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INFLUENȚA UNOR PORTALTOI VEGETATIVI ASUPRA CREȘTERII ȘI FRUCTIFICĂRII LA SOIUL DE PRUN 'ROMANȚA'

INFLUENCE OF SOME VEGETATIVE ROOTSTOCKS ON THE GROWTH AND FRUITING ON THE 'ROMANTA' PLUM CULTIVAR

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Abstract

The most popular rootstock in the plum orchards from Romania was 'Myrobalan' seedling which is very vigorous, incompatible with some cultivars, causes late bearing and intensive suckering. Recently researches were begun about the vegetative rootstocks suitability to conditions of Romania. In 2018-2022 periods the influence of four vegetative rootstocks ('Adaptabil', 'Mirodad 1', 'Mirodad 2' and 'Mirobolan dwarf') comparative with 'Mirobalan' seedling on growth, yield and fruits quality at 'Romanța' cultivar was carried out at Genetics and Breeding Department, in Research Institute for Fruit Growing Pitesti, Romania. The trees were planted in the spring of 2015 at 4 x 3 m and comprised 3 trees / 3 replications. As results of the investigations we found that: 'Adaptabil' and 'Mirodad 2' rootstocks induced a very low vigour; 'Romanța' cv. yielded significantly better on 'Adaptabil', 'Mirobolan dwarf' and 'Mirodad 2' rootstocks; the largest fruits were obtained when the cultivar was grafted on 'Adaptabil', 'Mirobolan dwarf' and 'Mirodad 1'; the best taste was obtained in the case of the 'Mirobolan dwarf' and 'Adaptabil' rootstocks. In conclusion, it can be said that all the vegetative rootstocks studied had a better influence than the 'Mirobalan' seedling on the growth and fruiting of the 'Romanța' cv., being able to be recommended for intensive plum orchards.

Cuvinte cheie: prun, soi, portaltoi, vigoare, producție, calitate fruct.
Key words: plum cultivar, rootstocks, growth, yield, fruits quality.

1. Introduction

European plum (*Prunus domestica* L.) is the most represented and important fruit species in Romania. According to data FAOSTAT, 2023, Romania was ranked on the first place in Europe and on the 2nd place in the world after China, with a production of 807,170 tones.

In Europe, including in Romania, plums were grown in extensive system (maximum 400 trees/ha), where the most used rootstock was 'Myrobalan' (*Prunus cerasifera* Ehrh.) (Kaufmane et al., 2007; Blazek and Pistekova, 2009; Butac et al., 2014, 2015; Glišić et al., 2016a; Milatović et al., 2019). The used of this rootstock is associated with some problems in nursery and in orchard, such as: non uniformity of seedlings, too vigorous growth, delayed precocity, intensive suckering and incompatibility or insufficient compatibility with some cultivars (e.g. 'Tuleu gras' and his progenies) (Paunovic, 2008; Paunovic et al., 2011; Ilic et al., 2019; Radovic et al., 2022; Zamfirescu et al., 2022). This is why for the establishment of modern orchards (intensive and super intensive system) it is very important to choose the best cultivars, as well as the most appropriate rootstocks. One of the basic requirements for the intensification of plum orchards is the use of vegetative rootstocks which induce low vigor to grafted trees and lead to a high planting density and implicitly higher yields and better fruit quality.

To overcome these problems, worldwide as well as in Romania, rootstock breeding programs have been carried out and new dwarf or semi-dwarf clonal rootstocks were registered (e.g. 'St. Julien A', 'Pixy', 'Fereley', 'Isthara', 'Docera 6', 'Dospina 235', 'Mirobolan dwarf', 'Mirodad 1', and others (Hartmann et al., 2007; Neumuller et al., 2013; Ilic et al., 2019; Radovic et al., 2022; Zamfirescu, 2022).

In the last years, a large number of new clonal rootstocks providing considerable value and have a positive influence on the grafted trees (Botu et al., 2002; Kaufmane et al., 2007; Kosina, 2007; Sitarek et al., 2007; Blazec and Pistekova, 2012; Dekena et al., 2017; Meszaros et al., 2015).

New valuable clonal rootstocks combined with a good cultural practice and training system are important for high density orchards (Magyar and Hrotko, 2006; Radovic et al., 2022).

The aim of this study was to evaluate the influence of four clonal rootstocks comparative with 'Mirobalan' seedling on the tree vigor, yield and fruit quality at 'Romanța' cultivar. The 'Romanța' is Romanian cultivar registered in 2012 and was chosen for this study because Romanian farmers and consumers positively appreciated it.

2. Material and methods

Field trial, plant material and climatic conditions

The study was conducted in the field trial at the Genetics and Breeding Department, in Research Institute for Fruit Growing Pitesti, Romania (central part of Romania 44°53'56" Northern latitude, and 24°51'35" Eastern longitude).

