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REASEARCH CONCERNING THE APPEARANCE OF ALTERNATION OF FRUCTIFICATION IN SUPERINTENSIVE APPLE ORCHARDS

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Abstract

The researches were carried out in the experimental field of the Faculty of Horticulture Bucharest in a super intensive orchard of apple, established in 2010 for study the alternation of fructification at new varieties of apple. Three romanian varieties 'Redix', 'Generos' and 'Iris' were studied during 4 years starting with 2016. The trees were grafted on the M9 rootstock and planted at 4 x 1 m, with a density of 2500 trees/ha. The research included three varieties represented by the variety and each repetition included three trees. Determinations were made regarding the morphological characteristics of the trees, percentage of fecundations flowers, the number of fruits on the tree, and productivity. The three apple varieties have high fructification potential, 'Redix' 22 kg/tree, 'Generos' 20 kg/tree and 'Iris' 18 kg/tree. In 2017 the production on the tree decreased with 75% in the 'Redix' variety, with 64% in the 'Generos' variety and with 58% in the Iris variety. In the years with high production, the average weight of the fruits was 180 g at variety 'Redix', 168 g at 'Generos' variety and 160 g at Iris variety and in the years with low production, the weight of the fruits increased, being 230 g at 'Redix' variety, 186 g at 'Generos' variety and 185 g at Iris. Fruit production fluctuates from year to year in the same agrotechnical conditions, and the size of the fruits was influenced by the number of fruits per tree. The alternation of fructification was very intense in the varieties cultivated in superintensive system and affects the level of production.

Key words*: apple, rootstock, alternation of fructification.*

INTRODUCTION

In Romania until the establishment of the first intensive orchards, the classical system was the only tree growing system (Cepoiu N., 1996).
On the Dâmbovița Valley, until 1950, the trees were grafted onto the generative rootstocks, planted at densities of 150-250 trees / ha and were conducted with the high trunk and globular crown (Petre, 1983). In these orchards, fruit production was carried out at relatively late economic parameters, starting with 8-10 years after planting. Some main works, such as the cutting and harvesting of fruits, required a very high consumption of work force due to the high size of the trees (6-8 m) and the use of large scales (Cepoiu, 1988, 1989, 2001). The mechanized execution of the phytosanitary treatments, and the works of the soil was hampered by the dimensions and the globular form of the crown. In view of all these shortcomings recorded in the classical plantations, it was gradually replaced by intensive and superintensive orchards. The scientific results obtained in other advanced fruit-growing countries such as Italy, France, Germany, Belgium, Holland, etc., have played a special role in the introduction of new tree cultivation systems in our country. The intensification of the culture in our country was achieved by the introduction of new tree culture systems, adapted to the social-economic conditions and the technical-material base that is constantly developing. All these concerns were aimed at the application in the orchards of modern technologies focused on fertilization , mechanization, cutting and different forms of crown, planting distances and rootstocks and not least on the extension of species and varieties of high productivity and with fruits of one choice quality (Cepoiu, 1987, 1992). According to the way the land is used worldwide, 103.4 million hectares are used for growing fruit trees and shrubs, which represent 0.79% of the agricultural land in the world (Gonda, 2003). From this surface occupied with fruit plants, in the temperate zone of the globe, about 7 million hectares are cultivated with apple (Ghena, 2003). In Europe, the largest apple producing countries are France,

