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DIVERGENCE OF MYROBALAN *(Prunus cerasifera* Ehrh.*)* TYPES ON THE TERRITORY OF SERBIA

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Variability of some more prominent pomological characteristics was examined in three regions of Serbia (central, western, southern). In all the regions, significant variability of all studied characteristics was established. However, no specifics were manifested between regions, therefore, identical types emerge in all the regions. This is indicated by similar intervals of variation as well as similar mean values of characteristics per region. The obtained results lead to the conclusion that the entire territory of Serbia should be observed as a unique myrobalan population with highly expressed polymorphism of characteristics. To preserve genetic variability of myrobalan, collection is recommended for those types that were arranged into various groups and subgroups according to the results of cluster analysis.

Key word: myrobalan, natural population, pomological characteristics, phenotypic variability

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INTRODUCTION

The myrobalan or cherry plum (*Prunus cerasifera* Ehrh.) is native to southeastern Europe or southwestern Asia. Its seedlings are used for the most part as a rootstock for plum (WEINBERGER, 1975; ERBIL and SOYLU, 2002), but lesser for apricot (DIMITROVA and MARINOV, 2002) and almond and peach (DUVAL *et al*., 2004). In addition, myrobalan types that have large-size fruits, high contents of sugars and acids are recommended for use in a raw state and industrial processing (GEORGIEV *et al*., 1985; PEJKIĆ *et al*., 1991; MILETIĆ, 1995; MILETIĆ *et al*., 2005). Being an autochthonous species, myrobalan is widely used in plum breeding. By hybridizing the types within species *Prunus cerasifera* and by crossing *Prunus cerasifera* to *Prunus salicina* and other plum species, hybrids of diverse use value were obtained (EREMIN, 1978).

Myrobalan is one of the oldest and most widely spread fruit species in natural population of Serbia (MIŠIĆ, 1983). It is found by the roads, bounds, individually or in groups. It thrives at 100 to 1700 m altitude. Of the total number of plum fruit trees in Serbia, myrobalan accounts for 15-20%, according to STANČEVIĆ *et al*. (1988), and even 40%, according to PEJKIĆ *et al*. (1991).

A broad areal, modest demands for growing and most commonly generative reproduction have conditioned high polymorphism of myrobalan. Natural population of this species is characterized by high variability in respect of vigor, yield, ripening time, fruit size and quality, low temperature tolerance, resistance to plum pox virus and other causal agents of diseases, seed germinability and seedlings vigor (MILUTINOVIC and NIKOLIC, 1994; OGAŠANOVIĆ *et al*., 1997; BOŽOVIĆ and JAĆIMOVIĆ, 2003).

To make a more complete analysis of variability and establish genetic divergence, it is desirable to take into account a larger number of characteristics simultaneously. Multivariance analyses and cluster analysis, being one of them, are suitable for establishing genetic distance of the examined material (LIN, 1982; RAMEY and ROSIELLE, 1983). VITKOVSKIJ *et al*. (1988) report that values of studied characteristics in combination with multivariance analysis provide a solid basis for establishing relationship between species and cultivars of the genus *Prunus*. Reliability of cluster analysis for identifying genetic divergence of the species of genus *Prunus* was confirmed by CASSAS *et al*. (1999) and SHIMADA *et al*. (2001) by means of RAPD marker. NASSI *et al*. (2003) established not only heterogeneity of the „Ramasin“ plum ecotype but also its likely origin by performing genetic characterization with RAPD marker and cluster analysis.

Urbanization and development of agriculture cause destruction of local populations, gene erosion and marked reduction of myrobalan genetic variability. Consequently, the task to preserve genetic divergence of this species primarily imposes studies and selection of types from natural populations. The first step is to make inventory of the existing germplasm and *in situ* examinations. There follows the description of some types. Finally, *ex situ* collecting of the genetically different types into „gene banks“ is done. It is thus contributed to the preservation of gene

fund of this plum species, while collected types could be employed for further breeding activities.

Since myrobalan is very widely distributed in natural population, possesses a range of positive characteristics, has high adaptability value to various environmental conditions and different purpose, the aim of the present work was to study its total variability from different regions of Serbia against some more prominent pomological characteristics. In addition, analysis was done on whether differences in climate and edaphic factors between regions had any influence on developing special ecotypes of myrobalan.

MATERIAL AND METHODS

Myrobalan types studied herein were selected from various localities in Serbia (Table 1). According to geographic position, the localities were arranged into three regions (central, western, southern). Although the entire territory of Serbia belongs to moderate-continental climate zone, there are specifics between regions, reflecting primarily in the amount of precipitation and heat conditions. Average amount of precipitation during vegetative period is highest in western Serbia, slightly lower in central Serbia and lowest in southern Serbia. As for mean air temperatures in the vegetative period, the region of western Serbia is characterized by somewhat lower temperatures compared to other two regions. In all three regions diversified earth's crust is typical, which is conditioned by diversity of parent substrate and relief. There is no specificity between regions concerning soil types, so the same soil types more or less emerge in each region.

