Scientific Papers, Series B, Horticulture, Vol. LVI, 2012
ISSN Online 2286-1580, ISSN-L 2285-5653

INFLUENCE OF VARIETY AND TREATMENTS WITH GROWTHS PROMOTERS AND FOLIAR FERTILIZERS ON GROWING AND DEVELOPMENT OF LETTUCE IN PROTECTED CROPS

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Abstract

The work presents results obtained in protected culture of the lettuce for autumn – winter harvest under different treatments with growth promoter (V4 - P & R) and foliar fertilizers (V2 Folimax, V3 Agriphyte) grown in the south of Romania in plastic high tunnels. These two varieties used in the experience have been distinguished by both vegetation period (125 days and May King and 85 days at Great Lakes 118), as well as by specific reaction to the treatments application. Plant growth was influenced differently by the two foliar fertilizers, the biggest differences from the control was on V3 (Agriphyte) for the variety May King and on V2 (Folimax) for Great Lakes 118. Plant height has increased on average by 1-1.5 cm; diameter rosette of leaves has reached 32 cm , respectively 28 cm; average weight of the lettuce head has exceeded the control with 17% for variety May King and with 4% for Great Lakes 118. Concerning the production of lettuce (t/ha) the influence of experimental treatments was similar to that observed on plant growth. From the control, the greatest differences in production were obtained in variant treated with Agriphyte (17.5 %) for the variety May King and to the fertilizer with Folimax, in the case of the variety Great Lakes 118 (4 %). The smallest production differences for both varieties was registered at V4 (P&R).The results show that for the variety May King the yield was 24 t/ha (V1 control) to 28 t/ha (V3 Agriphyte . Variety Great Lakes 118, gives yield average by 26 t/ha (V1control) to 27 t/ha (V2 Folimax).

Key words**:** *Great Lakes 118, high tunnels, Lactuca sativa L., May King.*

INTRODUCTION

The lettuce is cultivated regularly at early in spring and in autumn late like successive cultures. This system of culture assure the needs of vegetables in these periods of the year, creates the possibility to use more intensive the constructions and assure more benefits to producers. Short vegetation period and reduced height of plants recommended lettuce like a very good associated culture [2].

The advantages of this system of culture are the following: possibility of obtaining of very early and early productions, possibility of obtaining good harvest long time during the year, good quality of the products, obtaining of big production/ha, avoiding of aparition of weather accidents. Lettuce is cultivated for its heads, which are consumed mostly fresh like salads.

In recent times because of orientation of the population to a nutrition regime more close to nature, lettuce has begun one of the most consumed vegetable [2, 3]. It has nutritional importance because of the high content of vitamins, mineral salts and nutritive substances as following: 100 g of lettuce contains 43 mg Ca, 32 mg P, 0.3 mg Fe, 350 mg K, 15 mg vitamin E, 4.2 mg vitamin A, 0.07 mg vitamin B_1, 0.08 mg vitamin B_2, 0.5 mg vitamin PP. It contains also in this quantity of leaves 0.1 % sugar, 1.4 % proteins, 0.5 % cellulose. Lettuce is a good vegetable for remineralization, cleanser, sedative, emollient. Its energetic value is of 16 calories. Lettuce juice has very good properties because of the high content in magnesium and iron. This species was cultivated long time ago. Egiptians, greeks and romans cultivate lettuce on large surfaces and apreciated this culture like a very valuable vegetable. In present, lettuce is spread on all continents, on large areas, especially in the countries from Western Europe, in USA and

Japan. In the US, for example, this culture occupies over 100,000 ha and the consumption/inhabitant reached 10 kg/year. In our country, lettuce is grown both in pure culture and in the system of associated and successive culture, in all counties and especially around big cities and industrial centers, occupying 14,000-15,000 ha annually.
Different authors recommended for prolongation of preservation of lettuce a big number of products. Relatively recent was discovered many regulators of growth and fruiting with a large application in vegetables crops. They are natural or synthetic hormonal substances which influence the processes of growth and development of plants [4]. The authors shows that is possible to apply these products in combination with foliar fertilizers.
These foliar fertilizers are used on large scale in vegetable protected crops because of some advantages like: reduced concentration of mineral elements and quickly correction of nutrition deficiencies [5].

