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Effect of Rootstocks on the Content Dynamics of Starch and Sugars in Plum Branches

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Abstarct: The effect of rootstocks on the dynamics and average content of the carbohydrates, i.e. starch and sugars (reducing, non-reducing and total sugars) was studied in the shoots and two-year-old branches of newly bred plum cultivars during 1985, 1986 and 1987.

Research results show that only small differences in starch and sugar content of plum branches were due to rootstocks, somewhat higher ones due to cultivars and years, while the highest ones resulted from branch age categories. However, the analysis of variance (F test) indicates that effects of all the factors greatly dropped, due to their significant and highly significant interaction effects.

Key words: Starch, sugar, cultivar, rootstock, dynamics, content.

Introduction

It is well-known that carbohydrates represent a source of energy allowing extremely complex biochemical and physiological processes to be completed throughout the annual life cycle of fruits, all the more because, without these processes, fruits cannot normally grow and develop at all. Despite existing patterns determining carbohydrate formation and consumption, these compounds are mostly consumed for forming the so-called temporary organs (leaf, flower, fruit and stone) while only partly contributing to permanent organ formation (seedlings, shoots, branches - fruitful or fruitless, branches, blossoms and others).

Starch and sugars represent the most significant carbohydrates. In addition to their general functions, they are also the source of energy permitting

plants to survive and resist severe temperatures over the wintertime, thereby inducing the next stage of blossom formation.

The present studies aim at finding out whether and to what extent the *Myrobalan* and *Stanley* rootstocks affected accumulation, dynamics and average content of the most significant carbohydrates in one-year-old (shoots) and two-years-old branches of two new Yugoslav plum cultivars (*Čačanska Lepotica* and *Čačanska Najbolja*).

Similar problems were studied more comprehensively in *Pomodieae* than in *Prunoideae*. The pioneers of such studies on apple-shaped fruits are Price, 1916., Mtri, 1921., Potter et al., 1925., and Swarbrick, 1927 (cited by Stankovic and Jovanovic, 1977), then in recent years Tumanov (1963), Pristley (1960, 1969), Jones et al., (1963), Bulatovic et al. (1974), Azarova (1976), Perepadya and Malychenko (1982) and Stanisavljevic (1984) and those dealing with stone fruits, Scerbec (1980), Milosevic (1992, 1997) and others.

Material and Methods

Čačanska Lepotica and *Čačanska Najbolja*, as the two newly-bred plum cultivars on the assortment list of Yugoslavia, were used as a test material. They were grafted on the seedlings of *Prunus Myrobalan* and *Stanley*.

The content of starch was determined following the method of Tillman, while that of the total and reducing sugars was determined following the method of Bertrand. The content of non-reducing sugars was computed from the difference in content between the total and reducing sugars.

The results obtained were processed using the analysis of variance, and Duncan test served to test the differences.

Results and Discussion

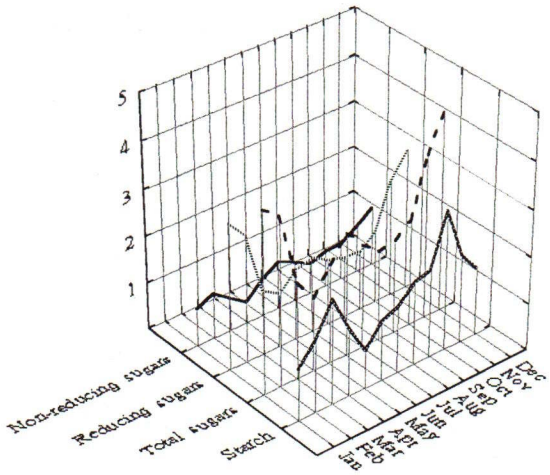
The results showed that sugar and starch content amounted to 61.95% and 38.05%, respectively from the total of the carbohydrates contained in the plum branches (Fig.1 and Tab.1). It was found out that reducing and non-reducing sugars amounted to 69.40% and 30.60% respectively in the total ones.

During the year, the content of starch in the plum branches proved to be the highest in March (2.25% of dry matter and 2.96%) and the lowest in January (1.11%) and May (0.81%).

The content dynamics of total sugars was inversely related to that of starch. The content of total sugars was reported to be the highest in January (3.88%) and December (2.67%) and the lowest in April (1.57%) and August (1.91%).

The content dynamics of reducing sugars followed that of the total ones, while that of non-reducing sugars was somewhat different. Namely, the percentage of non-reducing sugars contained in the plum branches was found to be the highest in June (1.00%) and December (1.25%) and the lowest in April (0.44%) and August (0.63%).

