THE BEHAVIOR OF SOME APPLE VARIETIES CULTIVATED IN SUPERINTENSIVE SYSTEM, IN FĂLTICENI FRUIT GROWING BASIN

STUDIUL COMPORTĂRII UNOR SOIURI DE MĂR, ÎN SISTEM SUPERINTENSIV ÎN BAZINUL POMICOL FĂLTICENI

FLOREA ŞT.[1], ZLATI Cristina[1]*, BUŢERCHI Ioana[1], Istrate M.[1]

*Corresponding author e-mail: cristina.zlati@iuls.ro

Abstract.
The purpose of this work is to follow the production of new apple varieties, grafted on a rootstock of low vigor (M9) cultivated in an area devoted to this species, the Fălticeni orchard basin. The work starts from the characterization of the natural environment in which the orchard is located, taking into account measurements regarding the growth vigor of the trees, the resistance to the limiting factors of production, the phenophases of the fruiting organs. However, the most important thing at the end of a fruit growing year is the economic yield given by the plantation, therefore it is important to determine the annual production obtained for each variety. For the observed year, production was satisfactory for all varieties, varying between 42.74 t/ha for the 'Golden D. Reinders' variety and 58.67 t/ha for the 'Szampion' variety. Although the quantity of fruits is important, their quality is equally important, therefore the physico-chemical properties are not a factor to be ignored and that is why periodic analyzes are carried out. Thus, the variety with the highest malic acid content is the 'Szampion' variety with 0.43 g/l ac. malic, at the same time this variety recorded the highest content of soluble dry matter 12.60°Bx.
Key words: apple varieties; productivity; quality; limitative factors.

Rezumat.
Scopul prezentei lucrări este de a urmari producția unor soiuri noi de măr, altoite pe un portaltoi de vigoare mică (M9) cultivate într-un areal consacrat acestei specii, bazinul pomicol Fălticeni. Lucrarea pornește de la caracterizarea cadrului natural în care se află exploatația pomicolă, avand in vedere măsurători privind vigoarea de creștere a pomilor, rezistența la factorii limitativi ai producției, fenofazele organelor de fructificare. Totuși, cel mai important lucru la finalul unui an pomicol îl reprezintă randamentul economic dat de plantație, de aceea este importantă determinarea producției anuale obținute la fiecare soi. Pentru anul urmărit producția a fost una satisfăcătoare pentru toate soiurile, variind între 42,74 t/ha la soiul 'Golden D. Reinders' și 58,67 t/ha la soiul 'Szampion'. Deși cantitatea de fructe este una importantă, la fel de

[1] "Ion Ionescu de la Brad" Iasi University of Life Sciences, Romania

importantă este și calitatea acestora, de aceea însușirile fizico-chimice nu sunt un factor de ignorat și de aceea se realizează analize periodice. Astfel, soiul cu cel mai ridicat conținut în acid malic este soiul 'Szampion' cu 0,43 g/l ac. malic, în acelasi timp acest soi a înregistrat și cel mai mare conținut de substanță uscată solubilă 12,60°Bx.

Cuvinte cheie: soiuri de măr, productivitate, calitate, factori limitativi.

INTRODUCTION

Apple culture is the most well-known and widespread in areas with a temperate climate and apples occupy the 1st place both in terms of production volume, qualitative-food value and their demand on the markets. Culture system has an important influence on the productivity of the apple, on their quality and on the efficiency of the whole system [Ogata *et al*., 1986]. The assortment, together with the climatic, edaphic and biotic factors, represents a determining element in the apple culture, its decisive contribution being reflected both in the quantity and in the quality of the production [Cârdei *et al*., 2007]. For these reasons, the apple assortment was in a permanent dynamic, the cultivated varieties being better and better in terms of productivity and fruit quality [Platon *et al.*, 2014].

The present study involved a series of observations and determinations regarding aspects related to the particularities of growth and fruiting, focusing on: the phenology of the growth and fruiting organs, the vigor of tree growth and the type of fruiting, productive potential and fruit quality. The aim of this study was to improve the assortment of apples for the Fălticeni area, by introducing new varieties from abroad. The general objective was to study the agricultural productivity of four new apple varieties, grown in a super-intensive system, in the pedoclimatic conditions of the Fălticeni orchard basin. In order to achieve this goal we studied tree growth vigor, the phenophases of the fruiting organs stages, fruit production obtained, calculation of the productivity index, the resistance to the limiting factors of production and the analysis of the physico-chemical properties of the fruits of some apple varieties.

