$ s^{-1}. In the case of 545 μmol cm $^{-2}$s^{-1} there has not been a significant positive impact on these indicators.

Antioxidant activity was found both in common and tartary buckwheat microgreens. High levels of flavonoids, carotenoids, and α-tocopherol were detected as well. Higher amount of flavonoids was detected in tartary buckwheat microgreens. No significant differences were detected between common and tartary buckwheat microgreens in content of phenolic acids. Microgreens of both common and tartary buckwheat represent potential nutritional sources of alternative vegetable in the Czech Republic (Janovská et al., 2010). All the vegetables (microgreens, sprouts and leafy greens) of both varieties of buckwheat can be regarded as a potent source of phenolics (rutin, quercetin, vitexin, isovitexin, orientin isoorientin and chlorogenic acids) and has high antioxidant activities. Nepalese strain buckwheat vegetables contain high phenolics with higher biological (antioxidant and α-glucosidase inhibition) activity and can be used as an alternative food. Therefore, mass production of more and more buckwheat food products should be encouraged and included in the daily diet, which would help the people to prevent diabetes and many other diseases caused by the free radicals (Sharma et al., 2012).

That microgreens are suitable sources for bioactive substances was also demonstrated by Sun et al and (2013) from studies conducted on five species of *Brassica* vegetables. Considering the use of advanced techniques, such as ultrahigh-performance liquid chromatography photodiode array multistage high-resolution mass spectrometry it was possible to identify 164 polyphenols: anthocyanins (30), flavonol glycosides (105) and hydroxycinnamic and hydroxybenzoic acid derivatives (29). It was also revealed that the phenolic profile was more complex and also the types of substances present in microgreens were varied unlike mature plants.

The lack of scientific data about the nutritional content of microgreens prompted Xiao et al. (2012) to undertake extensive research on concentrations of ascorbic acid, carotenoids, phylloquinone, and tocopherols in 25 commercially available microgreens. Red cabbage, cilantro, garnet amaranth, and green daikon radish had the highest concentrations of ascorbic acids, carotenoids, phylloquinone, and tocopherols, respectively. In comparison with nutritional concentrations in mature leaves (USDA National Nutrient Database), the microgreen cotyledon leaves possessed higher nutritional densities.

Increased nutritional value of microgreens can be also achieved by light management as demonstrated results of Kopsell et al. (2012). The authors' conclusion was that simple applications of short duration high light resulted in biochemical shifts in xanthophyll cycle pigment concentrations in the microgreens, most notably increases in zeaxanthin (characterized by antioxidant and protective effects of vision) may have beneficial effects for the human diet. Thus, the xanthophyll cycle pigments (zeaxanthin + antheraxanthin + violaxanthin) (known in plants as having a major role in the dissipation of excess light absorbed energy) by mustard (*Brassica juncea* L ' Florida Broadleaf ') microgreens exposure to increased light intensity before tissue harvest resulted in increased concentration in zeaxanthin levels. Treatment with 463 µmol photons m^{-2} s^{-1} after the appearance of the first true leaves (light treatment had accumulated 36 h during the photoperiod) resulted in a significant decrease in chlorophyll (a and b) content, β - carotene, and neoxanthin, which indicated the incidence of stress. Lutein content remained unchanged, while the concentration of zeaxanthin and antheraxanthin increased.

Also, management of LED lighting technology through preharvest, short-duration blue light acted to increase important phytochemical compounds influencing the nutritional value of broccoli microgreens (Kopsell and Sams, 2013). At 13 days after sowing broccoli plantlets were treated for 5 days before being harvested using: 1) red and blue LED light (350 µmol m^{-2} s^{-1}); or 2) blue LED light (41 µmol m^{-2} s^{-1}). Determinations done on biological material highlighted that short-term treatment before harvest with blue light significantly increased shoot tissue β-carotene, violaxanthin, total xanthophyll cycle pigments, glucoraphanin, epiprogoitrin, aliphatic glucosinolates, essential micronutrients of copper, iron, boron, manganese, molybdenum, sodium, zinc, and the essential macronutrients of calcium, phosphorus, potassium, magnesium, and sulphur.

The nutritional value of microgreens was also demonstrated by Pinto et al. (2015), who carried out a comparative study as regard as microgreens and mature lettuces mineral profile. Studies have led to excellent results, not only in scientific terms but rather in terms of practical utility. Microgreens had higher content of Ca, Mg, Fe, Mn, Zn, Se and Mo than mature lettuces, although the former possessed higher N, P and K content. Therefore, microgreens may be considered a good source of minerals. In addition, very low content of NO_3 justifies their recommendation as being safety in the human diet, especially for children, in order to complete their requirements for minerals.

HEALTHY MICROGREENS WITH A LONGER SHELF LIFE

Microgreens senesce rapidly after harvest and have typically a very short shelf-life (1-2 days) at ambient temperature, due to the sudden disruption of plant growth at a very early stage (Guo and Gan, 2012; Xiao et al., 2014).

At broccoli microgreens (Sun et al., 2015), obtaining a high production and extend shelf life has been demonstrated to be possible by applying preharvest treatment with 10 mM calcium chloride. Metabolome analysis obtained by ultra-high-performance liquid chromatography with mass spectrometry led to the conclusion that glucosinolates were the main group of chemical compounds in the treatment variant and the amount of aliphatic and indolic glucosinolates was significantly higher compared with control.

