Original scientific paper
UDC 634.11-152.61(497.16)"2009/2012"

POSSIBILITY OF PRODUCING ONE-YEAR OLD SEEDLINGS OF THE AUTOCHTHONOUS APPLE VARIETIES IN THE REGION OF NORTH MONTENEGRO

Gordana Šebek[1*]

[1]Biotechnical Faculty, University of Montenegro, Mihaila Lalića 15, 81000 Podgorica, Montenegro

[*]e-mail: sebek@t-com.me

Abstract

The aim of this paper is to determine morphological characteristics of autochthonous apple seedling sorts (Senabija, Arapka, Pašinka, Šarenika, Dapsićanka and Bjelija) with the vegetative rootstocks MM106 and wild apple seedlings (*Malus sylvestris Miller*) and water attaining capability of the leaves in one-year old seedlings of autochthonous apple cultivars .

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 graftings 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 apple generative rootstock or vegetative rootstock for apple (MM106). 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. Examples of leaves for analysis will be taken when it is dry weather: three times a year - at the end of June, the end of July and the end of August. The dynamics of leaf dehydration per measured interval was determined by method of Eremeev 1964.

The study was conducted in three successive years to examine the possibility of producing in nursery one-year old seedlings of autochthonous apple cultivars grafted on vegetative rootstocks and wild apple seedlings (*Malus sylvestris Miller*) during the first year after bud grafting.

The results of this research also showed that the water attaining capability of the leaves in one-year old seedlings of autochthonous apple cultivars as an indicator of their resistance to drought was genetic characteristics of the cultivars.

Production of seedling material of autochthonous sorts with vegetative rootstocks MM 106 will be enormous contribution for even partially saving of fruit genofund that is the unity product of our ecological environment and autochthonous biocenosis.

Key words*: Autochthonous cultivars, Grafting, Morphological characteristics, One-year old seedlings, Resistance to drought, Water attaining capability.*

1. Introduction

Apple is the major fruits after citrus and banana in the world fruit production and it is widespread on all continents, in different environmental conditions, which indicates its extreme adaptability to changing environmental conditions (Ercisli *et al.,* [1]; Gharghani *et al.,* [2]). In modern apple production, new apple plantations are establishing with a few standard varieties that provide high and regular yields and high quality fruits that meet the demands of the market. However, dominance of world apple production with a few cultivars produces bottleneck effect and *Malus* germplasm irretrievably can be lost. Thus, it is necessary to take measures to prevent further loss of genotypes that possess valuable genes (Mratinić and Fotirić-Akšić, [3]; Mratinić and Fotirić-Akšić, [4]).

Apple is the second most important fruit in Montenegro after plum. Beside the modern varieties, autochthonous apple varieties are still important in Montenegro. In Montenegro, probably some of these autochthonous varieties originate here or some of them has long been cultivated here and has unknown origin. The imported autochthonous apples from other countries have been adapted to the existing conditions well over the long period of time, and are of great economic importance. Autochthonous apples varieties are distributed as individual trees or in small plantations in a number of localities in Montenegro, especially in Polimlje region with the highest concentration around Berane and Bijelo Polje provinces (Božović *et al.,* [5]). As opposed to some modern apple cultivars, these varieties are long-lived and resistant to: frost, heavy snow, summer droughts, and pathogens. Old varieties require much less care, and yet they give fruitage regularly and generously (Šebek, [6]).

The rapid developments of fruit tree nursery technology, and rootstock research and introduction of new clonally propagated rootstocks, opened in new area in fruit science (Ecisli *et al.,* [7]).

From year to year, fruit production in Montenegro is more and more difficult without watering. The fertile buds production is extremely reduced in the drought conditions. Since these buds should bring the yield in the next year, dry year indicates law yields in the next one too.

In Dinaric Mountains annual rainfall varies from 1,000 to 5.500 mm/m^2 in Crkvice (Montenegro) what is the European maximum. Though these regions are abundant in participation, the lack of water appears in the summer period because of porous soils and in some summers because of drought. Traditionally the people who live there collect rain from the roof tops. The rainfall potential could be used in more economical way by building concrete walls accumulations or by finding and protecting autochthonous varieties. In the most fertile valley in Bijelo Polje (Nedakusko-Rasovska ravnica), vegetable production depends on watering. Water capacity of the autochthonous plum varieties leaves was tested as an indicator of their resistance to drought in Bjelo Polje, Montenegro (Šebek, [8]).