Italy, Germany, Spain, countries that have a high degree of intensification and high productivity of plantations. In the orchards of these countries modern culture systems with high densities, with a valuable assortment of varieties predominate, where the fertilization, mechanization and irrigation ensure apple productions of over 40-50 tons per hectar (Balan, 2001). Most varieties are grafted on rootstocks of reduced vigor (M9, M27) and fruit even from the first years after planting (Cepoiu et al., 2005). The trees used for the establishment of these orchards differentiate fruit buds in the nursery, and at high densities (10-12 thousand trees per hectare), they produce economically, even from the first year of planting 15-16 tons per hectare Amzăr et al., 2000). The realization of these orchards is done with great financial efforts, but the investments recover very quickly. In these orchards are produced of high quality fruit that can be selled at a high price. At present, the assortment at the apple is in a continuous change, determined by the demands of the consumers, productivity and quality, as well as by the resistance of the varieties to diseases and pests. A great emphasis is placed on obtaining biological crops, without traces of pollution produced by the chemicals used to treat crops (Petre, 1989). It should also be noted that the large number of very good quality apple varieties, created in recent years, tend to gradually replace the assortment of old varieties (Păun, 2017). From these varieties of perspective we mention ′Elstar′, ′Red Elstar′, ′Fiesta′, ′Elshof′, ′Gala′, ′Royal Gala′, ′Imperial Gala′, ′Gala Must′, ′Sweet Carolina′ etc. (Petre, 2005). Also varieties genetically resistant to diseases, ′Prima′, ′Priam′, ′Priscila′, ′Florina′, ′Wanda′ etc. They make their place in the assortment due to the demand for the least polluted fruits (Branişte et al., 1999). The main aim of this study was to test these varieties in orchard and obtain the unpolluted fruits at a small price.

MATERIALS AND METHODS

The researches were carried out in the experimental field of the Faculty of Horticulture Bucharest in a superintensive orchard of apple, established in 2010. Three romanian varieties 'Redix', 'Generos' and 'Iris' were studied during 4 years starting with 2016. The trees were grafted on the M9 rootstock and planted at 4 x 1m, with a density of 2500 trees/ha. The research included three varieties represented by the variety and each repetition included three trees. Determinations were made regarding the morphological characteristics of the trees, percentage of fertilized flowers, the number of fruits on the tree, the average weight of the fruits and the chemical characteristics of the fruits.

The biological material studied was represented by 3 varieties of apple obtained in Romania, respectively, 'Redix', 'Generos' and 'Iris'. During the research period, observations were made regarding the triggering of the phenophases of the generative and vegetative organs, noting the moment of the triggering and the moment of the end of these phenophases. The circumference of the trunk was measured at a height of 20 cm from the ground, using the roulette. The number of fruit branches and semi-schaffold branches was determined by careful evaluation and registration in the synthetic tables. The number of related fruits was determined by counting the flowers in the bud stage and after forming the fruits when they were 10 mm in diameter. Fruit production was determined by harvesting the fruits from the 3 repetitions when the fruits reached maturity. The determination of the evolution of the fruit mass in dynamics was carried out in the field and laboratory by weighing the fruits and measuring the height and diameter of the fruit.

RESULTS AND DISCUSSIONS

For a correct interpretation of the research results, repeated measurements were made during the study period. The vigor of the 3 varieties conducted in the form called vertical axis was expressed by the trunk circumference measured 20 cm from the ground surface (Table 1).

Table 1. The determinant vigour features

Variety	H. tree (m)	Trunck circumferince (cm)		Difference (cm)
		2016	2019	
Redix	**2.0**	**21.3**	**25.6**	**4.3**
Generos	**1.9**	**19.3**	**25.3**	**6**
Iris	**2.0**	**20.6**	**25.3**	**4.6**

Immediately after the petals were shaken, observations were made regarding the fruit binding process. Because the flowers are grouped into inflorescences, research was carried out to see if the number of flowers in the inflorescence directly influences the binding process (Table 2).

Table 2. The capacity to fecundate of flowers from inlorescences

Variety	Percent of flowers fecundated per inflorescence				
	`16	`17	`18	`19	Ave rage
Redix	70.3	69.7	76.4	69.2	**71.5**
Generos	97.1	57.3	74.2	63.4	**73**
Iris	57.5	64.5	78.2	62.6	**65.7**

The observations regarding the percentage of fecundated flower from inflorescences revealed interesting data from one variety to another. Thus, the percentage of fecundated flowers was determined according to their number in inflorescence, registering different results each time. The results obtained from the research showed that the percentage of fecundated flowers in some varieties is higher as the number of flowers in inflorescence increases. The 3 varieties studied had very high percentages of flower fecundated, which explains the high production of these varieties.
'Iris' variety has lower percentages of flower fecundated compared to the other varieties studied, but nevertheless the production of this variety is high, the explanation being of a different nature (genetic origin of variety, being obtained by irradiation of seeds). Between the variety 'Iris' and the variety 'Redix' there is a difference in the percentage of flowering inflorescence.
The 3 varieties studied behaved very well in the process of pollination and fecundation and during the period studied there were no losses of fruits due to the non-flowering. And for these morphological and physiological aspects, (good flowering, good pollination and good fecundation of the flowers) we recommend the varieties studied for culture in our country. During the research period, observation were made on the fruits. In the year 2017 and 2019, the number of fruits obtained was lower than in previous years, as a result of the appearance of the alternating fructification, which affected the level of production (Table 3, Figures 1 and 2).

