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Research Article

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# Comparison of budding methods of two cultivars of cornelian cherry (*Cornus mas* L.)

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Cornelian cherry (*Cornus mas* L.) is a little-known fruit species that deserves attention because of the possibility of increasing the biodiversity of crops and making the human diet more attractive. The fruit of the cornelian cherry, due to its health-promoting properties, can be widely used in the food, pharmaceutical and cosmetic industries. Increasing the cultivation area of this species depends on the availability of high-quality planting material. The reproduction of valuable varieties is possible only with the use of vegetative reproduction. One of the most effective methods of cornelian cherry reproduction is budding on cornelian cherry rootstocks. In the experiment carried out in the conditions of South-Eastern Poland, the efficiency of T-budding and chip-budding of two cultivars of cornelian cherry (Nikolka and Koralovyi Marka) was compared depending on the intensity of fertilization. Unusual weather conditions in spring, especially low temperature, delay the growth of rootstocks. However, foliar fertilization resulted in obtaining maiden trees with a larger diameter than those fertilized in the soil. The efficiency of budding under the experimental conditions was on average 40 %, and it was higher for the cultivar Koralovyi Marka and the chip-budding method. The variety and method of fertilization did not affect the efficiency of budding. In contrast, chip-budding budding was higher than that of T-budding multiplied. In this experiment a strong positive correlation was proved between the trunk diameter of maiden trees and their height.

**Keywords:** Cornelian cherry, cultivars, chip-budding, T-budding, sleeping eye, budding efficiency

## Introduction

Cornelian cherry (*Cornus mas* L.) is a valuable fruit plant belonging to the Cornaceae family. Cornelian cherry was known already in antiquity, where its wood was used to make tools, as well as in everyday life when consuming fruit (Bieniek et al., 2017). Cornelian cherry is a widespread species in Eurasia, as its range extends from Central and Southern Europe to the Caucasus and Central Asia. Prefers sunny positions, mountain dry, rocky slopes. The range of its occurrence is up to 1511 m above sea level (Hassanpour et al., 2012). It also withstands heavily shaded positions. In the forest it grows with hornbeam (*Carpinus*) and Hungarian oak (*Quercus frainetto*). Larger concentrations of these plants can be found in the Aegean, Mediterranean, Black Sea basins and in the North-Eastern Anatolia in Turkey (Šilić, 2005). In natural sites, cornelian cherry occur most often in the form of multi-stem shrubs growing up to 3–7 m tall. However, when formed, they produce a trunk and a crown. First, they form lofty crowns, and at a later age they become spherical-flattened (Czerwińska and Melzig, 2018). Cornelian cherry fruits are associated with cherries or plums due to their juicy fruit, which are also drupes with a tart-sour, sometimes sweet-sour taste and a specific aroma. It grows slowly and the first tiny fruitlet can be seen in late April when the leaves unfold. The shape of the fruit depends on the variety. It can be round, oval, oblong, pear-shaped, bottle-shaped, elongated. The length of the fruit varies between 1–4 cm and the diameter is about 2 cm. The

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colour of the fruit can range from cream, yellow, pink, red, cherry to almost black. The peel of the fruit is elastic and shiny. The weight of the fruit ranges from 1.2 g to 6 g and even up to 10 g (Ukrainian cultivars) (Klymenko, 2017). Fruits from natural areas are small, sour and relatively little juicy with a large stone, especially in prolonged drought. Moreover, the yields from such sites are generally small: 3–5 kg of fruit per bush. They rarely reach 10–15 kg per bush, with very optimal humidity and temperature conditions. In the case of cornelian cherry, breeding selection is carried out in terms of the following criteria: fruit size, colour and shape, share of the stone in the total weight of the fruit, period of ripening and harvesting, uniformity of fruit ripening, yielding size and quality, frost resistance, growth strength and self-fertility (Hassanpour and Ali Shiri, 2014).