The development of drought resistant cultivars/lines of crops through selection and breeding is of considerable economic value for increasing crop production in areas with low precipitation or without any proper irrigation system (Subbarao *et al.,* [9]). However, availability of genetic variation at intra-varietal level is of prime importance for selection and breeding for enhanced resistance to any stress (Serraj *et al.,* [10]). In order to develop drought tolerant cultivars, it is imperative to develop efficient screening and suitable selection criteria. Various agronomic, physiological and biochemical selection criteria for drought tolerance are being used to select drought tolerant plants, such as: seed yield, harvest index, shoot fresh and dry weight, leaf water potential, osmotic adjustment, accumulation of compatible solutes, water use efficiency, stomatal conductance, and chlorophyll fluorescence (Ashraf *et al.,* [11]; Tambussi *et al.,* [12]; Neumann, [13]).

Development of drought tolerance in adaptation for a plant is the result of overall expression of many traits in a specific environment. Since many adaptive traits are effective only for certain aspects of drought tolerance and over a limited range of drought stress, there is no single trait that breeders can use to improve productivity of a given crop in a water deficit environment. In this context, Subbarao *et al.*, [9] suggested that those traits, whether physiological or morphological, that contribute to check water loss through transpiration, and enhance water use efficiency and/yield are traits of interest. However, priority should be given to those traits that will maintain or increase yield stability in addition to overall yield, because traits for higher yield may in fact decrease yield stability (e.g. longer growth period). Thus, in order to improve crop productivity under water stress conditions: selection of a cultivar with short life span (drought escape), incorporation of traits responsible for well - developed root system, high stomatal resistance, high water use efficiency (drought avoidance), and traits responsible for increasing and stabilizing yield during water stress period (drought tolerance) should be given high priorities.

Drought stress is highly variable in its timing, duration and severity, and this result are in high environmental and G×E variation. With a projected increase in drought with climate change, the breeding for drought tolerant crops is even more emphasised (Witcombe *et al.*, [14]).

2. Materials and Methods

Montenegro is situated between 41°31' and 43°33' north latitude and 18°25' and 20°21' east longitude. The distance from the northernmost to the southernmost point is 200 km of the crow flies and from the westernmost to easternmost point is of 173 km. Of the total territory, 10.9% is at an altitude up to 200 m, 5.7% from 200 to 500 m, 27% from 500 to 1000 m, 39.85% from 1000 to 1500 m, 15% from 1500 to 2000 m and 1.15% over 2000 m. Climatic conditions in Montenegro are influenced by the vicinity of the sea and the relief interrupted with river valleys and high mountains. Regarding the vegetation aspect, territory of Montenegro is classified into two major plant-geographical regions: the Mediterranean and continental. To the first regions belongs coastal and sub-Mediterranean part of Montenegro and to the other mountain valley-like Montenegro (Šehić *et al.,* [15]).

Fruit biodiversity in Montenegro is reflected in many autochthonous varieties like: plums, sweet cherries, pears, apples as well as sour cherries, apricots, peaches etc. Although this particular area of former Yugoslavia or the newly created states could be considered as a great biodiversity source for many fruit species, this is not recognized in literature due to the lack of systematic studies in the earlier period. Apple is second the most important fruit in Montenegro after plum. Beside the modern varieties, autochthonous apple varieties are still important in Montenegro. In Montenegro, probably some of these autochthonous varieties originate from here or some of them has long been cultivated here and has unknown origin. The imported autochthonous from other countries have been adapted to the existing conditions well over the long period of time, and are of great economic importance (Božović *et al.,* [16]).

The domesticated apple is one of the most important fruit crops, grown extensively in colder and temperate climate. Many consider apple as the fruit above all fruits. Although modern apple varieties and autochthonous cultivars are an essential part of the region inheritance, 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.

