

ORCHARD PERFORMANCE OF SOME PLUM CULTIVARS GRAFTED ON DIFFERENT ROOTSTOCKS

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Abstract

In Romania, European plum (*Prunus domestica* L.) is the predominant species owing to its large grown acreage, production, various ways of marketing. The most used rootstocks for plum is Myrobalan seedling, which is very vigorous and insufficient compatible with some cultivars. Modern orchards, with high density, need dwarfing or semi-dwarfing rootstocks. This study was carried out at Genetics and Breeding Department, in Research Institute for Fruit Growing Piteşti, Romania. Five plum cultivars ('Andreea', 'Pitesteana', 'Romanta', 'Cacanska Lepotica', 'Jojo') grafted on three rootstocks ('Adaptabil', 'Mirodad 1', 'BN4Kr') were evaluated. The trees were planted in the spring of 2015 at 4 x 3 m and comprised 3 trees/3 replications. In 2017 and 2018 years, were evaluated: trunk diameter (mm), number of fruits per tree, yields (kg/tree) and fruit quality (fruit weight and soluble solids content). As results of the investigations we found that: 'Adaptabil' rootstock induced a very high vigour; 'Cacanska Lepotica' and 'Romanta' trees had the smallest trunk diameter; the best production have been obtained when the cultivars were grafted on 'Mirodad 1' and 'Adaptabil' rootstock; from all the cultivars studied 'Pitesteana' had a high number of fruits per tree and a high yield; 'Romanta' cv. had the low number of fruit on the tree but the production was high due to the fact that this cultivar has very large fruits (over 65 g); 'Cacanska Lepotica', although having a large number of fruit on the tree, has a small production due to the fact that this cultivar has small fruit (35 g); 'Andreea' had the lowest number of fruits per tree, but with a high fruit soluble solids content (18.72% Brix).

Key words: plum, cultivars, rootstocks, fruiting, fruits quality.

INTRODUCTION

Romania has a long tradition in plum growing, plum being the major fruit species which covers acreage of 65.114 ha and having a production of 512,975 tons (Butac et al., 2014; Butac et al., 2015; Coman et al., 2012; Data Fao, 2018).

The most common rootstock for plums in Romania is Myrobalan (*Prunus cerasifera*). This rootstock has some disadvantages: large tree vigor, sensitivity to Plum Pox Virus, incompatibility with some cultivars (e.g. 'Tuleu Gras' and its progenies), late bearing and intensive suckering (Blazec and Pistekova, 2009, 2012; Butac et al., 2016; Kaufmane et al., 2007; Sosna, 2002).

At the beginning of the 1980s, the interest in plum growing was increasing because were registered a lot of cultivars and rootstocks and

was a development of new training systems. For modern orchard in a dense system, dwarfing or semi-dwarfing rootstocks are necessary (Botu et al., 2002; Hartman et al., 2007; Sosna, 2002).

At present, the using of low vigorous rootstocks represents a very important way in the intensification of plum orchards. This is the reason why in Romania (at RIFG Pitesti, RSFG Bistrita and UCv-RSFG Vâlcea), started a breeding program for rootstocks. The main objectives of this program are: a low to medium vigour, good ability to vegetative propagation techniques, resistance and/or tolerance to important pest and diseases, adaptability to pedo-climatic conditions of our country, good compatibility with plum cultivars and good influence to precocity, yield and fruit quality (Botu et al., 2006; Mazilu et al., 2013; Mazilu and Dutu, 2014). As results of this

program, in these three centers, 12 plum rootstocks were registered: 'Oteşani 8', 'Oteşani 11', 'Miroval', 'Rival', 'Pinval', 'Corval', 'Oltval', 'Mirololan C5', 'Mirololan dwarf', 'Adaptabil', 'Mirodad 1' and 'BN4Kr'. The aim of the present study was to evaluate the influence of 'Mirodad 1', 'Adaptabil', 'BN4Kr' rootstocks on vigour, yield and fruit quality of 'Andreea', 'Pitesteana', 'Romanta', 'Cacanska Lepotica' and 'Jojo' plum cultivars, in the four year after planting.

MATERIALS AND METHODS

The experimental orchard was established during spring of 2015 at RIFG Pitesti – Maracineni, Genetic and Breeding Department. Five plum cultivars grafted on three rootstocks 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 five graduations (a1-'Andreea'; a2-'Pitesteana'; a3-'Romanta'; a4-'Cacanska Lepotica'; a5-'Jojo');

Factor B – rootstock, with three graduations (b1-'Mirodad 1'; b2-'Adaptabil'; b3-'BN4Kr'). The experiment was carried out in a randomized block design, in 3 replications with 3 trees per plot. The trees were irrigated and trained as open vase.

The experiment was done in following climatic conditions: 9.7°C - average annual temperature and 663.3 mm - average annual rainfall.

