Fruit Growing Research, Vol. XXXVIII, 2022 DOI 10.33045/fgr.v38.2022.15
https://publications.icdp.ro/index.php

EVALUAREA PERFORMANȚELOR PRODUCTIVE ȘI CALITATIVE ALE UNOR SOIURI DE MĂR CULTIVATE ÎN SISTEM SUPERINTENSIV ÎN BAZINUL POMICOL DÂMBOVIȚA

EVALUATION OF PRODUCTIVE AND QUALITY PERFORMANCES AT SOME APPLE VARIETIES CULTIVATED IN A HIGH DENSITY SYSTEM IN THE DAMBOVITA FRUIT BASIN

Comănescu Daniel-Nicolae, Petre Gheorghe
Research Station for Fruit Growing Voinești, Romania

Abstract

The research conducted within the Research Station for Fruit Growing Voinesti during 2019-2021 highlight the performance traits of some apple varieties grown in a high-density system which is widely extended at the private producers in the Dambovita fruit growing area. The extension and moreover the generalization of this high-density system for apple with the following abroad varieties: 'Gala', 'Red Gala', 'Pinova', 'Braeburne', 'Granny Smith', 'Jonaprince', 'Goden Delicious' grafted on 'M9' rootstock, remarked by high productivity and quality of fruits. The regular annual yields of 35-40 t/ha match the producer's expectations and consumers too. In the same time, there are emphasized new and old apple breds from Voinesti Research Station which proved a great scab resistance and has a big potential for the high-density growing system. The option for genetic resistance of apple varieties is steadily increasing in the high density orchards due to the economic efficiency and possibility to produce ecological fruits.

Cuvinte cheie: soiuri de măr, productivitate, eficiență economică, system superintensiv.
Key words: apple varieties, productivity, economic efficiency, high density growing system.

1. Introduction

Fruit growing remains one of the branches of horticulture of great interest to growers in established fruit growing areas in Romania, including the Dâmboviţa Fruit Growing Basin. Both from an economic and social point of view, the culture of trees, and especially of the apple, ensures a permanent activity, managing to capitalize on other areas unsuitable for other agricultural crops.

In the last period, a large part of Dâmboviţa fruit growers cleared areas with trees in the classic system and even intensive apple plantations that exceeded the age of 45-50 years, with the functionality period exceeded, being replaced by apple plantations in the high system density.

The promotion of modern apple culture systems, with rapid entry into fruit and short exploitation time, represents a way of periodic and rapid replacement of assortments, thereby encouraging the introduction of modern techniques and ideas in obtaining productions adapted to the demands of European quality standards.

The expansion of high-density orchards, in the apple-producing countries of Europe, with new apple varieties, allowed their promotion in the Dâmboviţa Fruit Growing Basin, on large areas, exceeding the age of 15-16 years, both for private growers, but also for SCDP Voinesti. Currently, there are enough data on the behaviour of some apple varieties from abroad, but also the recommendation of technological solutions and sequences that ensure apple culture performances, compared to those obtained in large growing countries.

Like any novelty, apple culture in a high-density system is making its debut more and more quickly in Romanian fruit growing, the results obtained fully confirm its great economic efficiency. The generalization in culture of the high-density apple system represents the leap in the modernization of fruit growing in our country, including in the Dâmboviţa Fruit Growing Basin.

2. Material and methods

The research was carried out between 2019 and 2021, monitoring several apple plantations in a high-density system, established after 2007 by some producers from the Dâmboviţa Fruit Growing Basin. The trees were planted at a distance of 3.5x1 m (2,857 trees/ha), with the varieties: 'Gala', 'Red Gala', 'Pinova', 'Braeburne', 'Granny Smith', 'Jonaprince', 'Goden Delicious', grafted on 'M9' rootstock, coming from abroad.