2.1 Materials

The material of this study were autochthonous apple sorts: Senabija, Arapka, Pašinka, Šarenika, Dapsićanka and Bjelija. These autochthonous varieties of apple are grafted on vegetative rootstocks MM 106. Comparative or control graft was performed on generative rootstock of wild apple (*Malus sylvestris* Miller).

2.1.1 Senabija

By origin, Senabija is domestic cultivar grown in a large number of private gardens and few orchards as an exceptional processing apple. For several centuries it was prized as a delicious dessert and culinary apple. Th apple is medium sized, on average 64 mm long, 79 mm wide and weights 153.5 g. Its shape is oblong, and uniform. Fruit skin is: thin, smooth and tender. By color green to yellow, it's becoming yellow when ripe and it's slightly blush on sunny side. Develops russet over 10% to 30% of surface (Božović *et al.,* [16]). Morphometric properties and soluble solids of fruits of apple variety Senabija are: 129.57g (weigh), 58.84 mm (length), 68.79 mm (width), 0.86 mm (skin), 13.95% (soluble solids concentration - SSC), sweet-sour taste (Božović *et al.,* [16]).

2.1.2 Arapka

Arapka variety interestingly do not have ground color and uniformly, and have attractive red surface color. Morphometric properties and soluble solids of fruits of apple variety Arapka are: 128.39g (weigh), 69.77 mm (length), 64.62 mm (width), 1.08 mm (skin), 13.60% (SSC), sour-sweet (taste) (Božović *et al.,* [16]).

2.1.3 Pašinka

By origin is from Middle East, most probably introduced to the North of Montenegro region during period of Ottoman Empire presence. Its size and shape are: small and medium to large, in average 55.5 mm long and 64.1 mm wide, weight about 120.2 g. Fruit shape is round, and may vary from rounded oblong to obtusely conical, often asymmetric. Fruit skin characteristics are: thick epidermis, yellow to greenish, later straw yellow, with blush covering the sunny side. The surface is sprinkled with whitish dots. Fruit flesh is: white, very juicy, firm and crisp, mostly sweet taste, slightly sour and quite fragment (Božović *et al.,* [16]). Morphometric properties and soluble solids of fruits of apple variety Pašinka are: 125.35 g (weigh), 58.42 mm (length), 66.28 mm (width), 0.88 mm (skin), 13.85% (SSC), sweet (taste) (Božović *et al.,* [16]).

2.1.4 Šarenika (Šarica)

Morphometric properties and soluble solids of fruits of apple variety Šarica are: 124.23 g (weigh), 58.05 mm (length), 70.16 mm (width), 0.83 mm (skin), 11.50% (SSC), sweet (taste) (Božović *et al.*, [16]).

2.1.5 Dapsićanka

Morphometric properties and soluble solids of fruits of apple variety Šarica are: 175.35 g (weigh), 68.22 mm (length), 73.86 mm (width), 0.92 mm (skin), 15.50% (SSC), sweet (taste) (Božović *et al.,* [16]).

2.1.6 Bjelija

Morphometric properties and soluble solids of fruits of apple variety Bjelija are: 129.34 g (weigh), 60.85 mm (length), 69.01 mm (width), 0.88 mm (skin), 13.15% (SSC), sweet (taste) (Božović *et al.,* [16]).

The experiment was conducted in the village Njegnjevo in the period from 2009 to 2012. The nursery was located at Njegnjevo near Bijelo Polje (43°05'N; 19 °05'E), Nort 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 5.41 in the top soil), with a moderate organic matter (3.88%) and a very low N total content (0.18%), the values thereof gradually decreasing with the depth (data not shown). The contents of available P_2O_5 and K_2O in the 0 - 30 cm soil depth were 6.7 mg • 100 g^{-1}, and 14.07 mg • 100g^{-1}, respectively. Fertilization treatments included applications of mineral nitrogen fertilizers at the rate of 80 kg N/ha 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.

2.2 Methods

During 2009, the vegetative and generative rootstock were cultivated. Seeds of wild apple were collected the year before from local trees, and they were cleaned of flesh, dried and stratified in wet sand during the winter of 2008/2009. Wild apple 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 were hoping to accomplish in this research is to determine the compatibility between vegetative rootstocks (MM 106) and autochthonous varieties of apple. In Montenegro, autochthonous varieties of apple were only grafted on generative rootstocks. This fact prevents raising of apple orchards with intensive production.