Extending shelf life (by optimize postharvest handling conditions) is a permanent goal of all those who produce and sell horticultural products of any kind. There are concerns on this topic (Berba and Uchanschi, 2012: Chandra et al., 2012; Kou et al., 2013; Kou et al., 2014; Xiao et al., 2014). It should be noted that, recently Sasuga (2014) patented a method for providing a microgreens product with significantly longer shelf life than most other microgreens products, is claimed, where the product microgreens product has a shelf life of at least 10 days.

Researches carried out by Xiao et al. (2014) using radish seeds inoculated with *Escherichia coli* O157: H7 or O104: H4 and *E. coli* populations on harvested products (sprouts and microgreens) highlighted the followings: the proliferation of the bacteria was done in the case of both products, but on microgreens bacteria was significantly reduced. During sprouting, *E. coli* O157: H7 and O104: H4 has reached levels of 5.8-8.1 log cfu / g and 5.2-73 log cfu / g, respectively, depending on the inoculation level (1.5-4.6 log cfu / g and 0.8-43 log cfu / g on radish seeds, respectively), while for microgreens values ranged from 0.8 to 4.5 log cfu / g and from 0.6 to 4.0 log cfu / g, respectively. At table beet (*Beta vulgaris* L.) (‚of 'Early Wonder Tall Top') in order to biological control of the fungus *Pythium aphanidermatum* (Edson) Fitzp., Pill et al.

(2011) experienced the influence of the seeds treatment by using equal amounts of antagonistic fungus *Trichoderma harzianum* Rifai strain KRL-AG2 G41 and *T. virens* strain G-41 (*ThTv*) at 0 , 0.25 , 0.50 , 0.75 or 1.00 mg per seed ball. Four days before planting, the peat-lite was inoculated with *P. aphanidermatum* at 0, 0.5 and 1.0x the rate that resulted in 96% damping-off when non-*T. harzianum* -*T. virens*-treated dry seed balls were sown in peat-lite containing 1.0 *P. aphanidermatum*. Decreasing incidence of damping-off with increasing *T.hartzianum-T.virens* application to seed balls or growth media was associated with increasing shoot fresh weight m^{-2} at 14 days after planting, a response attributable to increased percentage plant survival and not to a *ThTv* growth-promoting effect.

Post-harvest tah tasai Chinese cabbage young leaf vegetable were washed in cold (5^o C) and warm (25^o C) chlorinated water (0, 50 or 100 mg L^{-1} free chlorine for 90 sec), then packaged in polypropylene film bag and stored for 8 days at 15^o C. Chlorinated water treatment at 5^o C had a more beneficial effect on visual quality, weight loss, SPAD (greenness) value change than 25^o C chlorinated water treatment. No significant difference was found in aerobic plate count on the surface of microgreens after 3-day storage period. Chlorinated water either at 5^0 C or 25^0 C with 50-100 mg L^{-1} free chlorine significantly reduced aerobic plate count during the initial period of storage (up to 2 days) (Lee et al., 2009).

As Hodges and Toivonen (2008) noticed, the two most important storage parameters for postharvest shelf life are storage temperature and atmospheric composition. For example, Kou et al. (2013) indicated that for buckwheat microgreens storage temperature significantly affected the changes in O_2 and CO_2 composition, tissue electrolyte leakage and microbial growth during storage. The authors suggested that buckwheat microgreens should be stored at 5^0 C with moderately high O_2 (14.0-16.5 kPa) and moderately low CO_2 (1.0-1.5 kPa) content to maintain optimal quality and maximal shelf life. Another useful measure to extend the microgreens shelf life is controlling respiration rates (Berba and Uchanschi, 2012). Post-harvest experiments on arugula (*Eruca sativa*), radish (*Raphanus sativus*), and red cabbage (*Brassica oleracea* var. *rubra*) designed to lower respiration rates, increase shelf life and will allow for transportation to larger markets.

In order to increase biomass and delays senescence of broccoli microgreens, Kou et al. (2014) studied the effect of pre-harvest daily sprays (for 10 days) with calcium chloride solution (1, 10 and 20 mM) as compared to the control (water). After harvesting fresh-cut microgreens packaged in sealed polyethylene film bags were stored on headspace atmospheric conditions. Visual quality and tissue membrane integrity were evaluated on days 0, 7, 14, and 21 during 5 degrees C storage. It was found that treatment with 10 mM calcium chloride resulted in the increase of biomass by more than 50% and the calcium content was triplet, as against the control. Also, this treatment led to an increase in superoxide dismutase and peroxidase enzyme activity, decreased electrolyte leakage in the plant tissue, improved visual quality and reduced microbial growth during storage. Following research in Tan Tasai, Chinese cabbage (*Brassica campestris* var. *marinosa*) Chandra et al. (2012) reported that citric acid and ascorbic acid mixed solution (0.25 % w/v) in addition with ethanol spray (50%) can be used to replace chlorine used for washing microgreens and polyethylene film can provide more benefits for packaging microgreens.

Storage temperature, packaging film, and wash treatment were investigated by Xiao et al (2014) at daikon radish (*Raphanus sativus* L. var. *longipinnatus*) microgreens. Accordingly, studies conducted in dynamics during storage highlighted that storage temperature significantly affected package atmosphere, product quality and shelf life. The optimal temperature for storage of radish microgreens with no chilling injury was proved to be 1^0C. Film oxygen transmission rate significantly affected O_2 and CO_2 composition, but this did not significantly affect quality attributes during 28 days of storage at 1 ^{0}C. Chlorine wash treatment (100 mg L^{-1}) significantly reduced initial microbial populations.