The strategy of the moment is to establish an apple assortment with disease-resistant varieties, either through SCDP Voinești's own creations: 'Iris', 'Real', 'Remar', 'Inedit', 'Valery', 'Cezar', 'Revidar', or some foreign varieties: 'Rubinola', 'Goldrush', 'Topaz', with high productivity capacity, with superior fruit quality. These varieties are expanding in Romanian fruit growing, managing to change the concept of growers sensitive to economic efficiency and the gradual change of assortment with apple varieties with high productive potential, with quality fruit in line with consumer requirements.

Data were recorded regarding the cultivated surface, the varieties and rootstocks used, the planting distances, the soil maintenance system, the used crown shape, the applied phytosanitary treatments, fertigation, etc. The production potential of the cultivated varieties was also monitored, especially since in the newly established plantations, tree-planting material from Italy or the Netherlands was used, with a different variety from that grown in Romania

3. Results and discussions

The existence of the Research Station for Fruit Growing Voinești, in the Dâmbovița Fruit Growing Basin, represented an incentive in the promotion of modern culture systems among private apple growers.

The high-density apple system offers greater ease in terms of changing the assortment (due to the shorter exploitation period of these orchards), increased yield when performing the works due to the execution entirely from the ground, as well as superior productions quantitatively and qualitatively.

In recent years, in the Dâmboviţa fruit culture, especially for apples, the system of high-density culture has been generalized, through the establishment of new modern plantations, using varieties of foreign origin, adapted to the pedo-climatic conditions of the Dâmboviţa Fruit Basin.

a) Evidence of high-density apple orchards in the Dâmboviţa Fruit Growing basin

The significant successes achieved in world of fruit growing, but especially in the European one, have led the growers of the Dâmboviţa Fruit Growing Basin to establish orchards with apple varieties in a high-density system, replacing the old plantations that were over 45-50 years old, the trees characterizing through a low production potential.

The high-density apple orchards, at 3 growers from the Dâmboviţa Fruit Growing basin, are highlighted in table 1, by the cultivated areas, the age of the trees and the planting thickness.

From the data presented, it follows that Grower 1 from Voineşti - Izvoare owns an area of 23 ha cultivated with apples in a high-density system, with trees aged 7-15 years, planted at a distance of 3.5 x 1 m, achieving a density of 2,857 trees/ha. On the same density of planting (2,857 trees/ha), but with trees aged 8-12 years, there are also apple orchards belonging to Grower 2 from Voinești - Izvoare, with an area of 5 ha and Grower 3 from Malu cu Flori with an area of 1.5 ha.

The 23 ha, cultivated with apples at Grower 1 in Voineşti - Izvoare, are equipped with a support system with 3 wires, the first placed 60 cm from the ground, on which the hose is fixed, which is part of the drip irrigation system, with a flow rate of 2.2 l/h. The irrigation system also has fertigation basins.

On the 5 ha cultivated with apples by Grower 2 from Voinești - Izvoare, the Dutch culture system with wooden guardians for each tree is promoted. The irrigation system is with a hose placed on the ground, with a flow rate of 2 l/h.

At the Producer Grower 3 in Malu cu Flori, the support system has 2 wires, the first wire being placed 60 cm from the ground level, on which the hose of the drip irrigation system with a flow rate of 2 l/h is installed. Each tree is supported by a bamboo thread.

The apple varieties grown on the 3 lots, being sensitive to diseases, to ensure an appropriate phytosanitary status, a number of 16-18 phytosanitary treatments were applied annually. In the years with overproduction, the chemical thinning of the fruits was applied, supplemented with a manual revision, in order to obtain fruits that respond to the competitive pressures on the market.

In all plots cultivated with apples, the crown shape is thin, and the soil in the orchard is divided by interval and weeded by tree row.

b) Evaluation of the production potential and fruit quality of some apple varieties grown in the high-density orchards of the Dâmboviţa Fruit Growing basin

One of the priority objectives of the undertaken study is the appreciation of the production capacity, being the most important characteristic in promoting the varieties for the establishment of new commercial plantations.