Table 1. Origin of myrobalan (Prunus cerasifera Ehrh.) types from different region of Serbia

Region	Place	Number of types
Central Serbia	Belgrade	10
	Smederevo	6
	Aranđelovac	5
	Kragujevac	9
	Jagodina	5
West Serbia	Loznica	6
	Valjevo	10
	Užice	8
South Serbia	Pirot	3
	Leskovac	8
	Vranje	4

On site visits to analyze the existing distribution of myrobalan in three different regions in Serbia were made in 2002. Seven thousand fruit trees were inspected and registered. During preliminary selection procedure, fruit trees with low yield and low resistance to diseases and low temperatures were eliminated.

Also, when a larger number of trees manifested identical characteristics, only one of them was selected, so that in the end 74 types of myrobalan that differed in phenotype were separated for further studies. Selection of types differing in phenotype was done in each region. From the region of central Serbia 35 types were selected, from western Serbia 24 types and from southern Serbia 15 types.

In 74 selected myrobalan types during the 2003-2005 period the following characteristics were studied: fruit skin colour, fruit height, fruit width, fruit weight, stone weight, petiole length and soluble solids content. Fruit skin colour was determined visually, and 5 categories of color were separated (yellow, yellow-red, red, dark red and blue). Fruit height, fruit width, fruit weight, stone weight and petiole length were determined using the sample of 30 fruits. Soluble solids content was determined refractometrically. All examinations were carried out *in situ.*

Statistical analysis of data was done using "Statistica" 99 Edition (StatSoft) program. Of basic statistical parameters, minimum, maximum and mean values were established for each region, for each examined characteristic. To gain insight into the variability of characteristics within the region, standard deviation (SD) and coefficient of variation (CV) were calculated. Phenotypic divergence of studied types was found by applying hierarchical cluster analysis, based on all examined characteristics. The UPGA method was used, the difference between groups being expressed over Euclidean distance (WARD, 1963).

RESULTS

With respect to fruit skin colour, myrobalan types from all five color categories are present in all three regions of Serbia (Figure 1). In central Serbia 51.4% of types had yellow color, 28.6% red, 8.6% yellow-red, and 5.7% each dark red and blue, respectively. The highest number of myrobalan types in western Serbia had yellow color (37.5%), slightly lower number had red (20.8%) and dark red (16.7%), and the lowest number had yellow-red (12.5%) and blue fruit skin (12.5%). In southern Serbia, the highest number of types had red fruit skin (40.0%), followed by types with yellow (26.7%), dark red (13.3%) and blue color (13.3%), while the lowest number of types had yellow-red fruit skin (6.7%).

The data presented in Table 2 indicate that similar intervals of variation in studied characteristics were established in all three regions of Serbia. Myrobalan types from central Serbia had, on average, the lowest fruit height (23.3 mm), fruit width (23.6 mm), fruit weight (8.59 g), stone weight (0.48 g) and soluble solids content (11.64%). The highest average fruit height (25.4 mm) and fruit width (24.5 mm) were found in myrobalan types from western Serbia, while highest average fruit weight (12.96 g), stone weight (0.76 g) and soluble solids content (14.54%) were found in myrobalan types from southern Serbia. Average petiole length in myrobalan types from three regions of Serbia was identical and amounted to 1.7 cm.

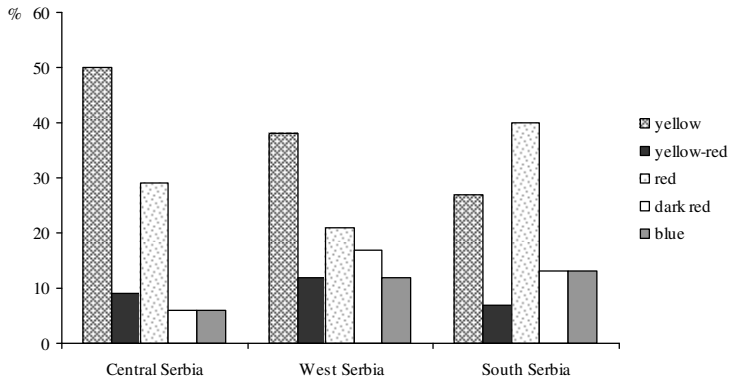

Figure 1. Distribution of frequency for myrobalan (*Prunus cerasifera* Ehrh.) fruit skin colour in three region of Serbia

Table 2. Minimum, maximum and mean values, standard deviations (SD) and coefficients of variation (CV) for 6 pomological myrobalan (Prunus cerasifera Ehrh.) properties in three regions of Serbia