As Artées-Hernández (2013) recently noticed, attention should be focused on “eco-innovative emerging alternative” to prolong the shelf life without losing quality characteristics specific to the fresh product.

CONCLUSIONS

Microgreens represent a new class of vegetables that can be considered as "functional foods". The manipulation of bioactive compounds biosynthesis and preserve nutritional quality after harvesting may be based on recent research works carried out on these topics so far, but mainly those that come as a necessity. The facts reviewed here indicate that there are promising results in terms of: 1. beneficial effects of pre-sowing treatments; 2. the lights effects on microgreens physiology (in terms of quantity, but mostly quality of light) concerning the growth process, as well as accumulation of bioactive compounds; 3. measures to influence microgreens post-harvest physiology, to avoid the incidence of some microorganisms, to extend shelf life and to maintain their nutritional quality.

Despite microgreens short life cycle, technological measures applied based on species physiology understanding are undoubtedly intended to result in increased the productivity, to obtain healthy products, with lower prices.

Undoubtedly, further studies are needed in terms of content in phytonutrients. These data may provide a scientific basis for evaluating nutritional values of microgreens and contribute to food composition database. Moreover, such results may be used as a reference for health agencies' recommendations and consumers' choices of fresh vegetables (Xiao et al., 2012).

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

IDENTIFYING USEFUL ORNITHOFAUNA IN HORTICULTURAL ECOSYSTEMS DURING WINTER SEASON

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Abstract

Species of birds that are useful to horticultural ecosystems have been identified between December 2014 and February 2015 in several ecosystems: Agronomie-Herăstrău Campus of the University of Agronomic Sciences and Veterinary Medicine in Bucharest, the orchard of Moara Domnească Didactic Station and the Dendrologycal Park in Chitila town. Species that are highly useful for plant protection have been identified at feeding hearths specially arranged in the mentioned horticultural ecosystems. Among other species, insectivorous and sedentary species like tit (Paride) and even winter guests in the Romanian Plain such as fieldfare (Turdus pilaris) – the latter hygienizing orchards while feeding with fruits in trees or fallen fruits, were observed. The proper identification of useful ornithofauna in a certain horticultural ecosystem is the first step for protecting such an ecosystem and, at the same time, the starting point for devising proper action plans to fight pests in integrated and ecological production systems. For horticultural ecosystems with landscaping architecture, identifying the existing species of birds helps diversifying the recreation alternatives (e.g. bird watching).

***Key words**: bird watching, winter guests, feeders.*

INTRODUCTION

Beside the agro technical measures and the chemicals used for pest control in plants and animals, an important role in this action of combat plays the useful birds that annually destroy millions of pests. (Cătuneanu, 1952).

The Great Tit (*Parus major*) consumes in all seasons all kind of pest insects: eggs, larvae, caterpillars, plat fleas, beetles and small butterflies. Using the stomach analysis, different species of Curculionidae, small Cerambicidae, small Buprestidae, small Ipide have been have found (Cătuneanu, 1952).

After researches done at Romanian Agronomic Research Institute by the ornithologist Ion I. Cătuneanu, one Buzzard (*Buteo buteo*) eats in 50 days about 265 mice while a Little Owl (*Athene noctua*) consumes monthly about 300 mice. One Titmouse (*Poicile palustris*) eats daily a equal quantity of its weight (Radu, 1960).

A garden can attract small birds if there are fruit-trees, trees, and bushes to offer breeding, shelter, and feeding places (Munteanu et al, 2000).

Starting with these premises and pleading for the importance of bird species, we did field observation regarding the identification of useful avifauna during winter in order to lay down several protection measures during birds reproduction season.

MATERIALS AND METHODS

Observation and feeding points localisation during winter

The field observations for useful avifauna identification were done in different places. We have installed two kinds of bird feeders in every point (the models are later described). The bird feeders were refilled almost daily with sunflower seeds.

The observations were realised on the whole studied area, including the surroundings for less than 300 meters in five places:

1. Exotic fruit species orchard - UASVM of Bucharest, surface: 1,600 m^2 (Figure 1);
2. Apple orchard - UASVM of Bucharest, surface: 1,430 m^2 (Figure 2);

3. Cherry and apricot orchard - Didactic Station Moara Domnească, Găneasa, Ilfov, surface: 6,600 m^2 (Figure 3);

4. Botanical Garden and Dendrological Park - UASVM of Bucharest, surface: 39,400 m^2 (Figure 4);

5. Chitila Dendrological Park – Chitila, Ilfov County, surface: 35,000 m^2 (Figure 5).

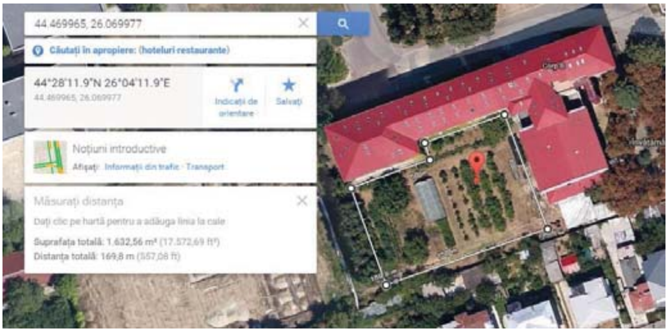

Figure 1. Exotic fruit species orchard - Agronomie-Herăstrău Campus, UASVM of Bucharest

