J. Agr. Sci. Tech. (2016) Vol. 18: 223-231

A Comparison of Grafting Methods for the Production of Quality Planting Material of Promising Cornelian Cherry Selections (*Cornus mas* L.) in Serbia

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ABSTRACT

The Cornelian cherry is one of those less common but, nevertheless, interesting fruit species found in Serbia which can be used both for food and medicine. Due to a great importance of Cornelian cherry fruits as safe food and a wide interest in growing this fruit species, this research was focused on examining the production technique of quality planting material of particularly large-fruit selections of Cornelian cherry in Serbia. In the region and even beyond, there are no Cornelian cherry plantations due to a lack of planting material. To that end, the best Cornelian cherry selections selected in Serbia were grafted onto generative rootstocks of a Cornelian cherry in two periods: I (bud grafting in August) and II (spring whip grafting in April), and the success of grafting, the effect of grafting period, and quality of produced nursery stock were assessed. The study of five large-fruit genotypes (CPC16, APRANI, BACKA, R1 and PPC1) during two years (2011 and 2012) showed that, on average, bud grafting in August (69.38%) was statistically significantly more successful than whip grafting in April (25.33%). The greatest grafting success was achieved in the period I with APRANI (83.62%) and BACKA (76.42%), while the poorest success was with CPC16 (21.67%) in the period II. On average, other examined parameters of young tree quality (height, diameter of plants, number and length of formed roots) did not indicate any statistically significant differences between the grafting periods. In this research, a technology was established for producing quality young trees of the Cornelian cherry.

Keywords: Bud grafting, Large-fruit genotype, Whip grafting, Nursery stock.

[DOR: 20.1001.1.16807073.2016.18.1.2.0]

INTRODUCTION

In the family *Cornaceae*, the genus *Cornus* includes about 50 species of shrubs and trees, most of which are used for decorative purposes. Only a few species of this genus produce edible fruits. Among these, the most important one is the Cornelian cherry (*Cornus mas* L.), which is also suitable for use as a horticultural species due to its great abundance of flowers and rich foliage. Cornelian cherries are rich in various essential elements and might be considered as important dietary mineral supplementation for individuals deficient in nutritional elements (Rop *et al*., 2010; Bijelić, 2011) and also, fruits are good source of natural antioxidants (Hassanpour *et al*., 2011). Consumption of *C. mas* leaves, which are rich in antioxidant polyphenolics, might increase the total antioxidant capacity of the body and in Turkish folk medicine they are used against cardiovascular disorders and hyperglycaemia (Celep *et al*., 2013). Also, bio-oil could be produced by hydrothermal processing of cornelian cherry stones (Akalin *et al*., 2012). Moreover, the

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Cornelian cherry wood is highly valued in carpenter's industry.

Serbia has a rich gene pool of Cornelian cherry genotypes adapted to different local conditions in different regions of the country (Bijelić, 2011). Most trees are open pollinated seedlings of wild genotypes which vary widely in terms of productivity and fruit characteristics. Seed propagation and long-term human selection has also given rise to a great diversity of trees (Yilmaz *et al*., 2009a; Bijelić, 2011). Despite its wide usage in Serbia and its region, there are no established standard cultivars of the Cornelian cherry, and there are not many of them in the world either, in comparison with other commercial fruits. In these regions, 99% of Cornelian cherry crop is harvested from open pollinated seedlings of wild genotypes (Bijelić 2011), just like in Iran (Hassanpour *et al*., 2012), Turkey (Ercisli 2004; Yilmaz *et al*., 2009b), Ukraine (Klimenko, 1990; 2004) and other regions. Consumer interest in healthy foods has increased market demand for high quality fruits such as the Cornelian cherry (Ercisli *et al*., 2008; Bijelić 2011). In recent years, increasing attention has been paid by consumers to less known fruits such as the Cornelian cherry, which have unusual flavors, qualities, and balance chemical composition and many of which are rich with antioxidants and anthocyanins (Yilmaz *et al*., 2009a; Popović *et al*., 2012; Gunduz *et al*., 2013). Considering that the needs of the processing industry and market for Cornelian cherries are much greater than the quantity of fruits that can be collected in nature, it is necessary and desirable to grow large-fruit selections and cultivars of the Cornelian cherry in plantations, and the basic prerequisite for starting a profitable Cornelian cherry plantation is the production of quality planting material of selected large-fruit genotypes. It is the first step in creating conditions for the transition from fruit gathering to plantation production of this fruit species. Currently in our region, there are not any larger plantations of the Cornelian cherry, because of a lack of quality planting material of large-fruit selections and existing Cornelian fruit cultivars. The first Cornelian cherry plantations up to 1 ha were planted in different parts of Serbia and the region from autumn 2012 to the present day with our planting material and selections, and this trend of Cornelian cherry plantations is increasing in line with an increase in the production of planting material, since there is a great interest of producers.

