

THE EFFECT OF INTERACTION VARIETY/ROOTSTOCK AT PLUM SPECIES ON THE SOILS OF OLTENIA

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Abstract

Plum is a specie cultivated from ancient times, and the hilly area in the south of the country show suitability for this culture especially for the plantations with valuable varieties and rootstocks. The work shows the influence of the variety, rootstock and the combination variety/rootstock on growth issues, correlations between genetic and physiological processes that occur. The data obtained emphasize the rootstock underground part, his influence on the growth of the trees and phenophases addressing all components. The varieties of plum tree investigated have presented a good compatibility with the two rootstocks, ('Oteşani 8' and 'P.F. Roşior vârtic'). The plum varieties grafted on 'Oteşani 8' rootstock showed a higher intensity of photosynthesis and 'Oteşani 8' rootstock influenced more the chlorophyll ratio a/b. 'P.F. Roşior vârtic' rootstock influenced the content of carotenoid pigments. The right choice of the combination variety/rootstock with the performance of the correct production technologies, can ensure high yields and quality of fruits.

Key words: plum species, rootstock, variety, physiology.

INTRODUCTION

The climatic and pedological conditions, the variety, the rootstock, the combination of the variety x rootstocks are important in the growth and development of the trees, which make a major contribution to obtaining quality fruits. All these factors also influence the physiological aspects that occur in trees. In some researches, states that there is a connection between the intensity of the photosynthesis process and the chlorophyll content of the leaves, with a fundamental role in photosynthesis (Cappellini et al., 1992).

The interaction of genotype x environmental factors in the pear species shows that rooting depth is influenced by rootstock and soil, (Cichi et al., 2008). Other authors point out that an important role in the vigour of trees is represented by the combination of variety x rootstock and environmental factors (Hall-Beyer et al., 1983).

Prunus cerasifera Ehrh seedlings rootstock has been found to influence the varieties at a fairly high level but has a good affinity, (Grzyb et al., 1992).

They were investigated plum varieties in the south of Romania, certain physiological parameters, such as photosynthesis, perspiration, factors that exhibited different oscillations (Botu et al., 2017).

Aspects of some physiological processes in some plum varieties reveal the rootstock's influence on some processes, so the 'Miroval' rootstock has a greater influence on some physiological processes than the 'Oteşani 8' rootstock (Cichi et al., 2009).

States that the main plum varieties grown in Norway are 'Opal' and 'Victoria', and among the most widely used rootstock is 'St. Julien A' (Sekse, 2007). In the evaluation of rootstocks in Italy, good results have been made by the 'GF 677' rootstock, the 'Petra' rootstock which gives a lower vigour and superior qualities superior to fruits (Sottile et al., 2012).

Some authors studied two plum varieties ('Shiro' and 'Stanley') grafted on five rootstocks, thus the surface of the trunk section of the 'Shiro' variety was larger than the 'Stanley' variety (Salvador et al., 2014). It induced a higher growth on the 'GF 677' rootstock than the 'Myrobolan 29C' rootstock.

Some researches present the characteristics of the ‘Rival’ rootstock which has a good compatibility with the varieties, has medium vigour, tolerant to diseases and pests, and other elites are under evaluation (Botu et al., 2007).

MATERIALS AND METHODS

This experience was placed on reddish preluvosoil on the outskirts of Craiova, comprising five varieties and two rootstocks on which they were grafted. The trees were placed randomly in two repetitions with five trees in repetition, 10 trees per variation, respectively. The varieties used in this experiment were ‘Ialomița’, ‘Vâlcean’, ‘Centenar’, ‘Tita’, ‘Vânăt de Italia’ and the rootstocks are ‘Oteșani 8’ and ‘P.F. Roșior vâratîc’. The shape of the crown was the form of a delay vase.

The maintenance system practiced was grassy between the rows and field work on the row of trees. During the plantation, cuts were carried out for maintenance, fruit setting, cuts during the winter rest, treatments were applied upon warning.

Photosynthetic intensity, pigment content (chlorophyll a and b) and content in carotenoids have been studied. The content of

chlorophyll a and b and total carotenoids were determined and calculated by method described by Wellburn (1994), using series T70+ UV-Vis Spectrophotometer.

For photosynthetic intensity was used method described by Rouhani & Khosh-Khui (1979).

The leaves were harvested from the middle of the shoots and the top of the trees, their middle and base. Physiological processes have been studied during the final phenophases of trees, namely intense shoots growth (CIL), slowing down and cessation of shoots growth (ICL) and beginning of fruit ripening (IPF).

