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COMPATIBILITY AND VERDURE OF SEEDLING FOR AUTOCHTONOUS PEER IN THE REGION OF NORTH MONTENEGRO

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The study was conducted in three successive years to examine the compatibility and verdure in nursery trees of autochthonous peer cultivars grafted on Quince MA and wild peer seedlings *(Pyrus communis L)* during the first year after bud grafting. The aim of this paper is to determine compatibility and verdure of autochthonous peer seedling sorts (Pećanka, Jerebasma, Lubeničarka, Sinka, Turšijača and Jarac) with the Quince MA and wild peer seedlings *(Pyrus communis L)*. The severity of incompatibility varies between varieties but is always more severe with Quince MC than Quince MA.

The incompatibility expresses itself in several ways. Firstly a poor 'bud' or 'graft' take in the nursery will be evident, secondly even if growing successfully in the nursery very often when 'lifted' breakages (brittle unions) occur between rootstock and scion and thirdly 'delayed' incompatibility where again the union between rootstock and scion breaks suddenly in later years, this is unpredictable and can often happen when there is a heavy crop load assisted by strong autumnal winds.

The production of seedling material of autochthonous sorts with vegetative rootstocks Quince MA will be enormous contribution for even partially saving of fruit genofond that is the unity product of our ecological environment and autochthonous biocenosis.

Key words: autochthonous varieties, acceptance of grafting, growth dynamic, compatibility, morphological characteristics,one-year old seedlings, wild peer

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INTRODUCTION

High density planting systems are the starting point of modern orchards. Small trees that come into production in the second year after planting area prerequisite to achieve regular yields of high quality fruits and to economise the use of land and labour costs for pruning and picking. Dwarfing rootstocks controlling the vigour of the scion cultivars and inducing precociousness form the basis for such high density orchards (WERTHEIM *et al*, 2005).

The lack of studies on compatibility of pear cultivars and rootstocks is one of the limiting factors on the development of the pear crop. The use of quinces as rootstocks for pear cultivars has several advantages, among them the reduction in vigor and earlier bearing trees, however, its combination with some scions cultivars results in problems of incompatibility, such as lost of trees of the orchard due to break of the graft union. It was observed that the pear cv. Packham's Triumph is compatible with the quince rootstocks cvs. Adams and Quince C, whereas the pear cv. Kieffer had morphological incompatibility with the Quince cvs. Adams and Quince C. (TOMAZ, 2009).

Many studies interactions rootstock - scion show that the rootstock controls the overall growth, while scions affect the number and type of shoots (FERREE *et a*l, 2001a, b).

The scion has a greater impact on the rootstock at a monthly growth rate of trees (TWORKOSKI *et al*, 2007). Dwarfing apple rootstocks M9 combined with different scions consistently has the lowest, and seedling rootstocks of *Malus silvestris* have the highest vegetative growth and tree trunk diameter (TWORKOSKI *et al,* 2007). Although the rootstock is used to control the size of the tree, the mechanism that is responsible and which is closely related to the action of the growth of the tree is still unclear (ATKINSON *et al*, 2001).

The nursery material of high quality is the basic of intensive fruit growing (BARYLA *et al*, 2006). Namely, modern pear orchards are planted at 2000 - 5000 trees · ha^{-1} on under Height Density Planting (HDP), if it is grafted on dwarf or semi-dwarf quince rootstocks, yielding at least 40-50 t· ha^{-1} (WERTHEIM, 2002). Intensive pear orchards are based on the concept of high density planting, training systems of low tree height and high productivity on the basis of the unit area (ha or m^2). However, quince is graft incompatible with some of the major pear cultivars, that has negative influence on cultivating pear in the area of Montenegro, and also in the world. So far, literature does not show us any findings about the eventual compatibility or incompatibility of Montenegrin autochthonous pear breeding on vegetative Quince MA rootstock. At the territory of Montenegro, the vegetative rootstocks that are dominantly used for production of pear and quince seedlings are Anžerska Quince MA and Provencal Ba 29.