Due to a great importance of Cornelian cherry fruits as safe food and a wide interest in growing this fruit species, various breeding programs have been established in some countries as well as systematic work on research into natural populations and establishing the collection of the Cornelian cherry (Klimenko, 1990; Karadeniz, 2002; Ercisli, 2004; Brindza *et al*., 2009; Bijelić, 2011). Apart from the Cornelian cherry propagation outlined by Klimenko (1990) in Ukraine, according to our insight and available literature, there is almost no research on establishing the mass production technology of quality planting material of the Cornelian cherry which would enable successful plantations to be raised with grafted selections and cultivars of this fruit species. Therefore, our research focused on the development of planting material production for establishing orchards of the Cornelian cherry according to the organic concept.

Hence, the aim of this research was the development of production technology of planting material of particular quality selections of the Cornelian cherry as the first step in the transition from fruit gathering to plantation production of particular selections of the Cornelian cherry in Serbia, as well as the continuation of research and their introduction to the official cultivar list.

MATERIALS AND METHODS

The study was conducted for two years (2011 and 2012) in a nursery at the experimental field of the Faculty of

[DOR: 20.1001.1.16807073.2016.18.1.2.0]

Agriculture in Novi Sad. The nursery is close to Novi Sad, where the soil type is chernozem with very favourable physical and chemical properties. Two-year-old generative rootstocks of the Cornelian cherry were used for grafting (Figure 1). Two grafting techniques were examined: bud grafting in August (period I) (Figure 2) and spring whip grafting in April (period II) in 2011 and 2012. Two hundred generative rootstocks were grafted for each examined genotype (CPC16, APRANI, BACKA, R1, and PPC1) in both study periods. Scions were taken from parent trees of selected genotypes of the Cornelian cherry at the experimental field of the Faculty of Agriculture in Novi Sad. In the same investigation period, morphometric fruit characteristics were established on the samples that contained 50 fruits per genotype. Measurements were done by means of precision analytical scales and digital micrometer calipers. Fruit shape index was calculated as a ratio of squared fruit length to width. Flesh to stone ratio was interpreted as a share of the mesocarp compared with fruit weight, expressed in percentage.

Grafted seedlings were cared for in the nursery in the usual way, which involved cultivation and irrigation, and were taken in the autumn of the next year, when the leaves had fallen at the start of dormancy. Afterwards, the plants were removed from the nursery and the quality of the produced plants was assessed. The following parameters were studied in the experiment: grafting success, young tree height and diameter, root collar

Figure 1. Generative rootstocks of Cornelian cherry.

[DOR: 20.1001.1.16807073.2016.18.1.2.0]

Figure 2. Bud grafted rootstock of Cornelian cherry.

thickness, and number and length of roots.

Data Analysis

The results obtained were statistically analyzed using StatSoft (2012) by factorial analysis of variance (ANOVA). Significance of mean differences among the characteristics was tested by Duncan's multiple range test for the significance level of 0.01%. The results are presented in

Figure 3. Ripe fruits of the Cornelian cherry selection PPC1

Tables 1 and 2, providing average value for each of the characteristics examined during the two-year test period.

RESULTS AND DISCUSSION

Fruit Characteristics of the Studied Genotypes

One of important goals of the breeding of the Cornelian cherry is getting the largest and most attractive fruits possible. The fruit mass of the examined genotypes varied from 3.76 g (APRANI) to 6.82 g (PPC1) (Figure 3) over the 2011-2012 years, while all

examined selections had very high flesh/stone ratio (Table 1), like PPC1 (88.84%) and R1 (87.76%) that had the largest values. Based on the index value of the fruit, which was determined by the

Table 1. Some morphometric fruit traits of Cornelian cherry selections, average 2011-2012. [a]

Genotype	Fruit length (mm)	Fruit width (mm)	Index	Fruit weight (g)	Flesh/stone ratio (%)
CPC16	18.05 d	17.18 b	1.10	3.79 c	86.09 bc
APRANI	22.62 c	14.55 d	2.42	3.76 c	83.86 cd
BACKA	22.95 c	16.65 c	1.90	4.13 bc	82.30 d
R1	25.28 b	16.88 c	2.24	4.59 b	87.76 ab
PPC1	28.30 a	19.71 a	2.06	6.82 a	88.84 a

[a] Values in the same column for each trait with different case letters are significantly different at $p < 0.01$.

[DOR: 20.1001.1.16807073.2016.18.1.2.0]

Table 2. The effects of the type of grafting and some quality parameters of young plants, average 2011-2012.