During the five year (2018-2022) the influence of four vegetative rootstocks comparative with 'Mirobalan' seedling on growth, yield and fruits quality at 'Romanța' cultivar was carried out.

The field trial was established in 2015. The trees were planted in a spacing of 4 m between the rows and 3 m between trees, according to the following experimental scheme: Factor A – cultivar, with one graduation (a1-'Romanța'); Factor B – rootstock, with five graduations (b1-'Adaptabil'; b2-'Mirodad 1'; b3-'Mirodad 2'; b4-'Mirobolan dwarf'; b5 – 'Mirobalan'). The experiment was carried out in a randomized block design, in 3 replications with 3 trees per plot.

The 2018-2022 climatic conditions were analyzed comparative with the last 53 years period (1969-2021). The average multi-annual temperature was 10.0°C, the maximum temperature 38.8°C, whereas the minimum temperature –24.4°C; total annual rainfalls recorded was 678.1 mm (Fig. 1, Table 1). The early autumn frosts usually occur at the end of October and the latest about mid April. Compared to the baseline for 53 years period, there is a tendency to increase average temperatures in the winter months (January and February), which causes an early start of trees in vegetation with negative influences on resistance to late spring frosts. There is also a tendency to increase temperature in the summer months (June, July and August), which determines a low resistance to drought. Regarding precipitation, there is a rainfall exceeding in winter (121 mm) and a rainfall deficit in summer (153 mm) (Fig. 1). During the study period, the average annual temperature was with 1.4°C higher than the multiannual average, and the precipitation was with 33.7 mm lower than the multiannual average (Table 1).

Measurements

In 2018 - 2022 periods, the following measurements were carried out: tree vigour expressed as trunk diameter at 30 cm above the soil in mm; fruit yield in kg/tree by weighting the fruits per tree; mean fruit weight in g with an electronic balance; soluble solids content with a digital refractometer in % Brix and malic acid content in % or g/100 g fresh matter with the device Minititrator Hanna Instrument 84532; fruit firmness with a penetrometer Qualitest HPE equipped with a plunger of diameter 0.10 cm^2.

Statistical analysis

The data were included in an Excel database and statistically interpreted with the SPSS 14.0 program, which uses the Duncan test (multiple t tests) at 0.05 level of probability.

3. Results and discussions

Rootstock effect on tree vigour, fruit yield and quality is well known (Webster, 2002; Botu et al., 2002, 2004; Hrotko et al., 2002).

Influence of rootstocks on tree vigour

Trunk diameter is considered as important indicator of tree vigour. In this experience there were significantly differences of vigour between cultivar – rootstock combinations studied. 'Romanța' cv. grafted on all four vegetative rootstocks had statistically lower average trunk diameter values compared to 'Mirobalan' seedling (Table 2). The highest trunk diameter was on 'Mirobalan' seedling (92.02 mm) and the lowest trunk diameter was on 'Mirodad 2' rootstock (86.99 mm). 'Adaptabil' rootstock also induces low vigour of the 'Romanța' cv. (87.37 mm). From previous dates it is known that the 'Adaptabil' rootstock (registered for peach cvs., but also for plum cvs.) in the first years after planting induces high vigour of the cultivars grafted on it (Butac et al., 2016; Zamfirescu et al., 2020), but in the bearing period growth decreased and finally the growth increase is lower than in the case of other rootstocks (Table 2). Regarding 'Romanța' cv., it is known that it has low vigor (Zamfirescu et al., 2019).

Influence of rootstocks on yield

Regarding the fruits yield, it can see that there were significantly differences between combinations studied. The average yield per tree was highest on 'Adaptabil' rootstock (19.77 kg/tree), then on the 'Mirobolan dwarf' (16.03 kg/tree) and 'Mirodad 2' (16.02 kg/tree), while it was lowest on 'Mirodad 1' (14.37 kg/tree) and 'Myrobalan' seedling (14.55 kg/tree) (Table 3).

As expected in a young orchard, fruits yield increased from one year to another (from 12.98 kg/tree in 2018 to 20.21 kg/tree in 2022). From the data obtained it can be seen that the 'Romanța' cv. has a regular yield from one year to another on all vegetative rootstocks, not being affected by the bienniality. However, the plums had lower bienniality (Skrivele et al., 2000).

Higher yield on vegetative rootstock can be explained by their influence on lower vigour of grafted cultivars, more nutrients being distributed to fruit buds (Radovic et al., 2022).