Cornelian cherry is still a little-known fruit species and obtaining high-quality planting material has not yet been properly elaborated. There are attempts to reproduce this species by seed and vegetatively, however, with each method, difficulties are encountered. Unfortunately, cornelian cherry, when propagated vegetatively by softwood and semi-wood cuttings, develops roots very poorly (Pirlak, 2000; Korszun and Kolasiński, 2001; Korszun and Kolasiński, 2002; Jagła and Król, 2011). The commercial cultivation of popular fruit plants such as apple, pear, plum and cherry trees is based on the use of trees obtained by such the methods like budding or grafting on rootstocks. Rootstocks control the growth force of the plant, enabling the cultivation of trees in a smaller space when growing on their own roots, and above all, they accelerate the fruiting period. It is heterovegetative reproduction, which involves the joining of two plants, usually closely related, to create a new organism. The detached part of the plant, usually a short section of the shoot, is called a scion, and that part of the plant that constitutes the root system on which the scion is grafted is called the rootstock. Such a method in which a scion consisting of an internode or several internodes and one to several buds is transferred onto the rootstock is called grafting. However, if only the bud is transferred together with a small portion of the stem with an axillary bud, it is the so-called budding. Cornelian cherry can be propagated by budding, performed in summer with a sleeping eyes on cornelian cherry seedlings, and also by grafting in winter on cornelian cherry rootstocks, rushed in a greenhouse. In addition to the faithful reproduction of the mother plant‘s features, it guarantees a much faster start of the fruiting period. About 50 % of maiden trees bloom and bear fruit in the second year after budding, and almost 100 % in the third year.

The aim of this study was to investigate the effectiveness of budding methods (chip-budding and T-budding) with the sleeping eyes of two Ukrainian cultivars: Nikolka and Koralovyi Marka on cornelian cherry seedlings using foliar fertilization of rootstocks.

## Material and methodology

### Material

The experiment was carried out in 2019–2020, in a private nursery in Czesławice, 22.268333 °E, 51.306944 °N, near Nałęczów (Poland), on fertile loess soil, rich in humus.

The average air temperature in the years 2019 and 2020 (Table 1) exceeded the long-term average, but

**Table 1** Mean monthly air temperature and precipitation in the study years against the multi-annual mean/total (1951–2012)

| Month | Air temperature (°C) | | | Precipitation (mm) | | |
|---|---|---|---|---|---|---|
| | monthly mean | | | monthly total | | |
| | 2019 | 2020 | multi-annual mean (1951–2012) | 2019 | 2020 | multi-annual total (1951–2012) |
| **April** | 8.4 | 9.3 | 7.4 | 48.6 | 39.0 | 39.0 |
| **May** | 10.9 | 12.3 | 13.0 | 71.5 | 60.7 | 60.7 |
| **June** | 18.3 | 21.3 | 16.3 | 79.9 | 65.9 | 65.9 |
| **July** | 18.5 | 18.4 | 18.0 | 71.1 | 82.0 | 82.0 |
| **August** | 20.0 | 19.7 | 17.2 | 68.1 | 70.7 | 70.7 |
| **September** | 15.0 | 14.1 | 12.6 | 78.7 | 53.7 | 53.7 |
| **October** | 10.3 | 10.5 | 7.6 | 89.2 | 40.1 | 40.1 |
| **Mean/total for the year** | 9.6 | 9.8 | 7.3 | 861.9 | 558.9 | 558.9 |



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in May, the two seasons marked by a decline in the average temperature. Precipitation in the 2020 season were similar to the sum of multi-year, while the 2019 season was much more precipitation, especially in September and October.

200 pieces of two-year-old generative cornelian cherry rootstocks were used for the experiment. The seedlings were planted on April 16, 2019, spaced every 25–30 cm, in two rows. Before planting the plants, fertilizers such as urea in the amount of 200 kg/ha and hydrocomplex in the amount of 400 kg/ha were applied to the whole experiment. In each row, 50 rootstocks were separated, which from May were fertilized 8 times with foliar preparations such as: Yara Tera Kristalon Orange 0.05 g/10 l, Asahi SL 10 ml/10 l, Basfoliar Aktiv SL 10 ml/10 l, Yaraliva calcinit flakes 0.05 kg/10 l.