The data was recorded over a two-year period (2015-2017), the data being statistically processed with the CSS Statistics program.

RESULTS AND DISCUSSIONS

A very good continuity between grafts and rootstocks leads to good compatibility, without great differences in thickness growth between the two rootstocks and grafts. In the first years of life due to more intense growth processes, the ratio between the graft to rootstock was higher for plum varieties studied. Seven years after planting, the average of the ratio was 1.07 in 2016, and 1.08 in 2017 (Table 1).

Table 1. Ratio scion/rootstock (2016-2017)

Variety/Rootstock	Year 2016	Year 2017	Average
Ialomița/Oteșani 8	1.02	1.09	1.05
Vâlcean/Oteșani 8	1.07	1.10	1.08
Centenar/Oteșani 8	1.07	0.99	1.03
Tita/Oteșani 8	1.09	1.13	1.11
Vânăt De Italia/Oteșani 8	1.10	1.09	1.09
<i>Average</i>	<i>1.07</i>	<i>1.08</i>	<i>1.07</i>
Ialomița/P.F. Roșior vâratîc	1.10	1.05	1.07
Vâlcean/P.F. Roșior vâratîc	1.07	1.11	1.09
Centenar/P.F. Roșior vâratîc	1.08	1.17	1.12
Tita/P.F. Roșior vâratîc	1.04	1.04	1.04
Vânăt De Italia/P.F. Roșior vâratîc	1.10	1.09	1.09
<i>Average</i>	<i>1.07</i>	<i>1.09</i>	<i>1.08</i>
<i>Average X</i>	<i>1.07</i>	<i>1.08</i>	<i>1.07</i>

We noticed a better affinity for the five varieties grafted on the ‘Oteșani 8’ rootstock, so in 2017 the ratio was 1.08 and the ‘P.F. Roșior vâratîc’ rootstock was 1.09. The differences are not great with regard to the rootstock effect on the variety, so ‘Vânăt de Italia’ variety presented identical values in the two years, both grafted on the ‘Oteșani 8’

rootstock and ‘P.F. Roșior vâratîc’ rootstock (1.09 – 1.10).

Analyzing the average of the years for each variety grafted on each rootstock we observe that most of the varieties grafted on ‘Oteșani 8’ had a lower ratio than the same varieties grafted on the ‘P.F. Roșior vâratîc’ rootstock.

The ‘Ialomița’ variety grafted on ‘Oteșani 8’ had an average ratio of 1.05 and the same

variety grafted on ‘P.F. Roșior văratic’ rootstock had a slightly higher ratio of 1.07. A ratio very close to the unit (1) we met at ‘Centenar/Oteșani 8’ variety where the registered ratio was 1.03, followed by the ‘Ialomița’/‘Oteșani 8’ variety with a ratio of 1.05. ‘Tita’/‘P.F. Roșior văratic’ variety had a very close ratio to 1, respectively 1.04 (Figure 1).

Even if the other varieties showed slightly higher values, tree growth was normal without disruption.

After seven years of vegetation, correlating the mean annual values over the total variants of annual growths, crown diameter, trunk section surface with rootstock/scion ratio, we notice significant correlations (Table 2).

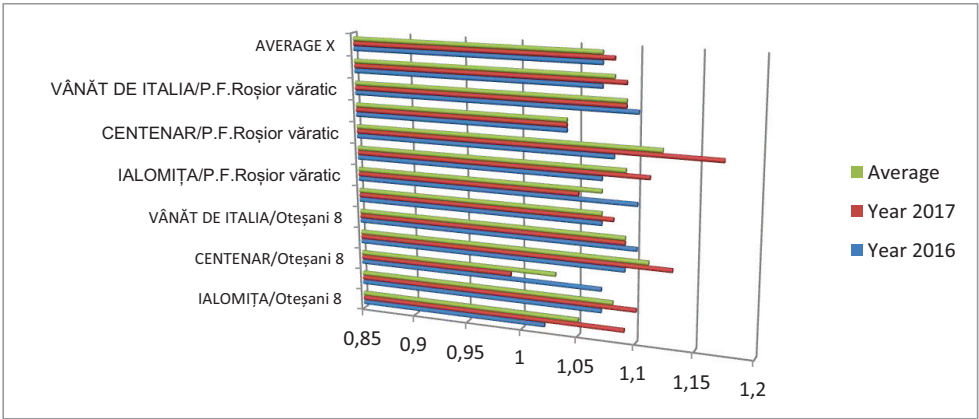


Figure 1. Ratio scion/rootstock of plum varieties studied

Table 2. Correlations between annual increases, crown diameter, trunk section surface and ratio rootstock/scion (Year 2017)