In 2017 and 2018 years, the following measurements were carried out: tree vigour expressed as trunk diameter at 30 cm above the soil in mm; number of fruits/tree; fruit yield in kg/tree; mean fruit weight in g and soluble solids content with a digital refractometer in % Brix. The results of the experiment were analyzed statistically by means of the analysis of variance. Differences between mean value were assessed using Duncan's multiple range test at a 0.05% significance level.

RESULTS AND DISCUSSIONS

Tree vigour.

The lowest tree vigour, expressed by the average trunk diameter was recorded in case of, 'Romanta' (59.15 mm) and 'Cacanska Lepotica' (55.63 mm) cultivars, and the highest

trunk diameter had 'Andreea' (67.41 mm) and 'Jojo' (66.70 mm) trees, between these cultivars being significant differences of trunk diameter (Table 1.a).

Regarding the influence of the rootstock to the cultivar tree growth, it was found that the lowest trunk diameter was recorded when 'Mirodad 1' was used as a rootstock (59.18 mm), while the most vigorous rootstock was 'Adaptabil' (65.94 mm) (Table 1.b).

The largest vigour, expressed in trunk diameter, was found in combinations 'Andreea'/'Adaptabil' (71.41 mm), 'Jojo'/'Adaptabil' (67.98 mm), 'Jojo'/'Mirodad 1' (67.15 mm), 'Andreea'/'BN4Kr' (66.10 mm), 'Cacanska Lepotica'/'Adaptabil' (65.08 mm), 'Jojo'/'BN4Kr' (64.98 mm), 'Andreea'/'Mirodad 1' (64.73 mm), and the lowest value of this parameter was recorded in case of combinations 'Cacanska Lepotica'/'BN4Kr' (50.00 mm), 'Cacanska Lepotica'/'Mirodad 1' (51.83 mm), 'Pitesteana'/'Mirodad 1' (55.33 mm), 'Romanta'/'Mirodad 1' (56.90 mm). The 'Andreea' and 'Jojo' trees had high vigour on all three rootstocks tested (Tables 1.a and 1.b).

In conclusion, 'Mirodad 1' rootstock induced a low vigour to the cultivars grafted on them; 'Adaptabil' performed as a very high vigour rootstock. Dutu et al. (2001) reported the similar data about the strong vigour induced by the 'Adaptabil' rootstock to the 'Red Haven' peach cultivar. Butac et al. (2016) studies have confirmed also very vigorous properties of 'Adaptabil' rootstock to the some plum cultivars. 'Adaptabil' rootstock was selected for peach mainly. However, in our study trees of all plum cultivars grafted on this rootstock did not show any incompatibility symptoms in the orchard.

Considering that in this experiment we have not studied other rootstocks as a control for example 'Myrobalan' or 'Saint Julien A', to compare the vigor of the rootstocks studied, we have exemplified with figure 1. Thus, the 'Adaptabil' rootstock in terms of vigour is comparable with 'Myrobalan', and 'Mirodad 1' is similar to 'Saint Julien A'.

Yielding capacity.

Regarding the average number of fruits per tree, it can be observed that in the fourth year

after planting, the number of fruits per tree ranged from 195.48 in case of ‘Andreea’ cv. to 464.03 at ‘Pitesteian’ cv. The significant differences between cultivars and rootstocks were found.

The highest average number of fruits per tree was recorded in the following combinations: ‘Cacanska Lepotica’/‘Adaptabil’ (519.44 fruits/tree), ‘Pitesteian’/‘Mirodad 1’ (473.56 fruits/tree), ‘Pitesteian’/‘Adaptabil’ (463.89 fruits/tree), ‘Pitesteian’/‘BN4Kr’ (454.67 fruits/tree) and ‘Jojo’/‘Mirodad 1’ (422.45 fruits/tree).

The largest number of fruits have been obtained from trees grafted on ‘Adaptabil’ rootstock (321.73 fruits/tree), while the lowest number of fruits had trees on ‘BN4Kr’ rootstock (257.11 fruits/tree) (Tables 1.a and 1.b).

Regarding the *fruits yield*, it can see that there are significant differences between cultivars and rootstocks. Among cultivars tested, trees of ‘Pitesteian’ and ‘Romanta’ were the most productive with the yield of 19.56 kg/tree and 16.97 kg/tree respectively. Making a correlation between the number of fruit on the tree and the yield of fruit it can be seen that at the ‘Romanta’ cv. the number of fruit on the tree was small, but the production was high due to the fact that this cultivar has very large fruits (over 65 g). The ‘Cacanska Lepotica’ cv., although having a large number of fruit on the tree, has a small fruit production due to the fruit size which was 35 g only.

The most productive among rootstocks tested were ‘Mirodad 1’ (14.78 kg/tree) and ‘Adaptabil’ (14.47 kg/tree).

