THE USEFULNESS OF FOUR ROOTSTOCKS FOR THE PRODUCTION OF MAIDEN PEACH TREES

Sławomir Świerczyński
and Aleksander Stachowiak

Department of Dendrology and Nursery Production
University of Life Sciences
Szamotulska 28, 62-081 Przeźmierowo, POLAND
e-mail: kdis@au.poznan.pl

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A B S T R A C T

The usefulness of four rootstocks for peach trees was evaluated in the experiment, conducted during 2006-2007. One-year old maiden peach trees of the cultivars: 'Harbinger', 'Royalvee', 'Redhaven' and 'Reliance' were produced in nursery on four rootstocks: Rakoniewicka seedling, 'Siberian C', 'Hui-hun-tao' and Minnesota seedling. The highest percentage of maiden peach trees was obtained on 'Siberian C' and Minnesota seedling rootstocks. The maiden peach trees obtained on Minnesota seedling rootstocks had the weakest growth vigour while these on 'Siberian C' rootstock were characterised by an average growth. The growth of maiden trees of 'Harbinger' cultivar was the strongest whereas the growth of maiden trees of 'Redhaven' cultivar was the weakest, independently of the rootstock used. The percentage of maiden peach trees compatible with Polish Norm depended on the growth vigour of the rootstock and the best result was obtained on Rakoniewicka seedling.

Key words: rootstocks, maiden peach trees, growth, efficiency, quality

INTRODUCTION

This is the rootstock that mainly determines the growth vigour of fruit trees. The rootstock also influences frost resistance, term of fructification and fruit yield of the cultivated trees. Peach trees are especially sensitive to low temperatures. They are also prone to bark and wood diseases. Thus, there is a need for such a rootstocks which can diminish growth vigour and, at

the same time, limit the necessity for pruning.

Many studies have been carried out to select new rootstocks for peach (Layne, 1974, 1975, 1978, 1980; Rom, 1983; Elfving and Tehrani, 1984; Guerriero et al., 1985; Layne, 1987; Ferree and Schmid, 1988; Maćkowiak and Stachowiak, 1994; Świerczyński and Stachowiak, 1999; Perry et al., 2000; Świerczyński and Sękowska, 2004). Breeding programmes for peach rootstocks are presently active in North and South America, Europe, Africa, Australia and Asia. These include selecting rootstocks tolerant to unfavourable soil properties such as alkalinity, high bulk density, water logging and drought. Other important goals are breeding for resistance to nematodes, soil-borne pathogenic fungi and bacteria, peach tree borers and aphids. Adaptation to regional climates and orchard replant sites are also important criteria in the evaluation of rootstocks for peach. Rootstocks are being developed for replant sites to reduce the incidence of perennial canker, the peach tree short life and bacterial canker complexes found in peach production regions having light textured soils (Reighard, 2000; Zhen-Xiang Lu et al., 2000; Dejong et al., 2004; Dirlewanger et al., 2004a, 2004b; Tsipouridis and Thomidis, 2004; Xiloyannis et al., 2004, Guzman at al., 2007; Loreti, 2008). Recently, an increased emphasis has been laid on developing dwarfing rootstocks for high-density orchard systems (Dejong et al., 2001; Weibel et al., 2003; Dejong et al., 2004). Currently, trees of a reduced vigour are preferred in orchard production. In nursery production of peach trees in Poland a main role play Rakoniewicka seedling and 'Hui-hun-tao' rootstocks. However, these rootstocks have too strong and dynamic growth. Also 'Siberian C' seedling has been often recommended as a rootstock for peach trees. So far Minnesota seedling rootstock has not been used in the production of peach fruit trees because nurserymen do not have enough information about it.

The aim of the experiment presented was to evaluate the usefulness of four seedlings as rootstocks for the production of one-year-old maiden peach trees in a nursery.

MATERIAL AND METHODS

The studies were conducted at the Experimental Station of the University of Life Sciences of Poznań in the years 2006-2007. A field experiment was established on pseudopodsolic soil overlaying boulder clay, classified as the third class. The nursery trial was set up in the randomised blocks design in four replications, with 30 rootstocks planted per a plot. Minnesota seedling, Rakoniewicka seedling, 'Siberian C' and 'Hui-hun-tao' (*Prunus kansuensis* Rehd.) rootstocks were budded with four cultivars of peach: 'Harbinger', 'Redhaven', 'Reliance' and 'Royalvee'. The budding was performed on 30 July by the "T" method. No herbicides were used during the studies and the nursery was weeded mechanically or, if needed, manually. No irrigation was applied, while fertilization and

pest and disease control were conducted according to the up-to-date recommendations for the nurseries of stone fruit trees.