Property	Region	Min	Max	Mean	SD	CV
Fruit height (mm)	Central Serbia	18.8	28.9	23.3	2.32	9.98
	West Serbia	21.3	30.1	25.4	2.65	10.45
	South Serbia	20.1	28.7	24.3	2.72	11.21
Fruit width (mm)	Central Serbia	18.8	28.4	23.6	2.53	10.71
	West Serbia	21.0	28.7	24.5	2.34	9.55
	South Serbia	19.7	29.0	24.3	3.36	13.83
Fruit weight (g)	Central Serbia	4.07	14.95	8.59	2.459	28.63
	West Serbia	6.23	18.93	10.31	3.403	32.99
	South Serbia	6.42	19.84	12.96	4.037	31.15
Stone weight (g)	Central Serbia	0.25	0.74	0.48	0.093	19.47
	West Serbia	0.34	1.12	0.69	0.209	30.45
	South Serbia	0.51	1.11	0.76	0.177	23.33
Petiole length (cm)	Central Serbia	1.2	2.2	1.7	0.22	13.64
	West Serbia	1.2	2.1	1.7	0.23	14.37
	South Serbia	1.3	2.1	1.7	0.24	14.40
Soluble solids (%)	Central Serbia	8.60	14.90	11.64	1.519	13.05
	West Serbia	11.06	16.73	13.68	1.737	12.71
	South Serbia	12.52	17.65	14.54	1.253	8.62

It is evident from coefficients of variation value (Table 2) that in central Serbia fruit height (9.98%) varied the least, while fruit weight (28.63%) the most. In western Serbia, fruit width (9.55%) varied the least but fruit weight (32.99%)

the most, and in southern Serbia soluble solids content (8.62%) varied the least, while fruit weight (31.15%) the most. Observed per region, fruit height (9.98%), fruit weight (28.63%), stone weight (19.47%) and petiole length (13.64%) varied the least in central Serbia, fruit width (9.55%) in western Serbia and soluble solids content (8.62%) in southern Serbia. Fruit height (11.21%), fruit width (13.83%) and petiole length (14.40%) varied the most in southern Serbia, fruit weight (32.99%) and stone weight (30.45%) in western Serbia and soluble solids content (13.05%) in central Serbia.

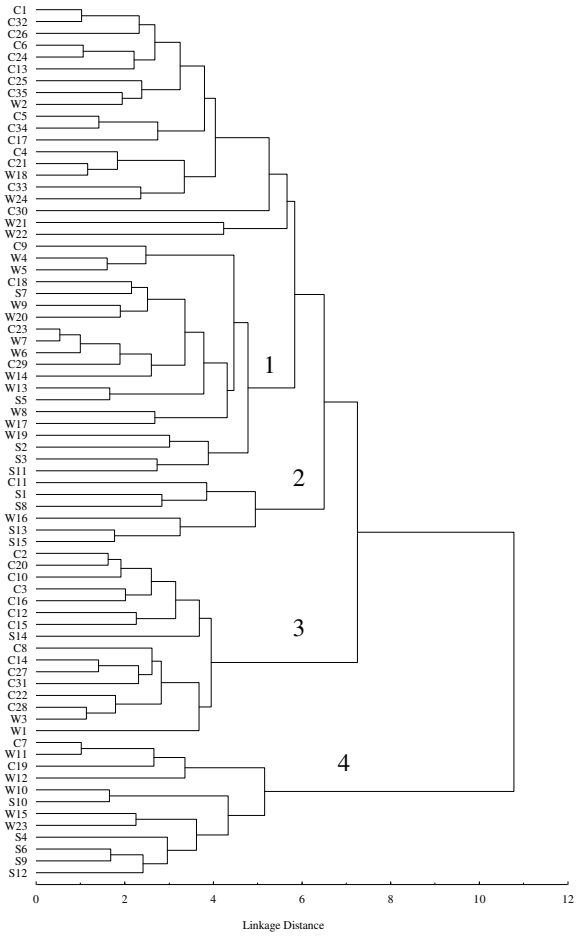

Figure 2. Dendrogram of phenotypic differences of myrobalan (*Prunus cerasifera* Ehrh.) types, based on pomological properties

It is evident from dendrogram designed by applying hierarchical cluster analysis (Figure 2) that myrobalan types are connected in various ways. This indicates to existence of a larger number of hierarchical levels. Types C23 and W7 are connected on the lowest hierarchical level. According to Euclidean distance values and manner of grouping, four groups of related types are separated. In each group a larger number of subgroups (two or more) can be separated. The highest number of types - 40 - is found in the first group. The second group comprises 6 types, the third group 16 types and the fourth group 12 types of myrobalan. Within each of the four groups separated according to phenotype relationship there emerge myrobalan types originating from all three regions of Serbia.