The best cultivar/rootstock combinations in respect of yielding of trees were: ‘Jojo’/‘Mirodad 1’ (21.64 kg/tree), ‘Romanta’/‘BN4Kr’ (21.35 kg/tree), and ‘Pitesteian’/‘Mirodad 1’ (20.01 kg/tree) (Tables 1.a and 1.b).

Fruit weight.

Statistical analysis of data on fruit weight, show that, between cultivars and rootstocks were significant differences. The biggest fruits had ‘Romanta’ cv. (68.52 g) and the smallest - ‘Cacanska Lepotica’ (37.77 g) (Table 2.a). The rootstocks tested did not modify significantly the size of the fruit (Tables 2.b).

Fruit soluble solids content.

After statistical analysis of fruit soluble solids content data, the values were statistically assured. The highest soluble solids content was recorded in ‘Andreea’ fruit (18.72 % Brix) and the lowest - in ‘Pitesteian’ (13.18 % Brix) (Table 2.a). No significant differences between rootstocks in content of soluble solids in fruit were found (Tables 2.b).

Following statistical analysis, significant correlations between the some parameters were obtained: number of fruit/tree and yield (kg/tree), number of fruit/tree and fruit weight (g), number of fruit/tree and soluble solids content (Brix), yield and soluble solids content (Table 3).

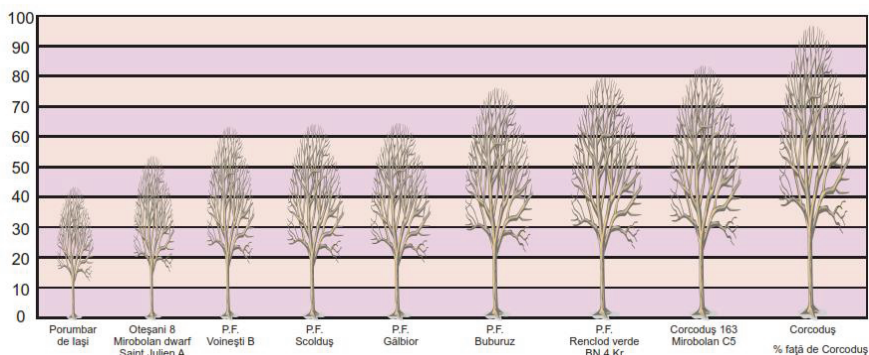


Fig. 1. Relative vigor of plum rootstocks (Mazilu and Dutu, 2014)

Table 1.a. Variation induced by the cultivar to the rootstock (average 2017 and 2018 years)

No.	Rootstock	Cultivar	Trunk diameter (mm)	No. of fruits/tree	Yield (kg/tree)
1	Adaptabil	Andreea	71.41 a	156.45 b	7.48 b
		Pitestean	63.85 a	463.89 a	19.10 a
		Romanta	61.37 a	237.22 b	16.08 a
		Cacanska lepotica	65.08 a	519.44 a	18.24 a
		Jojo	67.98 a	231.66 b	11.45 b
		Average	65.94 a	321.73 a	14.47 a
2	Mirodad 1	Andreea	64.73 ab	266.78 c	12.21 b
		Pitestean	55.33 ab	473.56 a	20.01 a
		Romanta	56.90 ab	192.33 d	13.47 b
		Cacanska lepotica	51.83 b	171.78 d	6.59 c
		Jojo	67.15 a	422.45 b	21.64 a
		Average	59.18 b	305.38 a	14.78 a
3	BN 4Kr	Andreea	66.10 a	163.44 d	7.32 b
		Pitestean	62.45 a	454.67 a	19.56 a
		Romanta	59.17 ab	314.89 b	21.35 a
		Cacanska lepotica	50.00 b	223.33 c	8.89 b
		Jojo	64.98 a	129.44 d	6.93 b
		Average	60.54 ab	257.11 a	12.81 a

Table 1.b. Variation induced by the rootstock to the cultivar (average 2017 and 2018 years)

No.	Cultivar	Rootstock	Trunk diameter (mm)	No. of fruits/tree	Yield (kg/tree)
1	Andreea	Adaptabil	71.41 a	156.45 b	7.48 b
		Mirodad 1	64.73 a	266.78 a	12.21 a
		BN4Kr	66.10 a	163.22 b	7.32 b
		Average	67.41 a	195.48 c	9.00 c
2	Pitestean	Adaptabil	63.85 a	463.89 a	19.10 a
		Mirodad 1	55.33 a	473.56 a	20.01 a
		BN4Kr	62.45 a	454.67 a	19.56 a
		Average	60.54 ab	464.03 a	19.56 a
3	Romanta	Adaptabil	61.37 a	237.22 b	16.09 b
		Mirodad 1	56.90 a	192.33 b	13.47 b
		BN4Kr	59.17 a	314.89 a	21.35 a
		Average	59.15 b	248.15 bc	16.97 ab
4	Cacanska lepotica	Adaptabil	65.08 a	519.44 a	18.24 a
		Mirodad 1	51.83 ab	171.78 b	6.59 b
		BN4Kr	50.00 b	223.33 b	8.89 b
		Average	55.63 b	304.85 b	11.24 c
5	Jojo	Adaptabil	67.98 a	231.66 b	11.45 b
		Mirodad 1	67.15 a	422.45 a	21.64 a
		BN4Kr	64.98 a	129.44 c	6.93 c
		Average	66.70 a	261.18 bc	13.34 bc