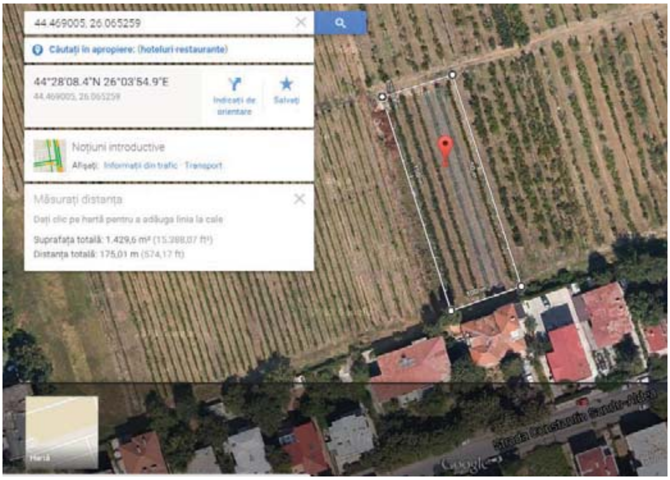

Figure 2. Apple orchard - Agronomie-Herăstrău Campus, UASVM of Bucharest

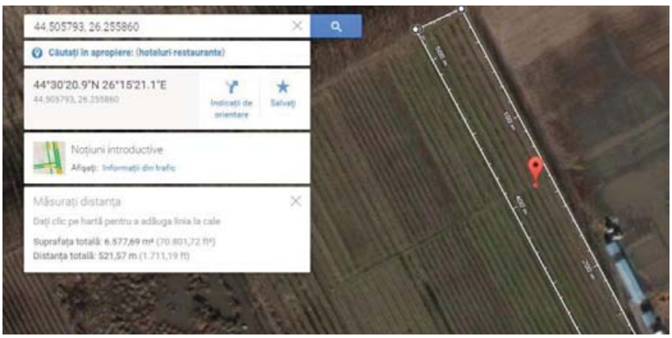

Figure 3. Cherry and apricot orchard - Didactical Station Moara Domnească, Găneasa, Ilfov

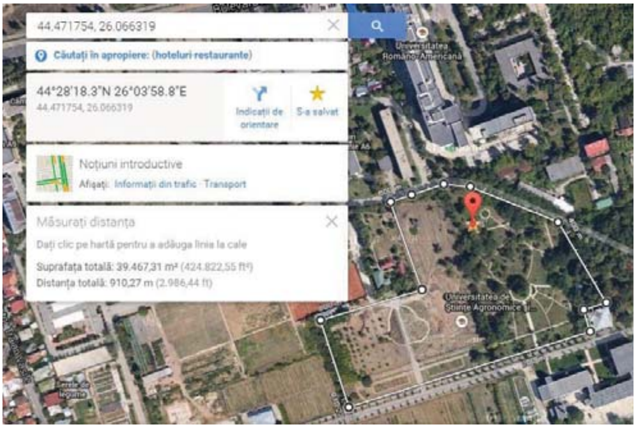

Figure 4. Botanical Garden and Dendrological Park - Agronomie-Herăstrău Campus, UASVM of Bucharest

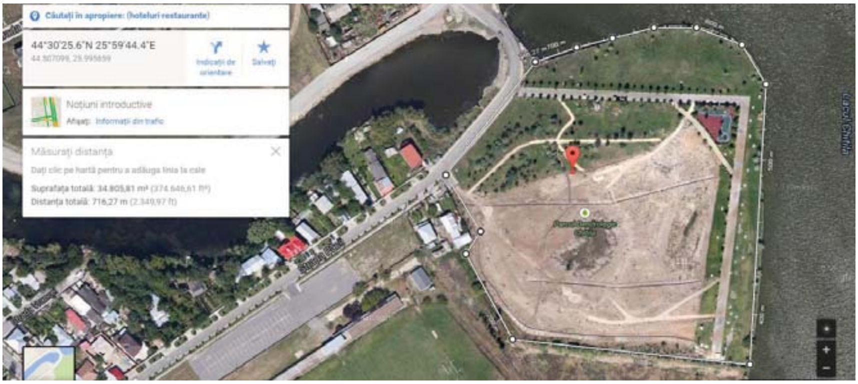

Figure 5. Chitila Dendrological Park – Chitila, Ilfov County

Observations methods

The following equipment and materials were used in order to attract, observe and identify the useful avifauna:

1. Olympus binocular 10X50 DPSI, 10 times zooms with 50 mm lenses diameter;
2. Canon Power Shot S5 IS, Photo Camera, with 8 Gb memory card was used for pictures and videos;
3. „Determinator ilustrat - Păsările din România ș i Europa”. Hamlyn Guide. Bertel Bruun, Hakan Delin, Lars Svensson, Ilustrations by Arthur Singer. Romanian version by Dan Munteanu;
4. „Birds of Europe”, second edition. Princeton Edition. Lars Svensson, Killian Mullarney, Dan Zetterstrom, Peter J. Grant;
5. Birds sounds recorded CD – Birds of Europe, J.C. Roche. Some bird species can be reported only if they were heard. These recordings are useful when the morphology of the bird is not clearly observed;
5. Bird feeders

Because of the meteorological conditions during winter, could be needed to help birds in finding food. The most vulnerable species are the insectivores and seed eaters. We layed out and built two bird feeders models that fit in the ecological requirements of these two bird cathegories.