Fig.1. Dynamics of starch and sugars in the plum branches



Analyzed by rootstocks, the branches of the cultivars grafted on *Myrobalan,* had higher content of starch (1.67%) and sugars (total - 2.68%, reducing - 1.88% and non-reducing - 0.83%) than those grafted on *Stanley.* Higher content of starch (1.68%) was also present in the branches of *Čačanska Lepotica.* However, the total (2.95%), reducing (1.96%) and non-reducing sugars (0.99%) were more contained in the branches of *Čačanska Najbolja.*

On a year-basis, the content of starch (2.16%) and reducing sugars (1.92%) was the highest in 1985, while that of total (2.68%) and non-reducing sugars (0.90%) was the highest in 1987.

Based on the analysis of variance (F test) and Duncan test of the average content of starch, reducing, non-reducing and total sugars contained in plum branches, taken individually, only roots (A) had no effect on the differences in content of these substances. In contrast, the other factors, i.e. cultivar (B), branch age, (C) and years (D) showed either significant or highly significant statistical effects in most cases. Still, all the existing significant and highly significant interaction effects, affecting the differences in matter content and content itself and subject to carbohydrate type, particularly in the case of that with double interaction (A x B x C), led to a considerably weaker individual effect of any one factor studied.

Similar data on the dynamics and average starch and sugar content were reported by Mitri, 1921, Potter et al., 1925., Swarbrick, 1927 (as cited by Stankovic and Jovanovic, 1977), Tumanov (1963), Pristley (1960, 1969), Jones et al. (1963), Bulatovic et al. (1974), Azarova (1976), Prepadya and Malychenko (1982), Stanisavljevic (1984), Scerbec (1980) and Milosevic (1992, 1997).

Table 1 - Average content of carbohydrates in plum branches

Variable	Starch	Reducing sugars	Non-reducing Sugars	Total sugars
Rootstocks (A)				
Myrobalan	1.67 a	1.88 a	0.83 a	2.71 a
Stanley	1.61 a	1.84 a	0.81 a	2.65 a
Cultivars (B)				
Cacnska Lepotica	1.68 a	1.75 b	0.65 b	2.40 b
Cacanska Najbolja	1.61 a	1.96 a**	0.99 a**	2.95 a**
Branches (C)				
One-year-old	1.77 a**	2.04 a**	0.90 a**	2.94 a
Two-year-old	1.51 b	1.68 b	0.74 b	2.42 a
Years (D)				
1985	2.16 a**	1.92 a*	0.77 b	2.69 a
1986	1.16 c	1.87 a	0.80 b	2.67 a
1987	1.60 b	1.78 b	0.90 a**	2.68 a
Interaction				
AB	Ns	Ns	**	**
AC	*	**	**	**
AD	Ns	**	**	Ns
BC	Ns	Ns	**	**
BD	Ns	**	Ns	Ns
CD	Ns	**	Ns	**
ABC	*	*	*	**
ABD	Ns	Ns	Ns	Ns
ACD	Ns	**	**	Ns
BCD	Ns	**	Ns	Ns
ABCD	Ns	*	Ns	Ns
Average	1.64	1.86	0.82	2.68

Non-reducing sugars were exposed to the greatest, starch to lower and total sugars to the lowest changes. The highest starch level existed at the beginning and at the end of vegetation, and its lowest level existed during the wintertime, just at the time of highly abundant sugars, particularly reducing and total ones.

Although roots, as an individual factor, had no essential effect on the average carbohydrate content, their effect manifested by an interaction with remaining factors, seemed much stronger.

The processes discussed above are not only dependent on the factors considered, but also on the environmental conditions and cultural practices used. Therefore, a high cultivation technology should be implemented for purpose of fruit survival during the winter and, its regular and ample storing with good quality cropping.

Conclusion

On the basis of everything done, several conclusions may be drawn:

- of the entire carbohydrate amounts, sugars and starch made up 61.95 and 38.05%, respectively;
- starch contained in the branches was the highest in March an October, and the lowest in January and May;
- the highest amounts of total sugars were reported to be in December and January, and their lowest amounts in April and August.;
- the branches of plum cultivars, grafted on Myrobalan had more starch and sugars than those grafted on Stanley.