The natural setting in which the research took place

Among the factors that play a large role in creating the apple culture biotope, the most important are: the geographical position of the area, the relief, the soil, the climate and the water resources [Branişte *et al*., 1989].

Fălticeni orchard basin is located in the hilly area with the limits of the left bank and the middle course of the Moldova river and on the opposite side, the western limit of the Suceava plateau, which stretches over three terraces between the Șomuzul Mare stream and the Buciumeni stream, the average altitude being 320 m.

Due to its geographical position, the climate in this orchard basin has a continental character with harsh winters and hot and dry summers, generally relatively mild temperate climate. Average temperature is 7-8°C, average annual precipitation is 621 mm, the humidity relative air temperature varied between 74-81%, with a maximum in winter and a minimum in summer, but without affecting the physiological processes in the apple. The dominant winds are those from the N-

W, followed by those from the East and North-East. Considering the major influence of climatic conditions on the growth and fruiting of apple varieties, an analysis of the main climatic factors (temperature, precipitation, relative humidity) and climatic accidents (haze and late spring frosts) that occurred in Fălticeni area is necessary, where the adaptability and behavior study of the recently introduced varieties was completed. The climatic conditions regarding the temperature and relative humidity of the air, from the year 2023 are presented in Figure 1. Predominant soils are argillaceous brown cambic chernozems and podzolite browns.

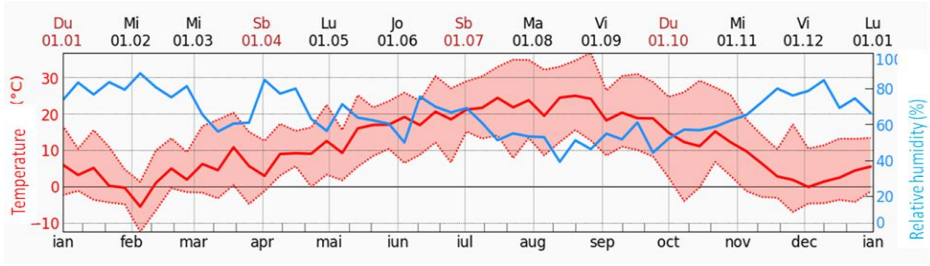

Fig 1. Temperature and relative humidity for Fălticeni, in 2023
(Surce: www.meteoblue.ro)

MATERIAL AND METHODS

The study on the behavior of some apple varieties was carried out in a super-intensive apple plantation, established in 2008, located in the village of Spătărești, Fântâna Mare commune, in the immediate vicinity of Fălticeni Municipality.

The experiment was organized in 2023, within the Florea Orchard, on a cambic chernozem type soil, with a 2.7% humus content, hydrolytic acidity 1.45, nitrogen index 2.32, pH = 5.9- 7.2 the topography of the terrain, the slope is 8%. The plantation was established at a distance of 4 x 1 m, with a density of 2500 trees/ha and the shape of the crown is spindle type.

The biological material used includes 4 varieties of apple (variants): Szampion Arno, Gloster, Golden D. Reinders and Rubinstar. Each variant includes 20 trees, with four repetitions of 5 trees, and the placement of the variants was linear.

The trellis with 4 wires spaced 50 cm apart was used as a means of support.

The soil maintenance system was the weeding of the intervals between the rows and the field worked on the row of trees. The irrigation system used was drip irrigation.

Phytosanitary treatments were carried out to combat the main apple diseases and pests: apple scab (*Venturia inaequalis*), powdery mildew (*Podosphera leucotricha*), apple worm (*Cydia pomonella*), San José scale (*Quadraspidiotus perniciosus*), mining moths (*L. blancardella, L. scitella*), defoliating insects (*Limantria dispar*, *Hedia nubiferana*), acarus (*Panonychus ulmi*, *Tetranychus urticae*). The intensity of the attack used the method described by Bodi and Cârdei [1998] and Istrate *et al.* [2006].