5.1. First bird feeder model is designed for *Paride* species, that is called „Titmice bird feeder”. This bird feeder has small holes and small support sticks, these features limiting the number of species that can use it. It is recommended for mounting in the areas with large presence of House Sparrows (Figure 6).

The bird feeders were built using pine wood painted with ecological paint for protection.

To hang it we used 4 mm nylon string.

Refilling of the bird feeder with seeds is done by lifting the lid.

Figure 6. Titmice bird feeder

The birds use the small sticks placed under the holes to stand while take the seeds from the birdfeeder.

5.2 The second bird feeder model was called „Finch bird feeder” (Figure 7).

This model was intended to be for seed eater birds, but in the area with large numbers of House Sparrows, might not be the best model to use.

This bird feeder has the same concept as the first one, with small differences.

Figure 7. Finch bird feeder

The holes used to take the seeds are placed in the lower part. The dimensions are 0.8x110 mm. To support the birds the base wood board comes out 5 cm on two sides of the bird feeder.

6. Sunflower seeds.

We have used 350 kg of sun flower seeds in order to refill the bird feeders. This kind of seeds are favorite for insectivore, seed eaters and omnivore species. Sunflower seed is nutrient, rich in fats and vitamins and the price is accesible.

7. Observations report

In the field observation report, we have written the observed bird species, the number of birds of each species, weather conditions, the place, the day and the hour and other observations when necessary.

Work method for useful avifauna attracting, observing and identification

Field observations were made three times per month in horticole ecosystems and their surroundings (but no more than 300 meters) taken in study.

Each time, before observations the bird feeders were filled with seeds. Time for observations was minimum 30 minutes.

Observation hours: between 10-11 a.m. the birds are very active, looking for food.

The optical equipment was used for detailed observations when needed.

We reported also the species flying above the ecosystems.

RESULTS AND DISCUSSIONS

At the Exotic fruit species orchard within Agronomie - Herăstrău Campus, UASVM of Bucharest, nine bird species were observed. The higher number of birds (20) was recorded at Tree Sparrow (*Passer montanus*) (Table 1)

Table 1. Bird species observed in Exotic fruit species orchard - Agronomie-Herăstrău Campus, UASVM of Bucharest

No.	Name	Average specimens observed Dec. 2014-Feb. 2015	Presence during the 9 visits	Observations
1	*Parus major*	8	9	Detalied searching of tree branches
2	*Cyanistes caeruleus*	3	8	
3	*Turdus merula*	3	9	
4	*Fringilla coelebs*	9	5	
5	*Fringilla montifringilla*	4	3	Winter visitor
6	*Passer montanus*	20	9	The most common species, being in competition with Tit for food
7	*Passer domesticus*	15	9	
8	*Falco tinnunculus*	1	3	Territorial behavior
9	*Pica pica*	3	3	

Four most common species were observed: Great Tit (*Parus major*), Blackbird (*Turdus merula*), Tree Sparrow (*Passer montanus*) and House Sparrow (*Passer domesticus*). The rarest observed specie was the Kestrel (*Falco tinnunculus*) with three records.

Table 2. Bird species observed in the apple orchard - Agronomie-Herăstrău Campus, UASVM of Bucharest

No.	Name	Average specimens observed Dec. 2014-Feb. 2015	Presence during the 9 visits	Observations
1	*Parus major*	2	4	
2	*Cyanistes caeruleus*	1	3	
3	*Turdus merula*	2	2	
4	*Fringilla coelebs*	3	1	
5	*Accipiter nisus*	1	1	Was sitting watching in a Norway Spruce out of the orchard

At the Apple orchard within Agronomie - Herăstrău Campus, UASVM of Bucharest the total number of bird observed species was five (Table 2). The most common species expressed numericaly was Chaffinch (*Fringilla coelebs*). The most common species was the Great Tit (*Parus major*) with a frequency of 4 from 9 observations and the rarest species: the Sparrowhawk (*Accipiter nisus*) with a single view.

Table 3. Bird species observed in the Cherry and apricot orchard - Didactic Station Moara Domnească

Nr. crt.	Name	Average specimens observed Dec. 2014-Feb. 2015	Presence during the 9 visits	Observations
1	*Parus major*	7	9	
2	*Cyanistes caeruleus*	8	9	
3	*Dendrocopos syriacus*	2	3	
4	*Sitta europea*	2	5	
5	*Picus canus*	1	1	
6	*Buteo buteo*	1	4	
7	*Accipiter nisus*	1	1	
8	*Fringilla coelebs*	5	7	
9	*Turdus merula*	5	3	
10	*Turdus pilaris*	25	9	
11	*Pica pica*	3	2	
12	*Garrulus glandarius*	2	3	

Nr. crt.	Name	Average specimens observed Dec. 2014-Feb. 2015	Presence during the 9 visits	Observations
13	*Phasianus colchicus*	1	6	
14	*Passer domesticus*	7	9	
15	*Passer montanus*	14	9	
16	*Corvus frugilegus*	6	4	
17	*Corvus cornix*	2	3	
18	*Chloris chloris*	7	2	

In the Cherry and apricot orchard - Didactic Station Moara Domnească, Ilfov (Table 3), we observed 18 bird species. The most common (numerical) species was the Fieldfare (*Turdus pilaris*) with 25 birds. We found 5 most common species: 5 Great Tit (*Parus major*), Blue Tit (*Cyanistes caeruleus*), Fieldfare (*Turdus pilaris*), House Sparrow (*Passer domesticus*) and Tree Sparrow (*Passer montanus*). The rarest bird species were the Grey-headed Woodpecker (*Picus canus*) and the Sparrowhawk (*Accipiter nisus*) with a single view, each.

