

EFFECT OF ROOTSTOCK QUALITY AND HEIGHT OF HEADING BACK ONE-YEAR-OLD GRAFTS ON THE QUALITY OF TWO-YEAR-OLD TREES IN THE NURSERY

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A B S T R A C T

M.26 rootstocks of different diameters (from 6.0 to 12.0 mm) were used for winter grafting of the apple cultivar 'Šampion'. The best and the strongest one-year-old grafts were those grafted on rootstocks 10.0 to 12.0 mm in diameter.

One-year-old grafts of 'Jonagored' on M.9 rootstock and 'Šampion' on M.26 rootstock were subjected to four different heading back treatments: 1) Heading back at 65 cm above ground level; 2) Heading back 45 cm above ground level; 3) Heading back at 5 cm above the graft union; and 4) No heading back, with only correctional pruning in May and June as the control.

Quality of two-year-old trees depended on the height of heading back and on the diameter of one-year-old grafts. Heading back at 65 cm above ground level produced high quality two-year-old trees with a well-branched, one-year-old crown. Trees that had not been headed back were also of good quality and had the best shoot formation. However, they required very good soil conditions and irrigation after planting in the orchard.

Key words: apple tree, two-year-old tree with one year old crown, nursery, quality, grafts, height of heading back

INTRODUCTION

When planting intensive dwarf fruit orchards, it is best to plant young, well-branched trees. If one-year-old trees with few branches or one-year-old grafts are planted, they need at least one year to produce

crowns, which delays production by one year. When one-year-old grafts are kept another year in the nursery, they can easily be treated to enhance crown formation. When well-branched trees are planted, little if any pruning is needed later, which means earlier and larger yields (Van Oosten,

1978; Mika, 1998). Commercial nurseries are producing more two-year-old trees with one-year-old crowns (Czynczyk, 1997a). Studies both in Poland and in other countries have demonstrated the superior quality of two-year-old trees with one-year-old crowns (Czynczyk et al., 1997; Czynczyk, 1997ab; Mika and Krawiec, 1998; Bootsma and Baart, 1990).

The method used earlier to produce these trees is different from the method now recommended. Bud-grafted one-year-old trees were kept in the nursery for another year and were headed back to produce trees with vigorous two-year-old stems and root systems, and well-branched one-year-old crowns (Poniedziałek et al., 1992). It is easy to induce strong crown formation in cultivars that produce sylleptic shoots, such as 'Jonagold', 'Elstar' and 'Gala'. The high quality of these trees has aroused great interest among Polish fruit growers, which has persuaded many nurserymen to start producing these trees. The height at which one-year-old trees are headed back affects tree quality and the number of shoots in the crown. Therefore, trials were carried out at the Department of Pomology, Gene Resources and Nursery to determine optimal height for heading back.

MATERIAL AND METHODS

Field experiments were carried out at the nursery and fruit farm of Andrzej and Szymon Nowakowski in Żdźary near Nowe Miasto in central Poland. For the last few years, this nursery has specialized in producing

two-year-old trees with one-year-old crowns, mainly apple trees.

The stem diameter experiment was carried out from 1999 to 2000 to determine the optimum diameter of rootstock for producing two-year-old trees with one-year-old crowns. M.26 semi-dwarfing rootstocks of three diameters were used: 6-8 mm, 8.1-10.0 mm, and 10.1-12 mm. In the winter, scions of the cultivar 'Šampion' were grafted onto the rootstocks using the "in the hand graft" method. In the spring, grafts were planted in a commercial nursery in a split-plot system, 25 grafts per plot with four replicates. In the autumn, when vegetative growth had stopped, stem diameter of the one-year-old grafts was measured 10 cm above the graft union.

The heading back height experiment was carried out from 1997 to 2000 to determine the optimal height for heading back to obtain high quality two-year-old trees with one-year-old crowns. One-year-old grafts of 'Jonagored' on M.9 rootstock and 'Šampion' on M.26 rootstock were used. 'Jonagored' trees were produced in three runs: 1997-98, 1998-99 and 1999-2000. 'Šampion' trees were produced in two runs: 1997-98 and 1998-99. In the spring, before heading back, stem diameter of the one-year-old grafts was measured 10 cm above the graft union. The experimental trees were of uniform quality. Average stem diameter was 9.8 mm with 'Jonagored' and 10.6 mm with 'Šampion'. The experiment was carried out in a split-plot block system, with cultivars in blocks and height of