Yara Tera Kristalon Orange is a multi-component mineral fertilizer, perfect for foliar feeding of plants, it is fully water-soluble and it is a chloride-free fertilizer. It contains NPK 6 + 12 + 36 and MgO with microelements (boron, copper, iron, manganese, molybdenum and zinc).

In contrast, Asahi SL is a growth regulator in liquid form, it has an influence on growth and better quality of the crop. It is used when the conditions are unfavorable and stressful for plant growth, e.g. drought, low temperature.

Basfoliar Aktiv SL foliar fertilizer based on sea algae extract, is an organic and mineral solution containing NPK 3 + 27 + 18 with the addition of boron, copper, iron, manganese, zinc and molybdenum, and also contains plant hormones, amino acids, vitamins and micronutrients.

Yaratera calcinit flakes is a calcium saltpetre in flakes to be dissolved in water, it improves the condition and development of plants, and also reduces the susceptibility of plants to fungal diseases and possible damage.

### Methods

Adult cornelian cherry trees are not susceptible to disease and pests, however seedlings can be susceptible to diseases, particularly fungal diseases. Therefore, the following preparations were used in the experiment: Topsin M 500 S.C. (thiophanate – methyl) in the amount of 1.5 l/ha, Mospilan 200 SP (acetamiprid) in the dose of 125 mg/ha. Topsin is a contact fungicide, used against tree cancer, bark rot and brown rot of stone trees. On the other hand, Mospilan is systemic insecticide that protects the plant against pests such as aphids or adults cockchafer.

Budding began on August 17, 2019. Before budding, maintenance works were carried out, such as: manual weeding, removing the sprouds from the trunk area (at a height of 25 cm from the ground) and wiping the trunk with a clean cloth to remove soil dirt on the rootstock in order to be able to perform the budding procedure in a clean manner.


**Figure 1** Methods of budding of cornelian cherry with the "sleeping eye":
A – T-budding; B – Chip-budding





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Two cultivars of sleeping eyes were used for budding: Nikolka and Koralovyi Marka. In one row the rootstocks were budded with buds (quiescent) of the cv. Nikolka, and in the next – cv. Koralovyi Marka. In each row, both in the part fertilized only with soil and in the foliar fertilization, two budding methods were performed: T-budding and chip-budding.

In the next season on March 19, 2020, the effectiveness of budding was assessed on the basis of the percentage of successful unions.

On August 21, 2020, the diameter of the maiden stem (at the base of the stem) was measured with an electronic calliper and the height of the maiden trees was determined with a ruler.

### Statistical analysis

Statistical calculations were performed in STATISTICA for Windows Version 5.5A. The obtained results were subject to statistical analysis by means of analysis of variance (ANOVA). The significance of the differences among the characteristics was assessed based on confidence intervals calculated by means of a Tukey's test, with a significance level of 5 %.

## Results and discussion

Cornelian cherry, due to its very valuable fruit, is cultivated in many countries, incl. in Ukraine, the Czech Republic, Slovakia, Iran, Turkey, Serbia, France, Austria and Poland. The cultivars differ in fruit ripening, shape, colour, taste, the share of seeds in the fruit, as well as in chemical properties, e.g. soluble solids content, vitamin C, anthocyanins (Kucharska et al., 2011), antioxidant activities and phenolic compounds (Klymenko et al., 2019). Obtaining valuable varieties is possible only through vegetative reproduction. An important factor in intensifying the production is high-quality nursery material. On a small scale, dogwood can be reproduced by layering (Ivanicka and Cvopa, 1977; Klymenko, 2004; Fedosova and D'Antuano, 2012; Klymenko et al., 2017). Another way of vegetative reproduction is cuttings. Herb seedlings are very delicate, sensitive and it is necessary to use fogging in their production (Ivanicka, 1989). It is an effective method, but to a large extent depends on the date of harvesting the cuttings and the type of rooting preparation (Stepanowa et al., 1986; Smykov et al., 1987; Pirlak, 2000; Gąstoł, 2007). Jagła and Król (2011), comparing the efficiency of reproduction of several less known fruit species, including dogwood, with the use of cuttings collected at the turn of July and August, supported by rooting Himal and Rhizopon, concluded that the dogwood took root the least. At both dates of picking the cuttings, the degree of rooting ranged from 0 % (seedlings without rooting preparation) to 33 % of seedlings treated with Rhizopon rooting preparation. Cornelian cherry can also be propagated *in vitro*. It is a species that is relatively easy to replicate, but in tissue cultures, as in the case of cuttings, rooting is very poor.