Table 4. Bird species observed in Dendrological Park and Botanical Garden - Agronomie-Herăstrău Campus, UASVM of Bucharest

No.	Name	Average specimens observed Dec. 2014-Feb. 2015	Presence during the 9 visits	Observations
1	*Parus major*	7	9	
2	*Cyanistes caeruleus*	2	9	
3	*Fringilla coelebs*	3	7	
4	*Fringilla montifringilla*	4	2	
5	*Turdus merula*	5	7	
6	*Troglodytes troglodytes*	1	5	
7	*Corvus frugilegus*	5	3	
8	*Accipiter nisus*	1	2	Captured a Blackbird
9	*Sturnus vulgaris*	2	1	In December the juvenils were feeding with *Celtis* fruits
10	*Turdus pilaris*	6	3	
11	*Phalacrocorax carbo*	80	1	Flying from Herăstrău Park
12	*Erithacus rubecula*	1	1	
13	*Coccothraustes coccothraustes*	3	2	
14	*Dendrocopos syriacus*	1	5	
15	*Picus viridis*	1	2	
16	*Pica pica*	3	2	
17	*Garrulus glandarius*	2	1	
18	*Passer montanus*	10	2	
19	*Chloris chloris*	5	2	
20	*Periparus ater*	2	1	

At the Dendrological Park and Botanical Garden located in Agronomie - Herăstrău Campus, UASVM of Bucharest the total number of observed bird species was 2. The most common (numerical) species were the Cormorant (*Phalacrocorax carbo*): 80 birds flying and terrestrial ecosystem was the Great Tit (*Parus major*) with 7 birds. The most common species were Great Tits (*Parus major*) and Blue Tit (*Cyanistes caeruleus*) while the rarest species was the Robin (*Erithacus rubecula*)

Table 5. Bird species observed in Dendrological Park, Chitila, Ilfov

No.	Name	Average specimens observed Dec. 2014-Feb. 2015	Presence during the 9 visits	Observations
1	*Parus major*	12	9	
2	*Cyanistes caeruleus*	4	9	
3	*Coccothraustes coccothraustes*	1	5	
4	*Fringilla coelebs*	5	5	
5	*Fringilla montifringilla*	4	4	
6	*Cygnus olor*	20	3	The largest number: 52 birds
7	*Pica pica*	2	4	
8	*Garrulus glandarius*	1	3	
9	*Dendrocopos major*	1	3	
10	*Larus michahellis*	30	3	
11	*Chroicocephalus ridibundus*	43	3	
12	*Casmerodius albus*	1	4	
13	*Ardea cinerea*	8	3	
14	*Emberiza schoeniclus*	5	2	
15	*Lymnocryptes minimus*	1	1	Passage species
16	*Ciconia ciconia**	1	1	Observation by Cristian Mihai
17	*Ciconia nigra**	1	1	Observation by Cristian Mihai
18	*Tadorna tadorna**	1	1	Observation by Cristian Mihai
19	*Carduelis carduelis*	10	1	
20	*Turdus pilaris*	30	2	
21	*Phalacrocorax pygmeus*	20	3	
22	*Phalacrocorax carbo*	15	3	
23	*Anas platyrhynchos*	33	3	
24	*Larus canus*	6	1	Winter visitor
25	*Falco columbarius*	1	1	Winter visitor

*Observations made by another ornithologist

In the Dendrological Park, Chitila city, Ilfov, the total number of observed bird species was 25. The most common (numerical) species: (43) Black-headed Gull (*Chroicocephalus ridibundus*) aquatic species and (30) Fieldfare (*Turdus pilaris*) terrestrial species. The most common species were (12) Great tit (*Parus major*) and Blue tit (*Cyanistes caeruleus*). The rarest observed species were the Merlin (*Falco columbarius*) and Jack Snipe (*Lymnocryptes minimus*).

CONCLUSIONS

1. In the ecosystems with a great plant species diversity and with shelter belts, the number of bird species and specimens is much greater than the number in those with monocultures and without shelter belts.
2. The Great Tit and the Blue Tit are the most frequent species in all horticole ecosystems – they are two very useful species for the protection of horticole plants against pests.
3. In larger orchards, the Fieldfare is the most common specie and also as number of individuals – it shouldn't be dismissed since doesn't harm the fruit-trees. The Fieldfare comes from the north that feeds during the winter with the fallen fruits or left in the trees. It shouldn't be mistaken for the Starling (*Sturnus vulgaris*) – especially that the Starling is gone in warer areas during the winter in our country.
4. In the horticole ecosystems with landscape architecture, the number of species is higher where there is lake, with a considerable surface. As it was seen in the Dendrological Park of Chitila city, although is a young ecosystem, it managed to change the balance regarding the number of observed species. That brings a plus to it's leasure value.

5. While talking with the managers and workers of these horticole ecosystems, we observed how little these people know about birds and the benefits they can bring. One common example is Fieldfare dismissed from the orchard being confused with the starlings.