The Boscova pear exhibited poor compatibility with quince, while good compatibility between Conference pear and quince was observed. Thus far, the new pear cultivars Bohemica, Dicolor, Vonka, Jizera and Morava pear have good compatibility with quince rootstocks (KOBĚLUS *et al,* 2007). There are other quince rootstocks in use such as Adams, Ba29 and the more recently introduced EMH and Eline, and it must be assumed for the sake of caution that the incompatibilities mentioned here are probably expressed in some degree in all such quince rootstock forms. As said before, there are no practical experience and literature related to the compatibility autochthonous varieties of pear with Quince MA rootstock in Montenegro, with the exception of our scientific work.

The actuality of these studies is increased by the positive results obtained in the world that relate to the resistance to disease of autochthonous varieties of pears, especially from the area Polimlje and wider Balkan Peninsula. It is pointed out that the title of the ’Balkan Peninsula

treasures' can only be carried by varieties of pears Karamanka and Jerebasma, that are highly resistant to *Psilli pyri* and the *Erwinia amylovora* (BELL, 2003). The special attention has been paid to the group of cultivars resistant to the causal agent of pear fireblight *Erwinia amylovora Burill*. The most important and superior among them are Canadian cultivars resistant to the above mentioned pathogen (Harrow Sweet, Harrow Delight), American cultivar (Potomac) and Rumanian cultivar (Getika) (NIKOLIĆ *et al,* 2000*).*

The main objectives of pear breeding are: high quality of fruits, precocious bearing and good productivity, extension of the harvesting period, long storage life, environmental adaptation and resistance to the most dangerous diseases and pests (fireblight, pear scab and pear *psylla*). The European pear breeders pay attention primarily to the fruit quality. The breeders from North America place greater emphasis on disease resistance (especially fire light resistance) and cold hardiness (MILATOVIĆ, 2009).

MATERIALS AND METHODS

The domesticated pear is one of the most important fruit crops, grown extensively in colder and temperate climate. Many consider pear as the fruit above all fruits. Although modern pear varieties and autochthonous cultivars are an essential part of the inheritance of the region, knowledge about the former is becoming rarer. An autochthonous cultivar is a variety with a high capacity to tolerate biotic and abiotic stress, resulting in high yield stability under a low input agricultural system. Agricultural industrialization, Green Revolution technologies and environmental changes have all been cited as factors contributing to the erosion of crop biodiversity, including pear. Changing characteristics of markets – including distance to market, means of transportation, fruit appearance and storage requirements – are also contributing towards the old varieties becoming less popular.

The Balkan Peninsula is known as one of the most important genetic, species and ecosystem diversity centres in Europe. It is an extremely rich source of genetic variation in pear, which may contribute greatly to the improvement of economically important traits of this valuable fruit. Because of the existing variability in the region, differing ecological conditions and human activities, the Balkan Peninsula can be regarded as one of the most important secondary centres of genetic diversity in pear (MRATINIĆ, 2000).

Based on scientific and practical experience, the autochthonous pear cultivars from the Upper Polimlje territory have a variety of interesting characteristics related to resistance to law temperatures (ŠEBEK, 2008) and drought (ŠEBEK, 2010).

The above mentioned characteristics are of great importance for the process of cultivar selection, as well as rootstock selection in recent years, and for production purposes. In so far scientific researches, the generative rootstocks (gained from the seed of autochthonous pear cultivars) at the territory of Bijelo Polje have shown potential for their use as generative rootstocks, that opened another additional field of practical use (ŠEBEK *et al*, 2006). Owing to a favorable ratio of P and K: N, seedlings sijerak and kačmorka are to be singled out for generative rootstock production (ŠEBEK *et al*, 2007a;) The average seed germination amongst autochthonous sorts of pears was from 65,33% (cultivar Medunak) to 90% (cultivar Kačmorka) (ŠEBEK *et al*, 2007b).

The materials of this study were autochthonous pears: Pećanka, Jerebasma, Lubeničarka, Sinka, Turšijača and Jarac. These autochthonous varieties of pears are grafted on

vegetative rootstocks Quince MA. Comparative or control graft was performed on generative rootstock of wild pear (*Pyrus communis L*).