Table 3. The productive capacity

Variety	Repeti tion	Vertical axis			
		Number of fruits/tree			
		2016	2017	2818	2019
Redix		**117.6**	**29.4**	**115**	**28.7**
Generos		**110**	**39.6**	**129.6**	**46.7**
Iris		**112**	**53.1**	**145**	**60.9**

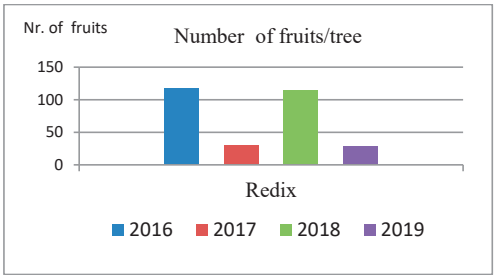

Figure 1. The fructification capacity

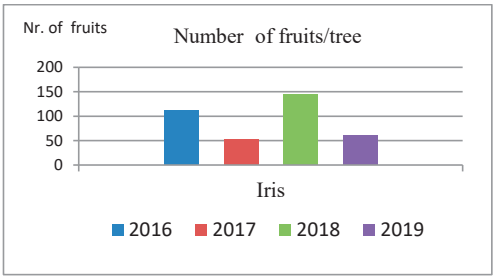

Figure 2. The fructification capacity

The fruit production obtained in 2016 was about 22 kg / tree for the 'Redix' variety, 20 kg for the 'Generos' variety and 18 kg for the 'Iris' variety (Table 4).

Table 4. The fructification capacity

Variety	Repe-tition	Vertical axis			
		Yield (kg/tree)			
		2016	2017	2018	2019
Redix		**22.0**	**6.7**	**26.4**	**6.59**
Generos		**20.0**	**4.8**	**27.8**	**8.68**
Iris		**18.0**	**9.81**	**27.5**	**11.2**

In 2016 the studied varieties were a high fructification potential, 'Redix' 22 kg/tree, 'Generous' 20 kg/tree and 'Iris' 18 kg/tree. In 2017 the production on the tree decreased with 75% in the 'Redix' variety, with 64% in the 'Generos' variety and with 58% in the 'Iris' variety.

At the end of 2019, the obtained production was small, compared to the previous year. The decrease in production can be explained by the manifestation of the alternating fructification, which is frequently encountered in this species (Cepoiu, 1996). The results regarding the production capacity of the studied varieties showed that the average multiannual production was between 37.9 t/ha ('Redix') and 41.5 t/ha in the 'Iris' variety (Table 5, Figure 3).

Table 5. The fluctuation of the yield and the annual average yield

Variety	Annual yield (t/ha)				The annual average yield (t/ha)
	16	17	18	19	2016-2019
Redix	52.7	16.7	66	16.8	37.9
Generos	49.2	12	69.5	21.7	38.1
Iris	44.7	24.5	68.7	28	41.5

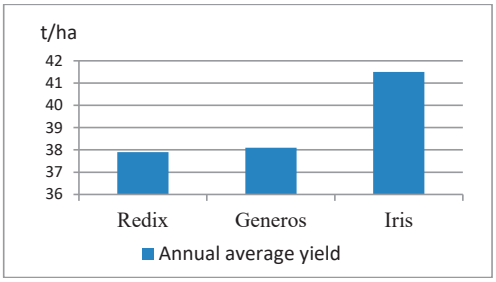

Figure 3. The annual average yield

It is noteworthy that these productions are obtained early, immediately after the establishment of the orchard. The level of production is different from year to year. The alternation of the fructification comprises a different number of trees from one year to the next. Even under the conditions of applying correct fruiting cuttings, the alternation of fruit appears and influences the production per hectare. Fruit production fluctuated from year to year as a result of the alternation of fructification (the inconstant level of production at the same tree from year to year), table 5.

