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The Selection of Vegetative Rootstocks for Stone Fruits

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Abstract: Modern stone fruit cultivation involves the use of selected vegetative rootstocks, primarily those exhibiting lower vigour. Countries that have long experience in vegetative rootstock selection show that the genetic resources for this type of selection can be primarily found in the germplasm of polycultural varieties. Serbia has a large fund of domestic cultivars and genotypes of stone fruits of the Prunus *genus,* which can be presumably used in the development of high-quality vegetative rootstocks. Breeding of vegetative rootstocks from autochthonous genetic material has been unjustifiably neglected in Serbia. The present paper examines the possibility of vegetative rootstock selection in 15 genotypes of autochthonous plums of different species of the *Prunus* genus, being as follows: *Prunus domestica* L., *Prunus cerasifera* Ehrs., *Prunus insititia* L. and *Prunus spinosa* L. Plum vegetative rootstocks were propagated by mounding as a type of vegetative propagation. Some species of the *Prunus* genus differed in regenerative capacity. The rooting potential was very low in genotypes derived from *P. cerasifera* Ehrh. (2.61% and 2.66%), as well as in those originating from *P. insititia* L. (1.85-4.17%). Relatively good regenerative ability was exhibited by the genus *P. domestica* L. Of the ten investigated genotypes, three genotypes did not produce rooted shoots, whereas seven genotypes showed a highly variable percentage of mother bushes responding to rooting, ranging from 7.14% to 100%.

Key words: selection, vegetative rootstocks, autochthonous genetic material.

Introduction

The selection of vegetative rootstocks exhibiting different degrees of vigour is a basic precondition for the intensification and improvement of stone fruit production. This issue has been addressed intensively by many major world producers of this fruit. Genetic resources for this type of selection can be primarily found in the germplasm of polycultural varieties. The abundance of polycultural

varieties and genotypes of stone fruits of the *Prunus* genus in Serbia has made breeding of vegetative rootstocks a challenging scientific endeavour.

The selection of stone fruit rootstocks is currently of great concern. It is also a basic precondition for successful cultivation of stone fruits, primarily plums and apricots. Rootstock selection gains increasingly high importance due to current problems in the cultivation of the two fruit species stated above (plum pox virus, sudden withering of apricot trees). In stone fruit cultivation, vegetative rootstocks should be given priority over generative ones.

Fruit rootstock breeding and selection programmes have a number of goals. Above all, rootstocks should be adapted to environmental conditions, the soil and climate excesses (frosts and drought) and resistant to or at least tolerant of diseases and pests. A good rootstock is expected to be easily propagated (vegetatively or generatively); to be able to create a straight smooth tree that can be easily grafted; to be compatible with cultivated varieties; not to produce root shoots; to produce grafted fruit trees characterized by the lowest possible vigour, precocity and abundant cropping; to result in uniform fruit tree behaviour in the orchard; to have a good anchoring ability and adequate tolerance to mineral deficiency. These are, in fact, general objectives of fruit tree rootstock selection (Misic 1984).

Many world countries have been engaged in developing stone fruit rootstocks. Focus has been placed on the creation of rootstocks of lower vigour suitable for intensive and highly intensive stone fruit cultivation. Specific attention has been given to the development of vegetative rootstocks that induce reduced vigour as well as precocity and hence better fruit quality.

The selection of rootstocks for stone fruit cultivation is crucial to longevity, productivity, quality and maturation of the fruit of grafted cultivars. When cultivating the above fruits, priority should be given to vegetative rootstocks, which have not come into wide use under Serbian agroenvironmental conditions, yet (Milosevic 1997).

The advantages of vegetative rootstocks over generative ones include the following: seedling uniformity in both the nursery and the orchard, precocity of grafted cultivars, simpler method of propagation etc. The primary disadvantage of vegetative rootstocks is risk of virus transmission, hence the necessity for a strict safety control of the seedlings grafted on vegetative rootstocks (Milosevic 2002).

Material and Method

Over 1996-2001, examinations were conducted on the possibility of selecting vegetative rootstocks for stone fruits from autochthonous genetic material.