6. After identification of species, we can improve the breeding, feeding and shelter conditions for the species that are important especially in the horticole plants protection or to vary the leasure in the public parks and gardens.

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Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EVALUATION THE ABILITY OF THE FUNGUS *ASPERGILLUS* TO REMOVE OIL FROM CONTAMINATED SOILS

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Abstract

The paper aims to present the capacity to consumption of petroleum products by the fungus Aspergillus. The Aspergillus sp. was isolated in an area that is often polluted with crude oil as a result of oil pipes breaking from Olt County. The best activity towards gasoline and diesel was presented by the Aspergillus sp. *strain noted I2. However, it is interesting that the Aspergillus strain noted I3 is more active against crude oil than other strains used. During the period of 40-day*s *of the experiment the isolated strains were able to degrade petroleum by-products in percentages ranging over a wide range between 32.46% and 78.42%. The degree of degradation depends on the composition of petroleum and their chemical structure.*

Key words*: oil pollution, bioremediation, Olt County, Aspergillus* sp.

INTRODUCTION

Population growth and therefore increasing energy and fuel needs in the recent decades has led to an increase in unwanted areas polluted with oil products both oceans and seas as well as of soil. The soil pollution problem is more complicated in oil extraction areas because, while oil residues pollution takes place and wastewater pollution, salt, capable of causing a strong salinization of soils polluted with oil. Under the conditions of such pollution is virtually unproductive soil and is removed completely from the economic circuit.

Most studies on the remediation of soils polluted by oil have used for bioremediation processes different microorganisms such as bacteria (*Bacillus, Dietzia, Ochrobactrum, Alcanivorax, Peudomonas, Sphingomonas sp., Stenotrophomonas, Gordonia, Micrococcus, Marinobacter, Microbulbifer, Sphingomonas, Cellulomonas,),* fungi (*Fusarium, Aspergillus, Penicillium, Amorphoteca, Paecilomyces, Talaromyces, Graphium, Neosartorya)* or yeasts *(Candida, Yarrowia sau Pichia)* (Jain et al. 2011; Margesin and Schinner, 1997; Mueller et al. 1996; Matei et al. 2004; Matei et al. 2007).

In most studies, selected microorganisms for bioremediation came from the oil polluted areas (Mariano et al. 2007; Santhini et al. 2009; Wang et al. 2011, Chibuike and Obiora, 2014).

In bioremediation it is necessary that petroleum products to be accepted as carbon source by microorganisms and to have at their disposal an electron acceptor which may be oxygen or nitrates. In addition, microorganisms require also nutrients for growth and the lack of specific inhibitors that can block the development of the maximum capacity of microbial selected (Collins 2007).

Thus in different experiments has been shown that by increasing soil nitrogen and phosphorus there has been an degradation of oil up to 45.5% over a period of about 50 days (Mariano et al., 2007).

In this context, the paper presents an analysis of the efficiency of *Aspergillus* sp microorganisms isolated from soils polluted with oil in 2012 in the Icoana village, Olt County, Romania.

MATERIALS AND METHODS

In order to characterize the efficiency of fungus *Aspergillus* on oil products, were used three *Aspergillus* sp. Isolates obtained in September 2012 from soils of Icoana village, which were polluted in May 2012 by damaging of an oil pipeline. About 0.005g of soil sample was scattered on the bottom of a sterile Petri dish and molten cooled agar medium (PDA) was added, which was then rotated gently to disperse the soil particles in the medium. The Petri dishes were then incubated at around 28^0C in dark for three days.

Fungal morphology were studied macroscopically by observing colony features and microscopically by staining with lacto phenol cotton blue and observe under compound microscope for the conidia, conidiophores and arrangement of spores in order to identify the fungi. The fungi were identified as *Aspergillus* sp. The *Aspergillus* strains were noted I1, I2 and I3.

Unpolluted soil samples were dried at 105^0 for 2 hours to kill the own microorganisms and portions of 5 kg were placed in special containers. Soil samples were polluted with gasoline, diesel and crude oil in proportion of 50 g oil product to 1 kg of soil. In order to have the necessary moisture of soil to develop microorganisms in each sample was added 1 L of nutrient solution (25 g $(NH_4)_3PO_4$, 25 g K_2HPO_4, 2g $MgSO_4$ and 100g NaCl in 1 L water). The soil samples so prepared were inoculated with selected microorganisms. Each soil sample was inoculated with about 10 mg mycelium, collected from the mycelium developed on the plates. Evaluation of the oil concentration was carried out by the gravimetric method. For this evaluation was used as the extraction solvent a mixture of hexane and petroleum ether in the ratio of 1: 1. Each soil sample was extracted three times to obtain reproducible results and has been calculated the average for values differed no more than 5% each. Evaluation of the consumption / destruction of fuel (diesel, gasoline and crude oil) of soils were carried out at intervals of 5-10 days.

RESULTS AND DISCUSSIONS

The results of the average values obtained are shown in Table 1. Oil content was very high at pipe breakage (of 61.16 times higher), but also has high values between 11.57 to 43.44 times higher than the maximum limit allowed (MAL is 500 ppm for land used for agriculture).

Table 1. The average oil content from soil samples

Place of soil sampling	Oil content, g/kg	Report towards the maximum limit allowed
0	122.32	61.16
200 m	83.46	41.73
400 m	68.53	34.27
600 m	86.87	43.44
800 m	34.45	17.23
1000 m	23.14	11.57

The results obtained regarding evaluation of the consumption of fuel by *Aspergillus* sp. are presented in Table 2.