There are not many experiments comparing the effect of planting material on the growth and yield of cornelian cherry in an orchard. However, when assessing the rate at which fruiting begins, the best method seems to be grafting or budding on cornel rootstocks *Cornus mas* (Klymenko, 2004; Klymenko et al., 2017) or *Cornus amomum* (Ochmian et al., 2019). In addition to repeating the characteristics of the mother plant, it guarantees a much faster start of fruiting, even compared to plants obtained by cuttings. About 50 % of maiden trees bloom and yield in the second year after budding and almost 100 % in the third year (Klymenko, 1990). On the other hand, cornelian cherry seedlings obtained from seeds, bear their first fruit 8 years after planting at the earliest. Ochmian et al. (2019) found that the cornelian cherries varieties obtained by budding *Cornus amomum* showed weaker tree growth, but the fruit quality did not deteriorate compared to trees on their own roots. The fruits of dark-skinned cultivars (Jolico, Schönbrunner and Shumen) from budded trees had significantly more anthocyanins. Ciltivar Jolico mainden tree was characterized by a much larger diameter and weight.

The rootstock is an important component of the tree as it determines its growth strength, adaptation to soil conditions, disease resistance, size and quality of crops, tolerance to salinity and drought. In the case of cornelian cherry, seedlings of cornelian cherry is a good rootstock in terms of physiological compatibility. Difficulties with vegetative reproduction necessitate the use of generative rootstocks, i.e. rootstocks propagated from seeds. This type of reproduction does not ensure uniform quality, but in the case of stone trees (cherries, cherries and plums), generative rootstocks are also used in nursery technology. When comparing the method of producing dogwood trees, one can refer to the production of maiden trees with a 2-year-old-crown (Sadowski et al., 2006). The root system of such trees is three years old. Trees must be well developed and branched. The quality characteristics of trees depend on the species. For apple trees, budding 20 cm above the ground are most desirable, on dwarf rootstocks with a highly formed crown, at least 60–80 cm high, with not very long side shoots (up to 60 cm long). In the case of cornelian cherry, the budding



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site cannot be too high, it is practically the area of the second internode (oral information). On the basis of the research by Bielicki et al. (2008) assessing the quality of young apple, pear, cherry, plum and quince trees obtained by the ecological method, the largest number of trees in relation to seed stocks was obtained in the case of apple trees (80.3–91.2 %) and pear trees (42.9–87 %), and the lowest for cherries (8.4–17.3 %). Klimenko (2004) and Fedosova and D'Antuano (2012) confirmed that the most effective way to reproduce cornelian cherry is budding (90–98 % yield) and grafting (75–78 % yield). In the work of Szot et al. (2020), the efficiency of budding was very high (from 92.91 to 97.95 %), which indicates the usefulness of this method for cornelian cherry reproducing. The quality of the rootstocks has a great influence on the buds acceptance. In organic farming, it is difficult to protect against diseases and pests, thanks to which the rootstock is less overgrown and the duration of cambium activity is limited. Cornelian cherry, devoid of monocultures, is quite resistant to diseases and dangerous pests such as aphids and mites. The growth of maiden trees also depends to a large extent on the date of budding. According to nurserymen, the best term for budding in the T-budding is the period of intensive cambium division. In Central, Southern and Eastern Poland, cornelian cherry budding should start from late July to mid-August (Hołubowicz et al., 1993). In the experiment of Szot et al. (2020), the budding was performed in mid-August, and the high effectiveness of the treatment proves the good activity of the cornelian cherry cambium during this period. The cultivar Szafer had the highest budding efficiency (97.95 %), while the weakest genotypes: Roch, Okazały, Gruszkowy, Za bankkiem S1 and cultivar Paczoski (from 92.91 to 93.65 %). This confirms the observations of Bijelić et al. (2016), who proved in Serbia that August budding is a more effective method of reproduction (from 56.67 to 83.62 %) than grafting in the April (from 21.67 to 30.33 %). In this experiment, the effectiveness of budding was investigated (Table 2, Figure 2).