During the experimentation period, observations and determinations were made regarding: the growth vigor of the trees; the phenophases of the fruiting organs stages, the fruit production obtained; productivity index; the fertility coefficient through free pollination and self-fertility; productivity index; resistance to frost and diseases; the physico-chemical properties of the fruits.

RESULTS AND DISCUSSIONS

The main elements for assessing the vigor of the trees were the increase in the area of the trunk section, the length of the annual growths and the height of the trees.

Until the trees begin to bear fruit, the growth of the trunk is greater, being different from one variety to another depending on the biological particularities, the rootstock and the degree of affinity between the variety/rootstock.

After the entry of the trees into the fruit, the increase in the growth of the surface of the trunk section registers low values, as a consequence of the influence of the environmental factors and the fruit production obtained. Knowing the biological particularities of apple varieties, allows the adoption of technologies differentiated by culture depending on: the ecological zone, the vigor and the type of fruiting of the trees; crown shape and planting distance.

Trees growth vigor (expressed by the area of the trunk coross section) in the 15th year from planting for the apple varieties taken in the study recorded values between 49.36 cm^2 ('Golden D. Reinders') and 73.57 cm^2 ('Gloster') (table 1). Celelalte soiuri au avut valori de 53.40 cm^2 ('Szampion') and 72.61 cm^2 ('Rubinstar') (Table 1).

Table 1

Shoot and height growth, TCSA and trunk diameter, in studied apple tres

Variety	Shoot growth (cm)	Trees high growth (m)	Trunk Cross-Sectional Area (TCSA) (cm^2)
'Gloster'	27.43	3.28	73.57
'Szampion'	23.85	2.85	53.40
'Golden D. Reinders'	22.27	2.54	49.36
'Rubinstar'	29.22	3.42	72.61
Average	25.69	3.03	62.24

The length of the annual growth on the tree is a criterion that must be taken into account regarding the vigor of the trees, constituting an index of characterization of apple varieties, being dependent on the combination of variety-rootstock, environmental conditions, crown shape, agricultural techniques used, the level of the harvest obtained which directly influences vegetative growth [Istrate and Rominger, 1992].

It is the indicator that suggests how the trees vegetated in the previous year. Depending on this, the method of intervention in the tree crown is established in the spring, namely how maintenance and fruiting pruning will be applied.

The average and total length of the annual growth is influenced by the amount of fruit on the tree, the state of the soil supply with water and nutrients, the number and especially the efficiency of phytosanitary treatments

The average length of the annual growth is influenced by the variety, but also by the agricultural techniques applied, being at the same time an indicator of the correlation between the synchronous processes of growth-differentiation-fruiting.

Analyzing the data on the average length of annual growth recorded in the apple varieties studied, the 'Rubinstar' variety stands out with 29.22 cm, followed by 'Gloster' (27.43 cm), 'Szampion' (23.85 cm), the last being 'Golden D. Reinders' with 22.27 cm (Table 1).

The highest values of tree height were recorded for the 'Rubinstar' variety with 3.42 m, followed by 'Gloster' (3.28 m), 'Szampion' (2.85 m) and the lowest values for the 'Golden D. Reinders' variety with 2.54 m (Table 1).

Observations on the phenology of the varieties highlighted the fact that the onset, progress and duration of the vegetation phases were closely linked to the climatic conditions of each year (Table 2).

The beginning of flowering in the apple varieties studied was recorded between 1st of May and 10th of May, and the flowering period overlaps in the four varieties, thus ensuring cross-pollination.

The duration of flowering was 10 days, being influenced by the climatic conditions of this period. In deficient years, the duration of flowering was longer by over 5 days than normal, prolonging the consumption of reserve substances during flowering, with a negative influence on the percentage of set fruits, reducing the production of sour cherries.

For the development of the pollination and fertilization process in good conditions, moderate temperatures of 15 - 17ºC are preferred, which maintain the viability of the stigma, pollen for a longer period of time and allow the flight of bees. In years with late spring, temperatures are sometimes too high and speed up the succession of phenophases, dry out the stigma and shorten the optimal period for pollination and fertilization.