Budding of sleeping bud was conducted in the fall (late August) during 2009, 2010 and 2011. Due to poor production results there were other grafting's 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 apple generative rootstock or vegetative rootstock for apple (MM106). 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 micrometre 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 in: June, July, August and September. The results were analysed using one-way analysis of variance (statistical program Systat 11) where the middle of treatment compared to the LSD test.

Examples of leaves for analysis were taken when the weather was dry, and three times a year - at the end of June, the end of July and the end of August. The dynamics of leaf dehydration per measured interval was determined by method of Eremeev 1964 (cit. according to Šebek, [17]). Eremeev's method (Šebek, [17]) is relevant for determination of leaves water attaining capability. Loss of water at the time of transpiration was monitored by measuring the weight of cut leaves (Slavik, 1974 cit. according to Šebek, [26]). Level of regained hydration was monitored after 8h, 12h and 16h from cutting the leaves from one-year seedlings of apple autochthonous cultivars. The loss of water due to transpiration was followed by measuring the weight of leaves (Šebek, [25]). The dynamics of leaf dehydration was measured in order to obtain initial resistance rate of autochthonous apple cultivars towards drought conditions. The dynamics of leaf dehydration depends on the thickness of leaf cuticle and leaf average size.

3. Results and Discussion

The average acceptance of autumn grafting process in the shape of the „T" letter of autochthonous apple sorts with MM106 seedlings (vegetative rootstocks) had been with the following percent of success: 77.3% (Senabija); 94.3% (Arapka); 55.67% (Pašinka); 45% (Šarenika); 81% (Dapsićanka), and 85% (Bjelija). The acceptance of autumn grafting process in the shape of the „T" letter of autochthonous apple sorts with wild apple seedlings (generative rootstocks) had been with the following percent of success: 85.3% (Senabija); 80% (Arapka); 92.7% (Pašinka); 71% (Šarenika); 77.67% (Dapsićanka), and 91% (Bjelija). 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 apple sorts with MM106 seedlings was: 95.3% (Senabija); 95% (Arapka); 89.67% (Pašinka); 81.67% (Šarenika); 85% (Dapsićanka), and 85% (Bjelija). Achieved percent after the repetition of the grafting process for autochthonous apple sorts with wild apple seedlings (*Malus sylvestris* Miller) seedlings was: 93.3% (Senabija); 85.7% (Arapka); 96.3% (Pašinka); 96% (Šarenika); 88% (Dapsićanka), and 94% (Bjelija).

Growth dynamic of one-year-old seedlings (height and corpulence of the seedlings) was monitored during vegetation in time treatments: June, July and August. Values of the monitored parameters (height and corpulence of the seedlings) showed differences in average values and seedling growth dynamic. By analysing the data for apple sort Senabija (rootstocks is MM 106), average height of the seedling in June was 29 cm. In the month of the July average height was 54 cm. For August average height was 90 cm. The average corpulence of the seedlings, 10 cm from the grafting spot, of the same sort was 2.9 mm in June. In July, data for the average corpulence was 5.15 mm. In August, corpulence was 8.75 mm. Parallel data for apple sort Arapka (rootstocks is MM 106), of studied parameters in three different time treatments were following: 32 cm; 57 cm; 94 cm; (height), and 3 mm; 5.95 mm; 9.25 mm (corpulence). Parallel data for apple sort Pašinka of studied parameters in three different time treatments were following: 37 cm; 61 cm; 109 cm; (height), and 3.5 mm; 6.75 mm; 10 mm (corpulence). Parallel data for apples sort Šarenika of studied parameters in three different time treatments were following: 39 cm; 69.5 cm; 116 cm; (height), and 3.25 mm; 7.5 mm; 10.75 mm (corpulence). And, parallel data for apples sort Dapsićanka of studied parameters in three different time treatments were following: 41 cm; 73 cm; 124 cm; (height), and 3.9 mm; 9 mm; 14 mm (corpulence). Analysis had shown that the average height of apple sort Bjelija was 37 cm in June. In July the average height was 68.5 cm. In August average height was 97 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 8.1 mm. In August, corpulence was 12.5 mm.