The investigations were carried out at the experimental field of the Faculty of Agronomy at Mojsinje, under greenhouse conditions and at the laboratories of the Faculty of Agronomy, Cacak.

The possibility of selection of vegetative rootstocks from autochthonous genetic material of plum was studied in 15 genotypes of different cultivars of autochthonous plums of the genus *Prunus*, i.e. *Prunus domestica* L., *Prunus cerasifera* Ehrh., *Prunus insititia* L. and *Prunus spinosa* L.:

- genotype 2 - Belosljiva (*P.domestica* L.)
- genotype 5 - Crvena Ranka (*P.domestica* L.)
- genotype 6 - Džanarika (*P.cerasifera* Ehrh.)
- genotype 7 - Džanarika (*P.cerasifera* Ehrh.)
- genotype 1 - Crnošljiva (*P.domestica* L.)
- genotype 3 - Crnošljiva (*P.domestica* L.)
- genotype 4 - Crnošljiva (*P.domestica* L.)
- genotype 1/6 - Trn (*P.spinosa* L.)
- genotype 3/6 - Bjelica (*P.domestica* L.)
- genotype 4/6 - Trnošljiva (*P.insititia* L.)
- genotype 5/6 - Miškovačka Rana (*P.domestica* L.)
- genotype 6/6 - Trnošljiva (*P.insititia* L.)
- genotype 7/6 - Dobojska Rana (*P.domestica* L.)
- genotype 9/6 - Crnošljiva (*P.domestica* L.)
- genotype 10/6 - Crnošljiva (*P.domestica* L.)

The seedlings of the genotypes examined were used to create a mother plantation of the selection I where mounding was employed during the growing season for testing of the root regeneration ability.

Mounding was used as a type of vegetative rootstock propagation.

At the end of the growing season, testing for rooting was performed. The degree of rooting of the mounded shoot parts was estimated visually by 1-5 grades (1 – no response, 5 – excellent rooting).

The analysis of the rate of rooting at the mother plantation of the selection I included the following:

- the ability to emit rooted shoots (number of mother bushes showing response);
- average number of rooted shoots per mother bush;
- average shoot length per mother bush;
- singling out individual bushes with a positive rate of rooting;
- assessment of predispositions of certain species of the *Prunus* genus and their genotypes to vegetative rootstock selection.

Results and Discussion

The rooting ability was examined in the mother plantation of the selection I made up of seedlings of 15 autochthonous plum genotypes studied (Tab. 1). The rooted shoot emission ability was tested in 2,352 mother plants. The response to rooting was registered in 170 mother plants (accounting for 7.23 % of the total number). The response was recorded in 12 genotypes, but it was not evidenced in genotypes 5/6 (Miskovacka Rana), 7/6 (Dobojska Rana) and 10/6 (Crnosljiva).

The results presented in Table 1 suggest a great difference between certain species of the *Prunus* genus as well as between certain genotypes within the same genus. Regenerative abilities were different in certain species of the *Prunus* genus. The rooting ability in genotypes derived from *Prunus cerasifera* was found to be very low (the percentage of mother bushes showing response to rooting was very low – 2.61% and 2.66%, respectively). The genotypes of the genus *Prunus insititia* showed a low rooting ability (the percentage of mother bushes with response ranging from

1.85-4.17%). Relatively good regenerative abilities were exhibited by the genus *Prunus domestica*, nevertheless great differences between certain genotypes were reported. The ability of root regeneration on mounded shoot parts was not exhibited by all studied genotypes of *P. domestica* L. Of the ten genotypes examined, three genotypes (5/6, 7/6 and 10/6) did not produce rooted shoots on the mounded part of the bush, whereas in other seven genotypes the percentage of mother bushes responding to rooting was highly variable, ranging from 7.14% to 100%.