MATERIAL AND METHOD

The main objective of research was to determine the optimal variant of stimulation and foliar fertilization of the lettuce in protected crops for obtaining early and hi quality production.
The experience was held in 2011 in village Poiana, Ialomiţa county, in high tunnels on a surface of 400 m^2. The installation of trial was done in subdivided parcels, in three repetitions. The experimental variants consist of three products used: two foliar fertilizers and one natural stimulator, which are compared with a untreated control (Table 1).
The technology used in the experiences was selected from the literature for lettuce [2].
Under climatic conditions of the year 2011, the culture has been established by planting of seedling on 18 of the October. The seedling was by 49 days old, 5-6 leaves.
Biological material has been represented by two varieties: May King and Great Lakes 118, recommended for protected and open field crops. (Table 2, Photo 1). The density used was 160,000 plants/ha.

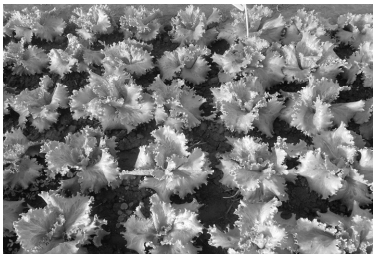
Photo 1. View with variety Great Lakes 118

Table 1 Experimental variants – 2011

Biological material	Treatments	Specification
May King Great Lakes 118	V1 Control (untreated)	-
	V2 Folimax-0.3%	Foliar fertilizer with microelements; ensure steady growth, disease resistance, increase the number of fruits and production
	V3 Agriphyte-0.3%	Foliar fertilizer with 33% phosphorus and 28% potassium; secondary has systemic fungicide properties
	V4 P&R-0.5%	Organic product with role of protection and recovery of the plants from damage caused by extreme temperatures or diseases; help to a better use of the nutrients in different types of soils; increase the assimilation of some nutrients (Fe, Zn, Mn, B, Cu); may be used together with protective agents for plants (herbicides, insecticides, fungicides).

Table 2. Description of the lettuce varieties from the trial

Biological material	Characterization
May King	Early variety, for protected and open field crops, for autumn and spring, with compact medium head, blade present corrugating; resistent to flowering.
Great Lakes 118	Mid – early variety, for protected and open field crops; with head by round to oval shape, with curled leaves, crisp and of iceberg type.

At two weeks from planting it was applied treatments with growth promoter (P&R) and foliar fertilizers (Folimax and Agriphyte) in accordance with experimental variants.
Harvesting was done from the first half of the December, by variants. During the experimentation period has been carried out observations, measurements and determinations, which were used specific working methods namely: Phenological determinations: sowing date, date of emerging, date of planting and date of harvest and was

counted the number of days necessary for each phenophase and also the vegetation period.
Morphometric determinations: average number of leaves, diameter of rosette and the height of plant on 10 plants/ variant; Production potential was determined by registering of the mass of each head harvested by variants.
The results were interpreted statistically by analysis of variance and it has been determined the correlations between parameters of productivity and productions [1].
The paper presents partial results regarding the influence of the treatments with growth promoters and foliar fertilizers on growth, development and production of lettuce for protected crops.

RESULTS AND DISCUSSIONS

In weather conditions of the year 2011 from Poiana, the emergence occured on 3rd of September (at 4 days from sowing) for May King and for Great Lakes 118 on 5th of September (6 days from sowing).
Planting was done on 18th of September, at 49 days for both varieties.
For May King, all treated variants was harvest before the control. First variant was V3 (Agriphyte), at 102 days, compare with control, at 107 days from sowing. The vegetation period was between 98-103 days. First variant for Great Lakes 118 was also Agriphyte at 97 days. Vegetation period was between 91-97 days depends by variants (Table 3, Fig. 1, 2).
The results shows the favourable effect of the stimulators and foliar fertilizers to earliness.

