

Morphologic Characteristics Variability in *Prunus spinosa* L. Shrubs Identified in Southern Area of Oltenia, Romania

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Abstract

This paper aims to analyse the variability of morphological characteristics of *Prunus spinosa* L. shrubs, identified and studied in the spontaneous flora in southern Oltenia, Romania (localities Calopar and Gura Văii). The observations made on trunk diameter, stem height, spinosity degree, ability to form basal shoots, have outlined the high variability, which is useful in breeding programs. Variability coefficient ranged between 26.02% and 30.87% for the stem diameter, between 23.48% and 32.32% for the plant height, between 30.93% and 37.81% for canopy diameter. Based on the obtained results, the C31, GV26, GV28, GV29, GV30, GV31, GV33, GV34, GV37 and GV8, GV9, GV27, GV35, C5, C24, C25, C26 and C29 genotypes are recommended for fixing the eroded lands, owing to their very strong, strong and medium ability to form basal shoots; while C10, C12, C23, C27, C28, C30, GV6, GV10, GV24, GV25, GV32 and GV36 genotypes are recommended to be studied as rootstocks in fruit tree species, having in view the low or missing vigor and ability to form basal shoots.

Keywords: blackthorn; diversity; genotypes; selection; vigour

Introduction

Prunus spinosa L. is a shrub commonly found in spontaneous flora in different regions, either at lower altitudes (Parvu, 2005) up to 1000 m or at higher altitudes up to 2200 m (Özcan, 2008) in Turkey. It is more abundant in North, West and South Anatolia in the remaining forests and whole forests at altitudes between 0-1700 m a.s.l. (Erturk *et al.*, 2009). Clinovschi (2005) mentions that in Romania, this species appears frequently in forest edges, woodland, on sunny hillsides, cliffs, from the plain up to the lower mountain floor (1000 m); it is often the sub-arboretum of xerothermophile oak forests (Dobrogea, Moldova) and it presents various types in the forest steppe and hilly areas (Ghena *et al.*, 1977). It is commonly found in the spontaneous flora of southern Oltenia, in association with the hawthorn (*Crataegus monogyna*) and the dog rose (*Rosa canina*). Blackthorn is a thorny shrub with deciduous leaves, forming dense bushes with complicated branches and numerous basal shoots (Popescu and Caudullo, 2016); the

fruits are small spherical drupes of about 1 g weight, although there are varieties (var. *macrocarpa*) or selections with larger fruit, some of them have even entered into culture, e.g. “buburuze” and “nemteste” fruits in Transylvania (Cociu *et al.*, 1999; Gavrilă Calusaru *et al.*, 2017). Bakker *et al.* (2004) reports that *P. spinosa* is a clonal shrub which spreads mainly through root shoots and by clonal expansion it can form dense portions of young bush that can provide better protection against herbivores. Blackthorn is a less demanding species with regard to environment and soil conditions, is resistant to frost and drought; it loves sunny areas, is a plant searching for direct light and it does not like the shade. Being highly resistant to frost it can also be used in hilly regions. It is a xerophyte species (Cosmulescu, 2014). Netoiu *et al.* (2008) reports that, although blackthorn is a xerophyte (mesoxerophyte) plant, it has great adaptive amplitude, supporting well also the soils with high humidity in meadows. This study aims to emphasize the variability of morphological characteristics of *Prunus spinosa* L. shrubs that were identified and studied in the spontaneous flora in southern Oltenia, near villages of Calopar and Gura Văii, in order to further use the respective genotypes according to identified characteristics, either for fixing the land subject to erosion, or for using it in fruit growing farming.