Influence of rootstocks on fruit characteristics

One of the most important traits of cultivars is *fruit weight* (Radovic et al., 2022). Usually plum rootstocks have not significant effect on fruit weight (Hrotko et al., 2002; Sosna, 2002; Lanauskas, 2006). Fruit weight of 'Romanța' cv. ranged from 66.52 g on 'Mirodad 1' to 60.64 g on 'Myrobalan' seedling (Table 4). Significantly higher fruit weight was obtained on all four vegetative rootstocks compared with 'Myrobalan' seedling. The fruits weight of 'Romanța cv. grafted on 'Mirodad 1' was higher than on the other vegetative rootstocks studied and that can be explained by the fruits yield smaller.

Usually there were no significant differences among rootstocks on contents of *soluble solids and malic acid i*n fruits of different cultivars (Sitarek et al., 2007; Milosevic and Milosevic, 2012; Reig et al., 2018; Zamfirescu et al., 2020; Radovic et al., 2022). The results obtained in this study are in accordance with the results of other researchers.

The highest *soluble solids content of fruits* was recorded on 'Mirobolan dwarf' and 'Mirodad 1' rootstocks (14.27 % Brix, respectively 14.13 % Brix) and the lowest on 'Mirodad 2' and 'Adaptabil' rootstocks (13.84 % Brix, respectively 13.63 % Brix) (Table 5).

The *acids content of fruits* varying from 0.54 % on 'Adaptabil' and 'Mirodad 2' rootstocks to 0.58 % on 'Mirobolan dwarf' rootstock (Table 6). The differences between cultivar-rootstock combinations regarding malic acid content were statistically insignificant.

Firmness is an important factor related to taste and shelf life, and firmness assessment is used both in the market and in the research field to judge the fruits quality (Sekse and Wermund, 2010). Generally, flesh firmness decreases during the maturation and ripening. Plum rootstocks have not significant influence on fruits firmness. The highest *fruits firmness* was recorded on 'Adaptabil' rootstock (60.67 HPE units) and the lowest on 'Mirodad 2' rootstock (57.48 HPE units) (Table 7).

4. Conclusions

All studied vegetative rootstocks had a positive effect on reducing the vigour and increasing the yield of 'Romanța' cv.

The lowest vigour was found in trees grafted on 'Mirodad 2' rootstock, followed by 'Adaptabil' rootstock.

The yield per trees was significantly higher on trees grafted on vegetative rootstocks compared to 'Myrobalan' seedling. The highest yield was obtained on the 'Adaptabil' rootstock.

The largest fruits were obtained when the cultivar was grafted on 'Adaptabil', 'Mirobolan dwarf' and 'Mirodad 1'.

The best taste was obtained in the case of the 'Mirobolan dwarf' and 'Adaptabil' rootstocks.

Based on the results obtained, it can be concluded that all vegetative rootstocks showed better results than 'Myrobalan' seedling, and can be recommended for establishing intensive orchards with higher planting density.

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Tables and Figures

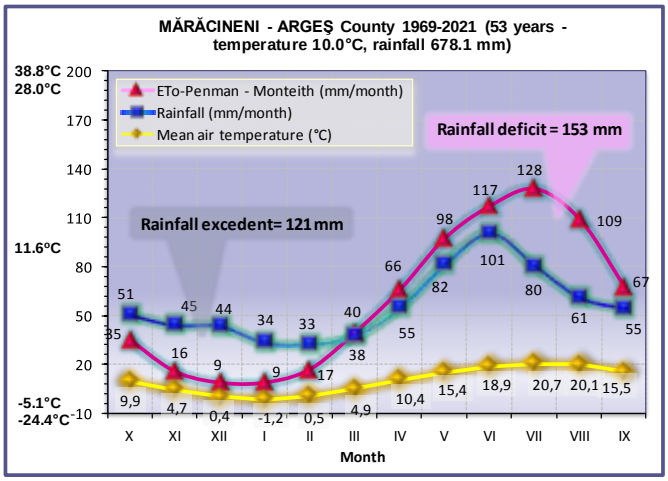

Fig. 1. The values of the main meteorological parameters (1969-2021)

Table 1. The main meteorological parameters (2020-2022)

No.	Meteorological parameters	Years					
		2018	2019	2020	2021	2022	1969-2021
1	Average temperature (°C)	11.2	11.9	11.8	10.7	11.6	10.0
2	Maximum temperature (°C)	33.9	35.1	35.3	36.8	38.3	38.8
3	Minimum temperature (°C)	-19.8	-14.1	-10.2	-14.1	-12.0	-24.4
4	Annual rainfalls (mm)	745.9	634.7	679.1	636.2	526.3	678.1
5	Rainfall deficit (mm)	-16.7	94.2	63.9	258.5	307.0	153.0

Table 2. Influence of the rootstocks on the vigour of the 'Romanța' cultivar – trunk diameter (mm)

No.	Rootstock	2018	2019	2020	2021	2022	Average
1	Adaptabil	57.15	82.88	90.89	99.36	106.59	**87.37 c**
2	Mirodad 1	58.56	86.35	92.83	101.38	107.94	**89.41 b**
3	Mirodad 2	57.77	82.43	90.43	98.57	105.79	**86.99 c**
4	Mirobolan dwarf	59.15	84.95	91.16	100.27	107.43	**88.59 b**
5	Myrobalan	72.50	80.83	93.85	102.26	110.65	**92.02 a**
	Average	**61.03**	**83.49**	**91.83**	**100.37**	**107.68**	

*Duncan multiple ranges test. Numbers followed by the same letter within a column are not significantly different (P≤0.05).