Table 3. The influence of stimulation and foliar fertilization on the phenophasis of the protected cultures of autumn lettuce varieties May King and Great Lakes 118 - 2011

Variety	Treatment	Sowing date	Phenophases*						Vegetation period **
			Emergence		Planting		Harvest		
			Date	Days no.	Date	Days no.	Date	Days no.	Days no.
May King	V1 Control	30.08.2011	3.09.2011	4	18.10.2011	49	15.12.2011	107	103
	V2 Folimax						12.12.2011	104	100
	V3 Agriphite						10.12.2011	102	98
	V4 P&R						14.12.2011	106	102
Great Lakes 118	V1 Control		5.09.2011	6		49	11.12.2011	103	97
	V2 Folimax						07.12.2011	99	92
	V3 Agriphite						05.12.2011	97	91
	V4 P&R						10.12.2011	102	96

* Days number from sowing
** Days number from emergence to harvest

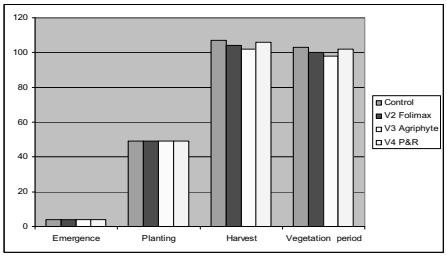

Fig.1. The influence of stimulation and foliar fertilization on the phenophasis of the protected cultures of lettuce May King – 2011

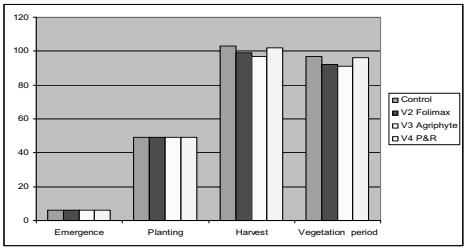

Fig.2. The influence of stimulation and foliar fertilization on the phenophasis of the protected cultures of lettuce Great Lakes 118– 2011

In the experimental conditions of 2011, the average number of leaves at May King was of 10 (control) to 11.2 (Agriphyte). The diameter of rosette varied between 27 cm (control) to 32 cm (Agriphyte). The average height of plants varied between 12.5 (control) to 13.5 (Agriphyte). At Great Lakes 118, the average number of leaves was of 7.3 (control) to 7.8 (Folimax). The diameter of rosette varied between 25 cm (control) to 28 cm (Folimax).
The average height of plants varied between 12.5 (control) to 14 (Folimax).
At both varieties the treatments was favourable for the growth of plants and the values of all morphometric characteristics was superior to the control ones (Table 4).

Table 4. The influence of treatments with stimulators and foliar fertilizers on morphometric characteristics

Variety	Treatment	Average no. of leaves	Diameter of rosette (cm)	Average height of plant (cm)
Great Lakes 118	V1 Control	7.3	25	12.5
	V2 Folimax	7.8	28	14
	V3 Agriphyte	7.7	27	13.5
	V4 P&R	7.4	26	13
May King	V1 Control	10	27	12.5
	V2 Folimax	11	30	13
	V3 Agriphyte	11.2	32	13.5
	V4 P&R	10.5	29	13

Concerning the average mass of the head at variety May King, the values varied between 150 g (control) and 176 g (Agriphyte). At Great Lakes 118, the average mass of the head varied between 162 g (control) and 168 g (Folimax) (Table 5, Photo 2).

Table 5. The influence of treatments with stimulators and foliar fertilizers on the average mass of the head and on production of lettuce -2011

Variety	Treatment	Average mass of head - kg/pl -	Production t/ha
May King	V1 Control	0.150	24.0
	V2 Folimax	0.170	27.2
	V3 Agriphyte	0.176	28.2
	V4 P&R	0.168	26.9
Great Lakes 118	V1 Control	0.162	25.9
	V2 Folimax	0.168	26.9
	V3 Agriphyte	0.166	26.6
	V4 P&R	0.163	26.1

In terms of total production achieved at the variety May King, this varied between 24 t/ha (control) and 28.2 t/ha (Agriphyte). For Great Lakes 118, on the first place was the variant treated with foliar fertilizer Folimax (26.9 t/ha), compare to the control (25.9 t/ha). Compare to variety Great Lakes 118, May King has an average production with 1% bigger, but the difference of productions was insignificant (Table 6). It can be observed that treatments applied favored average weight of the head and production.