The annual recording of apple production at variety level shows that there are differences between them in terms of production level.

Analysing the productions made at Grower 1 in Voineşti - Izvoare during the 3 years of study (2019-2021), it is found that the most productive apple varieties, for trees aged 13 - 15 years, were 'Golden Delicious' with 48.2 t /ha, followed by the 'Braeburn' apple varieties with 39.7 t/ha and 'Gala' with 38.2 t/ha, the varieties being grafted on the 'M9' rootstock, with a planting density of 2,857 trees/ha (Table 2).

For trees aged 10 - 12 years, the highest productions, on average over 3 years, were recorded for the 'Jonaprince' and 'Idared' apple varieties with 41.7 and 42.8 t/ha, followed by the 'Gala' and 'Stark Delicious' varieties with 38.2-39.3 t/ha, the varieties being grafted on 'M9' rootstock.

In the apple orchard with 7-year-old trees, in 2021, for the 'Golden Delicious/M9' a production of 56.6 t/ha and 60.5 t/ha for the 'Jonaprince/M9' was recorded, with an average for the years 2019 – 2021 of 46.5 – 47.4 t/ha.

At the second owner from Voineşti, it can be seen that the highest productions were recorded, during the three years of study (2019-2021), for the 'Golden Delicious/M9' with 42.4 t/ ha, 'Idared/M9' with 42.1 t/ha and 'Gala/M9' with 37.2 t/ha. The lowest productions on average over the last 3 years were recorded for the 'Braeburn' and 'Granny Smith' apple varieties with 31.8 t/ha and 28.5 t/ha, respectively (Table 3).

At the grower located in the Malu cu Flori commune, with trees in the 8th year after planting, the most productive were the varieties 'Pinova/M9' with 47.8 t/ha and 'Golden Delicious/M9' with 44.9 t/ha, productions averages achieved over the 3 years of study (2019-2021).

Fruit quality

The quality of apples in the varieties grown in the high-density orchards of private growers in the Dâmbovița Fruit Growing basin is assessed by biometric indicators and a series of biochemical components, characteristics that can be used to direct the exploitation.

It is estimated that a fruit size of 170-180 g is appropriate for a modern apple variety, characteristics that are met by a large part of the apple varieties studied.

The destination of the fruit for fresh consumption, in addition to taste, size and shape, the colour of the apples is also taken into account, which must be intense and uniform (red - 'Jonathan' type, yellow - 'Golden Delicious' type), ensuring an attractiveness necessary for capitalization on the market .

The study undertaken on the apple varieties in the composition of the high-density orchards, at apple producers in the Dâmbovița Fruit Growing basin, established with planting material from Italy or the Netherlands, not all varieties meet the colour and quality conditions preferred by consumers.

The varieties that best adapt to the climatic conditions in the area are 'Golden Delicious' and 'Idared' cultivated many years ago, to which are added a number of varieties that are in demand on the market and that entered the apple orchards established in the last decade, respectively: 'Gala', 'Red Gala', 'Pinova', 'Jonaprince' and even 'Braeburn' at Malu cu Flori (Fig. 1).

c) Performance characteristics of some apple varieties with genetic resistance to diseases, own creations and some varieties from abroad

The seven varieties of apple with resistance to diseases approved at SCDP Voinești in the period 2004-2020 and those from abroad, cultivated in a high-density system, meet the demands of the producer, sensitive to economic efficiency, with high production potential, with fruits of quality, with low pesticide residues, which are sure to meet the demands of ever-increasing consumers.

From the data presented in table 4, the production potential during the full fruiting period, in years 11-13 from planting, of the 7 apple varieties with genetic resistance to diseases created at RSFG Voinesti and the 3 varieties from abroad, cultivated in a system of high density, it was 31.7 – 45.9 t/ha. The most productive were the apple varieties: 'Iris', 'Real', 'Remar', 'Valery', 'Cezar', 'Rubinola', 'Goldrush' and 'Topaz', with productions of over 38 t/ha (Table 4).