Based on the data in Table 1, the highest average tree height (168.3 cm) had the variety Dapsićanka grafted on the rootstock MM106. Based on LSD values, we can note that the height of the seedling in interaction between Dapsićanka and the rootstock 'MM 106' was significantly higher compared to other seedling (interactions) height. Seedlings of apple Šarenika grafted on the rootstock MM 106 had significantly higher height than any other seedling grafted on the same rootstock. The diameter (corpulence) of the seedlings was the greatest in the variety Dapsićanka grafted on the rootstock MM 106 (21.3 mm), 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 MM 106 of cultivars Šarenika (45%) and Pašinka (55.67%) can be significantly improved in next spring grafting (81.67% Šarenika and 89.67% Pašinka). The same effect of improving was evidenced in grafting of the variety Senabija, the percent of successfully grafted seedlings was increased from 77.3% to 95.3%. The lowest effect of improving was evidenced in grafting of the varieties Šarenika and Dapsićanka'.

Based on the data in Table 2, the highest average tree height (186 cm) had the variety Dapsićanka grafted on the generative rootstock (*Malus sylvestris* Miller). Based on LSD values we can note that the height of the seedling in interaction between Dapsićanka and the generative rootstock (*Malus sylvestris* Miller) was significantly higher compared to other seedling (interactions)

Table 1. Growth dynamic of one-year-old seedlings of apples and achieved percent of the grafting process (rootstocks is MM106)

Cultivar/ rootstocks	Height of the seedlings				Corpulence of the seedlings			
	VIx	VIIx	VIIIx	IXx	VIx	VIIx	VIIIx	IXx
	cm				mm			
Senabija/MM106	29	54	90	147.3b	2.9	5.15	8.75	17.3c
Arapka/MM106	32	57	94	145.8c	3.0	5.95	9.25	21.5a
Pašinka/MM106	37	61	109	147.6c	3.5	6.75	10	18.7b
Šarenika/MM106	39	69.5	116	159.2a	3.25	7.5	10.75	18.5bc
Dapsićanka/MM106	41	73	124	168.3a	3.9	9	14	21.3a
Bjelija/MM106	37	68.5	97	142.0c	3.6	8.1	12.5	19.3b
LSD 0.05				7.8				1.5
LSD 0.01				8.8				1.8
Cultivar/ rootstocks	**Percent of the grafting process (autumn: „T"letter)**				**Percent of the grafting process (spring: English linking)**			
	2009	2010	2011	X	2010	2011	2012	X
	%				%			
Senabija/MM106	72	81	79	77.3dc	94	96	96	95.3a
Arapka/MM106	94	91	98	94.3a	95	96	94	95a
Pašinka/MM106	54	57	56	55.67h	87	90	92	89.67b
Šarenika/MM106	41	48	46	45ij	78	86	81	81.67c
Dapsićanka/MM106	79	84	80	81c	82	89	84	85cb
Bjelija/MM106	89	86	80	85b	82	87	86	85cb
LSD 0.05				5.6				4.4
LSD 0.01				7.9				6.5

height. Seedlings of all studied varieties of apples grafted on the generative rootstock (*Malus sylvestris* Miller) had significantly higher height than any seedlings grafted on the vegetative rootstock (MM 106). Results of autumn grafting of autochthonous varieties of apples Senabija (85.3%) and Arapka (80%) on the generative rootstock (*Malus sylvestris* Miller) show that they have higher percentage of successfully grafted seedlings than varieties Dapsićanka (77.67%) and Šarenika (71%). The same results also show that the varieties of apples Senabija (85.3%) and Arapka (80%) have lower percentage of successfully grafted seedlings than varieties Pašinka (92.7%) and Bjelija (91%). Because of the method of re-grafting in spring we had higher amount of successfully grafted seedlings on both generative and vegetative rootstocks.