Tab. 1. Rooting ability in the mother plantation of selection I

Item	Genotype	Origin	Total number of mother bushes	Number of mother bushes showing response	% of mother bushes showing response	GRADE				
						1	2	3	4	5
1	2	*P.domestica* L.	293	42	14.33	251	27	6	8	1
2	5	*P.domestica* L.	237	24	10.13	213	13	3	8	0
3	6	*P.cerasifera* Ehrh.	728	19	2.61	709	15	2	1	1
4	7	*P.cerasifera* Ehrh.	451	12	2.66	439	12	0	0	0
5	1	*P.domestica* L.	7	7	100,00	0	1	3	2	1
6	3	*P.domestica* L.	4	4	100,00	0	0	0	3	1
7	4	*P.domestica* L.	6	5	83,33	1	0	0	3	2
8	1/6	*P.spinosa* L.	15	3	20,00	12	2	1	0	0
9	3/6	*P.domestica* L.	150	37	24,67	113	7	21	9	0
10	4/6	*P.insititia* L.	108	2	1,85	106	2	0	0	0
11	5/6	*P.domestica* L.	8	0	0	8	0	0	0	0
12	6/6	*P.insititia* L.	288	12	4,17	276	5	5	2	0
13	7/6	*P.domestica* L.	6	0	0	6	0	0	0	0
14	9/6	*P.domestica* L.	42	3	7,14	39	3	0	0	0
15	10/6	*P.domestica* L.	9	0	0	9	0	0	0	0
∑	15		2352	170	7,23					

The long-term examination of regenerative abilities of autochthonous plums aimed at vegetative rootstock selection (Lucic *et al.* 1994) indicates that if the number of individuals within the same genotype displays positive response to the rooting test (10-15%), this can be considered a good result. The rate of rooting is a crucial, but not the only selection parameter. This is the reason why further investigations included all of the genotypes that responded to rooting, specific focus being placed on the genotype 3/6 (Banjalucka Bjelica). The genotype showed good rooting performance in the mother plantation as it produced superbly rooted shoots (Fig. 1). Other traits of this genotype should be examined in the near future.

Fig.1. Rooted shoot of the 3/6 genotype

The assessment of the potential of certain species of the genus *Prunus* to develop root on the mounded part of the aerial system suggests that seven of the ten genotypes derived from *Prunus domestica* L. produced rooted shoots. The rooting ability was also registered with the species *Prunus cerasifera* Ehrh., *Prunus insititia* L. and *Prunus spinosa* L. The number of rooted mother bushes per individual genotype was higher in the species *Prunus domestica* L. as compared to the other ones. Therefore, the highest potential to develop vegetative progeny in the production of vegetative rootstocks by mounding was exhibited by the above species.

For the purpose of developing vegetative rootstocks, the selection of mother bushes displaying the best shoot rooting performance was conducted at the mother plantation of selection I. The selection of plants with the best rooting ability will be used in further selection and research. As the rate of rooting is not the only parameter of vegetative rootstock selection, due attention should be given to other parameters - shoot emission and vigour.

The average number and average length of the rooted shoots per mother bush are presented in Tab. 2. The average shoot number per mother bush ranged from 2.25-5. The highest and lowest shoot numbers per mother bush were recorded in the genotypes 1/6 (Crni Trn) and 6/6 (Trnosljiva), respectively.

Lucic *et al*. (1994) report that the genotypes producing less than three shoots per mother bush are of no interest for further investigation as this is a small number of rooted shoots. Their further investigations involved genotypes with more than three shoots emitted.

Kapetanović *et al*. (1972) examined vegetative progeny by mounding. The number of rooted shoots per mother bush in their research ranged from 6.1 in Ruzica to 13 in Banjalucka Bjelica. They reported that the number of rooted shoots was greatly dependent on climate conditions in the mounding period; namely, the rooting of mother bushes was determined to be lower during the drought period accompanied by high temperatures. Apart from the number of rooted shoots, the above authors gave a review of the variations in the rooted shoot number per mother bush, suggesting that the number was rather high (ranging from 4.5-23 in Banjalucka Bjelica and from 2-11.5 in Ruzica).

