

COMPARATIVE STUDY ON THE RESPONSE OF SEVERAL PLUM CULTIVARS IN CENTRAL TRANSYLVANIA CONDITIONS, ROMANIA

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Abstract. In the conditions of central Transylvania, Romania, five plum cultivars were studied, with different fruit ripening: earlier (Tuleu timpuriu), semi-earlier (Reine Claude d'Althan), medium (Valor), semi-late (Vinete de Italia), late (Vinete romanesti). Tuleu timpuriu and Reine Claude d'Althan distinguish for their high productivity (over 20 kg of fruits per tree), Valor for the large fruits (with the average of 68.0 g, but with a lower quality), Vinete romanesti and Vinete de Italia for their extreme susceptibility to the most important diseases (*Polystigma rubrum* and Plum-pox virus). One of the traditional plum cultivars from Romania, still largely spread in Transylvania, Vinete romanesti, which is very appreciated, both for its fruit taste and for the alcohol distillation obtained, confirmed its estimation due to fruit quality. Vinete romanesti has small fruits compared to the actual commercial requirement of the fresh plum, low productivity, and it is extremely susceptible to Plum-pox virus and *Polystigma rubrum* attack, thus the cultivar unfulfills the conditions for modern cultivars. In addition, the cultivar can be used in plum breeding, as genitor for quality (taste of fruits) and the low vigour of trees. The high values of the heritability coefficient, in a broad sense, applied to the majority of the analyzed traits, suggest that, through an adequate selection of the genitors, descendents, which can present valuable traits from the parental form, can be obtained and thus, new cultivars can be selected. Vinete romanesti can be used in plum breeding, as genitor for quality (taste of fruits) and the low vigour of trees.

Key words: plum, cultivars, selection, quality, variability, breeding

INTRODUCTION

The plum tree is cultivated on all the continents due to its adaptability, on a surface of more than 2 million ha. In the temperate climate, the plum is one of the most cultivated species. The consumers appreciate the fruits of this species, either fresh or used for jam, compote, dehydrated plums, juices etc. Plums are high in carbohydrates, low in fat and low in calories. Plums are an excellent source of vitamin A, calcium, magnesium, iron, potassium and fibre. Plums are free of sodium and cholesterol, and contain a substantial amount of vitamin C. Because of its economical, social, supply importance, the creation of new varieties of plum remains a priority (Weinberger, 1975; Ramming and Cociu, 1990; Cimpoieş, 2002).

In Romania, the plum tree was the most spread species, because of the good climate conditions, the fruit value (energetic, nourishing, dietetic) and was further considered a

traditional variety (Cociu et al., 1997, 1999, 2002; Drăgoi, 2000; Ropan et al., 2002; Zagrai, 2000).

In Transylvania, plum cultivation has an old and rich tradition. However, from the year 1989, plum areas have diminished (Ropan et al., 2002), similar to all Romania. The phenomenon can be explained by means of economical and social elements, although results can seem paradoxical. Because of the researches conducted on plum tree breeding, the high number of varieties obtained, but also the value of the new varieties, Romania is situated on a premier position in international pomiculture (Cociu et al., 1997, 1999, 2002; Sestraş, 2004).

The present study deals with the way in which some cultivated varieties in Transylvania correspond to their requirements, intensity of pomiculture plantations, production and quality, and also the response to diseases attack. Of all diseases, the Plum-pox virus (PPV or Sharka) is granted special attention because of its importance (Fischer and Männel, 1994; Hartmann, 2002; Rankovic, 1994).

MATERIAL AND METHODS

The biologic material studied was represented by five plum varieties, being located in a commercial plantation in Batos, near the town of Reghin, in the centre of Transylvania, Romania. Some of these varieties were native: Tuleu timpuriu (Early Tuleu) and Vinete romanesti (synonym Vinete de Bistrita; vinete = dark blue; romanesti = Romanian), and some had foreign origin: Vinete de Italia (Dark Blue of Italy), Reine Claude d'Althan (Renclod Althan) and Valor.

Out of these varieties, the earliest is Tuleu timpuriu (which has a fruit ripened in the last decade of July, the first decade of August), followed by Reine Claude d'Althan (the second and third decade of August) and Valor (the second decade of August, and the first of September). The latest ripening varieties are Vinete de Italia (the first and second decade of September) and Vinete romanesti (the second and third decade of September).

The distance of plantation was 5 m between each tree and 4.5 m between rows, with a density of 444 trees per hectare. The trees were grafted on the same rootstock (myrobolan - *Prunus cerasifera*), and measurements and analysis were made for the tree vigour, fruit productivity and quality. The plantation is 20 years old.

The measurements, determinations and the organoleptical value were made at the optimum fruits consuming moment. The data were processed as average values for each trait, by analysis of variance (ANOVA test).