The quality of the fruits expressed by their biomass was between 155 and 180 g, with smaller fruits being recorded for the varieties 'Iris', 'Inedit', 'Voinicel', 'Revidar', 'Goldrush' and larger for the varieties 'Cezar', 'Valery', 'Remar' and 'Redix', with fruits over 170 g. The dry substance content had values between 13 and 16.5% (Fig. 2).

The apple varieties that have been the object of the study show genetic resistance to scab (*Venturia inaequalis)* and an increased degree of resistance to powdery mildew, the appropriate phytosanitary status being maintained through a reduced number of treatments with fungicides, especially to combat *Gleosporium*.

The Research Station for Fruit Growing Voineşti was and remains the promoter of the disease-resistant assortment and the high-density apple system in our country, in which varieties are promoted that lead to the increase of the competitive level on the Romanian market and the preparation of fruit production at the level of standards of marketing, both on the internal and external market, with priority in the European Community.

d) The yield and exploitation period of apple orchards in different culture systems

The yield of the productions achieved in the high-density apple system during the exploitation period is superior, reflected by the differences in productive potential compared to the intensive and classic culture systems (Fig. 3).

The differences between the apple cultivation systems are quite obvious in terms of the entry of the trees into fruit, the economic fruiting and the level of productions during the period of full fruiting, as well as the upper limit of the exploitation period.

What clearly differentiates the apple culture systems is the fact that full economic fruiting occurs in the classic system after 10-12 years from planting, in the intensive system after 6-7 years, and in the high-density system after 3-4 years.

If we take stock of the first 10 years after planting, it can be seen that the productions made significantly differentiate the apple cultivation systems. If in the high-density system and even in the intensive one, the yield/ha is high as a result of the rapid entry of the trees into the fruit and the achievement of a large productive volume of the crown through the very density of the planting of the trees, in the classic system one must expect much more, both for the entry of the trees into the fruit, as well as the formation over time of the skeleton that will bear the fruit.

The high-density apple system is recommended for expansion in the established fruit-growing areas of our country, including in the Dâmboviţa apple-growing basin, due to the high yield and economic efficiency, the method of periodic and rapid replacement of assortments, but also for obtaining batches of apples increasingly demanded by consumers. Economic efficiency increases by promoting apple varieties with genetic resistance to diseases.

4. Conclusions

The extension of the high-density apple system in the Dâmbovița Fruit Growing basin corresponds to the demands of the grower, sensitive to economic efficiency and to the assortment that adapts to the climatic conditions in the area.

The assortment promoted in the high-density orchards, originating from abroad or composed of apple varieties with genetic resistance to diseases, ensures a high production potential and fruit qualities corresponding to market requirements.

The highest productions on average over 3 years (2019-2021), in the orchard belonging to a producer from Voineşti - Izvoare, were recorded for the apple varieties: 'Golden Delicious' (48.2 t/ha), 'Braeburn' (39,7 t/ha) and 'Gala' (38.2 t/ha), for trees that are 11-15 years old and for the 'Jonaprince' (41.7 t/ha) and 'Idared' (42.8 t/ha) apple varieties, in trees aged 10-12 years.

In the apple orchard with 7-year-old trees, for the 'Golden Delicious' and 'Jonaprince' varieties, productions of 47.4 t/ha and 46.5 t/ha were achieved on average for the years 2019-2021.

On the 5 ha area belonging to owner 2 from Voinești - Izvoare, with trees aged 12 years, for the last 3 years (2019-2021), the most productive varieties were: 'Golden Delicious' with 42.4 t/ha, 'Idared' with 42.1 t/ha, 'Gala' with 37.2 t/ha.

