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**USEFULNESS OF FOUR ROOTSTOCKS
IN THE PRODUCTION OF ORNAMENTAL APPLE TREES
(*MALUS* × *PURPUREA* REHD.) IN A NURSERY**

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ABSTRACT. In the experiment carried out the growth and flowering of selected cultivars of ornamental apple trees grafted on four rootstocks: M.9, M.26, MM.106 and ‘Antonówka’ seedling were estimated. The used rootstocks significantly differentiated the obtained results for the following characteristics of ornamental apple trees: the height, the thickness of a trunk, the sum of long-shoots lengths, and the number of flowers. The observed power of growth of ornamental trees was the biggest for ‘Antonówka’ seedling, the same for M.26 and MM.106 rootstocks but for M.9 this feature was poorer. The trees of ‘Lemoinei’, and ‘Makowiecki’ cultivars were growing stronger than ‘Royalty’. Flowering of trees on rootstocks M.9 and ‘Makowiecki’ cultivar was the best.

Key words: cultivars of *Malus* × *purpurea*, flowering, growth, rootstocks

Introduction

The interest in deciduous ornamental trees is growing each year whereas a declining trend of planting coniferous trees can be observed. People return to leafy species, especially to those with changing ornamental features. One of such trees is a *Malus* × *purpurea* which blooms with colourful leaves in spring and gives fruit in different sizes in autumn. Depending on the cultivar the leaves have different colour (**Bugała** and **Straus** 1980, **Marosz** 1999 a, b, 2000). Taking all these traits into consideration there is a great need to propagate *Malus* × *purpurea* trees.

In nursery production different rootstocks are used for the production of ornamental apple trees. Unfortunately, contrary to available vast knowledge on their usefulness for fruit apple trees, there is very little information on their usability for ornamental nursery.

The aim of these studies was the evaluation of the usefulness of four selected rootstocks with a different power of growth for the production of three cultivars of *Malus* × *purpurea* tree in a nursery.

Material and methods

The experiment was carried out in years 2003-2005 using a random block design with four replicates, with 25 trees in each replicate. In winter rootstocks M.9, M.26, MM.106 and 'Antonówka' seedlings were grafted in hand with three cultivars of *Malus* × *purpurea* tree: 'Lemoinei', 'Makowiecki', 'Royalty'. In spring the trees were planted into the nursery.

Flowering of the above mentioned trees was evaluated in the second year of their growth taking into consideration the number of flowers. The influence of the applied rootstocks on the growth of ornamental apple trees was identified on the basis of the following features: height (cm) and thickness of the trunk (measured 30 cm above the ground), (mm), sum of long-shoots' lengths (cm) and the number of roots. All the measures and observations were carried out, in the last decade of October after the end of growing period in the second year of growth.

Statistical analysis of the results was carried out using two-factor variance analysis (cultivar, rootstock). Significance of differences among combinations was evaluated on the basis of confidence intervals calculated from Duncan's test for the confidence level $\alpha = 0.05$.

Results

The examined rootstocks and cultivars differentiated the height and thickness of ornamental apple trees (Table 1, 2). The best results of these features were obtained on 'Antonówka' seedling, the worst ones on M.9 rootstock. The values obtained for M.26 and MM.106 did not differ significantly and comprised in the range of data for these rootstocks. Independently from the rootstock the trees of 'Lemoinei' and 'Makowiecki' cultivars were higher and thicker than 'Royalty' ones.

Table 1
The height of ornamental apple trees depending on rootstock (cm)
Wysokość drzewek jabłoni ozdobnych w zależności od podkładki (cm)

Cultivar Odmiana	Rootstock Podkładka				Mean value for a cultivar Średnia dla odmiany
	M.9	M.26	MM.106	seedling 'Antonówka' siewka 'Antonówka'	
'Lemoinei'	117.7 ab*	133.3 b	124.0 ab	169.6 c	136.2 b
'Makowiecki'	112.0 a	134.7 b	122.0 ab	163.9 c	133.2 b
'Royalty'	100.9 a	111.0 a	108.7 a	136.7 b	114.3 a
Mean value for a rootstock Średnia dla podkładki	110.2 a	126.3 b	118.7 ab	156.7 c	

*Means followed by the same letters are not significant at the level of $\alpha = 0.05$.

*Średnie oznaczone tymi samymi literami nie różnią się między sobą istotnie na poziomie $\alpha = 0,05$.

Table 2
The thickness of trunk of ornamental apple trees depending on rootstock (cm)
Grubość pnia drzew jabłoni ozdobnych w zależności od podkładki (cm)

Cultivar Odmiana	Rootstock Podkładka				Mean value for a cultivar Średnia dla odmiany
	M.9	M.26	MM.106	seedling 'Antonówka' siewka 'Antonówka'	
'Lemoinei'	1.4 bc*	1.7 cd	1.5 bc	1.9 d	1.6 b
'Makowiecki'	1.4 bc	1.6 cd	1.8 d	1.9 d	1.7 b
'Royalty'	1.1 a	1.3 ab	1.3 ab	1.4 bc	1.3 a
Mean value for a rootstock Średnia dla podkładki	1.3 a	1.5 b	1.5 b	1.7 c	

*Means followed by the same letters are not significant at the level of $\alpha = 0.05$.