The nursery productivity was presented as the percentage of the maiden trees obtained in relation to the budded rootstocks. At the end of October (in 2006 and in 2007) the following features of maiden peach trees were measured: height (cm), diameter of the tree trunk 30 cm above the ground (mm) and number and length of lateral shoots. The measurements were performed on 15 randomly chosen maiden peach trees per a plot. The quality of the trees was expressed as the percentage of the trees compatible with Polish Norm PN-R-67010.

Statistical analysis of the results was carried out by two-factorial variance analysis (cultivar, rootstock) using Duncan's test for means separation at $p \leq 0.05$. The percentage values were transformed according to ($y = \arcsin\sqrt{x}$). The results presented in tables are mean values from two years because the results obtained in each year (2006, 2007) showed the same tendency in terms of the influence of rootstocks and cultivars on the growth of a maiden peach tree. Moreover, the climatic conditions were similar in both years.

RESULTS AND DISCUSSION

The percentage of the maiden peach trees obtained depended on the rootstock and the cultivar. The highest percentage was noted for 'Reliance' cultivar on Minnesota seedling rootstocks and for 'Reliance' and 'Royalvee' cultivars on 'Siberian C' rootstock, the lowest for 'Redhaven' cultivar on Rakoniewicka seedling rootstocks (Tab. 1). Among four rootstocks studied, a biggest percentage of the maiden peach trees was obtained on 'Siberian C' rootstock, compared with the rest of the rootstocks studied. The experiments conducted by other researchers (Young and Houser, 1980; Yadava and Doud, 1989) show that 'Siberian C' rootstock positively influences the longevity of the trees in an orchard and their frost resistance. In the experiment presented the high percentage of the maiden peach trees obtained on the 'Siberian C' rootstock confirms that the survival rate of buds during winter was higher on this rootstock, which resulted in a higher efficiency of maiden tree production in the nursery. Also Minnesota seedling rootstock was characterized by a high percentage of maiden peach trees obtained in the nursery.

Comparing the cultivars, a higher percentage of peach trees was obtained for 'Reliance' and 'Royalvee' and a lower for 'Redhaven' (Tab. 1). Hołubowicz and Bojar (1998, 1999) in their experiment observed a bigger frost resistance of 'Reliance' trees. The results of both experiments confirm the usefulness of this cultivar for production.

Both the rootstocks used and the budded cultivars affected the height and the diameter of the trunk of maiden peach trees in the nursery. The highest and with the biggest trunk diameter were maiden trees of

Table 1. Percentage of maiden peach trees obtained depending on rootstock and cultivar

Cultivar	Rootstock				Mean value for cultivar
	Rakoniewicka seedling	Hui-hun-tao	Siberian C	Minnesota seedling	
Harbinger	66.4 bc *	70.5 f	76.3 h	73.8 g	71.8 b
Royalvee	68.5 d	74.4 g	78.9 i	76.2 h	74.6 c
Redhaven	58.5 a	65.5 b	67.9 cd	70.2 ef	65.6 a
Reliance	68.8 de	73.0 g	79.7 i	79.9 i	75.5 d
Mean value for rootstock	65.6 a	70.9 b	75.8 d	75.1c	

*Means followed by the same letters do not differ significantly at $p \leq 0.05$

Table 2. Height of maiden peach trees [cm] depending on rootstock and cultivar

Cultivar	Rootstock				Mean value for cultivar
	Rakoniewicka seedling	Hui-hun-tao	Siberian C	Minnesota seedling	
Harbinger	178.7 j *	168.1 i	155.5 h	135.4 e	159.4 d
Royalvee	145.7 fg	143.7 f	144.7 fg	130.5 cd	141.1 c
Redhaven	127.5 bc	125.5 b	127.0 b	120.2 a	125.1 a
Reliance	147.8 g	145.6 fg	133.3 de	126.6 b	138.3 b
Mean value for rootstock	149.9 d	145.7 c	140.1 b	128.2 a	

*For explanations, see Table 1

Table 3. Diameter of trunk [mm] of maiden peach trees depending on rootstock and cultivar