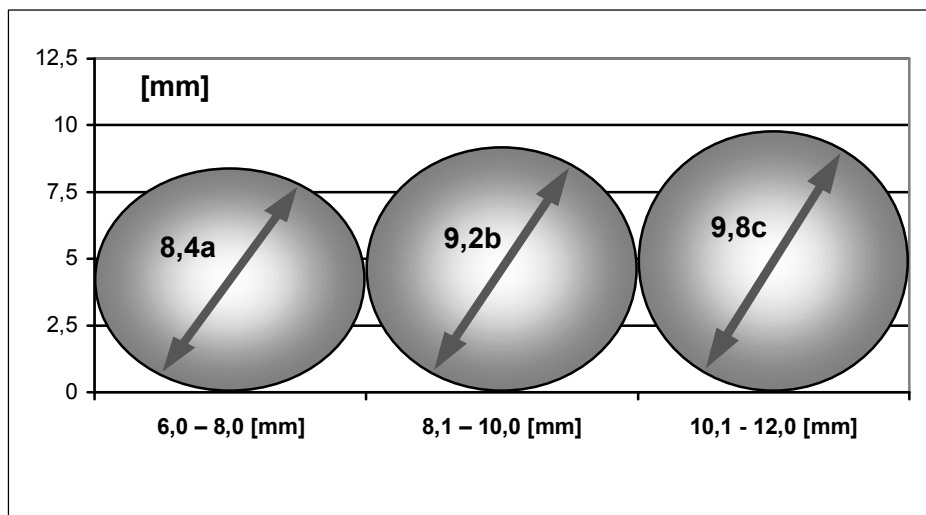
heading back in sub-blocks, 25 trees per plot with four replicates. Trees were subjected to four different heading-back treatments: 1) Heading back at 65 cm above ground level; 2) Heading back 45 cm above ground level; 3) Heading back at 5 cm above the graft union; and 4) No heading back, with only correctional pruning in May and June as the control.

Each autumn before the trees were dug out, stem diameter and height of the two-year-old trees were measured, and the number and length of all sylleptic shoots were determined. Results were subjected to variance analysis followed by Duncan's multiple range t-test at $P = 0.05$. There were no significant differences between results

from different years, which made comparisons between years impossible.

RESULTS AND DISCUSSION

In the stem diameter experiment, the diameter of one-year-old 'Šampion' grafts was directly proportional to the diameter of the rootstock used for grafting (Fig. 1). This agrees with the findings of Bielicki and Czynczyk (1992), who concluded that one-year-old graft diameter was largely dependent on rootstock diameter. The size of the grafts and the number of sylleptic shoots increased with increasing rootstock diameter and the size of the root system.



* Values marked with the same letter are not significantly different.

Figure 1. Stem diameter of one-year-old grafts of 'Šampion' apple cultivar obtained by winter grafting on various diameter rootstocks of M.26

In 'in the hand' grafting, it is essential to use well-developed rootstocks with strongly developed root systems. Czynczyk (1998) found that

the best rootstocks were two-year-old, nursery-grown rootstocks more than 10 mm in diameter, and that grafting should be done 30-40 cm above the

base. This gives a quick and good union between scion and rootstock, which promotes good stem growth in the first year in the nursery.

In the heading back height experiment, the tallest and thickest two-year-old trees were those that had not been headed back in the

spring. ‘Jonagored’ and ‘Šampion’ trees reacted differently to heading-back at all heights. Trees that had not been headed-back had more total lateral shoots, shoots shorter than 10 cm, and shoots longer than 30 cm (Tabs 1 and 2).

Table 1. Effect of heading back one-year-old grafts on the quality of two-year-old ‘Jonagored’/M.9 apple trees in Żdźary near Nowe Miasto, average of 1998, 1999 and 2000

Height of heading back	Stem diameter 30 cm above ground level in mm	Height of two-year-old trees in cm	Total lateral shoots per tree	Average length of lateral shoots per tree in cm	Average number of lateral shoots shorter than 10 cm per tree	Average number of lateral shoots longer than 30 cm per tree
65 cm above ground level	16.1 b*	191.7 b	12.3 b	43.7 b	1.7 a	9.3 c
45 cm above ground level	15.5 b	184.7 a	11.6 b	36.4 a	2.1 a	6.8 b
5 cm above graft union	13.6 a	179.6 a	8.8 a	36.6 a	1.7 a	5.4 a
No heading back	17.1c	212.9 c	14.1 c	36.5 a	3.2 b	8.2 c

*Means followed by the same letter in columns do not differ significantly with Duncan’s multiple range t-test at P = 0.05

Table 2. Effect of heading-back of one-year-old grafts on the quality of two-year-old ‘Šampion’ /M.26 apple trees in Żdźary near Nowe Miasto, average of 1998 and 1999

Height of heading back	Stem diameter 30 cm above ground level in mm	Height of two-year-old trees in cm	Total lateral shoots per tree	Average length of lateral shoots per tree in cm	Average number of lateral shoots shorter than 10 cm per tree	Average number of lateral shoots longer than 30 cm per tree
65 cm above ground level	15.5 b*	161.5 b	10.9 b	22.8 b	4.0 b	4.0 b
45 cm above ground level	15.5 b	152.1 a	11.4 b	21.1 ab	4.3 b	3.9 b
5 cm above graft union	13.5 a	146.5 a	8.9 a	19.9 a	2.7 a	2.6 a
No heading back	16.9 c	178.1 c	14.6 c	22.6 b	6.4 c	5.1 c

*Explanation see Table 1

With one-year-old grafts of both 'Jonagored' and 'Šampion', heading back had a significant effect on stem diameter, height, and crown quality (Tabs 1 and 2). Trees headed back at 65 cm produced the most shoots. The height of heading back also affected the number of dwarf shoots, which significantly effects when trees start bearing. Studies in Poland and the Netherlands have shown that trees with more well-developed lateral shoots yielded better in the first years after planting (Czynczyk, 1989; Bootsma, 1995). Choice of rootstock clone has a large influence on the size, vigour and quality of two-year-old trees. Bielicki and Czynczyk (1999b) found that, when grafted on the semi-dwarfing M.26 rootstock, two-year-old 'Jonagored' trees were taller and thicker than when grafted on the dwarfing M.9 rootstock. Trees grafted on M.26 rootstock had more dwarf and sylleptic shoots.