In the case of the 'Redix' variety, fruit yield decreased in 2017 by 68.3% compared to 2016 yield. In 2018, the yield increased by 295.2% compared to 2017 production. In 2019, the yield decreased by 74.5 % compared to the yield of the year 2018. The causes of this fluctuations are the genetic factors and the technological measures and were observed and by other researchers.

Table 6. Average weight of the fruits (g)

Variety	Year with big yield	Year with small yield	Difference (g)
Redix	180	230	50
Generos	168	186	18
Iris	160	185	25

In the years with high production, the average weight of the fruits was 180 g at variety 'Redix', 168 g at 'Generos' variety and 160 g at 'Iris' variety and in the years with low production, the weight of the fruits increased, being 230 g at 'Redix' variety, 186 g at 'Generos' variety and 185 g at 'Iris' (Table 6). Fruit production fluctuates from year to year in the same agrotechnical conditions, and the size of the fruits is influenced by the number of fruits per tree.

The fruit production was not constant and so the alternation of fructification was manifested in the studied varieties (alternation of fructification) (Figure 4).

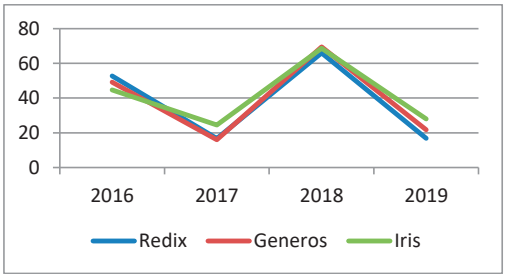

Figure 4. The fluctuation of the yield

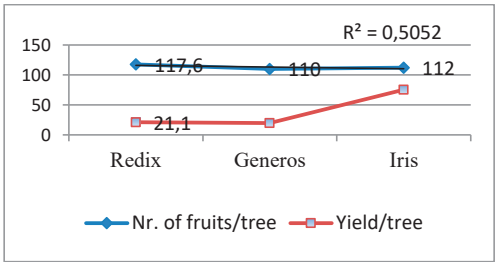

Figure 5. The correlation between nr. of fruits per tree and yield per tree in high production conditions (2016)

In the years with high production there was no strong correlation between the number of fruits per tree and the level of the production per

hectar (a great number of fruits per tree no means a great production, important is the number of the trees non affected by alternation of fructification - per hectar) (Figure 5).
In the years with smaller productions, the correlation between the production level of the tree and the number of fruits per tree is strong (small number of fruits per tree, big weight of the fruits and good production), the correlation coefficient being 0.993(Figure 6.

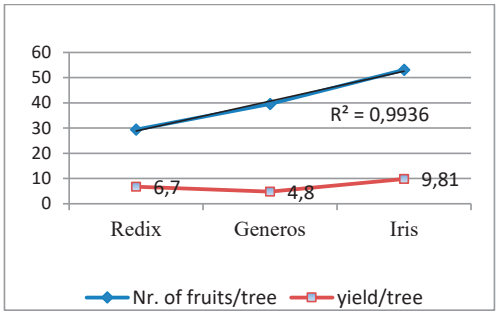

Figure 6. The correlation between nr. of fruits per tree and yield per tree in low production conditions (2017)

CONCLUSIONS

In superintensive orchards the higher the yields obtained, the greater the alternation of fructification.
The average annual yields are different depending on the variety. In the case of the studied varieties the average annual production was between 37.9 t/ha and41.4t/ha. This level of production is not a high level, if we take into account the investments that are made for the establishment and operation of the plantation and the life span of the trees.
The alternation of fructification has affected all the studied varieties.
Fruit production fell from 74.5% year-on-year in the case of the 'Redix' variety.
After a year with low production, the production increased in 2018 to the Redix variety by 295%.
The alternation of fructification was very intense in the varieties cultivated in superintensive system and affects the level of production.

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