Table 2

Fruiting phenophases of studied varieties, data for 2023

Variety	Start of budding (dates)	Start of of the swelling of the fruit buds (dates)	Blossoming (Limit dates)		Intensity of flowering (grades)	Fruit ripening (interval)
			Start	End		
'Gloster'	5-10th of April	15-20th of April	1st of May	5th of May	4	1-5th of October
'Szampion'					5	15-20th of Seprember
'Golden D. Reinders'					5	20-25th of Seprember
'Rubinstar'					4	25-30th of Seprember

Regarding the intensity of flowering, the 'Szampion' and 'Golden D. Reinders' varieties recorded a very abundant flowering (grade 5) while the 'Gloster' and 'Rubinstar' varieties showed abundant flowering (grade 4).

Regarding the fruit ripening period (harvest season) it also has different dates, falling within the calendar interval 15 IX-5 X. The first variety to be harvested of the 4 is 'Szampion' (15-20 IX), followed by 'Golden D. Reinders' (20-25 IX), 'Rubinstar' (25-30 IX) and the last is 'Gloster' (1-5 X).

Productivity, along with the quality of the harvest, is the main elements pursued in a fruit orchard and on which the economic efficiency of the crop ultimately depends. Studies show that fruit production is influenced by several factors: variety, age, degree of differentiation of fruit buds, fruit setting, crown volume and climatic conditions of the previous year and the harvest year (Table 3).

The production obtained from the apple varieties studied ranged between 18.91 kg/tree (42.74 t/h) for the 'Golden D. Reinders' variety and 25.96 kg/tree (58.67 t/ha) for the 'Szampion' variety.

Table 3

Fruit production and average fruit weight, data for 2023

Variety	Fruit production		Average fruit weight (g)
	Kg/tree	t/ha	
'Gloster'	21.53	48.66	162
'Szampion'	25.96	58.67	183
'Golden D. Reinders'	18.91	42.74	155
'Rubinstar'	20.23	45.72	187
Average	21.66	48.95	171

In terms of productivity, the 'Szampion' variety stood out, with a production of 58.67 t/ha, followed by the 'Gloster' varieties (48.66t/ha), 'Rubinstar' (45.72 t/ha) and 'Golden D. Reinders' (42.74 t/ha).

The average fruit weight (g) recorded the highest values for the 'Rubinstar' variety (187g), followed by the 'Szampion' variety (183 g), 'Gloster' (183 g) and 'Golden D. Reinders' (155 g).

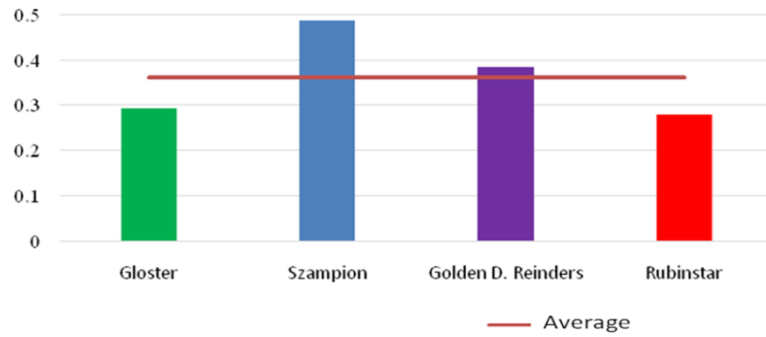

Fig. 2. Productivity index at studied apple varieties, kg fruit/cm^2

The productivity index is calculated as the ratio between the average fruit production in kilograms per tree and the cross-section of the tree trunk in cm^2. The

value of the productivity index is closely related to the increase in fruit load, implicitly the applied agrotechnics. The productivity index obtained falls between the values of 0.486 kg fruit/cm2 for the 'Szampion' variety and 0.278 kg fruit/cm^2 for the 'Rubinstar' variety, the average of the resulting values being 0.360 kg fruit/cm2 (Figure 2).

To determine the physico-chemical properties of the studied four apple varieties, three determinations were made, acidity, firmness and soluble dry substance content (Table 4).

Knowing the malic acid content in apples is important because it determines the taste and state of freshness of the analyzed product. Malic acid content is an important factor for the taste and state of freshness of the product.

From the analysis of the data presented in table 4, it appears that the acidity recorded values between 0.175 g/l malic acid ('Gloster') and 0.425 g/l malic acid ('Szampion'), in the other two varieties, the acidity had values of 0.370 g/l malic acid ('Golden D. Reinders') and 0.280 g/l malic acid ('Rubinstar').