Materials and Methods

Biological material

Genotypes of *Prunus spinosa* L. from two populations in southern Oltenia, Dolj County (Gura Văii - 44°12'28"N 23°47'53"E and Calopar - 44°10'03"N 23°44'27"E), were identified and evaluated. Oltenia has a continental, forest-steppe or steppe type climate, which is characterized by a thermal regime with a slight increasing trend which is caused by very high temperatures of the warm season and the rainfall regime characterized by obvious fluctuation, but with a slight decreasing trend. Thermophilic and xerothermophilous plants are suitable to this climate and they can provide pretty high crops even under the specific pluvio-thermal conditions of Oltenia Plain (Vladut, 2010).

Method

Growth vigor of each genotype was determined using the stem diameter and plant height characteristics (Vescan, 2011). A 1 to 5 scale of evaluation (Cociu and Oprea, 1989) was used for vigor: 1. low, 2. medium-low, 3. medium-high, 4. high, 5. very high. While the literature has not set limits on growth vigor, based on annual growth rate in *Prunus spinosa* L. (Asanica, 2016), the following criterion was proposed to determine the growth vigor: 1. Low vigor at a growth rate of stem thickness between 1-3.99 mm, and at a height growth rate between 0-10 cm; 2. Low-to-medium vigor at a growth rate in thickness between 4-7.99 mm and a height growth rate between 10-20 cm; 3. Medium-to-high vigor at a growth rate in thickness between 8-11.99 mm and at a height growth rate of 20-30 cm; 4. High vigor, at a growth rate in thickness between 12-15.99 mm and a height growth rate between 30-40 cm; 5. Very high vigor at a growth rate in thickness between 16-19.99 mm and a height rate of more than 40 cm.

Evaluation of trunk diameter was carried out using a caliper at 5 cm above the soil and expressed in millimeters, while the height was measured by means of tape measure. *Canopy diameter* was measured on two perpendicular directions and expressed in centimeters.

Ability of each genotype to form basal shoots was assessed based on the number of basal shoots observed in the closest proximity to mother-plant (within 50 cm radius range) on a 1 to 5 scale (Vescan, 2011). Further on, depending on the number of basal shoots identified, the following criterion/method was proposed to determine the ability to form basal shoots: 1. Missing ability to form basal shoots (missing basal shoots); 2. Low ability to form basal shoots (1-5 basal shoots); 3. Medium ability to form basal shoots (5-10); 4. Strong ability to form basal shoots (10-15 basal shoots); 5. Very strong ability to form basal shoots (15-20 basal shoots).

Degree of spinosity was assessed by counting the thorns on the trunk (up to the first ramification). Depending on the number of thorns, a 1 to 5 evaluation scale was set up: 1. Missing degree of spinosity: there is no thorn up to the first ramification; 2. Low degree of spinosity: between 1 and 3 thorns; 3. Medium degree of spinosity: between 4 and 7 thorns; 4. Medium-to-high degree of spinosity: between 8 and 11 thorns; 5. High degree of spinosity: between 12 and 16 thorns.

Statistical analysis

Data obtained were statistically processed, calculating the average, the standard deviation, amplitude and variation coefficient (Botu and Botu, 2010), in order to further conduct a comparison between the two populations. In order to analyze these statistical parameters the authors have used the option Data Analysis in Microsoft Office Excel program.