When assessing the influence of the variety, the method of budding and fertilization on the effectiveness of budding, it was found that the participation of successful unions (50 %) was in the case of the cv. Koralovyi Marka, with the budding in the T-budding and without the application of foliar fertilizers. The poorest efficiency (22 %) was that of budding in the T-budding with the buds of the cv. Nikolka, without the application of foliar fertilizers. Chip-budding was found to be more effective with both cultivars. The buds of the cv. Koralovyi Marka were better taken than by cv. Nikolka. The climatic conditions, which determine the quality of the rootstocks, have a significant influence on the budding effect.

The growth of maiden trees in a nursery depends on the genetic characteristics of the species and the variety. Bielicki et al. (2008) found that among the studied species, plums grew best on seedlings, and the cultivar had a decisive influence on the quality of the obtained maiden trees. Stachowiak and Świerczyński (2004) proved that the growth of cherry maiden trees in a nursery depends mainly on the rootstock, but among the studied cultivars, the cultivars 'Hardy Giant' and 'Sumit' had the highest trunk diameter and total height. Jacyna (2004) found that in the case of pear trees, the variety has a greater influence on the branching of maiden trees than the rootstock. Jacyna (2004) and Łanczont (2004) proved that there is a strong correlation between the trunk diameter and the number of shoots of apple, pear and plum maiden trees, which makes the trunk diameter an important quality feature of young trees. Lipecki et al. (2015) found a strong correlation between the diameter of 'Łutówka' maiden trees and the total length of

**Table 2** The influence of *Cornus mas* L. cultivar, budding method and fertilization on efficiency of budding determined as participation of successful unions (%)

| Cultivar | Budding method | Fertilization | Participation of successful unions (%) | | |
|---|---|---|---|---|---|
| **Koralovyi Marka** | T-budding | application of foliar fertilizers | 34 | 42 | 43.5 |
| | | without the foliar fertilizers | 50 | | |
| | Chip-budding | application of foliar fertilizers | 42 | 45 | |
| | | without the foliar fertilizers | 48 | | |
| **Nikolka** | T-budding | application of foliar fertilizers | 34 | 28 | 35.0 |
| | | without the foliar fertilizers | 22 | | |
| | Chip-budding | application of foliar fertilizers | 46 | 42 | |
| | | without the foliar fertilizers | 38 | | |



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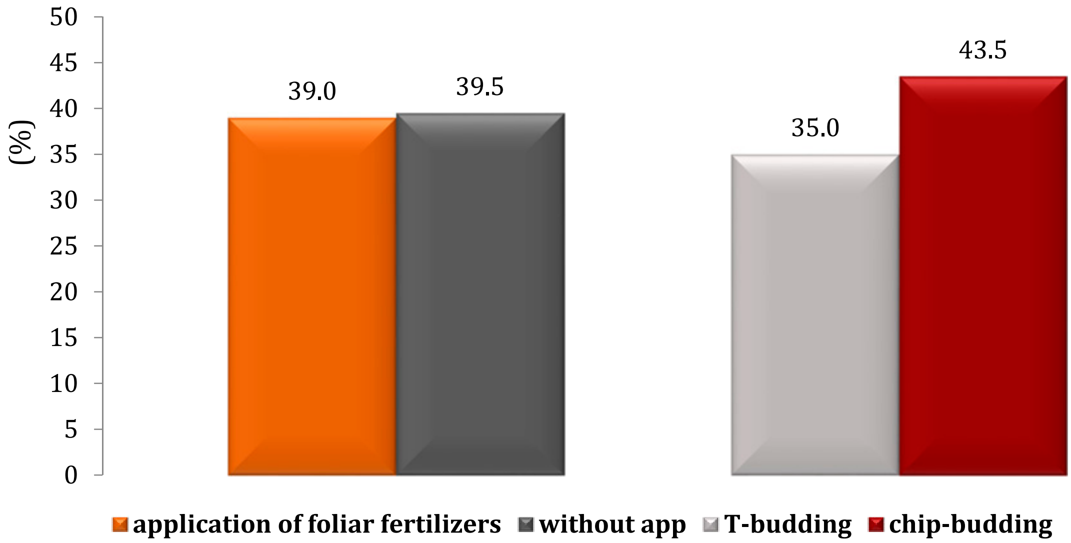