Tabel 4

Fruits physico-chemical characteristics

Variety	Acidity (g/l malic acid)	Firmness (kg f/cm$^{2)}$	Solubile dry matter (°Bx)
'Gloster'	0.175	2.60	12.60
'Szampion'	0.425	1.42	12.55
'Golden D. Reinders'	0.370	2.10	11.87
'Rubinstar'	0.280	2.00	12.20
Average	0.320	2.03	12.31

Firmness is an important characteristic, it helps in determining the direction of valorization and represents the interdependence link between structure and texture. [Irimia, 2013] Fruit firmness recorded values between 1.42 kg f/cm^2 ('Szampion') and 2.60 kg f/cm^2 ('Gloster' variety). The other varieties recorded intermediate values, respectively 2.10 kg f/cm^2 ('Golden D. Reinders') and 2.10 kg f/cm^2 ('Rubinstar').

Knowing the malic acid content in apples is important because it determines the taste and the state of freshness in which the analyzed product is found.

The soluble dry matter content is a characteristic that determines the degree of ripening of the fruit, the more sugars the fruit has, the more ripe the fruit is. Analyzing the apple varieties in terms of soluble dry matter content, 'Gloster' stands out for its high values (12.6°Bx), followed by the 'Szampion' (1255°Bx), 'Rubinstar' (12.2°Bx) and 'Golden D. Reinders' (11.87°Bx).

Analyzing the data on frost resistance, it can be seen that of the 4 varieties, 3 of them ('Szampion', 'Rubinstar' and 'Golden D. Reinders') have a frost resistance rating of 4 (very weakly affected by frost), while the 'Gloster' variety has a rating of 5 (completely resistant) (Table 5).

For drought resistance the situation is identical, 3 of the 4 varieties (‘Szampion’, ‘Gloster’ and ‘Golden D. Reinders’) have a resistance of 4 (very weakly affected by drought) while the ‘Rubinstar’ variety has a score of 5 (completely resistant to drought).

Regarding the intensity of the attack by scab and powdery mildew, the situation differs.

For the attack by scab 3 of the 4 varieties (‘Gloster’, ‘Rubinstar’ and ‘Golden D. Reinders’) have a score of 1 (attacked area between 1-3%), the only variety with a score of 2 (attacked area 4-10%) being the ‘Szampion’ variety.

While for the powdery mildew attack the situation is balanced, 2 of the varieties (‘Gloster’ and ‘Szampion’) have a score of 1 (attacked area between 1-3%) and the other 2 varieties (‘Rubinstar’ and ‘Golden D. Reinders’) have a score of 2 (attacked area 4-10%).

Table 5

Resistance to frost, drought and the intensity of the attack of apple scab and powdery mildew

Variety	Frost resistance (Grade)	Drought resistance (Grade)	Intensity of apple scab attack (Grade)	Intensity of apple mildew attack (Grade)
‘Gloster’	5	4	2	1
‘Szampion’	4	4	1	1
‘Golden D. Reinders’	4	4	2	2
‘Rubinstar’	4	5	2	2

* - the grade for the intensity of the attack on a scale from 1 to 6: 1 for 3 % attacked surface; 2 for 10 %, 3 for 25%, 4 for 50 % and 6 for 100 %.

**frost and drought resistance is appreciated using grades from 0 to 5: 5-completely resistant to frost/drought; 4- very weakly affected; 3- weakly affected; 2-medium resistant; 1- heavily affected; 0- very strongly affected by frost/drought.

CONCLUSIONS

The **pedoclimatic conditions** in this fruit growing basin are among the most favorable for apple culture, the only negative aspect being the uneven distribution of precipitation during May-July interval.

Under the aspect **of productivity**, the variety ‘Szampion’ stood out, with a production of 58.67 t/ha, followed by ‘Gloster’ (48.66 t/ha), ‘Rubinstar’ (45.72 t/ha) și ‘Golden D. Reinders’ (42.74 t/ha).

Average fruit weight (g) registered the highest values in ‘Rubinstar’ variety (187 g), followed by ‘Szampion’ (183 g), ‘Gloster’ (183 g) and ‘Golden D. Reinders’ (155 g).

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