The fact that 'Jonagored' and 'Szampion' reacted differently to heading back agrees with earlier results for 'Lobo' on the semi-dwarfing P 60 rootstock, 'Jonica' on the dwarfing M.9 rootstock, and 'Jonagold' and 'Melrose' on various rootstocks (Bielicki and Czynczyk, 1998; 1994). Two-year-old trees with one-year-old crowns are ideally suited to the needs of modern 21st century fruit production because they start bearing earlier and produce higher yields, especially in the first two or three years after planting (Czynczyk et al., 1997; Bielicki and Czynczyk, 1999a; Bootsma and Baart, 1990). Grafting in the winter with the "in the hand

graft" method provides high quality trees for modern commercial orchards. To obtain well-developed trees, nurseries should be set up on fertile, humus-enriched soil. This method of accelerated production of trees with dwarf crowns is increasingly used in nurseries. Because of their high yield potential, two-year-old trees with one-year-old crowns should be planted only in very good soil and provided with ample water after being planted in the orchard. The lack of cold stores in nurseries may limit production of trees by this method because the grafts have to be stored at 2°C or lower from February to as late as the middle of April (Borecki, 1999).

CONCLUSIONS

1. The diameter of one-year-old grafts was directly proportional to the diameter of the rootstocks used for 'in the hand' winter grafting.
2. Trees that had not been headed back in the spring had the most dwarf shoots (up to 10 cm long).
3. Heading back one-year-old trees in their second year in the nursery had a significant effect on the quality of two-year-old trees with one-year-old crowns.
4. Heading back one-year-old trees at 65 cm above ground level produced high quality two-year-old trees with one-year-old crowns with the most shoots longer than 30 cm.

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WPLYW JAKOŚCI PODKŁADEK I WYSOKOŚCI PRZYCIĘCIA SZCZEPÓW JEDNOROCZNYCH NA JAKOŚĆ DRZEWEK DWULETNIICH W SZKÓLCE

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S T R E S Z C Z E N I E

W doświadczeniu pierwszym badano przydatność podkładek zróżnicowanych pod względem grubości do produkcji drzewek dwuletnich z jednoroczną koroną. Badaniem objęto podkładki półkarłowe M.26, w trzech klasach grubości: \varnothing 6,0- 8,0 mm, \varnothing 8,1-10,0 mm i \varnothing 10,1-12,0 mm. Podkładki szczepiono zimą „w rękę” przez stosowanie zrazami odmiany ‘Szampion’. Wiosną szczepy posadzono w szkółce, a jesienią wykonano pomiary grubości szczepów jednorocznych na wysokości 10 cm powyżej miejsca szczepienia. Na podstawie uzyskanych wyników stwierdzono zależność proporcjonalną grubości podkładek użytych do szczepienia do średnicy uzyskanych szczepów jednorocznych.

W drugim doświadczeniu badano wysokość przycięcia szczepów jednorocznych dla uzyskania dobrych jakościowo drzewek dwuletnich z jednoroczną koroną. Materiał doświadczalny stanowiły szczepy jednoroczne dwóch odmian jabłoni: ‘Jonagored’ na podkładce M.9 i ‘Szampion’ na M.26. Zastosowano 3 wysokości przycięcia drzewek na wiosnę, które porównywano do kombinacji kontrolnej, nie ciętej: 1. Bez przycinania, 2. Cięcie wysokie na wysokości około 65 cm od ziemi, 3. Cięcie średnie na wysokości około 45 cm od ziemi, 4. Cięcie niskie na wysokości około 5 cm nad miejscem szczepienia. Najsilniejsze drzewka dwuletnie (najwyższe i o największej średnicy) uzyskano pozostawiając szczepy jednoroczne bez cięcia wiosną. Ponadto pozostawienie szczepów jednorocznych nie przyciętych na wiosnę istotnie zwiększało nie tylko ogólną liczbę pędów bocznych, ale też liczbę krótkopędów oraz pędów o długości powyżej 30 cm. Przycięcie szczepów jednorocznych obu odmian wpłynęło istotnie na ich parametry jakościowe, przede wszystkim na średnicę, wysokość pni oraz liczbę pędów w koronie. Stosując przycięcie szczepów jednorocznych na wysokość 65 cm uzyskano bardzo dobrze wyrosnięte drzewka.

Słowa kluczowe: jednoroczny szczep, drzewko dwuletnie z jednoroczną koroną, jabłoń, podkładka, szkółka, jakość, wysokość przycięcia