The experiment was conducted in the village Njegnjevo in the period from the year 2009 to the year 2012. The nursery was located at Njegnjevo near Bijelo Polje (43º05'N; 19 º05'E), North Montenegro. This is mainly an upland area, with an average altitude of about 320 m, characterized by temperate continental climate. The nursery soil was typically eutric land on alluvial and colluvial deposits, mildly acid (a pH of 5,41in the topsoil), with a moderate organic matter (3,88 %) and a very low Ntot content (0,18%), the values thereof gradually decreasing with the depth (data not show). The contents of available P2O5 and K2O in the 0-30 cm soil depth were 6,7mg·100g^{-1} and 14,07mg·100g^{-1}, respectively. Fertilization treatments included applications of mineral nitrogen fertilizers at the rate of 80 kg N·ha^{-1} prior to growing season and following the cutting of the rootstock above the graft union, i.e. towards the end of March in three seasons. The drip irrigation was performed in the nursery.

During the year of 2009, the vegetative and generative rootstock was cultivated. Seeds of wild pear were collected the year before from local trees; they were cleaned of flesh, dried and stratified in wet sand during the winter of 2008/2009. Wild pear seedlings were cultivated in 2009. The same procedure of producing generative and vegetative rootstocks was repeated two times more in order to have results from three different years. We already knew that generative rootstocks have diverse genetic characteristics but we included them in this project in order to compare them to the vegetative rootstocks. What we are hoping to accomplish in this project is to determine the compatibility between vegetative rootstocks and autochthonous varieties of pears. In Montenegro, autochthonous varieties of pears were only grafted on generative rootstocks. This fact prevents raising of pear orchards with intensive production. Budding of sleeping bud was conducted in the fall (late August) during the years of 2009, 2010 and 2011. Due to poor production results there were other grafting that took place in the spring of years 2010, 2011 and 2012, in which the method of 'English linking' was used. Grafting height is 10 cm from the root collar of wild pear generative rootstock or vegetative rootstock for pear (Quince MA). Scions for grafting were collected in the spring before the abrupt movement of buds and stored in the basement until the proper grafting conditions. Acceptance of grafting was monitored during three years of production. The study (2010 -2012) includes those morphometric characteristics of plants that are used as basic parameters for their classification according to outward, phenotypic characteristics. Determination of seedling growth indicators was done with a sample of 80 rootstocks. One-year seedling height was measured with a meter. The diameter of seedlings on 3 cm from the seedling grafting point was measured with a micrometer of 0, 01 mm precision. The dynamic of evolution of the one-year seedlings (seedling height and thickness) was followed during the growing season treatments: June, July, August and September. The results were analyzed using one-way analysis of variance (statistical program Systat 11) where the middle of treatment compared to the LSD test.

RESULTS

The average acceptance of autumn grafting process in the shape of the „T" letter of autochthonous peer sorts with Quince MA seedlings (vegetative rootstocks) had been with the following percent of success: 76,3 % (Pećanka); 93,3 % (Jerebasma); 54,67 % (Lubeničarka); 44 % (Sinka); 80 % (Turšijača) and 84 % (Jarac). The acceptance of autumn grafting process in the shape of the „T" letter of autochthonous peer sorts with wild peer seedlings (generative

rootstocks) had been with the following percent of success: 86,3 % (Pećanka); 81 % (Jerebasma); 94 % (Lubeničarka); 72 % (Sinka); 78,67 % (Turšijača) and 91 % (Jarac). Due to the results of the grafting process in the shape of the „T“letter there was a need for repetition of the grafting process (next spring: English linking) for defining causes of low acceptance of seedlings regarding individual sorts and for increasing of production results. When the grafting process was repeated, satisfied results from the aspect of plantation production profitability had been achieved. Achieved percent after the repetition of the grafting process for autochthonous peer sorts with Quince MA seedlings was: 98,3 % (Pećanka); 98 % (Jerebasma); 92,67 % (Lubeničarka); 84,67 % (Sinka); 88 % (Turšijača) and 88 % (Jarac). Achieved percent after the repetition of the grafting process for autochthonous peer sorts with wild peer seedlings *(Pyrus communis L)* seedlings was: 95,3 % (Pećanka); 86 % (Jerebasma); 98 % (Lubeničarka); 98 % (Sinka); 90 % (Turšijača) and 96,3 % (Jarac).