**Figure 2** Participation of successful unions (%) depending on fertilization (first two bars) and methods of budding (another 3 and 4 bars)

side shoots. In the experiment of Szot et al. (2020) showed that the stem diameter was strongly positively correlated with the height of the maiden trees and the number of branches. In this experiment a strong positive correlation was proved between the trunk diameter of maiden trees and their height ($r = 0.66$, $p <0.05$) In the experiment of Szot et al. (2020), plant height was influenced by genetic features, i.e. cultivar and genotype. The highest values were found for the cultivar Bolestraszycki, the genotype Okazały and the cultivar Dublany (respectively: 1493, 1461 and 1493 mm), and the shortest ones for the Za bankiem S1 and Roch genotypes (1013 and 1050 mm). The height of the maiden trees determined on the basis of Ekaterina (2008) is similar, as in the first year of vegetation the maiden trees reach 120–150 cm. On the other hand, Bijelić et al. (2016) obtained significantly lower trees (from 73.7 to 90.7 cm) as a result of budding in August and grafting in April. In this experiment, the maiden cultivars of individual cultivars did not differ significantly in height (Table 3).

The maiden trees of cv. Nikolka were 89.54 cm high, while cv. Koralovyi Marka height was 90.68 cm. When assessing the influence of the variety, method of budding and fertilization, it was found that the highest were cv. Koralovyi Marka at chip-budding budding after foliar fertilization (93.12 cm), while the lowest cv. Nikolka, budding in T-budding, after foliar fertilization (88.34 cm). Maiden trees reproduced by chip-budding were found to be higher than T-budding.

An important feature that proves the quality of maiden trees is the diameter of the trunk. In the experiment of Szot et al. (2020) the diameter of the stem was similar for the cultivars and genotypes tested. However, the largest diameter was achieved by the cv. Dublany (16.84 mm), while the cv. Raciborski (12.93 mm) was the smallest. The obtained results confirmed the

**Table 3** The influence of *Cornus mas* L. cultivar, budding method and fertilization on height of maiden

| Cultivar | Budding method | Fertilization | Height of maiden (cm) | | |
|---|---|---|---|---|---|
| **Koralovyi Marka** | T-budding | application of foliar fertilizers | 88.60ab* | 89.51ab | 90.68a |
| | | without the foliar fertilizers | 90.41ab | | |
| | Chip-budding | application of foliar fertilizers | 93.12b | 91.85b | |
| | | without the foliar fertilizers | 90.58ab | | |
| **Nikolka** | T-budding | application of foliar fertilizers | 88.34a | 88.76a | 89.54a |
| | | without the foliar fertilizers | 89.18ab | | |
| | Chip-budding | application of foliar fertilizers | 92.25ab | 90.32ab | |
| | | without the foliar fertilizers | 88.40ab | | |

Notes: * – values in the same column with different letters are significantly different at $p <0.05$

**Table 4** The influence of *Cornus mas* L. cultivar, budding method and fertilization on diameter of maiden stem (mm)

| Cultivar | Budding method | Fertilization | Diameter of maiden stem (mm) | | |
|---|---|---|---|---|---|
| **Koralovyi Marka** | T-budding | application of foliar fertilizers | 8.03a* | 8.06a | 8.18a |
| | | without the foliar fertilizers | 8.10a | | |
| | Chip-budding | application of foliar fertilizers | 8.47ab | 8.30a | |
| | | without the foliar fertilizers | 8.13a | | |
| **Nikolka** | T-budding | application of foliar fertilizers | 9.46c | 9.23b | 9.25b |
| | | without the foliar fertilizers | 9.00bc | | |
| | Chip-budding | application of foliar fertilizers | 9.29c | 9.26b | |
| | | without the foliar fertilizers | 9.23c | | |

Notes: * – values in the same column with different letters are significantly different at p <0.05

research of Klymenko (1990), which in the case of the trunk diameter of cornelian cherry maiden trees was from 13 to 15 mm and is slightly higher than in the case of Bijelić et al. (2016), where the maiden trees of the studied genotypes had a diameter of 10 to 13.61 mm.