Table 2.a. Variation induced by the cultivar to the rootstock (average 2017 and 2018 years)

No.	Rootstock	Cultivar	Fruit weight (g)	Soluble solid contents (% Brix)
1	Adaptabil	Andreea	47.89 b	19.30 a
		Pitestean	41.16 c	13.26 d
		Romanta	67.73 a	13.39 cd
		Cacanska lepotica	35.12 d	13.82 c
		Jojo	49.26 b	16.40 b
		Average	48.23 a	15.23 a
2	Mirodad 1	Andreea	45.75 c	17.47 a
		Pitestean	42.25 d	13.20 d
		Romanta	70.02 a	14.00 c
		Cacanska lepotica	38.35 e	15.24 b
		Jojo	50.98 b	13.82 c
		Average	49.47 a	14.75 a
3	BN 4Kr	Andreea	44.87 c	19.40 a
		Pitestean	43.03 d	13.07 e
		Romanta	67.81 a	14.76 c
		Cacanska lepotica	39.83 e	13.83 d
		Jojo	53.62 b	15.59 b
		Average	49.83 a	15.33 a

Table 2.b. Variation induced by the rootstock to the cultivar (average 2017 and 2018 years)

No.	Cultivar	Rootstock	Fruit weight (g)	Soluble solid contents (% Brix)
1	Andreea	Adaptabil	47.89 a	19.30 a
		Mirodad 1	45.75 b	17.47 b
		BN4Kr	44.87 b	19.40 a
		Average	46.17 c	18.72 a
2	Pitestean	Adaptabil	41.16 b	13.26 a
		Mirodad 1	42.25 ab	13.20 a
		BN4Kr	43.03 a	13.07 a
		Average	42.15 d	13.18 d
3	Romanta	Adaptabil	67.73 b	13.39 c
		Mirodad 1	70.02 a	14.00 b
		BN4Kr	67.81 b	14.76 a
		Average	68.52 a	14.05 c
4	Cacanska lepotica	Adaptabil	35.12 c	13.82 b
		Mirodad 1	38.35 b	15.24 a
		BN4Kr	39.83 a	13.83 b
		Average	37.77 e	14.30 c
5	Jojo	Adaptabil	49.26 b	16.40 a
		Mirodad 1	50.98 b	13.82 c
		BN4Kr	53.62 a	15.59 b
		Average	51.29 b	15.27 b

Table 3. Correlations between the indicators studied

		Trunk diameter (mm)	No. of fruit/tree	Fruit weight (g)	Yield (kg/tree)	SSC (%Brix)
Trunk diameter (mm)	Pearson Correlation	1	,046	,017	,032	,276(**)
	Sig. (2-tailed)		,598	,844	,714	,001
	N	135	135	135	135	135
No. of fruit/tree	Pearson Correlation	,046	1	-,307(**)	,878(**)	-,552(**)
	Sig. (2-tailed)	,598		,000	,000	,000
	N	135	135	135	135	135
Fruit weight (g)	Pearson Correlation	,017	-,307(**)	1	,153	-,076
	Sig. (2-tailed)	,844	,000		,077	,383
	N	135	135	135	135	135
Yield (kg/tree)	Pearson Correlation	,032	,878(**)	,153	1	-,574(**)
	Sig. (2-tailed)	,714	,000	,077		,000
	N	135	135	135	135	135
Soluble solid contents (%Brix)	Pearson Correlation	,276(**)	-,552(**)	-,076	-,574(**)	1
	Sig. (2-tailed)	,001	,000	,383	,000	
	N	135	135	135	135	135

**Correlation is significant at the 0.01 level (2-tailed).

CONCLUSIONS

As results of the investigations we found that:

- ‘Adaptabil’ proved to be a vigorous rootstock;
- ‘Cacanska Lepotica’ and ‘Romanta’ created the smallest tress;
- The most productive rootstocks were ‘Mirodad 1’ and ‘Adaptabil’;
- From all the cultivars studied ‘Pitesteian’ performed as the most productive;
- ‘Romanta’ produced the largest fruit;
- ‘Cacanska Lepotica’ produces many fruits, however of small size;
- ‘Andreea’ trees are not very productive, but fruit contain the most soluble solids.

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