The growth dynamic of one-year-old seedlings (height and corpulence of the seedlings) was monitored during vegetation in time treatments: June, July and August. The values of the monitored parameters (height and corpulence of the seedlings) showed differences in average values and seedling growth dynamic. By analyzing the data for pear sort Pećanka (rootstocks is Quince MA), average height of the seedling in June was 30 cm. In the month of the July average height was 55 cm. For August average height was 91 cm. The average corpulence of the seedlings, 10 cm from the grafting spot, of the same sort was 2.9mm in June. In July, data for the average corpulence was 5.15mm. In august, corpulence was 8.75 mm. Parallel data for pear sort Jerebasma (rootstocks is Quince MA), of studied parameters in three different time treatments were following: 33cm; 58cm; 95cm; (height) and 3.0mm; 5.95mm; 9.25mm (corpulence). The parallel data for pears sort Lubeničarka of studied parameters in three different time treatments were following: 38cm; 62cm; 110cm; (height) and 3,5mm; 6.75mm; 10mm (corpulence). Parallel data for pears sort Sinka of studied parameters in three different time treatments were following: 40cm; 70.5cm; 117cm; (height) and 3.25mm; 7.5mm; 10.75mm (corpulence). Parallel data for pears sort Turčijača of studied parameters in three different time treatments were following: 42 cm; 74 cm; 125cm; (height) and 3.9mm; 9,0mm; 14mm (corpulence). The analysis had shown that the average height of peer sort Jarac was 38 cm in June. In July the average height was 69,5 cm. In August average height was 98 cm. The average corpulence of the seedlings, 10 cm from the grafting spot, of the same sort was 3.6 mm in June. In July, data for the average corpulence was 8.1mm. In August, corpulence was 12.5 mm.

Based on the data (Table 1), the highest average tree height (169.3 cm) had the variety Turšijača grafted on the rootstock Quince MA. Based on LSD values we can note that the height of the seedling in interaction between Turšijača and the rootstock Quince MA was significantly higher compared to other seedling (interactions) height. Seedlings of pears Sinka grafted on the rootstock Quince MA had significantly higher height than any other seedling grafted on the same rootstock (accept Turšijača). The diameter (corpulence) of the seedlings was the greatest in the variety Turšijača grafted on the rootstock Quince MA (21.2mm), which is statistically significantly higher than all other. The results showed that the low amount of successfully grafted seedlings after the fall grafting on the rootstock Quince MA of cultivars Sinka (44%) and Lubeničarka (54, 67%) can be significantly improved in next spring grafting (84.67% Sinka and 92.67% Lubeničarka). The same effect of improving was evidenced in grafting of the variety Pećanka, the percent of successfully grafted seedlings was increased from 76.3% to 98.3%. The lowest effect of improving was evidenced in grafting of the varieties Jarac and Turšijača.

Table 1. Growth dynamic of one-year-old seedlings of pears and achieved percent of the grafting process (rootstock is Quince MA)

Cultivar / rootstock	Height of the seedlings				Corpulence of the seedlings			
	VIx	VIIx	VIIIx	IXx	VIx	VIIx	VIIIx	IXx
	cm				mm			
Pećanka / Quince MA	30	55	91	148.3	2.9	5.15	8.75	17.3
Jerebasma / Quince MA	33	58	95	146.8	3.0	5.95	9.25	18.8
Lubeničarka / Quince MA	38	62	110	148.6	3.5	6.75	10	18.7
Sinka / Quince MA	40	70.5	117.	160.2	3.25	7.5	10.75	18.5
Turšijača / Quince MA	42	74	125	169.3	3.9	9.0	14	21.2
Jarac / Quince MA	38	69.5	98	143.0	3.6	8.1	12.5	19.3
LSD 0.05				3.2*				1.3*
LSD 0.01				4.2**				1.7**

Cultivar / rootstock	Percent of the grafting process (autumn: „T“letter)				Percent of the grafting process (spring: English linking)			
	2009 X	2010		2011	2010 X	2011		2012
	%				%			
Pećanka / Quince MA	71	80	78	76.3	97	99	99	98.3
Jerebasma / Quince MA	93	90	97	93.3	98	99	97	98
Lubeničarka / Quince MA	53	56	55	54.67	90	93	95	92.67
Sinka / Quince MA	40	47	45	44	81	89	84	84.67
Turšijača / Quince MA	78	83	79	80	85	92	87	88
Jarac / Quince MA	88	85	79	84	85	90	89	88
LSD 0.05				6.9*				5.4*
LSD 0.01				7.3**				6.1**