Variable	Correlations are significantly marked for $p < 0.05$		
	Annual increases	Crown diameter	Trunk section surface
Ratio scion/ rootstock	0.227	0.113	0.099
	N=10	N=10	N=10
	p=0.04	p=0.17	p=0.30

Separately analyzing the influence of the rootstock was found that values closer to 1.00 were noted especially at the ‘Oteșani 8’

rootstock (1.06) and then at the ‘P.F. Roșior văratic’ rootstock (1.08) (Table 3).

Table 3. Influence of rootstock (Years 2016-2017)

Rootstock	Variety	Rao R (17.192)= 3.57 $p<.0000$	
		Year 2016	Year 2017
Oteșani 8	1.061122	1.064621
P.F. Roșior văratic	1.081556	1.081636

The trees are considered to be a living organism with an intense activity that during the vegetation synthesizes the organic vegetal substance.

Based on the results obtained we find that the intensity of photosynthesis differs from

phenophase to phenophase and differs also in each variety/rootstock combination (Table 4).

In the case of ‘Oteșani 8’ rootstock, varieties achieved an average of photosynthetic intensity in 2017 of 231.4 mg CO₂/dm²/h at the beginning of the ripening, a value of higher intensity compared to vegetative phenophase.

Table 4. The photosynthetic intensity (mg CO₂/dm²/h) of the plum varieties studied (2015-2017)

Variety/rootstock	CIL	ICL	IPF
Ialomița/Oteșani 8	216.200	220.300	230.500
Vâlcean/Oteșani 8	200.400	213.500	225.600
Centenar/Oteșani 8	213.600	227.200	240.300
Tita/Oteșani 8	213.200	218.200	220.500
Vânăț de Italia/Oteșani 8	220.500	233.500	240.500
<i>Average</i>	<i>212.7</i>	<i>222.5</i>	<i>231.4</i>
Ialomița/P.F. Roșior văratic	220.700	236.700	240.500
Vâlcean/P.F. Roșior văratic	197.600	225.100	235.500
Centenar/P.F. Roșior văratic	217.600	233.400	240.400
Tita/P.F. Roșior văratic	213.700	230.600	238.500
Vânăț de Italia/P.F. Roșior văratic	220.200	232.600	236.500
<i>Average</i>	<i>213.9</i>	<i>231.6</i>	<i>238.2</i>

Phenophases: CIL - intense shoots growth, ICL- slowing down and cessation of shoots growth (ICL) and IPF - beginning of fruit ripening.

The phenophase slowing down and cessation of shoots growth (ICL) showed a higher photosynthetic intensity (222.5 mg CO₂/dm²/h) in the case of the plum varieties grafted on ‘Oteșani 8’ rootstocks, but also to varieties grafted on ‘P.F.Roșior văratic’ (231.6 mg CO₂/dm²/h) than in the phenophase the intense growth of the sprouts.

In the phase of slowing down and cessation of shoots growth (ICL), new leaves were formed on the branches, which reached the maximum size and thus the area of assimilation increased by favoring more intense photosynthesis. The results obtained mention that the intensity of photosynthesis is higher during leaf growth period. The intensity of photosynthesis decreases in the aging phase of the tissues (Sams et al., 1982).

The varieties grafted on the ‘Oteșani 8’ rootstock showed a lower photosynthesis intensity than the varieties grafted on the ‘P.F. Roșior văratic’ rootstock in all the phenophases. The variety with a stronger photosynthesis intensity was the ‘Ialomița’/

‘P.F. Roșior văratic’ varieties with 220.7 mg CO₂/dm²/h in the intense growth of shoots (CIL), in the slowing down and cessation of shoots growth (ICL) by 236.7 mg CO₂/dm²/h and in the beginning of fruit ripening (IPF) by 240.5 mg CO₂/dm²/h.

We have found out that the rootstock has a great influence on the photosynthesis process, and the rootstock that imprints the trees a larger growth will reach higher values of the photosynthesis intensity than the lower vigour rootstock.