The data table shows that the nature of the fuel led to a different consumption specific to each *Aspergillus* isolate for different oil products. Thus it appears clearly that AI2 strain is best fitted to oil products consumption.

Table 2. The evolution of oil products content in soil at different periods of time (g/kg)

Oil product	Microorganism	Day, oil content g/kg					
		5	10	15	20	30	40
Diesel	*Aspergillus* I1	49.25	46.85	39.40	33.40	29.78	28.15
	Aspergillus I2	47.13	42.07	34.08	27.87	22.49	19.80
	Aspergillus I3	48.01	44.11	38.31	34.71	27.77	21.24
Gasoline	*Aspergillus* I1	44.96	38.77	33.16	26.19	22.13	19.63
	Aspergillus I2	43.93	39.44	32.15	24.37	17.70	10.79
	Aspergillus I3	45.48	38.79	32.72	26.95	22.84	13.07
Crude oil	*Aspergillus* I1	48.63	45.64	45.97	38.24	36.01	33.77
	Aspergillus I2	46.33	40.41	34.30	33.33	31.50	25.75
	Aspergillus I3	48.16	42.21	36.71	37.59	31.24	25.06

To better visualize the microorganisms behaviour towards different fuel, these were plotted in Figures 1, 2 and 3.

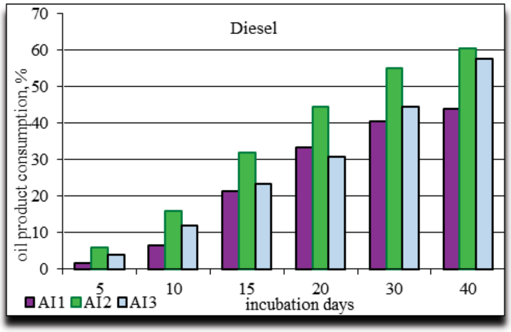

Figure 1 Degradation evolution of diesel by *Aspergillus* sp strains.

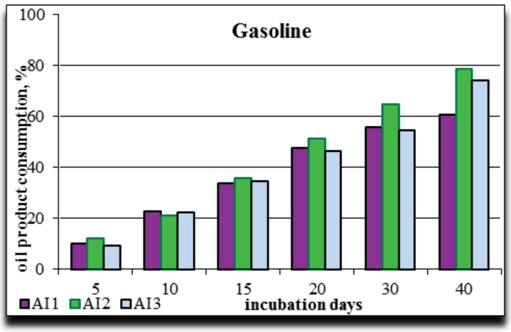

Figure 2. Degradation evolution of gasoline by *Aspergillus* sp. strains

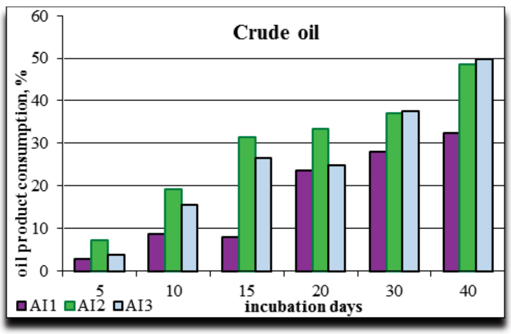

Figure 3. Degradation evolution of crude oil by Aspergillus sp. strains

All *Aspergillus* sp. isolate have the ability to faster reduce gasoline followed by diesel and then crude oil.

It is also clear the slow progress of petroleum products degradation. Thus, it is noted that none of the microorganisms used was not able to decompose at least one fuel completely even after 40 days of incubation at room temperature. However, different studies have shown that microorganism's consortium own polluted soil in a shorter time. For example a study shown that the microorganisms own of soil degrade petroleum by-products between 16-31% in unfertilized soils and between 27-53% in fertilized soils after 20 days at a temperature of about 10^0C. So, microorganism's consortium is more effective for decontamination process than a particular species isolated separately (Margesin and Schinner, 1997).

It should be noted however, that *Aspergillus* sp I2 strain manages to decompose gasoline and diesel up to 80% respectively 60% but after 40 days. Meanwhile, *Aspergillus* sp. I3 strain becomes more active after 30 days of incubation being the most active to decomposition of crude oil.

In addition some studies show that the most effective microorganisms in the degradation of hydrocarbons are bacteria such as *Flavobacterium* sp., *Brevibacterium* sp. or Micrococcus sp. (Santhini et al. 2009; Wang et al. 2011)

CONCLUSIONS

Pollution degree of areas where accidents occur by breaking petroleum products pipelines is over 10 times higher than the limit for less sensitive use areas and more than 200 times higher than those accepted for normal soils (500 ppm).

Among *Aspergillus* sp. isolate obtained from the polluted area and used in laboratory experiments, I2 has proven to be the most active for gasoline and diesel, while I3 is the best for crude oil.

As a general conclusion it can be said that the use of contaminated soil microorganisms their own in bioremediation processes and enriching them with nutrients to help these microorganisms in their work is an affordable way of regenerating polluted areas.

ACKNOWLEDGEMENTS

This work was was carried out with the support of European Social Found, Human Resources

Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/13276 and was financed from Project PN-II-PT-PCCA-2011-3.2-1351 - Contract No.68/2012.

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