Based on the data (Table 2.) the highest average tree height (184 cm) had the variety Turšijača grafted on the generative rootstock (*Pyrus communis L.*). Based on LSD values we can note that the height of the seedling in interaction between Turšijača and the generative rootstock (*Pyrus communis L.*) was significantly higher compared to other seedling (interactions) height. The seedlings of all studied varieties of pears grafted on the generative rootstock (*Pyrus communis L.*) had significantly higher height than any seedlings grafted on the vegetative rootstock (Quince MA). The results of autumn grafting of autochthonous varieties of pears Pećanka (86,3%) and Jerebasma (81%) on the generative rootstock (*Pyrus communis L.*) show that they have higher percentage of successfully grafted seedlings than varieties Turšijača

(78,67%) and Sinka (72%). The same results also show that the varieties of pears Pećanka (86,3%) and Jerebasma (81%) have lower percentage of successfully grafted seedlings than varieties Lubeničarka (94%) and Jarac (91%). Because of the method of re-grafting in spring we had higher amount of successfully grafted seedlings on both generative and vegetative rootstocks.

Table 2. Growth dynamic of one-year-old seedlings of pears and achieved percent of the grafting process (rootstock is Pyrus communis L.)

Cultivar / rootstock	Height of the seedlings				Corpulence of the seedlings			
	VIx	VIIx	VIIIx	IXx	VIx	VIIx	VIIIx	IXx
	cm				mm			
Pećanka /*P. communis*	35	69.5	105	163.3	4.2	6.75	10.25	20.6
Jerebasma /*P. communis*	37.	68.8	109	169	4.0	6.45	11.05	21.3
Lubeničarka / *P. communis*	5	80.5	125	170.5	4.6	7.9	11	20.8
Sinka / *P.communis*	42	79	1129	180	5.9	8.5	13.2	21.5
Turšijača / *P.communis*	48	83	129.	184	4.3	9.8	16.8	23.7
Jarac / *P.communis*	48.	73.5	5	171.5	4.0	8.6	15.2	21
LSD 0.05	5		104	4.1*				1.9*
LSD 0.01	40.			5.1**				2.1**
	6							

Cultivar / rootstock	Percent of the grafting process (autumn: „T“letter)				Percent of the grafting process (spring: English linking)			
	2009		2010	2011	2009	2010	2011	X
	X							
	%				%			
Pećanka /*P. communis*	89	83	87	86.3	97	90	99	95.3
Jerebasma /*P. communis*	80	79	84	81	89	85	84	86
Lubeničarka / *P. communis*	89	95	98	94	99	96	99	98
Sinka / *P.communis*	67	74	75	72	98	97	99	98
Turšijača / *P.communis*	75	80	81	78.67	86	88	96	90
Jarac / *P.communis*	88	92	99	91	94	95	100	96.3
LSD 0.05				5.4*				4.2*
LSD 0.01				6.8**				5.1**

DISCUSSION

Pyrus rootstocks are attractive from the point of view of better compatibility, frost hardiness and tolerance to lime-induced chlorosis than most quince rootstocks. However, all *Pyrus* rootstocks evaluated so far resulted in stronger growth, lower production efficiency and general smaller fruit size than Quince MC (MAAS, 2006). The generative rootstocks (gained from the seed of wild pear cultivars) have been used as dominant rootstocks for autochthonous pear

cultivars from the territory of Upper Polimlje. These cultivars are planted as individual trees (in situ) across the above mentioned territory. The verdure is their main characteristic and therefore the possibility of raising more intensive production orchards is decreased. Comparing the characteristics from the (Table 1) and (Table 2), height of seedlings and corpulence of seedlings, it is evident that the verdure is higher when it comes to every case of grafting on *Pyrus communis*.

Of the tested quinces the weakest growth and highest production efficiency was observed for Conference and Doyenné du Comice cultivars. However, based on the anatomy of the graft union and the poor leaf quality the dwarfing by these rootstocks seems to be caused by incompatibility, especially with Conference. The cultivars Quinces MH, Eline®, and C132 were the best performing rootstocks and their control of tree vigour and production efficiency was quite similar to Quince MC. (MAAS, 2006). In our scientific paper, the best control of tree vigour has been observed in interaction Pećanka / Quince MA (Table 1).