The organoleptical estimations of the fruits were made through bulletins of estimation, the marks being given for the exterior aspect (size, shape, colour), but also for internal characteristics (pulp colour, firmness, juiciness, taste, flavour), a different score resulting for each cultivar.

The response of cultivars to the Plum pox virus on leaves, fruits and plum leaf blister (*Polystigma rubrum*) on leaves was determined by Frequency (F%) and Intensity (I%) attack, in the natural conditions of infections and lack of treatments.

Thus, the Attack Degree (AD%) was calculated with the formula: $AD\% = (F\% \times I\%) / 100$ (Cociu and Oprea, 1989), representing expressly the extension of the attack seriousness, as a mean for the tree years in question.

The Frequency of attack (F%) was determined by dividing the number of organs (leaves or fruits) affected by disease (n) by the total number of organs analysed (N), the formula being: $F\% = n / N \times 100$. The Intensity of attack (I%) was a percentage assessed for every tree, with the formula: $I\% = \sum(i \times f) / b$, where 'i' represented the percentage of

coverage with symptoms per organs, 'f' was the number of cases with symptoms framed in certain percentage and 'b' was the number of disease affected organs.

RESULTS AND DISCUSSION

The results regarding the main elements of tree vigour growth are presented in table 1. Because of tree height, the most vigorous cultivar seems to be Reine Claude d'Althan (with a mean of 5.96 m) and with a very significant difference, compared to the average of experience, as control (4.70 m). At the opposite side, the cultivar Vinete de Italia it is located, with a mean tree height of 4.00 m.

Table 1

The growth tree vigour at five plum cultivars

Nr. crt.	Soiul	Height of trees (m)	Crown diameter "D" (m)	Crown diameter "d" (m)	Trunk diameter (cm)	Length of shoots (cm)
1.	Tuleu timpuriu	4.88	4.89	4.54	25.08	27.40
2.	Vinete romanesti	4.26	3.66 ^{ooo}	3.66 ^{ooo}	17.86 ^{oo}	21.56 ^{oo}
3.	Vinete de Italia	4.00 ^o	5.14	4.56	23.80	28.20
4.	Valor	4.38	5.10	4.46	24.36	34.80
5.	Reine Claude d'Althan	5.96 ^{xxx}	5.44 ^{xx}	5.00 ^{xx}	23.34	49.40 ^{xxx}
Mean of experience (Control)		4.70	4.85	4.44	22.89	32.27
DL 5% =		0.51	0.38	0.40	3.31	6.22
DL 1% =		0.71	0.52	0.55	4.55	8.57
DL 0.1% =		0.97	0.72	0.75	6.27	11.80

For the other tree vigour traits (crown diameter, trunk diameter and length of shoots), the lowest values, showing a reduced vigour compared to the mean of experience, were registered at the Vinete romanesti cultivar.

Reine Claude d'Althan was registered as the most vigorous, with the highest values for growth, except trunk diameter, where the Valor cultivar had the highest value (24.36 cm).

Main differences between the analysed cultivars were obtained for fruit weight, the trait being strongly influenced by the tested cultivars genotypes (table 2). The cultivars with extreme values were Vinete romanesti (26.0 g) and Valor (68.0 g).

Table 2

The elements of the productivity and general marks for fruit quality

Nr. cv.	Cultivar	Fruit weight (g)	Number of fruits / tree	Fruit yield / tree (kg)	Productivity index (kg/cm ²)	Quality fruits marks
1.	Tuleu timpuriu	50.2	406.4 ^{xxx}	20.2 ^{xxx}	0.034	44.0
2.	Vinete romanesti	26.0 ^{ooo}	305.0	7.9 ^{ooo}	0.035	46.0 ^{xx}
3.	Vinete de Italia	48.4	189.0 ^{ooo}	9.1 ^{ooo}	0.021	42.0
4.	Valor	68.0 ^{xxx}	222.6 ^{ooo}	15.1	0.032	39.0 ^{oo}
5.	Reine Claude d'Althan	53.0	379.2 ^{xxx}	20.1 ^{xxx}	0.051 ^s	41.0
Mean of experience (Control)		49.1	300.4	14.5	0.030	42.4
DL 5% =		7.1	19.1	0.9	0.020	2.6
DL 1% =		9.8	26.3	1.3	0.024	3.4
DL 0.1% =		13.5	36.2	1.8	0.031	4.5

The highest fruit yield was obtained in Tuleu timpuriu and Reine Claude d'Althan (more than 20 kg/tree), and the lowest production was registered at Vinete romanesti and Vinete de Italia (7.9 and 9.1 kg/tree). The productivity index (PI), calculated as the ratio

between fruit yield in kg/tree and area of transversal cross section of trunk oscillated between 0.021-0.051 kg/cm². The cultivar with the highest value of PI was Reine Claude d'Althan, with a significant superior difference compared to the mean of experience. The tree vigour and productivity index offer useful information regarding the distance between the rows and trees on plantation, technology, cultivars crop potential, cultivars suitability in an intensive culture system (Botu et al., 2002; Cimpoieș, 2002; Sestraș, 2004).