Results and Discussion

Determination of growth vigor

Growth vigor of shrubs was assessed based on two characteristics: trunk diameter and shrub height. The annual growth rate was calculated for each of the two characteristics, in each genotype, in order to outline the difference of growth vigor between shrubs. Data presented in Tables 1 and 2 show that among the 30 genotypes of *Prunus spinosa* L. they have a different growth vigor; the annual growth rate in thickness of genotypes in Calopar population is comprised between 2.28 mm and 3.48 mm. A slightly higher difference of trunk thickness growth is noted in C10, C26, C27, C29 and C30 genotypes, with the following values of difference: 3.45; 2.99; 3.48; 3.27 and 2.63, respectively. If the annual growth rate of trunk height is analyzed, it is noteworthy that in case of genotypes of Calopar population, it has recorded values between 12 cm (C12) and 23 cm (C31). In case of Gura Văii population (Table 2), the annual growth rate in trunk thickness is a few millimeters, ie between 1.28 mm (GV32) and 3.10 mm (in GV8 and GV33), respectively, 3.19 mm in GV37. In this later genotype the thickness growth rates are higher in comparison to the other genotypes within Gura Văii population, but they are lower in comparison to certain genotypes in Calopar population. In blackthorn genotypes of Gura Văii population the annual growth rate of shrub height has recorded values between 13 cm (in GV25) and 25 cm (in GV8). A similar difference of height growth to the value recorded in GV8 is found also in GV33 genotype (24 cm). In comparing the annual height growth rate of genotypes in Gura Văii population to the genotypes in Calopar population, it is found that it has the highest values in two genotypes within Gura Văii population (GV8 and GV33). The average growth rate in trunk thickness by population is 2.75 mm in case of Calopar population, and 1.95 mm in Gura Văii population. The average annual growth rate of shrub height by population is 19.08 cm in genotypes of Calopar population and 17.78 cm in case of Gura Văii population. According to the criterion set up for growth vigor that is evaluated in terms of annual growth rate, the analyzed genotypes of *P. spinosa* have low growth vigor and, respectively, low-to medium growth vigor. Results are in accordance to the ones reported by Botu (1994). As a rootstock, blackthorn is only compatible with certain European plum cultivars, whose crop volume is medium. Blackthorn is sporadically used as rootstock for plum cultivars, especially in very dry areas (Cociu *et al.*, 1997).

Differences between genotypes of the two populations are also due to climatic and edaphic factors, having in view that genotypes belonging to Calopar population are located at an altitude between 139 m and 165 m, while the ones of

Gura Vaii population are between 81 m and 165 m. The distance is 6 km between the two areas taken under study. The influence of climatic and edaphic factors on characteristics of fruit tree plants is also upheld by authors in other species (Cosmulescu, 2013; Botu *et al.*, 2010; Cosmulescu and Ștefănescu, 2018). Comparative statistical analysis of growth characteristics in the two populations is presented in Table 3. With regard to trunk diameter, the shrubs in Calopar population have recorded an average value of 32.32 mm, which is higher than in genotypes of Gura Vaii population (28.18 mm). With regard to the average canopy diameter, the highest value was recorded in genotypes of Calopar population (151.44 cm), followed by the ones in Gura Vaii population (113.74 cm). With regard to shrub height, the variation range is found in two genotypes within the same population: 124 cm in GV25 and 340 cm in GV8 genotype (Table 2), values that are

somehow in accordance with height values suggested by Woldring (2015), who considers that *P. spinosa* has the shape of a shrub or a small size tree, with height between 3 m and 5 m. In 2018 the ranges of the same characteristic is maintained in the same genotypes: 137cm (in GV25 genotype) and 365 cm in GV8 genotype (Table 2). Variation coefficient of trunk diameter has varied between 26.02% (in genotypes of Calopar population) and 30.87% (in genotypes of Gura Vaii population), (Table 3), which indicates a high variability among genotypes of the same population. In terms of canopy average diameter, the variation coefficient recorded the values from 30.93% to 37.81%, thus demonstrating a very high variation, and respectively, a high non-uniformity within genotypes studied. A high variation was also found in shrub height, whose variation coefficient was 32.32% in case of Gura Vaii population.