There is also one more similar research dealing with the issue of selection most appropriate vegetative and generative rootstocks for Conference and Erika cultivars. In the stated research (LEWKO, 2007), a trial for evaluation of different pear rootstocks was established in spring 2002, on a loam alluvial soil at the Wilanów Experimental Station of the Warsaw Agricultural University. The following rootstocks were tested: Caucasian pear seedling (*Pyrus communis* var. *caucasica*), OH×F 333 (*Pyrus communis*), 'Pyrodwarf' (*Pyrus communis*), and Quince S1 (*Cydonia oblonga*), Quince MA (*Cydonia oblonga*) and Quince MC (*C. oblonga*). 'Conference' and 'Erika' were used as scion cultivars (LEWKO, 2007).

The biological characteristics in development of seedlings are mainly manifested in the first year of cultivating. In designing the research and the experiment we assumed that the morphological characteristics of researched one year old varieties of autochthonous pear seedlings will be interaction between the characteristics of rootstocks and scions. However, literature data have pointed out the complexity of the problem by stating that many studies of interaction rootstock - scion show that the rootstock controls verdure of seedlings, while the scion influences the of growth such as long or short gains as well as the number of buds that will become a flower (BEHMEN, 2011). The previous researches of relationships between rootstocks and scions determined the effect of intermediate buds (from the scion) on growth and quality of fruit trees (BEHMEN, 2011).

Taking into account all evaluated autochthonous pear cultivars in our paper (all six of them), the good compatibility with the rootstock Quince MA was observed. These results refer on the production possibilities of seeding materials for autochthonous pear cultivars, which would allow their use in orchards. Their conservation throughout production practice would give the best possible results for the purposes of organic pear orchard breeding.

CONCLUSION

The seedlings of all studied varieties of pears grafted on the generative rootstock (*Pyrus communis L.*) had significantly higher height than seedling grafted on the vegetative rootstock (Quince MA). We also have observed the significant difference between the diameters of seedlings. Those differences are the consequences of lower verdure in vegetative rootstocks than in generative rootstocks. The quince is a common rootstock for autochthonous pear (*Pyrus communis L.*) because of its size control, which makes high density orchards possible.

The most important result of our research is the fact that we determined the compatibility between researched autochthonous varieties of pears and vegetative rootstocks (Quince MA). The method of re-grafting in spring is very useful, because we had higher amount of successfully grafted seedlings on both generative and vegetative rootstocks after re-grafting.

The production of seedling material of autochthonous sorts with vegetative rootstocks Quince MA is enormous contribution for even partially saving of fruit genofond that is the unity product of our ecological environment and autochthonous biocenosis.

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KOMPATIBILNOST I BUJNOST SADNICA AUTOHTONIH SORTI KRUŠKE NA PODRUČJU SEVERA CRNE GORE

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Izvod

Rad prikazuje rezultate trogodišnjih istraživanja kompatibilnosti i bujnosti u rasadniku autohtonih sorti kruške kalemljenih na vegetativnoj podlozi dunja MA i sejancu divlje kruške *(Pyrus communis L)*.

Cilj rada je utvrđivanje kompatibilnosti i bujnosti sadnica autohtonih sorti kruške (Pećanka, Jerebasma, Lubeničarka, Sinka, Turšijača i Jarac) sa podlogom dunja MA i sejanaca divlje kruške *(Pyrus communis L)*.

Stepen nekompatibilnosti varira između sorti, ali je uvek izraženija kod dunje MC nego kod dunje MA. Nekompatibilnost se ispoljava na više načina. Kao prvo, kada je loš prijem pupoljka ili spojnog mesta kalema u rasadniku očigledan; kao drugo, čak i ako uspešno raste sadnica u rasadniku veoma često se kasnije u zasadu lomi spojno mesto između podloge i plemke i kao treće je pojava „zakasnele“ nekompatibilnosti, gde se spojno mesto između podloge i plemke lomi iznenada u kasnijim godinama, što je nepredvidivo i često može biti posledica tereta useva uz prisustvo jakih jesenjih vetrova. Proizvodnja sadnog materijala autohtonih sorti na vegetativnim podlogama dunje MA daje ogroman doprinos za makar delimično očuvanje genofonda, koji predstavlja bogotstvo naše ekološke sredine i autohtone biocenoze.

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