Genotype	Success of grafting (%)		Height of plants (mm)		Diameter of plants (mm)		The average number of root		The average length of root (mm)	
	I	II	I	II	I	II	I	II	I	II
CPC16	56.67 c [a]	23.83 de	764.04 c	750.28 c	11.57 ab	11.06 b	13.67 cd	12.67 de	112.72 cd	116.39 bcd
APRANI	83.62 a	30.33 d	736.67 c	740.47 c	13.61 a	13.32 a	19.67 a	19.00 ab	142.38 a	145.22 a
BACKA	76.42 a	27.83 de	849.36 b	872.63 ab	11.56 ab	11.15 b	18.00 bc	19.67 a	132.58 ab	129.83 abc
R1	62.60 bc	23.00 de	906.82 a	911.85 a	11.01 b	10.48 bc	12.00 de	9.67 e	103.34 e	103.34 e
PPC1	67.60 b	21.67 e	746.90 c	777.38 c	10.00 bc	9.15 c	14.67 cd	13.00 d	126.89 abc	131.05 abc
Average	69.38 A	25.33 B	800.76 A	810.52 A	11.55 A	11.03 A	15.60 A	14.80 A	125.16 A	123.58 A

[a] Values in the same column for each trait with different case letters are significantly different at $p < 0.01$. (I - bud grafting in August; II - spring whip grafting in April)

length and width of the fruit, it was found that only CPC16 had a spherical shape (1.10), BACKA had a cylindrical shape (1.90), while fruits of other selections were of an elongated cylindrical shape. These results are consistent with earlier studies of morphometric fruit traits of the mentioned selection (Bijelić, 2011; Bijelić *et al.*, 2011a). Besides the favorable fruit properties, these five selections have shown harmonious and balanced chemical composition of the mesocarp of the fruit (Bijelić *et al.*, 2011b). The obtained results are in accordance with the data presented by other authors, both for selected genotypes and selections and for accepted cultivars of the Cornelian cherry (Yalcinkaya *et al.*, 1999; Klimenko, 2004; Ercisli, 2004; Řezníček 2007; Yilmaz *et al.*, 2009b). Also, in some recent research, which followed all the growth and development stages, morphometric characteristics, and fruit chemical composition in 66 Cornelian cherry genotypes, the five selections we studied showed the optimal values of these parameters, which are important indicators of economic value of the Cornelian cherry genotype and among the main aims of selection programs (Bijelić, 2011).

Grafting success is one of the main indicators for applicability of propagation methods, including this case. On the basis of the obtained results (Table 2), it can be noticed that, on average, for all examined genotypes and years, grafting in August (period I) on a dormant bud was significantly more successful (69.38%) than whip grafting in April (period II) with the average success of only 25.33%, which is in accordance with the claims of Ekaterina (2008). However, some authors claim that grafting of the Cornelian cherry is not an acceptable method for commercial production. Namely, Ďurkovič (2008) states that grafting of the Cornelian cherry on a two-year-old seedling on a dormant bud has a number of drawbacks, such as seasonal dependence, low coefficient of multiplication, stratification of a seed, etc, which did not represent problems in our

[DOR: 20.1001.1.16807073.2016.18.1.2.0]

research. On the other hand, Klimenko (1990) reports the grafting success of over 90%, which proves the results of this research. Also, Maghradze *et al*. (2009) reported that budding is the main method of cornelian cherry propagation in Georgia region, while, according to Bosančić (2009), as the specific of cornelian cherry landrace of Drvar Valley has been created mostly by seed propagation, there is no grafting practice and a loss of diversity is a real threat.

There were significant differences between the genotypes for both examined years on average, while for all genotypes on average, there were no significant difference between the periods of grafting, except for grafting success.

The greatest grafting success was achieved with APRANI in the period I (83.62%) and with the genotype BACKA in the same period (76.42%), while the poorest success was with CPC16 (21.67%) grafted in the period II. PPC1 and R1 genotypes had similar success when bud grafted in the period I (67.60% and 62.60%, respectively). On average, other examined parameters of young tree quality did not indicate any statistically significant differences between the grafting periods, since the successfully grafted rootstocks developed equally well and evolved into young trees of similar quality (Figure 4), regardless of the method of grafting.