*Średnie oznaczone tymi samymi literami nie różnią się między sobą istotnie na poziomie $\alpha = 0.05$.

The sum of long-shoots' lengths of ornamental apple trees varied, depending on the rootstock and cultivar (Table 3) Significantly the highest value of this parameter was observed for 'Antonówka' seedling, the smallest one for M.9. The results obtained for the remaining two rootstocks did not differ much between each other. The trees of 'Lemoinei' and 'Makowiecki' cultivars had a bigger value of the sum of long-shoots' lengths than 'Royalty'.

Table 3
The sum of long-shoots length of ornamental apple trees depending on rootstock (cm)
Suma długości długopędów drzewek jabłoni ozdobnych w zależności od podkładki (cm)

Cultivar Odmiana	Rootstock Podkładka				Mean value for a cultivar Średnia dla odmiany
	M.9	M.26	MM.106	seedling 'Antonówka' siewka 'Antonówka'	
'Lemoinei'	165.3 bc*	207.5 d	203.0 d	340.6 e	229.1 b
'Makowiecki'	141.3 b	172.2 c	182.5 cd	358.2 e	213.6 b
'Royalty'	72.7 a	91.7 a	87.0 a	166.1bc	104.4 a
Mean value for a rootstock Średnia dla podkładki	126.4 a	157.1 b	157.5 b	288.3 c	

*Means followed by the same letters are not significant at the level of $\alpha = 0.05$.

*Średnie oznaczone tymi samymi literami nie różnią się między sobą istotnie na poziomie $\alpha = 0,05$.

The plants of ornamental apple trees on M.9 rootstock had significantly the biggest number of flowers. The next, in a declining order of the flowers, were rootstocks: M.26, MM.106 and 'Antonówka' seedling on which the flowering was the poorest. The best flowering was observed for 'Makowiecki' cultivar (Table 4).

The smallest number of roots was found on apple trees on M.9 rootstock, bigger on M.26 and MM.106, and the biggest on 'Antonówka' seedling. Grafted cultivars of apple trees did not differentiate significantly the number of roots (Table 5).

Table 4

The number of flowers on ornamental apple trees depending on rootstock
Liczba kwiatów na drzewkach jabłoni ozdobnych w zależności od podkładki

Cultivar Odmiana	Rootstock Podkładka				Mean value for a cultivar Średnia dla odmiany
	M.9	M.26	MM.106	seedling 'Antonówka' siewka 'Antonówka'	
'Lemoinei'	18.3 d*	12.1 c	6.3 b	2.7 a	9.9 a
'Makowiecki'	36.0 h	28.3 g	22.0 e	12.3 c	24.7 c
'Royalty'	24.3 f	11.3 c	6.0 b	3.4 a	11.3 b
Mean value for a rootstock Średnia dla podkładki	26.2 d	17.2 c	11.4 b	6.1 a	

*Means followed by the same letters are not significant at the level of $\alpha = 0.05$.

*Średnie oznaczone tymi samymi literami nie różnią się między sobą istotnie na poziomie $\alpha = 0,05$.

Table 5

The number of roots of ornamental apple trees depending on rootstock
Liczba korzeni drzewek jabłoni ozdobnych w zależności od podkładki

Cultivar Odmiana	Rootstock Podkładka				Mean value for a cultivar Średnia dla odmiany
	M.9	M.26	MM.106	seedling 'Antonówka' siewka 'Antonówka'	
'Lemoinei'	13.3 a*	16.7 ab	17.0 ab	28.1 c	18.8 a
'Makowiecki'	12.3 a	15.3 ab	15.7 ab	26.7 c	17.5 a
'Royalty'	12.0 a	15.7 ab	15.0 ab	24.2 bc	16.7 a
Mean value for a rootstock Średnia dla podkładki	12.5 a	15.9 b	15.9 b	26.3 c	

*Means followed by the same letters are not significant at the level of $\alpha = 0.05$.

*Średnie oznaczone tymi samymi literami nie różnią się między sobą istotnie na poziomie $\alpha = 0,05$.

Discussion

In the literature there is lack of available publications on the usability of rootstocks for the nursery production of ornamental apple trees. Every comparison made in these studies refer mainly to apple fruit trees, budded on M.9, M.26 and MM.106 rootstocks.