Photo 2. View with variety May King

Table 6. The influence of the variety on the production at lettuce – Poiana – 2011

Variety	Average production (t/ha)	%	Differences t/ha	Significance
a1 -Great Lakes 118	26.4	100	-	-
a2 - May King	26.6	101	0.2	-
		DL 5%	0.745643	
		DL 1%	1.730586	
		DL 0.1%	5.479612	

Concerning the influence of the treatment on the production it can observe that all treated variants surpass the control with significantly distinct difference at variant V4 - P&R (1.6 t/ha) and very significant differences at Folimax (2.1 t/ha), respectively Agriphyte (2.5 t/ha) (Table 7).

Table 7. The influence of the treatment on the production at lettuce – Poiana – 2011

Treatment	Average production (t/ha)	%	Differences t/ha	Significance
b1Control	25.0	100	-	-
b2 Folimax	27.0	108	2.1	***
b3 Agriphyte	27.4	110	2.5	***
b4 P&R	26.5	106	1.6	**
		DL 5%	0.969835	
		DL 1%	1.361327	
		DL 0.1%	1.921874	

In the case in which the factor "a" is constant, it can observe that the treatment has a different influence depending on variety. In the case of the variety Great Lakes 118, the treated variants surpass the control with 0.2 t/ha (P&R), 0.7 t/ha (Agriphyte) and 1.0 t/ha (Folimax), but these differences are insignificant.

The variety May King obtained positive differences between 2.9 – 4.2 t/ha, which are very significant. It notes with the highest yield (28.2 t/ha) variant treated with Agriphyte (Table 8).

If we consider both factors (variety and treatment), the most constant production was obtained at Agriphyte variant, which is superior to other treatment variants in both varieties. This variant realizes significant and significantly distinctive differences at almost all combinations (Table 9).

Table 8 The influence of the treatments on the production of the lettuce at same variety - Poiana - 2011

Treatment	Average production (t/ha)	%	Differences -t/ha-	Significance
a1b1 (Control)	25.9	100	-	-
a1b2	26.9	104	1.0	-
a1b3	26.6	103	0.7	-
a1b4	26.1	101	0.2	-
a2b1 (Control)	24.0	100	-	-
a2b2	27.1	113	3.1	***
a2b3	28.2	118	4.2	***
a2b4	26.9	112	2.9	***
		DL 5%	1.37155	
		DL 1%	1.92521	
		DL 0.1%	2.71794	

Table 9 The influence of variety and treatment on the production at lettuce - Poiana – 2011

Treatment	Average production (t/ha)	%	Differences t/ha	Significance	Treatment	Average production (t/ha)	%	Differences t/ha	Significance
a1b1 (Control)	25.9	100	-	-	a1b3 (Control)	26.6	100	-	-
a2b1	24	93	-1.9	0	a2b1	24	90	-2.6	00
a2b2	27.1	105	1.2	-	a2b2	27.1	102	0.5	-
a2b3	28.2	109	2.3	**	a2b3	28.2	106	1.6	*
a2b4	26.9	104	1	-	a2b4	26.9	101	0.3	
a1b2 (Control)	26.9	100	-	-	a1b4 (Control)	26.1	100	-	-
a2b1	24	89	-2.9	00	a2b1	24	92	-2.1	00
a2b2	27.1	101	0.2	-	a2b2	27.1	104	1	
a2b3	28.2	105	1.3	-	a2b3	28.2	108	2.1	**
a2b4	26.9	100	0	-	a2b4	26.9	103	0.8	-
		DL 5%	1.3264				DL 5%	1.3264	
		DL 1%	2.0644				DL 1%	2.0644	
		DL 0.1%	3.8139				DL 0.1%	3.8139	

Between the number of leaves and production it was remarked the existence of a significant correlation for both varieties. The value of the correlation coefficient was for May King r=0.9722, respectively for Great Lakes r=0.9568 (Fig. 3, 4).