Concerning the other examined parameters of young tree quality, the greatest height was observed with R1 genotype grafted in the period II (911.85 mm) and in the period I (906.82 mm), and then with BACKA genotype in the period II (872.63 mm). Other genotypes formed shorter young trees of uniform height. Young trees produced during this research were shorter than the ones from the research of Ekaterina (2008), who reported that the Cornelian cherry young trees were 120–150 cm in height in the first vegetation, with 4 to 5 side branches, and that they could be planted at a permanent location. The largest diameter of a young tree was formed with APRANI in the period I (13.61 mm) and in the period II (13.32 mm), and then with BACKA genotype grafted in the period I (11.56 mm), in agreement with the results of Klimenko (1990) who reported diameters from 1.3 to 1.5 cm. The largest number of roots formed was observed with APRANI in both periods (19.67 and 19.00, respectively) and with BACKA in the period II (19.67), while the smallest number of roots was formed with

Figure 4. Produced young trees of the Cornelian cherry ready for planting

[DOR: 20.1001.1.16807073.2016.18.1.2.0]

R1 grafted in the period II (9.67). Klimenko (1990) received a significantly smaller number of roots (from 10.6 to 14.4). The longest root system was formed with APRANI and BACKA in both periods, and there was no statistically significant difference with PPC1 genotype.

CONCLUSION

On the basis of our research results, it could be concluded that bud grafting of two-year-old generative rootstocks on a dormant bud during August produces quality planting material, and it can be recommended for mass production of young trees with large and quality fruits. The greatest grafting success in August was achieved with APRANI (83.62%) and BACKA (76.42%), while success with the other selection was very satisfactory. The greatest height was observed in R1 (906.82 mm), the largest diameter of a young tree was observed for APRANI (13.61 mm), BACKA (11.57 mm) and CPC16 (11.56 mm), the largest number of roots formed was recorded for APRANI (19.67) while the longest root system formed in APRANI, BACKA and PPC1 (142.38, 132.58, and 126.89 mm, respectively).

Also, it can be concluded that this grafting method is suitable for production of the first class planting material, considering that, for all produced young trees already planted in orchards, the receiving was almost complete and some have already given the first fruits.

Owing to this research, Cornelian cherry young trees which produce secure and stable yield were made available for the first time in Serbia and the region. The first conditions were created for the transition from fruit gathering to organic plantation production of this versatile fruit species, which, until recently, grew only in forests. Due to the developed production technology of planting material, it is slowly taking its place in the cultivated areas in Serbia and the neighboring region.

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مقایسه روش های پیوند زنی برای تولید نهال های با کیفیت از زغال اخته های (*Cornus mas* L.) منتخب در صربستان

س. م. بیجلیک، ب. ر. گلوسین، س. ب. کروویک، و ب. و. بگدانوویک

چکیده

زغال اخته از شمار گونه های میوه های کمتر شناخته شده ولی جالب است که در صربستان یافت می شود و می تواند برای غذا و دوا استفاده شود. از آنجا که این میوه به عنوان غذای سالم اهمیت زیادی داشته و علاقه زیادی برای کاشت آن وجود دارد، در پژوهش حاضر، بررسی روش های تولید نهال های با کیفیت (به ویژه تولید میوه های بزرگ) در صربستان درکانون توجه بود. در این منطقه و ماورای آن، به علت در دسترس نبودن مواد کاشتنی(نهال)، هیچگونه کشت گسترده زغال اخته وجود ندارد. به این منظور، در این پژوهش، منتخبی از بهترین زغال اخته های صربستان روی پایه های زایشی این درخت در دو دوره مختلف شامل دوره I (پیوند جوانه در ماه اوت) و II (چو پیوند زبانه ای در بهار) پیوند زده شد و سپس موفقیت پیوند زدن، تاثیر دوره و زمان پیوند زدن، و کیفیت نهال های خزانه ارزیابی شد. بررسی ژنوتیپ های درشت میوه (شامل CPC16، APRANI، BACKA، R1، و PPC1) در طی دو سال ۲۰۱۱ و ۲۰۱۲، نشان داد که به طور میانگین، پیوند جوانه در ماه اوت (با ۶۹/۳۸٪ موفقیت) به طور معنی داری موفق تر از چو پیوند زبانه ای در آوریل (۲۵/۳۳٪) بود. بیشترین موفقیت در دوره I در ژنوتیپ APRANI (۸۳/۶۲٪) و BACKA (۷۶/۴۲٪) به دست آمد در حالیکه کمترین موفقیت در ژنوتیپ CPC16 (۲۱/۶۷٪) در دوره II بود. ولی، به طور میانگین، پارامتر های کیفیتی دیگر که روی نهال های جوان اندازه گیری شد (ارتفاع نهال، قطر نهال، تعداد و طول ریشه های تشکیل شده) تفاوت معنی داری بین دو دوره پیوند زنی نشان ندادند. به این قرار، در پژوهش حاضر، یک فناوری برای تولید نهال های کیفیت دار زغال اخته پایه ریزی شد.

[DOR: 20.1001.1.16807073.2016.18.1.2.0]