Tab. 2. The average number and average length of rooted shoots per mother bush

Genotype	Number of mother bushes producing rooted shoots	Average number of rooted shoots per mother bush	Average length of rooted shoot aerial system (cm)
2	42	2.74	27.32
5	24	2.29	28.24
6	19	3.89	35.09
7	12	3.83	25.55
1	7	3.43	39.40
3	4	2.50	56.67
4	5	3.60	44.22
1/6	3	5.00	64.14
3/6	37	3.89	46.04
4/6	2	3.50	26.87
6/6	12	2.25	46.46
9/6	3	4.00	71.17

As the number of rooted shoots per mother bush ranged in some genotypes, the selection of mother bushes with the highest production of rooted shoots to be used in further vegetative propagation should be conducted.

The average length of the aerial part of the rooted shoots ranged from 25.55-71.17 cm (Tab. 2). The rooted shoots had lower height, which was favourable in terms of the selection of lower-vigour vegetative rootstocks. Kapetanovic and Prica (1976) reported good rooting per mother bush, but rather vigorous growth of rooted shoots, which was not favourable in terms of the selection of lower-vigour vegetative rootstocks.

Conclusion

The long-term research results on the ability of selection of vegetative root-stocks for stone fruits from autochthonous genetic material and on the morphological and physiological characteristics of the rootstocks selected in such manner suggest the following:

- The four plum species studied exhibited high variability in vegetative propagation;
- The ability to develop new vegetative rootstocks from autochthonous genetic material was determined to be different in certain species of the *Prunus* genus. It was very low among the *Prunus cerasifera* Ehrh. species, low in *Prunus insititia* L., somewhat better in *Prunus spinosa* L. and relatively good in *Prunus domestica* L.;

All examined genotypes of the species *Prunus domestica* L. showed very different ability of root regeneration on the mounded shoot parts. Some auto-chthonous plum genotypes did not show the ability to regenerate the root on mounded shoots

(genotypes 5/6 and 10/6), other genotypes, however, showing quite a wide range of the ability – from low (7.14-10.13%) to high (83.33-100%).

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SELEKCIJA VEGETATIVNIH PODLOGA ZA KOŠTIČAVE VRSTE VOĆAKA

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Rezime

Savremeno gajenje koštičavih vrsta voćaka podrazumeva primenu selekcionisanih vegetativnih podloga pre svega slabije bujnosti. Zemlje koje imaju višegodišnje iskustvo u selekciji vegetativnih podloga ukazuju da se genetski resursi za ovaj vid selekcije primarno nalaze u germplazmi polikulturnih sorti. Naša zemlja raspolaže sa velikim fondom domaćih sorti i genotipova koštičavih vrsta voćaka iz roda *Prunus*, pa se može pretpostaviti da se na osnovu bogatstva tog materijala mogu stvoriti kvalitetne vegetativne podloge. Rad na stvaranju vegetativnih podloga na bazi autohtonog genetskog materijala kod nas je neopravdano zapostavljen. Mogućnost selekcije vegetativnih podloga ispitana je kod 15 genotipova autohtonih šljiva različitih vrsta roda *Prunus* i to: *Prunus domestica* L., *Prunus cerasifera* Ehrh., *Prunus insititia* L. i *Prunus spinosa* L. U procesu proizvodnje vegetativnih podloga za šljivu korišćeno je nagrtanje kao jedan od načina vegetativnog razmnožavanja. Regenerativne sposobnosti su različite kod pojedinih vrsta roda *Prunus*. Veoma su male mogućnosti okorenjavanja kod genotipova poreklom od vrste *P. cerasifera* Ehrh. (2,61%, odnosno 2,66%). Male mogućnosti okorenjavanja su i u genotipova vrste *P. insititia* L. (1,85-4,17%). Relativno dobre regenerativne sposobnosti ima rod *P. domestica* L. Od deset ispitivanih genotipova tri genotipa ne daju okorenjene izbojke, dok kod sedam genotipova procenat matičnih žbunova sa reakcijom je jako varijabilan i kreće se u rasponu od 7,14% do 100%.