The influence of the variety on photosynthesis (Table 5) shows different data within each variety of each phenophase, so in all phenophases the variety with a higher intensity of photosynthesis is ‘Ialomița’ variety: CIL - 223.00 mg CO₂/dm²/h, ICL - 230.846 mg CO₂/dm²/h and IPF - 239.433 mg CO₂/dm²/h. Regarding the rootstock’s influence on the photosynthesis process, it can be noticed that the ‘P.F. Roșior văratic’ rootstock influences more strongly the photosynthesis process in all phenophases (Table 6).

Table 5. Variety effect on photosynthesis (Averages - year 2017)

Rootstock	Variety	CIL	ICL	IPF
....	Ialomița	223.000	230.846	239.433
....	Vâlcean	197.934	215.400	223.600
....	Centenar	207.712	218.246	230.596
....	Tita	210.356	218.533	226.243
....	Vânăț de Italia	211.312	224.276	233.853

Table 6. Rootstock effect on photosynthesis (Year 2017)

Rootstock	Variety	CIL	ICL	IPF
Oteşani 8	213.110	223.361	231.351
Roşior văratic	214.432	228.655	235.450

The mean values for vegetative phases were 235.4 mg CO₂/kg/h at CIL and 303.3 mg CO₂/kg/h at ICL. An important aspect in the growth and development of the trees is the content of pigments in leaves, respectively, the chlorophyll a/b ratio, the carotenoid content. All of these are different depending on variety, rootstock and phenophase. CIL phenophase -

the intensive growth of the shoots showed a higher ratio of chlorophyll a/b due to higher biosynthesis of chlorophyll a. The varieties grafted on 'Oteşani 8' showed an average value of the chlorophyll a/b ratio larger at ICL of 3.39, a CIL ratio of 3.32 and the lowest IPF ratio of 1.92 (Table 7).

Table 7. Values of the chlorophyll a/b ratio (2015-2017)

Variety/rootstock	CIL	ICL	IPF
Ialomiţa/Oteşani 8	3.350	3.570	2.200
Vâlcean/Oteşani 8	3.310	3.290	2.110
Centenar/Oteşani 8	3.470	3.470	1.800
Tita/Oteşani 8	3.320	3.320	1.300
Vânăt de Italia/Oteşani 8	3.160	3.310	2.200
<i>Average</i>	<i>3.32</i>	<i>3.39</i>	<i>1.92</i>
Ialomiţa/P.F. Roşior văratic	3.750	3.860	1.800
Vâlcean/P.F. Roşior văratic	3.440	3.480	2.600
Centenar/P.F. Roşior văratic	3.530	3.490	1.800
Tita/P.F. Roşior văratic	3.410	3.450	2.500
Vânăt de Italia/P.F. Roşior văratic	3.170	3.300	1.600
<i>Average</i>	<i>3.46</i>	<i>3.51</i>	<i>2.06</i>

The varieties grafted on the 'P.F. Roşior văratic' recorded higher values in the chlorophyll a/b ratio than the varieties grafted on 'Oteşani 8'. Analyzing separately the effect of the variety on the chlorophyll a/b ratio we can see that the value ranged between 3.412 in the 'Vâlcean' variety and 3.502 in the 'Centenar' variety in the intensive sprout growth phenophase (Table 8). Chlorophyll a/b ratio values have decreased

in the cessation of sprout growth phenophase (ICL) until the leaf aging phase, being comprised between 3.315 and 3.410. The rootstock effect on the chlorophyll a/b ratio indicates that the 'Oteşani 8' rootstock imprints higher values than the 'P.F. Roşior văratic' rootstock in the sprout intensive growth (CIL) and at the cessation of sprout growth (ICL) (Figure 2).

Table 8. The variety effect on the chlorophyll a/b ratio (year 2017)

Rootstock	Variety	CIL	ICL	IPF
....	Ialomiţa	3.425	3.410	3.573
....	Vâlcean	3.412	3.315	3.460
....	Centenar	3.502	3.400	3.520
....	Tita	3.430	3.410	3.435
....	Vânăt de Italia	3.420	3.352	3.352

