

## RESEARCHES ON THE INFLUENCE OF ROOTSTOCKS ON GROWTH AND FRUCTIFICATION OF PLUM VARIETIES

**CIOBANU ANDI**

University of Craiova, Faculty of Agronomy

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### ABSTRACT

Plum is a rustic species that succeeds in minimal agrotechnic conditions and therefore has expanded extensively in the gardens of the population.

Particularly favorable ecological conditions for the plum culture allow for the expansion of new varieties, recently created in our country or imported from abroad. By properly applying crop technologies, high and consistent production can be achieved to meet the needs of domestic consumption and to ensure availability for export.

The researches were carried out between 2014 and 2016 within a plantation set up in 1995. The biological material used in this paper is represented by 19 plum varieties (Diana, Ialomița, Silvia, Piteștean, Centenar, Minerva, Flora, Carpatin, Valcea, Tita, Tuleu gras, Renclod Althan, Pescăruș, Dâmbovița, Record and Anna Spath) grafted on 3 or 4 rootstocks (Oteșani 8, Pixy, Miroval and Roșior văratic).

The paper aims to establish the rootstock's influence on growth and fructification within the graft / rootstock biosystem.

The Oteșani 8 rootstock imprints to the studied varieties the smallest growth, while the Miroval rootstock imprints the highest growth force to the varieties studied. In all studied elements. Pixy and Roșior văratic varieties give to the studied varieties an average growth force compared to the other two rootstocks.

### INTRODUCTION

In international fruit trade, plums account for about 2% of the total volume of trade, and in the Common Market (EU) it represents 6-7% (Chiriac, 1992).

Plums are appreciated for fresh, dehydrated consumption (dried plums) and processed in the form of jams, marmalades, compotes, jellies, liqueurs, brandy, candied or pickled fruits; it is more suitable than other kernel fruit for refrigeration storage, especially in sugar syrup (Botu M., 2000).

Sitarek et al. (2004), studying the behavior of 5 plum varieties grafted on three rootstocks under different conditions from the pedoclimatic point of view, concluded that varieties grafted on Pixy rootstock had lower yields compared to varieties grafted on rootstock *P. divaricata*, respectively smaller fruits.

Grzyb and Sitarek (2007), after four years of research, concluded that the Wangenheim Prune and Jaspi rootstocks impressed to Hanita and Dabrowice plum varieties, reduced vigor, high productivity and higher weight of fruit.

Gastrol and Poniedzialek (2007), studying the behavior of four varieties grafted on three rootstocks, highlighted a new promising semi-dwarf rootstock for modern plum orchards, characterized by moderate growth, good productivity and high tolerance to Plum Pox Virus.

Meland and Moe (1999), studying behavior in the climatic conditions of the area (60° northern latitude) of six plum varieties grafted on three rootstocks, concluded that the tested rootstocks gave rise to vigorous trees, from semi-dwarf to semi-vigorous, and the Saint Julien A and Pixy rootstocks led to the production of semi-vigorous trees, but which induce high yield and high quality fruit.

Botu I. and Achim Gh. (2004), studying the behavior of the graft / rootstock biosystem according to the soil type, found out that it has a major influence on the fruit production, its quality and the growth vigor.

Studying the physiological aspects of two plum trees grafted on three rootstocks, Cichi M. (2002) found out that the Miroval rootstock influences the photosynthesis and breathing processes more intensely than the Oteșani 8 rootstock.

## MATERIALS AND METHODS

The research was carried out between 2014 and 2016 within a plantation set up in 1995. The biological material used in this paper is represented by 19 plum varieties (Diana, Ialomița, Silvia, Piteștean, Centenar, Minerva, Flora, Carpatin, Valcea, Tita, Tuleu gras, Renclod Althan, Pescăruș, Dâmbovița, Record and Anna Spath) grafted on 3 or 4 rootstocks (Oteșani 8, Pixy, Miroval and Roșior varatic). The research methods used in the three years of study (2014-2016) have taken into account the proposed objectives.

To determine the rootstock's influence on growth, fructification and root suckers capacity within the graft / rootstock bio-system, the following researches were conducted on:

1) *biometric measurements*: trunk circumference (cm); trunk section area (TSA) (cm<sup>2</sup>) crown diameter (cm); tree height (cm); crown volume (m<sup>3</sup>) and land use degree (%). The research consisted in making measurements on trees each year, using the calipers, roulette, meter, etc.