DISCUSSION

Due to generative reproduction, natural population of Serbia includes a large number of myrobalan types with fruits of variuos characteristics. The results of our work demonstrated that the regions of central and western Serbia are dominated by myrobalan types of yellow fruit skin color, while in the southern region of Serbia the highest number of types had red skin color. Studying myrobalan types from western and northern Serbia, PAUNOVIC (1968) also established that the highest number of selected myrobalan types had yellow fruit skin color. PEJKIĆ *et al.* (1991) found the highest number of types with yellow fruit skin color in the Zaječar, Bor region (eastern Serbia). On the other hand, MILETIĆ (1995) stresses that the eastern region of Serbia is dominated by types with red fruit skin color. According to the results reported by the mentioned authors, differences in fruit skin color emerging even within the same region can be explained by the fact that for their studies they used types selected for different purposes. In the present work, however, the manifested differences in fruit skin colour can be considered typical, because we studied total variability in myrobalan.

Unlike fruit skin colour the analyzed regions did not have any other specifics considering variability of the majority rest of studied characteristics. In all three regions there emerge the same types relative to studied characteristics, as indicated by similar intervals of variation as well as similar mean values per region. Only for fruit weight and stone weight there are more significant deviations of mean values per region. Those deviations can be attributed to different agroecological conditions characteristic of studied regions. In central Serbia average fruit weight and stone weight was the lowest (8.59 g; 0.48 g), slightly higher in western Serbia (10.31 g; 0.69 g) and the highest in southern Serbia (12.96 g; 0.76 g). Similar intervals of variation for 6 pomological characteristics (fruit height, fruit width, fruit weight, stone weight, petiole length and soluble solids content) in 49 selections of myrobalan were reported by ČOLIĆ *et al.* (2003a). Somewhat higher average fruit weight (14.5 g) and stone weight (0.85 g) in 25 myrobalan genotypes selected from spontaneous population in eastern Serbia were found by MILETIĆ *et al.* (2005). Higher values of fruit weight and stone weight established by MILETIĆ *et al.* (2005) are due to the fact that those authors studied

types intended for table consumption, where the main criterion for selection was fruit size, which was not the case herein.

In all three regions of Serbia the highest variation as expressed by coefficient of variation was found for fruit weight, and the lowest for fruit dimension. Similar to our results, ČOLIĆ *et al.* (2003b) reported that in studied myrobalan population fruit weight varied the most. Just like in intervals of variation, coefficient of variation values established for a majority of studied characteristics in the present work did not differ significantly for studied regions. Considering variability through out regions, significant differences were established only for stone weight. The most uniform stone weight was proved in the types from central Serbia (CV=19.47%) slightly higher variability was found in southern Serbia (CV=23.33%), and the highest in western Serbia (CV=30.45%).

The results of cluster analysis indicate that in the three regions identical phenotypes of myrobalan types occur. This conditioned the separation of 4 groups of related types. So, grouping of types was not in the function of region, but within each of 4 separated groups there emerge types from all three regions. It follows that the entire territory of Serbia should be taken as a unique myrobalan population, which is in agreement with the findings of EREMIN (1989) who emphasizes that apart from Caucasus and Asia Minor in the area of the Balkans, where Serbia belongs too, only one subspecies of myrobalan occurs and that is typical myrobalan (*Prunus cerasifera subsp. cerasifera*).

High variability of myrobalan in natural population of Serbia imposes preservation of this fruit gene fund by collecting genetically different types. Types recommended for collecting are those which according to the results of cluster analysis have been classified into various groups and subgroups. Apart from contributing to preservation of this species' total variability, collected types could be involved into breeding programs depending on their goals.

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DIVERGENTNOST TIPOVA DŽANARIKE (*Prunus cerasifera* Ehrh.) NA PODRUČJU SRBIJE

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I z v o d

U ovom radu ispitivana je varijabilnost značajnijih pomoloških osobina u 3 regiona Srbije (centralni, zapadni i južni). U sva tri regiona ustanovljena je značajna varijabilnost svih proučavanih osobina. Međutim, među regionima nisu ispoljene specifičnosti, tako da se u sva tri regiona pojavljuju isti tipovi. Na ovo ukazuju slični intervali variranja, kao i slične srednje vrednosti osobina po regionima. Dobijeni rezultati navode na zaključak da čitavu teritoriju Srbije treba posmatrati kao jedinstvenu populaciju džanarike sa veoma izraženim polimorfizmom osobina. Radi očuvanja genetičke varijabilnosti džanarike za kolekcionisanje se preporučuju oni tipovi koji su prema rezultatima klaster analize svrstani u različite grupe i podgrupe.

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