The grower located in the Malu cu Flori commune, with trees in the 8th year after planting, produced apple varieties of 41.7 - 47.8 t/ha, as follows: 'Red Gala' - 41.7 t/ha, 'Golden Delicious' – 44.9 t/ha and 'Pinova' – 47.8 t/ha.

The production potential at the age of 11-13 years, for the 10 disease-resistant apple varieties studied, was between 38.6 - 43.9 t/ha, the most productive were: 'Iris', 'Real', 'Remar', 'Valery', 'Cezar', 'Rubinola', 'Goldrush' and 'Topaz'.

The yield of the high-density apple system is superior to the intensive and classic culture systems, offering greater flexibility in terms of changing the fruit varieties due to the shorter economic exploitation period of these orchards (22-30 years for intensive orchards, 15 -16 years for high-density ones).

The cultivation of disease-resistant apple varieties increases economic efficiency and is the main factor in obtaining ecological productions.

References

1. Comănescu D.N, 2012. Cercetări privind sistemul de mare densitate la măr, în scopul obţinerii de producţii adaptate la cerinţele de comercializare, PhD thesis.
2. Comănescu D.N, Petre Gheorghe, 2017. Rezultate privind creșterea și rodirea unor soiuri de măr cu rezistență genetică la boli, cultivate în sistem de mare densitate. Hortus Journal, no 15. Journal of Horticulturists and Vintners.
3. Petre Gh, 2006. Cerinţele pomiculturii moderne. Info AMSEM journal, no.7.
4. Petre Gh, Petre Valeria, Comănescu D.N., 2009. Promovarea sistemelor moderne la măr, în pomicultura românească. Agricultorul roman Journal, no 9.
5. Petre Gh., Comănescu D.N, Petre Valeria, 2021. Promovarea în cultură a livezilor de măr de mare densitate, oportunitatea esențială a Bazinului pomicol Dâmbovița. Info AMSEM Journal, no 9.

Tables and Figures

Table 1. The evidence of orchards grown in a high density system in the Dambovita Fruit Growing Basin

No.	Grower	Surface - ha -	Year of establishment	Age of trees in 2021 - years -	Planting distance - m -	Number of trees /ha
1	Grower 1 from Voineşti - Izvoare	4	2007	15	3.5x1	2,857
		4	2009	13	3.5x1	2,857
		2	2010	12	3.5x1	2,857
		7	2011	11	3.5x1	2,857
		6	2015	7	3.5x1	2,857
2	Grower 2 from Voineşti - Izvoare	5	2010	12	3.5x1	2,857
3	Grower 3 from Malu cu Flori	1.50	2014	8	3.5x1	2,857

Table 2. The yield potential of the apple varieties grown in a high-density system orchard between 2019-2021 at the No. 1 private producer from Voineşti – Izvoare

Age of trees (years)	Number of trees / ha	The variety/rootstock	Production obtained (t/ha), in the year			Average (t/ha)
			2019	2020	2021	
13– 15	2,857	Gala/M9	26.5	52.6	35.4	38.2
		Golden Delicious/M9	28.6	53.2	62.8	48.2
		Braeburn/M9	18.3	49.6	51.2	39.7
		Stark Delicious/M9	25.0	45.0	41.8	37.3
		Granny Smith/M9	22.0	35.1	42.6	33.2
10 – 12	2,857	Gala/M9	28.6	48.3	37.6	38.2
		Stark Delicious/M9	28.6	46.5	42.8	39.3
		Jonaprince/M9	25.2	41.3	58.6	41.7
		Idared/M9	28.6	52.3	47.5	42.8
5 – 7	2,857	Golden Delicious/M9	40.2	45.3	56.6	47.4
		Stark Delicious/M9	28.3	30.6	35.5	31.5
		Jonaprince/M9	38.6	40.4	60.5	46.5

Table 3. The yield potential of the apple varieties grown in a high-density system orchard between 2019-2021 at the No. 2 private producer from Voineşti – Izvoare and the private producer from Malu cu Flori