Table 3

The fruit quality estimated by the marks received at organoleptic testing

Trait of fruit	Scale of marks	Mark				
		Tuleu timpuriu	Vinete romanesti	Vinete de Italia	Valor	R. C. d'Althan
Peduncle	1-2	2	2	1	1	2
Shape	1-2	2	2	2	2	2
Size	1-5	3	2	5	5	4
Pruina*	1-2	2	2	2	2	1
Skin colour	1-5	4	5	5	4	4
Skin resistance	1-3	3	3	2	2	2
Firmness	1-5	5	5	3	3	3
Juiciness	1-3	3	3	3	3	2
Taste	1-12	10	12	9	9	10
Flavour	1-3	2	3	3	2	3
Pulp adherence	1-5	4	5	5	4	5
Stone size	1-3	2	2	2	2	3
General mark	Min. 12- Max. 50	44	46	42	39	41

*Pruina = powdery bloom or waxy secretion

After completing the bulletins of estimation for fruit organoleptic characteristics (Table 3) obvious differences among tested cultivars for fruits quality were obtained. The highest marks were the ones for the cultivar Vinete romanesti, an old native cultivar, with a large spreading in Transylvania, which received the highest mark for fruit taste. It is worth mentioning that the most appreciated alcohol named 'tzuica' is obtained from Vinete romanesti plums. It is traditional in Transylvania and it is considered here the best distillate drink (brandy).

Table 4

The main statistics and genetic parameters calculated for analyzed traits at five cultivars of plum

Nr.	Traits and unit of measurement	Limits of variability	Amplitude of variability	Coefficient of variability (s%)	Coefficient of heritability
1.	Height of trees (m)	5.96-4.00	1.96	8.62	0.845
2.	Crown diameter "D" (m)	5.44-3.66	1.78	6.12	0.761
3.	Crown diameter "d" (m)	5.00-3.66	1.44	7.58	0.718
4.	Trunk diameter (cm)	25.08-17.86	7.22	11.92	0.937
5.	Length of shoots (cm)	49.40-21.56	27.84	14.80	0.665
6.	Length of fruits (mm)	57.40-41.00	16.40	4.34	0.879
7.	Fruits diameter (mm)	45.80-29.20	16.60	4.80	0.885
8.	Fruits weight (g)	68.00-26.00	42.00	11.78	0.879
9.	Number of fruits / tree	406.4-189.0	217.40	4.30	0.796
10.	Fruit yield / tree (kg)	20.22-7.94	12.28	4.32	0.897
11.	Productivity index (kg/cm ²)	0.051-0.021	0.030	28.62	0.619
12.	Quality fruits marks	46-39	7	-	-

The coefficient of variability for the analyzed traits, shown in table 4, ranged between 4.30 and 28.62%. A lower variability among the cultivars was shown for the following traits: number of fruits per tree, length of fruits, fruits diameter, fruit yield per tree, crown diameter (both little and big), height of trees (for all of them $s\%$ were below 10%). Fruits weight, trunk diameter and length of shoots presented an average variability (between 10 and 20%) and only one trait (productivity index) can be considered to have a large variability (more than 20%).

In table 4, the limits of variability, amplitude of variability and coefficient of heritability are also presented in a broad sense for the analyzed traits (calculated after the model of Botez et al., 1995).

The traits with the highest value of heritability were trunk diameter, fruit yield per tree, fruit characteristics (length, diameter and weight). All of them show a great participation of genetic variance in total (phenotypic) variance. In addition, these characters can be transmitted easily from ascendants to seminal descendants in plum breeding.

Low values of heritability occurred for shoot length, productivity index, crown diameter, as these characters are highly influenced by the environment.

Table 5

The response of cultivars to plum leaf blister attack

Nr. cv.	Cultivar	Frequency of attack (%)	Intensity of attack (%)	Attack Degree (%)
1	Tuleu timpuriu	0	0	0
2	Vinete romanesti	100.0	60	60.00
3	Vinete de Italia	4.0	3	0.12
4	Valor	2.0	1	0.02
5	Reine Claude d'Althan	1.0	1	0.01

The data presented in table 5 show that the studied cultivars had a different response to plum leaf blister (*Polystigma rubrum*) attack. Based on the results obtained, it can be considered that Vinete romanesti is very susceptible to the disease. The cultivar was registered with an attack frequency on leaves of 100%, resulting in an attack degree of 60.0%. Tuleu timpuriu did not present any attack symptoms, and the other cultivars had lower values of attack degree.