2) *growth and fructification phenophases*: the beginning of swelling of vegetative buds; the beginning of the bloom; fruit maturation; end of vegetation period; the number of days of the growing season and the days with active temperatures (>5° C).

From the end of February to the beginning of March, all these phenophases were observed in the plantation, recording the calendar date for each variety and rootstock, the observations ending with the end of the vegetation period, respectively the fall of the leaves (calendar period: end of October - end of November).

## RESEARCH RESULTS

### 1. Influence of rootstock within the bio-system

If we follow the influence of rootstock on the growth of the variety (Table 1), we find that the average value of the trunk section surface at the four rootstocks is of 144 cm<sup>2</sup>. The highest value is recorded at the Miroval rootstock (189 cm<sup>2</sup>) and the lowest value at the Oteșani 8 rootstock (106 cm<sup>2</sup>). Roșior văratic and Pixy portals record values close to average, respectively 141 cm<sup>2</sup> and 140 cm<sup>2</sup>. If we take as control the Miroval rootstock, there are found very significant negative statistical differences: -83 cm<sup>2</sup> at the root of Oteșani 8, -49 cm<sup>2</sup> at Pixy rootstock, -48 cm<sup>2</sup> to Roșior văratic rootstock and -45 cm<sup>2</sup> to the average.

**Table 1**

### The influence of rootstock on trunk growth

No.	ROOTSTOCK	<i>Biometric measurements average</i>		
		TSA (cm <sup>2</sup> )	Difference +/-	Significance
1.	OTEȘANI 8	106	-83	000
2.	PIXY	140	-49	000
3.	MIROVAL (Ct)	189	-	Control (Ct)
4.	ROȘIOR V.	141	-48	000
<b>AVERAGE</b>		144	-45	000

LSD 5% = 3.6 cm<sup>2</sup>

LSD 1% = 5.2 cm<sup>2</sup>

LSD 0,1% = 7.9 cm<sup>2</sup>

The average diameter of the crown recorded in the four rootstocks is 356 cm, with the following values: 314 cm at the Oteșani 8 rootstock, 354 cm at Pixy rootstock, 364 cm at Roșior văratic rootstock and 392 cm at the Miroval rootstock (Table 2).

The average height of the trees on the four rootstocks is 399 cm, respectively 362 cm at the Oteșani 8 rootstock, 393 cm at Pixy rootstock, 399 cm at Roșior văratic rootstock and 441 cm at the Miroval rootstock (Table 2).

The average volume of tree crown grafted on the four rootstocks has a mean value of 34 m<sup>3</sup>, with 24 m<sup>3</sup> at the Oteșani 8, 32 m<sup>3</sup> at Pixy rootstock, 35 m<sup>3</sup> at the Roșior văratic and 46 m<sup>3</sup> to the Miroval rootstock (Table 2).

The average utilization rate of the land by trees is 62.1%, the values being 48.3% for the grafting on the Oteșani 8 rootstock, 61.4% for the trees grafted on Pixy rootstock, 65.0% for the grafted trees Roșior văratic rootstock and 75.3% for trees grafted on the Miroval rootstock (Table 2).

**Table 2**

### The influence of rootstock on variety growth

No.	ROOTSTOCK	<i>Biometric measurements average</i>			
		The diametre of the crown	Height of the tree (cm)	The average volum (m <sup>3</sup> )	The average utilization rate of the land (%)
1.	OTEȘANI 8	314	362	24	48,3
2.	PIXY	354	393	32	61,4
3.	MIROVAL (Ct)	392	441	46	75,3
4.	ROȘIOR V.	364	399	35	65,0
<b>AVERAGE</b>		356	399	34	62,1

In conclusion, we can state that the Oteșani 8 rootstock imprints the smallest growth of the studied varieties, namely the section of the trunk, the diameter of the crown, the height of the tree, the crown volume and the degree of use of the land, while the Miroval rootstock imprints the largest growth force to all the elements studied.

The Pixy and Roșior văratic rootstock imprints a medium growth force to the studied varieties, compared to the other two rootstocks, to all the elements that have been determined.

Studying the occupancy of the land, according to the size of the crowns and the planting distance, to the plum varieties grafted on the four rootstocks, the following were found (table 3):

- **to the plum varieties grafted on the Oteșani 8 rootstock**, at the planting distance of 4.0 / 4.0 m (625 plants/ha), the utilization rate of the land is 48.31%. The surface area occupied by a tree is 7.73 m<sup>2</sup>. If the planting distance is 4.0/2.0 m (1250 plants/ha) then the occupancy of the land is 96.62%. If the planting distance is 5.0/4.0 m (500 plants/ha), the occupancy rate of the land is only 38.65%.