In this experiment, the maiden tree of cv. Nikolka had a significantly larger diameter (9.25 mm) than that of cv. Koralovyi Marka (8.18 mm) (Table 4).

When assessing the influence of the variety, method of budding and fertilization on the diameter of the trunk, it was found that the highest values of the mentioned feature were characteristic of the Nikolka maiden trees with T-budding, after application of foliar fertilizers (9.46 mm) and chip-budding, both after fertilization and without fertilization (9.29 and 9.23 mm).

The lower values of the described features in relation to the data from the literature should be explained by the unfavourable weather conditions in the 2019 season, which had a significant impact both on the quality of rootstocks, and then on the buds takes and the development of maiden trees. The two-year-old seedlings after planting had very unfavourable growth conditions due to the low temperatures in May, so that at the time of budding they had a diameter of about 8.7 mm. The literature lacks data on the optimal diameter of the rootstock at which the cornelian cherry should be budding with a quiescent. When compared to other species, e.g. hazel (*Corylus colurna*), it is about 8–12 mm (Ninic-Todorovic et al., 2009). Thus, in the present experiment, the rootstocks reached the minimum optimal diameter for budding.

Cornelian cherry clearly responds favourably to fertilization with greater fruit mass and more vigorous growth. It is best if it is fertilized organically, but fertilization with artificial fertilizers is equally effective and has no negative side effects (Jaćimović et al., 2020). There is still no long-term experience concerning the

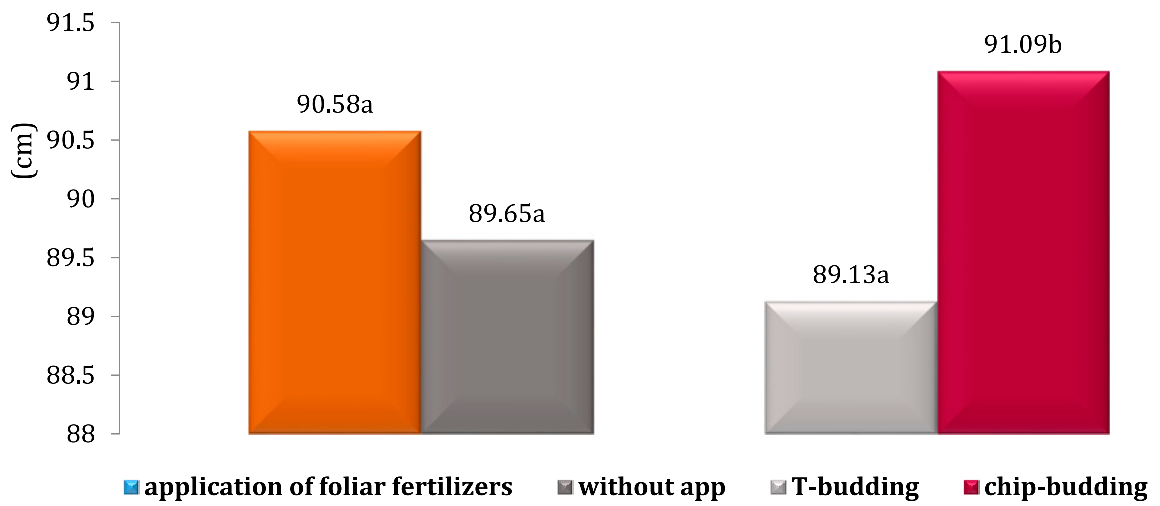


**Figure 3** Height of maiden of *Cornus mas* L. (cm) depending on fertilization (first two bars) and methods of budding (another 3 and 4 bars)