Biological characteristics in development of seedlings are mainly manifested in the first year of cultivation. In the research and the experiment designing, we assumed that the morphological characteristics of researched one year old varieties of autochthonous apple seedlings will be in interaction between the characteristics of rootstocks and scions. However, literature data (Behmen, *et al.*, [18]) 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. Previous research (Behmen, *et al.*, [18]) of relationships between rootstocks and scions determined the effect of intermediate buds (from the scion) on growth and quality of fruit trees.

The earliest methods used to detect graft incompatibility relied on external symptoms such as: graft union malformations, yellowing of foliage, decline in vegetative growth and vigour, and marked differences in growth rate of scion and rootstock, or anatomical abnormalities after grafting. This requires waiting until the symptoms are visible, which may take years. Additionally, early anatomical observations may not always correlate with long-term graft survival (Šebek, [19]).

Out of the studied water attaining capability of leaves in autochthonous apple cultivars (in nursery), the highest water attaining capability had the leaves of cultivar Pašinka. Over the monitored time interval (8 hours upon sample taking), leaves taken from the annual twigs of the studied cultivars (in nursey) lost on average 38.67% of water. The lowest level of stated capability was recorded with the leaves of cultivar Bjelija (47.61%). Over the monitored time interval (8 hours upon sample taking), leaves taken from the annual twigs of the control (one-year old rootstocks *Malus sylvestris*) lost on average 37.31% of water.

Out of the studies autochthonous plum cultivars, the highest water attaining capability had the leaves of cultivar Crvena ranka (Šebek [19]). Over the monitored time interval (8 hours upon sample taking), leaves taken from the annual twigs of the studied cultivars (one-year old seedlings) lost on average 33.54% of water. The lowest level of the stated capability was recorded with the leaves of cultivar Obični piskavac (41.74%).

Table 2. Growth dynamic of one-year-old seedlings of apples and achieved percent of the grafting process (generative rootstocks is *Malus sylvestris* Miller)

Cultivar/ rootstocks	Height of the seedlings				Corpulence of the seedlings			
	VIx	VIIx	VIIIx	IXx	VIx	VIIx	VIIIx	IXx
	cm				mm			
Senabija/*Malus sylvestris*	37	71.5	107	165.3d	4.0	6.55	10.0	20.4b
Arapka/*Malus sylvestris*	39.5	70.8	111	171cd	3.8	6.25	10.8	21.1ab
Pašinka/*Malus sylvestris*	44	82.5	127	172.5c	4.4	7.7	10.8	20.6b
Šarenika/*Malus sylvestris*	50	81	114.9	182a	5.7	8.3	13.0	21.3ab
Dapsićanka/*M. sylvestris*	50.5	85	131.5	186a	4.1	9.6	16.6	23.5a
Bjelija/*Malus sylvestris*	42.6	75.5	106	173.5b	3.8	8.4	15.4	20.8b
LSD 0.05				5.6				2.0
LSD 0.01				6.9				3.1
Cultivar/ rootstocks	**Percent of the grafting process (autumn: „T“letter)**				**Percent of the grafting process (spring: English linking)**			
	2009	**2010**	**2011**	**X**	**2010**	**2011**	**2012**	**X**
	%				%			
Senabija/*Malus sylvestris*	88	82	86	85.3b	95	88	97	93.3a
Arapka/*Malus sylvestris*	79	78	83	80c	87	83	87	85.7c
Pašinka/*Malus sylvestris*	88	94	96	92.7a	95	97	97	96.3a
Šarenika/*Malus sylvestris*	66	73	74	71e	96	95	97	96a
Dapsićanka/*M. sylvestris*	74	79	80	77.67d	84	86	91	88c
Bjelija/ *Malus sylvestris*	87	91	95	91a	92	93	97	94a
LSD 0.05				5.0				5.2
LSD 0.01				7.5				6.9

Table 3: Dynamics of leaf dehydration per measured interval (2010, 2011, 2012 and average) %