- **to the plum varieties grafted on Pixy rootstock**, the occupancy of the land is 61,43%, at the planting distance of 4.0/4.0 m. The area occupied by each tree is 9.83 m<sup>2</sup>. If tree planting is at a distance of 4.0/2.0 m (1250 plants/ha), then the occupancy of the land is 122.87%, meaning that the trees cross their crowns. As a result, this planting distance is not indicated for the plum varieties grafted on Pixy rootstock. If the planting distance is 5.0/4.0 m (500 plants/ha), the occupancy of the land is only 49.15%, therefore this planting distance is not recommended to be used.

- **to the plum varieties grafted on the Miroval rootstock** with a planting distance of 4.0/4.0 m (625 plants/ha), the occupancy rate of the land is 75.37%. The area occupied by a tree is 12.06 m<sup>2</sup>. If the planting distance is 5.0/4.0 m (500 plants/ha), the occupancy rate of the land is only 38.65%.

- **to the plum varieties grafted on the Roșior văratic**, the occupancy of the land is 65,00%, with the planting distance of 4.0/4.0 m (625 plants/ha). The area occupied by each tree is 10.40 m<sup>2</sup>. If the planting distance is 5.0/4.0 m (500 plants/ ha), the utilization rate of the land is only 52.00%, so this planting distance is not indicated for use.

In conclusion, we can say that, if we take into account the occupancy of the land, for the plum varieties grafted on the Oteșani 8 rootstock, the optimal planting distance is 4.0/2.0 m (1250 plants/ha), and for the varieties of plum grafted on the other rootstocks this distance is not indicated because the land occupancy degree is over 100%.

**Table 3**

**The occupancy rate of the land according to the size of the crowns to plum cultivated on different rootstock**

Nr. crt.	ROOTSTOCK	The occupancy of the land m <sup>2</sup> /625 trees (%)	The occupancy of the land m <sup>2</sup> /tree	The occupancy of the land to different distances (%)	
				4x2m (1250 trees)	5x4m (500 trees)
1.	OTEȘANI 8	48.31	7.73	96.62	38.65
2.	PIXY	61.43	9.83	122.87	49.15
3.	MIROVAL	75.37	12.06	-	60.30
4.	ROȘIOR V.	65.00	10.40	-	52.00

## 2. Cover of the main growth and fructification phenophases

In the phenophases of growth and fructification, the following aspects were studied: the beginning of the growth of vegetative buds, the beginning of the flowering, the maturation

of the fruits, the end of the vegetation period and the number of days of the vegetation period (days with active temperatures  $>5^{\circ}\text{C}$ ).

The beginning of vegetative buds (2014-2016) occurs when the sum of the active temperature degrees ( $>5^{\circ}\text{C}$ ) records values between 50-113 $^{\circ}\text{C}$ , in the case of varieties grafted on the rootstocks Oteșani 8 and Miroval (calendar between March 03 - March 15) between 50-117 $^{\circ}\text{C}$  for varieties grafted on Pixy rootstock (calendar between March 03 - March 16) and 56-117 $^{\circ}\text{C}$  in the case of varieties grafted on Roșior văratic rootstock (calendar between March 06 - March 16) (Table 4). It is thus found that the recorded differences are very small.

The beginning of the bloom (2014-2016) takes place when the sum of the active temperature degrees is between 129-184 $^{\circ}\text{C}$ , in the case of the Oteșani 8, Pixy and Miroval rootstocks (calendar between March 28 and April 04) respectively between 129-189 $^{\circ}\text{C}$  in the case of varieties grafted on the Roșior văratic rootstock (calendar between March 28 - April 5).

The varieties where blossom occurs most rapidly are Diana, Silvia, Vâlcean, Ialomița, Centenar, Renclod Althan and Valor, and those with the later flowering are Stanley, Dâmbovița, Anna Spath, Alina, Tuleu gras etc.

Fruit maturation occurs when the sum of the active temperature degrees is between 1239-2710 $^{\circ}\text{C}$  for varieties grafted on Oteșani 8 rootstock (calendar between 30 June to 12 September) between 1259-2710 $^{\circ}\text{C}$  to varieties grafted on the Miroval rootstock (calendar between July 1 and September 12), between 1298-2732 $^{\circ}\text{C}$  to varieties grafted on Pixy rootstock (calendar July 3 to September 14) and between 1430-2659 $^{\circ}\text{C}$  to the varieties grafted on the Roșior văratic rootstock (calendar July 10 - September 6).