Table 1. Growth vigor of genotypes in Calopar population, expressed in terms of growth rate in thickness and height

No.	Genotype	Trunk diameter (mm)		Growth rate in trunk diameter (mm)	Stem height (cm)		Growth rate of stem height (cm)
		2017	2018		2017	2018	
1.	C5	33.00	35.41	2.41	200.00	217.00	17.00
2.	C10	34.00	37.45	3.45	220.00	238.00	18.00
3.	C12	28.88	31.16	2.28	220.00	232.00	12.00
4.	C23	32.30	34.86	2.56	170.00	189.00	19.00
5.	C24	25.42	27.98	2.56	170.00	191.00	21.00
6.	C25	22.65	24.98	2.33	185.00	207.00	22.00
7.	C26	21.11	24.10	2.99	150.00	169.00	19.00
8.	C27	36.10	39.58	3.48	220.00	239.00	19.00
9.	C28	22.98	25.58	2.60	205.00	225.00	20.00
10.	C29	58.11	61.38	3.27	160.00	179.00	19.00
11.	C30	26.65	29.28	2.63	310.00	330.00	20.00
12.	C31	18.42	20.93	2.51	145.00	168.00	23.00
Mean				2.75 ± 0.43			19.08 ± 2.77

Table 2. Growth vigor of genotypes in Gura Vaii population, expressed in terms of growth rate in thickness and height

No.	Genotype	Trunk diameter (mm)		Growth rate (mm)	Stem height (cm)		Growth rate (cm)
		2017	2018		2017	2018	
1.	GV6	45.38	48.17	2.79	210.00	218.00	18.00
2.	GV8	48.55	51.65	3.10	340.00	365.00	25.00
3.	GV9	21.68	23.84	2.16	201.00	216.00	15.00
4.	GV10	26.52	27.86	1.34	226.00	244.00	18.00
5.	GV24	21.84	23.18	1.34	150.00	166.00	16.00
6.	GV25	30.99	32.69	1.70	124.00	137.00	13.00
7.	GV26	38.50	40.16	1.66	190.00	208.00	18.00
8.	GV27	22.38	23.69	1.31	175.00	191.00	16.00
9.	GV28	27.86	29.16	1.30	205.00	223.00	18.00
10.	GV29	22.99	25.10	2.11	153.00	169.00	16.00
11.	GV30	20.75	22.11	1.36	180.00	197.00	17.00
12.	GV31	29.56	30.98	1.42	200.00	217.00	17.00
13.	GV32	18.44	19.72	1.28	164.00	180.00	16.00
14.	GV33	41.90	45.00	3.10	330.00	354.00	24.00
15.	GV34	22.70	24.96	2.26	185.00	200.00	15.00
16.	GV35	26.41	27.89	1.48	212.00	230.00	18.00
17.	GV36	51.12	53.29	2.17	285.00	306.00	21.00
18.	GV37	25.26	28.45	3.19	230.00	249.00	19.00
Mean				1.95 ± 0.70			17.78 ± 3.02

Table 3. Average, maximum and minimum values/per population of trunk and canopy diameters and shrub height

Population	Trunk diameter (mm)				Canopy diameter (cm)				Shrub height (cm)			
	Mean±SD	Min.	Max.	Cv%	Mean±SD	Min	Max	Cv%	Mean±SD	Min	Max	Cv%
Gura Văii	28.18±8.70	17.99	51.12	30.87	113.74±43.01	34	211	37.81	195.5±63.19	95	340	32.32
Calopar	32.32±8.41	16.50	58.11	26.02	151.44±46.84	86	287	30.93	217.6±51.10	147	340	23.48

Determination of ability to form basal shoots in each genotype

All around the analyzed genotypes one can see many basal shoots that are formed on young ramifications of roots, and they are fed until formation and development of its own roots, by the mother plant. The ability to form basal shoots was determined in each genotype, according to the method. In analyzing the data (Table 4), it results that among the 30 genotypes of *P. spinosa*, 9 genotypes have very strong and strong ability to form basal shoots (more than 10 basal shoots), 9 genotypes have medium ability to form basal shoots (6-10 basal shoots), 10 genotypes have low ability to form basal shoots (between 1 and 5 basal shoots), and only 2 genotypes (C27, C10) have not formed basal shoots (inside a circle drawn at 50 cm from the trunk), because of their missing ability to form basal shoots. Calculating the percentage, 30% of total number of genotypes fall within