Age of trees (years)	Number of trees / ha	The variety/rootstock	Production obtained (t/ha), in the year			Average (t/ha)
			2019	2020	2021	
10 - 12	2,857	Golden Delicious/M9	35.3	35.6	56.3	42.4
		Idared/M9	30.6	36.3	59.3	42.1
		Granny Smith/M9	15.5	31.3	38.6	28.5
		Braeburn/M9	18.0	29.3	48.2	31.8
		Gala/M9	29.6	38.6	43.4	37.2
6 - 8	2,857	Pinova/M9	42.8	47.8	52.8	47.8
		Red Gala/M9	34.3	41.3	49.6	41.7
		Golden Delicious/M9	46.8	39.6	48.3	44.9

 DOI 10.33045/fgr.v38.2022.15

Fig. 1. Issues from apple orchards grown in a high-density system

Table 4. The production capacity and quality parameters of the fruits, of some apple varieties with genetic resistance to diseases, grafted on M9 rootstock (2,857 trees/ha)

No.	Variety	Production potential (t/ha)				Fruit quality parameters		
		Year 11 2019	Year 12 2020	Year 13 2021	Average	Fruit weight (g)	Content in the S.U (%)	Flesh Firmness (kgf/cm^2)
I. Varieties created at RSFG Voineşti								
1	Iris	48.3	37.6	45.9	43.9	155	14.2	7.6
2	Real	39.3	36.8	38.8	38.3	180	13.5	9.8
3	Remar	44.3	38.6	42.3	41.7	170	13.8	8.8
4	Inedit	36.3	28.7	38.7	34.6	155	15.0	8.1
5	Valery	44.5	38.0	45.6	42.7	185	16.5	10.6
6	Cezar	41.6	35.8	43.5	40.3	190	13.8	9.6
7	Revidar	34.1	28.4	32.6	31.7	160	13.0	7.8
II. Varieties that came from abroad								
1	Rubinola	39.0	33.6	42.8	38.5	165	14.5	9.8
2	Goldrush	47.4	38.6	54.6	45.9	160	13.8	11.2
3	Topaz	45.4	28.6	48.2	40.7	168	13.5	9.6

a) Valery **b) Cezar** **c) Revidar**

Fig. 2. Three new apple varieties obtained at RSFG Voinești

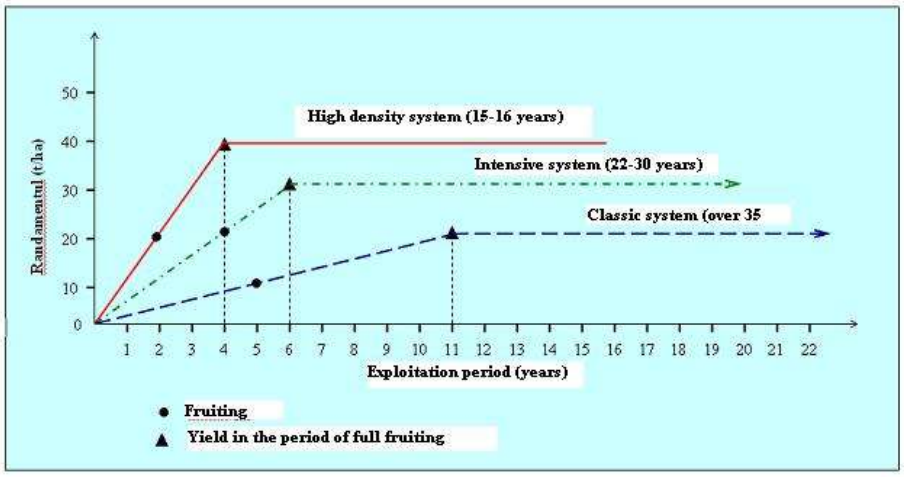

Fig. 3. The yield and the exploitation period of the apple orchards in different culture systems