Cultivar	Year	Measured interval					
		1h	**2h**	**4h**	**8h**	**16h**	**24h**
Senabija	2010	7.78	19.49	25.25	40.54	72.39	100
	2011	8.26	19.68	25	39.9	71.33	100
	2012	8.86	20.77	26.32	41.64	73.07	100
	Average	8.30bc	19.09d	25.43gh	40.6e	72.17ef	100
Arapka	2010	9.02	20.47	25.91	40.55	71.27	100
	2011	8.79	20.6	26.35	40.42	70.9	100
	2012	9.23	21.33	27.24	41.6	72.67	100
	Average	9.01e	20.8g	26.5k	40.86ef	71.62ce	100
Pašinka	2010	8	18.63	24.05	39.15	72.55	100
	2011	7.36	18.94	24.12	37.43	69.49	100
	2012	7.96	19.96	25.31	39.43	53.56	100
	Average	7.77a	19.17c	24.49c	38.67c	71.48c	100
Šarenika	2010	8.98	18.49	22.66	38.43	73.35	100
	2011	8.16	18.46	25.06	42.7	77.94	100
	2012	8.22	18.53	25.18	42.67	77.92	100
	Average	8.45c	18.49a	24.3d	41.27f	76.41f	100
Dapsićanka	2010	8.74	19.16	24.85	47.2	77.45	100
	2011	8.53	18.95	24.89	47.17	78.08	100
	2012	8.61	19.24	24.7	46.97	77.05	100
	Average	8.63d	19.12d	24.82e	47.12l	77.53l	100
Bjelija	2010	9.27	20.19	26.17	49.36	81.02	100
	2011	8.83	18.78	24.49	47.23	77.85	100
	2012	8.95	19.60	25.29	46.22	76.88	100
	Average	9.02e	19.53e	25.32g	47.61l	78.59k	100
Malus sylvestris* (generative rootstocks) *control	2010	7.61	17.4	22.61	36.37	62.53	100
	2011	7.78	17.28	21.31	34.74	60.49	100
	2012	9.1	20.34	25.28	40.85	66.87	100
	Average	8.16b	18.33a	23.06a	37.31a	63.29a	100
	LSD0.05	**0.16**	**0.23**	**0.35**	**0.47**	**0.79**	
	LSD0.01	**0.31**	**0.35**	**0.44**	**0.55**	**0.95**	

4. Conclusions

- The research was conducted on 6 different apple cultivars and that allowed us to obtain important genetically and physiological traits.

- Seedlings of all studied varieties of apples grafted on the generative rootstock (*Malus sylvestris* Miller) had significantly higher height than seedling grafted on the vegetative rootstock (MM 106). We also have significant difference between the diameters of seedlings. Those differences are the consequences of lower verdure in vegetative rootstocks than in generative rootstocks. MM 106 is a common rootstock for autochthonous apple cultivars because of size control, which makes high density orchards possible.

- 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.

- Production of seedling material of autochthonous cultivars with vegetative rootstocks MM 106 will be enormous contribution for even partially saving of fruit genofond that is the unity product of our ecological environment and autochthonous biocenosis.

- The results of this research show that the plant height, stem diameter one-year old seedlings are genetic characteristics of autochthonous apple cultivars, from which rapid growth and uniformity of scions depend.

- Highest water attaining capability had the leaves of cultivar Pašinka. The lowest level of the stated capability was recorded with the leaves of cultivar Bjelija.

5. References

[1] Ercisli S., Esitken A., Orhan E., Ozdemir O. (2006). *Rootstocks used for temperate fruit trees in Turkey: An overview*. Sodininkyste ir Darzininkyste, 25, pp. 27-33.

[2] Gharghani A., Zamani Z., Talaie A., Oraguzie N. C., Fatahi R., Hajnajapi H., Wiedow C.. Gardiner S. E. (2009). *Genetic identity and relationships of Iranian apple (Malus x domestica Borkh.) cultivars and land-races, wild Malus species and representative old apple cultivars based on simple sequence repeat (SSR) marker analysis*. Genet. Resource and Crop Evolution, 13, pp. 1-14.

[3] Mratinić E., Fotrić-Akšić M. (2011). *Evaluation of phenotypic diversity of apple (Malus sp.) germplasm in south Serbia*. Brazilian Archives of Biology and Technology, 55, (3), pp. 349-358.