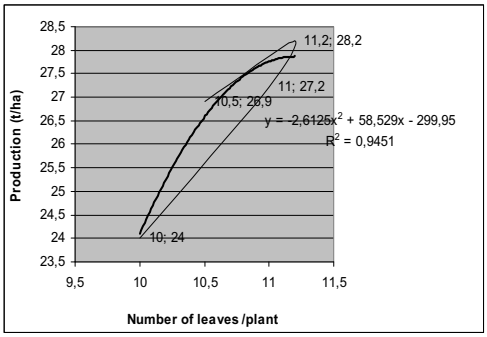

Fig.3 Correlation between the number of leaves and production at variety May King

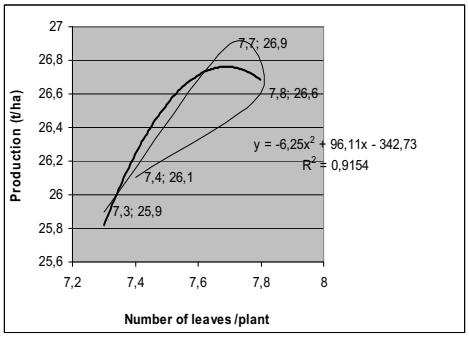

Fig.4 Correlation between the number of leaves and production at Great Lakes 118

Concerning the relation between the diameter of the rosette and production, the correlation obtained was significantly distinct for both varieties, respectively for May King r=0.9928 and for Great Lakes 118 r=0.990. (fig. 5, 6).

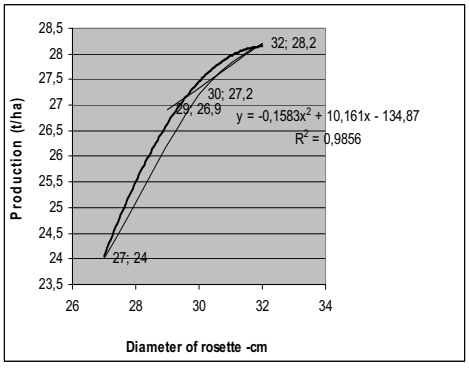

Fig.5 Correlation between the diameter of rosette and production at variety May King

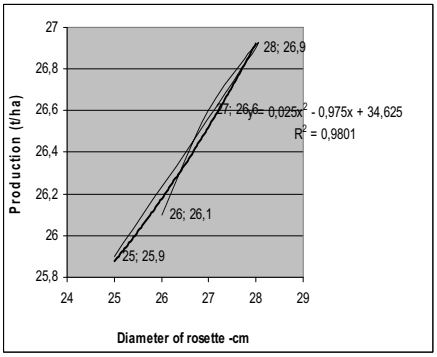

Fig.6 Correlation between the diameter of rosette and production at Great Lakes 118

CONCLUSIONS

The earliest variant for both varieties was V3 – Agriphyte. The vegetation period for the variety May King (Agriphyte) was by 98 days, with 5 days earlier than the control. For the variety Great Lakes 118 the vegetation period for Agriphyte treatment was by 91 days, with 6 days earlier than the control.

The biggest number of leaves was obtained at variants treated with Agriphyte, for variety May King (11.2 leaves) and for variety Great Lakes 118 (7.8 leaves).

The diameter of rosette at May King was between 27 cm (control) and 32 cm (Agriphyte). For Great Lakes 118 the diameter of rosette was between 25 cm (control) and 28 cm (Folimax).

The average weight of head at May King varied between 150 - 176g and the best variant was Agriphyte which surpass the control with 17%. For the varieties Great Lakes 118 the average weight of head varied between 162-168 g, with best results in the case of treatment with Folimax, which surpass the control with 4%.

It can be noted that the treatments has positive efects both for the average weight of head and for the production.

The best result was obtained for Agriphyte treatment (28.2 t/ha).

It was observed a significant correlation between the number of leaves and production, respectively a significantly distinct correlation between the diameter of rosette and production for both varieties.

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