class 4 and class 5 (strong and very strong ability to form basal shoots), 30% in class 3 (medium ability to form basal shoots), 33.33% in class 2 (low ability to form basal shoots), and only 6.66% in class 1 (missing ability to form basal shoots). It is noted that in 60% of total number of studied genotypes, the ability to form basal shoots is comprised in classes medium - strong - very strong, while in 39.99% of genotypes, in classes missing - low. *P. spinosa* species is known for its high ability to form basal shoots (Cociu *et al.*, 1999; Ghena *et al.*, 2010); it is not a plant of longevity, however it is constantly renewing itself owing to its strong ability to form basal shoots (Kovács, 2016). Results obtained in terms of spinosity degree are presented in Table 5. Of the total number of 30 *Prunus spinosa* L. genotypes it is noted that half of genotypes have recorded a missing spinosity degree, while the other half of genotypes have recorded low degree (6.66%), medium degree (20%), medium-high degree (13.33%) and high degree (10%) of spinosity.

Table 4. Genotypes of *Prunus spinosa* L. selected in southern area of Oltenia for their ability to form basal shoots*

No.	Genotype	Number of basal shoots	Ability to form basal shoots
1.	GV26	10-15	strong
2.	GV28	10-15	strong
3.	GV29	10-15	strong
4.	GV30	10-15	strong
5.	GV31	10-15	strong
6.	GV33	10-15	strong
7.	GV34	10-15	strong
8.	GV37	10-15	strong
9.	C31	15-20	very strong
10.	GV24	5-7	low
11.	GV25	5-6	low
12.	GV27	5-10	medium
13.	GV32	4-6	low
14.	GV35	5-8	medium
15.	GV36	4-6	low
16.	GV6	5-6	low
17.	GV8	6-7	medium
18.	GV9	5-6	medium
19.	GV10	1-3	low
20.	C23	2-3	low
21.	C24	7-8	medium
22.	C25	5-6	medium
23.	C26	5-6	medium
24.	C27	0	missing
25.	C28	1-2	low
26.	C29	5-7	medium
27.	C30	3-4	low
28.	C 5	10-12	medium
29.	C10	0	missing
30.	C12	3-4	low

Table 5. Degree of spinosity in *Prunus spinosa* L. genotypes in southern area of Oltenia

Population	Genotype	No. of thorns	Degree of spinosity
Gura Vaii Calopar	GV24, GV25, GV26, GV27, GV28, GV31, GV33, GV35, GV36 C23, C24, C25, C27, C28, C29	0	Missing
Gura Vaii Calopar	GV9, C31	1-3	Low
Gura Vaii Calopar	GV32, GV37 C10, C12, C26, C30	4-7	Medium
Gura Vaii Calopar	GV6, GV8, GV10, GV29	8-11	Medium-high
Gura Vaii Calopar	GV30, GV34 C5	peste 12	High

Conclusions

Higher diversity found in blackthorn genotypes is useful to the selection program and it indicates the fact that there is an opportunity to identify genotypes with important characteristics for farming practice. Having in view the results obtained, the authors recommend distribution of studied genotypes under the following classes, in terms of capitalization opportunities: a) In order to fixing the soils, recommended are genotypes with high ability / very high ability to form basal shoots (GV26, GV28, GV29, GV30, GV31, GV33, GV34, GV37 and C31) and medium ability (GV27, GV35, GV8, GV9, C24, C25, C26, C29, C5); b) In order to use them as rootstock in fruit tree farming, recommended are genotypes without basal shoots formation or with lower number of basal shoots: C27, C10, (without basal shoots forming) and GV24, GV25, GV32, GV36, GV6, GV10, C23, C28, C30, C12, (with lower ability to form basal shoots). Further observations shall also identify other characteristics of those genotypes to conduct a satisfactory evaluation based on capitalization guidelines.

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