[4] Mratinić E., Fotrić-Akšić M. (2012). *Phenotipic diversity of apple (Malus sp.) germplasm through the principle component analysis*. Genetika, 43, (2), pp. 331-340.

[5] Božović Dj., Lazović B., Sezai Ercisli S., Adakalić M., Jaćimović V., Sezer I., Koc A. (2015). *Morphological characterization of autochthonous apple genetic resources in Montenegro*. doi: 10.1007/s10341-015-0260-8.

[6] Šebek G. (2004). *Resistance to low temperatures of autochthonous varieties and selected types of forest apples (Malus silvestris L.)* (in Montenegrin). 1st Slovenian Fruit Congress with international participation Proceedings, Krško, Slovenia, pp. 263-270.

[7] Ercisli S., Esitken A., Orhan E., Ozdemir O. (2006). *Rootstocks used for temperate fruit trees in Turkey: An overview*. Sodininkyste ir Darzininkyste, 25, pp. 27-33.

[8] Šebek G. (2016). *The phenological and pomological traits of autochthonous plum cultivars in the area of North Montenegro*. ACTA Scientiarum Polonorum Hortorum Cultus, 15, (4), pp. 45-63.

[9] Subbarao G. V., Ito O., Serraj R., Crouch J. J. Tobita S., Okada K., Hash C. T., Ortiz R., Berry W. L. (2007). *Physiological perspectives on improving crop adaptaptation to drought-justification for a systematic component-based approach*. In: Pessarakli M. (Ed.), Handbook of Photosyntesis (2nd ed.), Marcel and Dekker, New York, USA, pp. 577-594.

[10] Serraj R., Hash T. C., Buhariwalla H. K., Bidinger F. R., Folkersma R. T., Chandra S., Gaur P. M., Kashiwagi J., Nigam S. N., Rupakula A. Crouch J. H. (2007). *Marker-assisted breeding for drought tolerance at ICRISAT: achievements and prospects*. In: Tuberosa R., Philips R. L., Gale M. (Eds.), International Congress In the Wake of the Double Helix: From The Green Revolution of the Gene Revolution Proceedings. Avenue Media, Bologna, Italy, pp. 217-238.

[11] Ashraf M., and Foolad M. R. (2007). *Roles of glycine betaine and proline in improving plant abiotic stress resistance*. Environmental and Experimental Botany, 59, (2), pp. 206-216.

[12] [12] Tambussi E. A., Bort J., Guiamet J. J., Nogués S., Araus J. L. (2007). *The photosynthetic role of ears in C3 cereals: metabolism, water use efficiency and contribution to grain yield*. Critical Reviews in Plant Science, 26, pp. 1-16.

[13] Neumann P. M. (2008). *Coping mechanisms for crop plants indrought-prone environments*. Ann. Bot., 101, pp. 901-907.0

[14] Witcombe J. R., Hollington P. A., Howarth C. J., Reader S., Steele K. A. (2008). *Breeding for abiotic stresses for sustainable agriculture*. Philosophical Transactions of the Royal Society, B, 363, pp. 703-716.

[15] Šehić D. Šehić D. Bertić I. (2005). *National atlas of Montenegro*. Monde neuf, Podgorica, Montenegro.

[16] Božović Dj., Lazović B., Sezai Ercisli S., Adakalić M., Jaćimović V., Sezer I., Koc A. (2015). *Morphological characterization of autochthonous apple genetic resources in Montenegro*. doi: 10.1007/s10341-015-0260-8.

[17] Šebek G. (2016). *The phenological and pomological traits of autochthonous plum cultivars in the area of North Montenegro*. ACTA Scientiarum Polonorum Hortorum Cultus, 15, (4), pp. 45-63.

[18] Behmen F., Murtić S., Aliman J. (2011). *The growth dynamics of apple seedlings depending on the exposure time and the position of the scion bud on it*. 46 Croatian and 6 International Symposium on Agriculture Proceedings. Abbey, Croatia, pp. 1006-1010.

[19] Šebek G. (2016). *The phenological and pomological traits of autochthonous plum cultivars in the area of North Montenegro*. ACTA Scientiarum Polonorum Hortorum Cultus, 15, (4), pp. 45-63.