The executed studies showed that M.9 rootstock limited the growth of ornamental apple trees the most. It is not surprising, though, as the above mentioned rootstock is classified as a dwarf rootstock. The height of the trees on M.26 and MM.106 was consistent with the tendency observed by **Gudarowska** (1998), **Skrzyński** and **Poniedziałek** (1998), **Szewczuk** and **Gudarowska** (1999) as well as **Ostrowska** and **Chelpiński** (2000). The above mentioned authors observed the poorest growth of some cultivars of apple fruit trees on M.9 rootstock, a medium one on MM.106 and the best on M.26.

The thickness of the tree trunk as well as the sum of long-shoots' lengths also belong to a group of indicators characterizing the power of growth. In the case of M.9 rootstock the lowest values of these traits were obtained, which is also consistent with the character of growth of this rootstock, classified as growing weak. This observation is confirmed by **Ugolik et al.** (1996), who found that the thickness of the apple tree trunks of 'Elstar' cultivar, measured in the year of planting the trees into an orchard, was smaller on M.9 than on M.26 and MM.106, on which the trees grew similarly. The same proportion of the power of growth of apple trees on the above mentioned rootstocks was also obtained by **Ostrowska** and **Chelpiński** (2000).

Evaluating the power of growth of individual cultivars one can say that the trees of 'Lemoinei' cultivar grew strongly in the experiment, which is confirmed by the opinion expressed by **Hieke** (1978). Taking into consideration especially the thickness of the trunk also the trees of 'Makowiecki' cultivar grew strongly. In a nursery practice these cultivars can be grafted on dwarf and semi-dwarf rootstocks. A cultivar that grew the slowest in the experiment was 'Royalty'. This particular cultivar should be grafted on strongly growing rootstocks e.g. 'Antonówka' seedling. It should be emphasized that the power of growth of ornamental apple trees differs and this factor must be taken into consideration while choosing appropriate rootstocks.

It is commonly known that dwarf rootstocks accelerate the periods of flowering and fructification of trees. In the case of ornamental apple trees cultivars the applied rootstocks significantly differentiated the number of flowers on trees. All cultivars of apple trees on M.9 were characterized with a bigger number of flowers compared with other rootstocks. The experiment executed by **Ostrowska et al.** (1996) also showed that 'Jonagold' cultivar on M.9 rootstock flowered abundantly in the second year after being planted into an orchard contrary to the same cultivar on M.26 rootstock, where no flowering was noticed. However **Gudarowska** (1998) obtained a bit different results. In the second year after planting into an orchard the trees of 'Elstar' cultivar on M.9 and M.26 had a similar number of flowers. Comparing the influence of a rootstock on flowering of cultivated and ornamental cultivars one can state that in case of ornamental trees the initiation of flowering is strictly connected with the power of growth of the applied rootstock.

An abundant flowering of 'Makowiecki' cultivar makes that it should be classified as one of the most beautiful cultivars, which **Borowicz** and **Bugała** (1951-1952) agree with. Young apple trees of 'Lemoinei' were flowering restrainedly, which is not completely concise with **Straus's** (1959) opinion, who classified this cultivar as abundantly

flowering. However, the observations may have come from different tree development stages.

The quality of the root system of a tree depended on the power of growth of the rootstock. The stronger growing rootstock the more roots the trees had. A positive connection between the growth of a root system and the size of above-the-ground part was observed. A grafted cultivar did not have any significant influence on the number of roots.

Conclusions

1. The growth of ornamental apple trees varied and depended on the power of growth of the applied rootstock and the cultivar.
2. The trees of ornamental apple grew the weakest on M.9 rootstock, restrainedly on M.26 and MM.106, and the strongest on 'Antonówka' seedling.
3. The best flowering of ornamental cultivars was obtained on M.9 rootstock, the worst on 'Antonówka' seedling.
4. 'Makowiecki' cultivar trees flowered better than the remaining two cultivars.
5. The quality of a root system depended only on the power of growth of the rootstock.

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PRZYDATNOŚĆ CZTERECH PODKŁADEK DO PRODUKCJI DRZEW
WYBRANYCH ODMIAN JABŁONI PURPUROWEJ
(*MALUS* × *PURPUREA* REHD.) W SZKÓLCE

S t r e s z c z e n i e

W przeprowadzonym doświadczeniu oceniono wzrost i kwitnienie wybranych odmian jabłoni purpurowej: 'Lemoinei', 'Makowiecki' i 'Royalty' w zależności od zastosowanej podkładki: M.9, M.26, MM.106 i siewki 'Antonówki'. Wzrost drzew był istotnie zróżnicowany przez zastosowaną podkładkę. Odmiany jabłoni ozdobnych rosły najsilniej na siewce 'Antonówki', najsłabiej na podkładce M.9, słabo na podkładkach M.26 i M106. Drzewa odmian 'Lemoinei' i 'Makowiecki' charakteryzowały się silniejszym wzrostem niż drzewa odmiany 'Royalty'. Kwitnienie drzew na podkładce M.9 i odmiany 'Makowiecki' było najlepsze.