Table 6

The respons of cultivars to Plum-pox virus

Nr. cv.	Soiul	Frecvency of attack (%)		Intensity of attack (%)		Attack Degree (%)	
		leaves	fruits	leaves	fruits	leaves	fruits
1.	Tuleu timpuriu	2	0	1	0	0.02	0.00
2.	Vinete romanesti	100	100	70	20	70.00	20.00
3.	Vinete de Italia	100	45	35	10	35.00	4.5
4.	Valor	5	0	3	0	0.15	0.00
5.	Reine Claude d'Althan	1	0	1	0	0.01	0.00

Vinete romanesti proved extremely susceptible to the Plum-pox virus attack (table 6), as the attack frequency on leaves and fruits was 100%. Another 100% attack frequency on leaves was registered for Vinete de Italia, as the attack degree of 35.0% illustrates susceptibility to PPV. The Plum-pox virus attack on leaves was pointed out at Tuleu timpuriu, Valor and Reine Claude d'Althan, AD% being reduced. The results confirmed that the

cultivar Vinete romanesti is very susceptible to PPV, while Reine Claude d'Althan is relatively tolerant to disease (Cociu et al., 1997; Sestras, 2004).

The Attack Degree on fruits was 20.0% on Vinete romanesti and 4.5% on Vinete de Italia. At the cultivars of Tuleu timpuriu, Valor and Reine Claude d'Althan no PPV symptoms were observed on fruits.

CONCLUSIONS

The results obtained offer useful information regarding the response of several plum cultivars in the central Transylvania conditions, Romania. Out of the studied cultivars, Tuleu timpuriu and Reine Claude d'Althan distinguish for high productivity, Valor for the large fruits (but with a lower quality), Vinete romanesti and Vinete de Italia for their extremely susceptibility to the most important diseases (Plum-pox virus and plum leaf blister).

One of the traditional plum cultivars from Romania, still largely spread in Transylvania, Vinete romanesti, is very appreciated both for the fruit taste and for the alcohol distillation obtained and confirmed its estimation because of fruit quality.

Vinete romanesti has small fruits compared to the actual commercial requirement of the fresh plum, low productivity, and it is extremely susceptible to the Plum-pox virus and *Polystigma rubrum* attack. Thus, the cultivar does not meet with the conditions for modern cultivars. In addition, the cultivar can be used in plum breeding, as a genitor for quality (taste of fruits) and the low vigour of trees.

The high values of the coefficient of heritability, in a broad sense, for the majority of the analyzed traits, suggest that through an adequate selection of genitors, descendents, which can present valuable traits from the parental form can be obtained and thus select new cultivars.

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REZUMAT

COMPORTAREA UNOR SOIURI DE PRUN ÎN CONDIȚIILE DIN CENTRUL TRANSILVANIEI, ROMANIA

În condițiile din centrul Transilvaniei, Romana, au fost studiate cinci soiuri de prun cu o coacere diferită a fructelor: timpurii (Tuleu timpuriu), semitimpurii (Reine Claude d'Althan), medii (Valor), semitardive (Vinete de Italia), tardive (Vinete românești). Tuleu timpuriu și Reine Claude d'Althan s-au remarcat printr-o bună productivitate (peste 20 kg fructe/pom), Valor prin fructe mari (68 g), dar cu nota cea mai mică pentru calitate, Vinete românești și Vinete de Italia prin sensibilitate la atacul principalelor boli (pătarea roșie a frunzelor - *Polystigma rubrum* și vărsatul prunului, sau Plum-pox virus). Unul dintre soiurile tradiționale de prun din Romana, încă larg cultivat în Transilvania, Vinete românești, foarte apreciat atât pentru gustul fructelor cât și pentru distilatul obținut, a confirmat aprecierea de care se bucură, datorită calității deosebite a fructelor. Întrucât soiul Vinete românești are fructe mici comparativ cu cerințele comerciale actuale pentru fructele destinate consumului în stare proaspătă, productivitate scăzută și, în plus, este deosebit de sensibil la atacul de Plum-pox virus și *Polystigma rubrum*, soiul respectiv nu mai îndeplinește condițiile de bază, necesare unui soi modern. Valorile ridicate ale coeficienților de eritabilitate în sens larg la majoritatea caracteristicilor analizate, denotă faptul că printr-o alegere judicioasă a genitorilor, se pot obține descendenți care să prezinte caracteristici valoroase de la formele parentale și din care pot fi selecționate noi soiuri. Vinete românești poate fi utilizat în noi lucrări de ameliorare a prunului, pe baza rezultatelor prezentului studiu putând fi recomandat ca genitor pentru calitatea (gustul) fructelor și vigoarea mică a pomilor.