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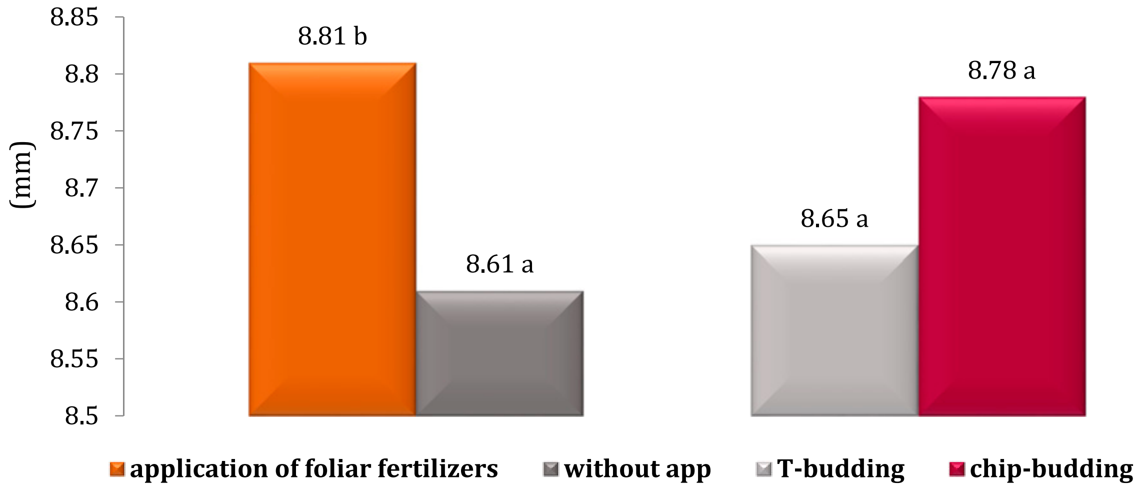


**Figure 4** Diameter of maiden stem of *Cornus mas* L. (mm) depending on fertilization (first two bars) and methods of budding (another 3 and 4 bars)

influence of cornelian cherry fertilization on its growth and yielding. However, based on the preliminary experiments of Krakow researchers (Domagała-Świątkiewicz et al., 2013), it can be concluded that the plant adapts to the different availability of macronutrients such as P, K and Mg, showing no clear symptoms of their lack. A strict correlation was found between the content of P and K in the soil and the amount of these components in the leaves. Further detailed research in this direction is necessary because the content of macro- and microelements in plant tissues depends to a large extent on the conditions prevailing in a given growing season.

In this experiment, the use of foliar fertilizers significantly increased the diameter of the trunk compared to maiden fertilizers fertilized only in the soil. However, no effect of foliar fertilization on the effectiveness of budding and the height of maiden trees was found (Figure 2 and Figure 3).

On the other hand, the diameter of the fertilized rootstocks was significantly larger than those without fertilizers (Figure 4).

The production of high-quality nursery material enables cornelian cherry to quickly enter the fruiting period. However, the production of a cornelian cherry tree is a very laborious and time-consuming period. In order to obtain a seedling as a rootstock, it is necessary to cool down twice for breaking seed dormancy. Then a minimum of two or three years for the thickening of the rootstock, i.e. obtaining a diameter of 8–12 mm, optimal for budding, and only the next year after budding, the trees are ready to be planted permanently. Therefore, including the period of obtaining the rootstock, the production of trees lasts 5–6 years. This period can be shortened to 2–3 years by producing rootstocks each year.

## Conclusions

Unusual weather conditions in spring, especially low temperature, delay the growth of rootstocks. However, foliar fertilization resulted in obtaining maiden trees with a larger diameter than those fertilized in the soil. The efficiency of budding under the experimental conditions was on average 40 %, and it was higher for the cv. Koralovyi Marka and the chip-budding method. The variety and method of fertilization did not affect the efficiency of budding. In contrast, chip-budding budding was higher than that of T-budding multiplied. In this experiment a strong positive correlation was proved between the trunk diameter of maiden trees and their height.


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