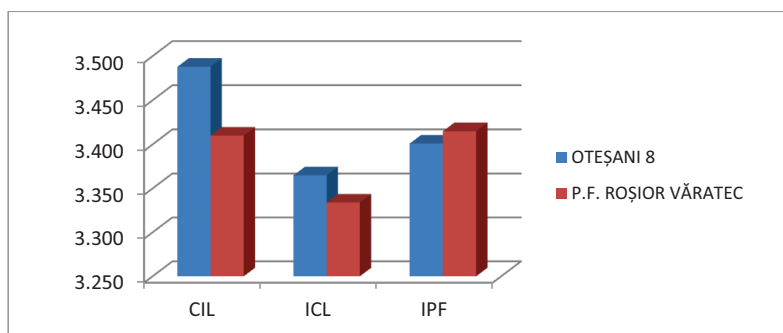


Figure 2. The rootstock effect on the chlorophyll a/b ratio

Table 9. The content of carotenoid pigments (2015-2017)

Variety/rootstock	CIL	ICL	IPF
Ialomița/Oteșani 8	8.000	8.400	8.000
Vâlcean/Oteșani 8	8.100	9.100	8.000
Centenar/Oteșani 8	7.900	8.900	8.500
Tita/Oteșani 8	9.100	10.100	9.300
Vânăt de Italia/Oteșani 8	8.400	9.400	9.100
<i>Average</i>	<i>8.30</i>	<i>9.18</i>	<i>8.58</i>
Ialomița/P.F. Roșior văratic	8.600	9.500	9.200
Vâlcean/P.F. Roșior văratic	8.600	9.400	8.700
Centenar/P.F. Roșior văratic	8.500	9.400	8.800
Tita/P.F. Roșior văratic	9.400	9.800	9.600
Vânăt de Italia/P.F. Roșior văratic	9.100	10.000	9.500
<i>Average</i>	<i>8.84</i>	<i>9.62</i>	<i>9.16</i>

It states that a variety can be influenced in growth and development by the respective rootstock, and ‘Marianna’ rootstock has influenced a higher content of chlorophyll in leaves (Gaudillere et al., 1990).

Regarding the content of carotenoid pigments, the plum varieties had a higher content in carotenoids in the phenophase – cessation of shoots growth (ICL) on both ‘Oteșani 8’ and ‘P.F. Roșior văratic’ rootstocks, thus on ‘Oteșani 8’ the average was 9.18 mg/100 g and on ‘P.F. Roșior văratic’ was 9.62 mg/100 g, (Table 9).

The average content in carotenoid pigments was between 8.58 and 9.16 mg/100 g in the phenophase cessation of shoots growth (ICL).

In the CIL phenophase - the intensive growth of the shoots in the varieties with a higher carotenoid pigment content were ‘Tita’ and ‘Vânăt de Italia’ on both rootstocks. The varieties grafted on the ‘Roșior văratic’ had a higher content than the plum varieties grafted on the ‘Oteșani 8’ rootstock in all the phenophases.

CONCLUSIONS

Plum varieties showed very good compatibility on the two rootstocks ‘Oteșani 8’ and ‘P.F. Roșior văratic’.

The ratio closest to 1 in terms of compatibility was demonstrated by the varieties ‘Centenar’/ ‘Oteșani 8’, ‘Ialomița’/ ‘Oteșani 8’ and ‘Tita’/ ‘P.F. Roșior văratic’.

Influence of the rootstock on the graft and vice versa may be lower if the differences between the two partners are small and the root system of the rootstock has an important role in these influences.

Roots have shown good development, able to ensure by the absorption of nutrients the differentiation of fruit buds, growth and development of the trees.

The varieties on the ‘Oteșani 8’ rootstock presented a lower intensity of photosynthesis during the two years of study and in all phenophases.

The ‘P.F. Roșior văratic’ rootstock, which imparts greater force to the varieties, influences

the intensity of the photosynthesis compared to the 'Oteşani 8' rootstock.

The effect of the variety on photosynthesis highlights varieties with a higher intensity of photosynthesis, namely 'Ialomița', 'Vânăț de Italia', 'Tita' and 'Centenar'.

In vegetative phenophases, intensive shoots growth phenophase (CIL) showed a chlorophyll a/b ratio much higher than in the phenophase of cessation of shoots growth (ICL).

The 'Oteşani 8' rootstock imprints higher values of the chlorophyll a/b ratio than the 'P.F. Roşior văratic'.

The studied plum varieties recorded a higher content in carotenoids in the cessation of shoots growth phenophase (ICL) in all years of study.

All phenophases presented oscillations each year, influence coming both from the graft, rootstock and both variety/rootstock partners.

An important role in the growth and development of trees, namely in the obtaining of fruits, has all the physiological aspects besides the other factors.

The plum varieties on the respective rootstocks find favourable conditions for growing, fructification in Oltenia.

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