The order of maturation of the varieties is as follows: Diana, Ialomița, Minerva, Piteștean, Carpatin, Vâlcean, Silvia, Centenar, Renclod Althan, Tita, Flora, Alina, Pescăruș, Dâmbovița, Tuleu gras, Stanley, Valor, Record and Anna Spath.

**Table 4**

**The influence of rootstock on the main of growth and fructification phenophases**

No.	ROOTSTOCK	ACTIVE TEMPERATURES ( $>5^{\circ}\text{C}$ )				
		The beginning of the growth of vegetative buds	The end of the vegetation period	The number of days of the vegetation period	The beginning of the flowering	The maturation of the fruits
1.	<b>OTEȘANI 8</b>	50-113	2575-3125	226-251	129-184	1239-2710
2.	<b>PIXY</b>	50-117	2581-3125	226-252	129-184	1298-2732
3.	<b>MIROVAL</b>	50-113	2586-3125	228-253	129-184	1396-2710
4.	<b>ROȘIOR VĂRATIC</b>	56-117	2586-3125	227-248	129-189	1259-2659

The end of the vegetation period (2014-2016) is recorded when are accumulated active temperatures ranging between 2575-3125 $^{\circ}\text{C}$  to varieties grafted on Oteșani 8 rootstock (calendar between October 22 - November 16), between 2581-3125 $^{\circ}\text{C}$  to varieties grafted on Pixy rootstock (calendar between 23 October to 18 November) between 2586-

3125<sup>0</sup>C to the varieties grafted on the Miroval and Roșior văratic rootstocks (calendar between 24 October to 20 November).

The number of days of active temperatures during the vegetation period varied between 226-251 days in varieties grafted on the Oteșani 8 rootstock, between 226-252 days at varieties grafted on Pixy rootstock, between 228-253 days for varieties grafted on the Miroval rootstock and between 227-248 days for varieties grafted on Roșior văratic rootstock.

In the light of the above, we can conclude that the influence of rootstock on the main phenophases of growth and fructification of plum varieties studied is not very high, the values recorded by the four rootstocks being close.

### CONCLUSIONS

#### *1. on rootstock's influence on growth within the graft / rootstock bio-system*

- the Oteșani 8 rootstock imprints the smallest growth of the studied varieties, namely the section of the trunk section, the crown diameter, the height of the tree, the crown volume and the degree of use of the land, while the Miroval rootstock imprints the greatest growth force to the varieties in all studies element. The Pixy and the Roșior văratic rootstock imprint a medium growth force to the studied varieties, compared to the other two rootstocks, to all the elements that have been determined.

- if we take into account the occupancy of the land, for the plum varieties grafted on the Oteșani 8 rootstock, the optimal planting distance is 4.0/2.0 m (1250 plants/ha), and for the varieties of plum grafted on the other rootstocks this distance is not indicated because the land occupancy degree is over 100%.

#### *2. on growth and fructification phenophases*

- *starting in vegetation, marked by the beginning of budding, occurs when the sum of active temperatures degrees (>5<sup>0</sup>C) records values between 50-117<sup>0</sup> C, these values being greatly influenced by the duration of the cold season;*

- The flowering of plum varieties in the central area of Oltenia took place in April during the registration of active temperatures ranging from 129-189<sup>0</sup>C, differences in flowering being found between varieties as well as within the variety, depending on the graft/rootstock biosystem. The varieties were blossom starts at the earliest are Diana, Silvia, Vâlcean, Ialomița, Centenar, Renclod Althan and Valor, and those with the later blossom are Stanley, Dâmbovița, Anna Spath, Alina, Tuleu etc.;

- for fruit maturation the sum of the recorded active temperatures (2014-2016) varies between 1239-2732<sup>a</sup>C, depending on the year and the graft / rootstock association. The order of maturation of the varieties is as follows: Diana, Ialomita, Minerva, Piteștean, Carpatin, Vâlcean, Silvia, Centenar, Renclod Althan, Tita, Flora, Alina, Pescăruș, Dâmbovița, Tuleu gras, Stanley, Valor, Record and Anna Spath.

- the end of the vegetation period, marked by the fall of leaves, occurs at the accumulation of 1575-3125<sup>a</sup>C active temperatures;

- the number of days with active temperatures during the growing season during the three years of study (2014-2016) varies between 226-253 days;

- the influence of rootstock on the main phenophases of growth and fructification of the studied plum species is not very high, the values of the four rootstock being close.

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