Table 3. Influence of the rootstocks on the yield of the 'Romanța' cultivar (kg/tree)

No.	Rootstock	2018	2019	2020	2021	2022	Average
1	Adaptabil	13.97	16.27	21.49	22.44	24.69	**19.77 a**
2	Mirodad 1	12.50	13.77	12.54	15.08	17.96	**14.37 c**
3	Mirodad 2	12.18	14.97	14.30	17.94	20.72	**16.02b**
4	Mirobolan dwarf	13.98	15.53	14.00	17.39	19.27	**16.03 b**
5	Myrobalan	12.26	13.07	13.69	15.35	18.39	**14.55 c**
	Average	**12.98**	**14.72**	**15.20**	**17.64**	**20.21**	

*Duncan multiple ranges test. Numbers followed by the same letter within a column are not significantly different (P≤0.05).

Table 4. Influence of the rootstocks on the fruits weight of the 'Romanța' cultivar (g)

No.	Rootstock	2018	2019	2020	2021	2022	Average
1	Adaptabil	68.43	62.40	68.20	66.28	65.47	**66.16 a**
2	Mirodad 1	69.97	64.57	65.87	66.45	65.74	**66.52 a**
3	Mirodad 2	65.23	63.50	60.17	64.34	63.84	**63.41 b**
4	Mirobolan dwarf	62.67	66.33	65.93	65.82	64.89	**65.13 ab**
5	Myrobalan	62.33	58.93	58.00	62.26	61.68	**60,.64 c**
	Average	**65.73**	**63.15**	**63.63**	**65.03**	**64.32**	

*Duncan multiple ranges test. Numbers followed by the same letter within a column are not significantly different (P≤0.05).

Table 5. Influence of the rootstocks on the fruits soluble solids content of the 'Romanța' cultivar (% Brix)

No.	Rootstock	2018	2019	2020	2021	2022	Average
1	Adaptabil	13.50	13.73	13.33	13.72	13.90	**13.63 a**
2	Mirodad 1	13.97	14.77	13.70	14.07	14.12	**14.13 a**
3	Mirodad 2	13.73	13.67	13.70	14.10	14.00	**13.84 a**
4	Mirobolan dwarf	15.33	13.93	13.90	14.13	14.05	**14.27 a**
5	Myrobalan	15.23	13.73	13.70	13.82	13.90	**14.07 a**
	Average	**14.35**	**13.97**	**13.67**	**13.97**	**13.99**	

*Duncan multiple ranges test. Numbers followed by the same letter within a column are not significantly different (P≤0.05).

Table 6. Influence of the rootstocks on the malic acid content of fruits of the 'Romanța' cultivar (% or mg/100 g)

No.	Rootstock	2018	2019	2020	2021	2022	Average
1	Adaptabil	0.46	0.46	0.82	0.48	0.50	**0.54 a**
2	Mirodad 1	0.46	0.49	0.84	0.50	0.50	**0.56 a**
3	Mirodad 2	0.45	0.43	0.85	0.48	0.51	**0.54 a**
4	Mirobolan dwarf	0.50	0.53	0.86	0.51	0.53	**0.58 a**
5	Myrobalan	0.43	0.51	0.88	0.51	0.53	**0.57 a**
	Average	**0.46**	**0.48**	**0.85**	**0.50**	**0.51**	

*Duncan multiple ranges test. Numbers followed by the same letter within a column are not significantly different (P≤0.05).

Table 7. Influence of the rootstocks on the fruits firmness of the 'Romanța' cultivar (HPE units)

No.	Rootstock	2018	2019	2020	2021	2022	Average
1	Adaptabil	64.07	46.13	63.00	65.20	64.96	**60.67 a**
2	Mirodad 1	60.67	45.23	64.93	64.18	63.67	**59.74 a**
3	Mirodad 2	51.93	42.73	63.03	64.38	65.34	**57.48 a**
4	Mirobolan dwarf	58.93	45.67	64.60	63.57	64.45	**59.44 a**
5	Myrobalan	61.50	44.40	64.53	64.34	63.72	**59.70 a**
	Average	**59.42**	**44.83**	**64.02**	**64.33**	**64.43**	

*Duncan multiple ranges test. Numbers followed by the same letter within a column are not significantly different (P≤0.05).