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UTICAJ PODLOGA NA DINAMIKU SADRŽAJA SKROBA I ŠEĆERA U GRANČICAMA ŠLJIVE

-originalni naučni rad-

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Rezime

Osnovni cilj rada je bio da se utvrdi u kojoj meri i na koji način različite podloge utiču na stepen nagomilavanja osnovnih ugljenohidratnih materija u tkivima nekih vegetativnih organa šljive tokom godišnjeg ciklusa.

Od ukupne količine ispitivanih ugljenih hidrata tokom godine 61.95% čine šećeri, a 38.05% skrob. Najviše skroba u grančicama tokom godine bilo je u martu i oktobru, a najmanje u januaru i maju. Najveće količine ukupnih šećera utvrđene su u decembru i januaru, a najmanje u aprilu i avgustu.

Grančice sorti šljive kalemljenih na dženarici imale su više skroba i šećera nego na stenliju.

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Possibilities of Selecting Vegetative Rootstocks for Plum on the Basis of Autochthonous Genetic Material *P. Domestica* L. and *P. cerasifera* Ehrh.

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Abstract: One of the basic pre-requisites for intensification of plum production in the world is considered to be selection of the vegetative rootstocks of differing vigour. Unless this is done, no significant progress towards increase in orchard density or growing habits to meet requirements of intensive production as well as higher fruit and yield quality per unit area, are expected.

With the aim of obtaining appropriate rootstocks for plum with a wider spectrum of vigour, the initially used orchard stock was: 11 autochthonous plum cultivars *P. domestica* L. and *P. institia* L. and 5 genotypes of *P.cerasifera* Ehrh. Of this material, 2.970 individuals tested on rooting, were produced. It was obvious that this material had a differing affinity to regenerating root on the above - ground parts, widely ranging from the genotypes without any response to the test on rooting (0) up to those with a high capability of rooting (5).

The paper presents regenerative abilities of the material surveyed as well as some basic characters of 5 cloned selections on the basis of *P.domestica* L. and *P. cerasifera* Ehrh. (6/209; 5/7; 2/53; 4/2; 3/3). The obtained selections have a substantial level of root regeneration, high zone of rooting and a satisfactory index of rooting (R/I). By their vigorousness, the obtained rootstocks belong to medium and low vigorous.

Key words: rootstock for plum, rooting, autchthonous plums, *Prunus domestica* L., *Prunus cerasifera* Ehrh., rooting ability index (RAI)

Introduction

One of the major pre-requisites, which leads to increase in plum production is an adequate selection of vegetative rootstocks of differing vigour, primarily those of moderate and low vigour. Unless an appropriate selection is obtained, neither progress in achieving higher orchard density per unit area nor better growing habits to meet the requirements of intensive production will be accomplished.

Investigations, carried out by Kapetanovic et al., 1976, Lucic et al., 1992 and 1993, show that some autochthonous plum cultivars are genetically prone to root regeneration on the above-ground parts. Thus, these cultivars may serve as a good initial material for further selection of the vegetative rootstocks.

The aim of the present study was to select vegetative rootstocks for plum of differing vigour from the autochthonous plum genotypes (*P. domestica* L.) and populations of numerous myrobalan genotypes (*P. cerasifera* Ehrh.).

Materials and Methods

The seedlings out of 11 autochthonous plum genotypes and 4 myrobalan genotypes were initially used for selection of the vegetative plum rootstocks.

The following procedure was used:

- seedling production in seedbed;
- development of mother plantation and selection;
- seedling screening of rooting with the application of stooling;
- propagation and development of mother plantation of II selection;
- selection according to the degree of rooting, the number of shoots, vigour and proportion of the total length of primary roots with that of shoots (rooting abiltiy index R/TS);
- propagation with the application of *in vitro* culture;
- grafting of the selected vegetative rootstocks on the cultivar Cacanska rodna and, evaluations of the fruit bearing, cropping material, fruit quality, vigour and compatibility between rootstock and scion.

Results and Discussion

The potential of developing new vegetative rootstocks on the basis of domestic plums is differing in individual cultivars, being almost none in *P. cerasifera* Ehrh, somewhat present in *P. insititia* L., and relatively good in *P. domestica* L. Even considerable differences exist between single cultivars. Some domestic cultivars are not able to regenerate root on the seedlings at all, whereas the others show a wider spectrum of root regeneration abilities, from very slight to relatively high. If a number of individuals positively responding to the rooting test accounts for 10-15%, then this result may be assumed to be a good one. Higher degree of rooting is a rare case. Rooting degree is considered to be a decisive index for selection, but not the only one. Emission of scions and vigour