Cultivar	Rootstock				Mean value for cultivar
	Rakoniewicka seedling	Hui-hun-tao	Siberian C	Minnesota seedling	
Harbinger	22.2 i *	22.0 i	19.6 h	18.0 g	20.4 d
Royalvee	16.3 f	15.4 e	15.2 de	13.7 b	15.2 b
Redhaven	15.3 e	14.7 cde	14.4 bc	12.8 a	14.3 a
Reliance	16.8 f	16.9 f	16.6 f	14.5 bcd	16.2 c
Mean value for rootstock	17.6 d	17.3 c	16.5 b	14.7 a	

*For explanations, see Table 1

'Harbinger' cultivar on Rakoniewicka seedling and on 'Hui-hun-tao' rootstocks, the smallest values of these parameters were obtained for 'Redhaven' cultivar on Minnesota seedling rootstock (Tab. 2 and 3). Among the four peach rootstocks analysed, the highest growth vigour (height, diameter of trunk) of maiden peach trees was obtained on Rakoniewicka seedling while the lowest on Minnesota seedling rootstock.

In an earlier experiment Świerczyński and Stachowiak (1999) also obtained higher maiden peach trees of 'Redhaven' cultivar on Rakoniewicka seedling (153.6 cm) and on 'Hui-hun-tao' (146.7 cm) than on Minnesota seedling (130.1 cm) rootstock. The diameter of these maiden peach trees was also different (17.9; 17.1; 16.7 mm). In the present studies the height and trunk diameter of the maiden peach trees grafted on Minnesota rootstock were also smaller, which confirms that this rootstock has significantly weaker growth than the other rootstocks tested. This rootstock should be preferred for more intensive peach orchards, because it reduces the growth of peach trees in a nursery and most likely wild retard their further growth in an orchard.

In the experiment presented maiden trees of 'Harbinger' cultivar had the highest vigour while the weakest were the trees of 'Redhaven' cultivar, independently of the rootstock used. As opposite to the results obtained in this study, in an earlier experiment done by Świerczyński and Stachowiak (1999) no significant differences in height and diameter of trunk of maiden peach trees of 'Redhaven' (153.6 cm; 17.9 mm) and 'Reliance' (156.3 cm; 17.1 mm) were noticed.

The sum of lengths of lateral shoots and their number were significantly differentiated by the rootstock used and the cultivar. Maiden peach trees of 'Harbinger' cultivar growing on Rakoniewicka seedling were characterized by the biggest length and number of lateral shoots, the smallest were maiden peach trees of all cultivars growing on Minnesota seedling rootstocks. Among four the rootstocks studied, the biggest number and sum of lengths of lateral shoots had maiden trees on Rakoniewicka seedling, compared with the rest of the rootstocks analysed (Tab. 4 and 5).

The budded cultivars had also an impact on these two growth parameters. Maiden peach trees of 'Harbinger' cultivar had biggest number lateral shoots and they were the longest whereas the maiden trees of 'Redhaven' had the fewest lateral shoots and they were the shortest. In another experiment carried out in a nursery (Świerczyński and Stachowiak, 1999) it was found that the length of lateral shoots of maiden peach trees depended only on a rootstock, whereas the number of lateral shoots was dependent both on the rootstock and the cultivar. The differences between these two experiments may have resulted from different soil and weather conditions in the years when the experiments were conducted. When maiden fruit

Table 4. The total length [cm] of lateral shoots depending on rootstock and cultivar

Cultivar	Rootstock				Mean value for cultivar
	Rakoniewicka seedling	Hui-hun-tao	Siberian C	Minnesota seedling	
Harbinger	883.5 i *	790.5 h	720.1 g	552.6 f	736.7 d
Royalvee	526.1 f	469.5 de	445.6 cd	435.5 cd	469.2 c
Redhaven	350.2 b	359.3 b	330.4 ab	304.9 a	336.4 a
Reliance	486. 3 e	433.6 cd	429.9 c	409.2 c	439.8 b
Mean value for rootstock	561.5 d	513.2 c	481.5 b	425.6 a	

*For explanations, see Table 1

Table 5. The number of lateral shoots depending on rootstock and cultivar

Cultivar	Rootstock				Mean value for cultivar
	Rakoniewicka seedling	Hui-hun-tao	Siberian C	Minnesota seedling	
Harbinger	21.2 i *	20.3 h	18.8 g	15.7 f	19.0 d
Royalvee	15.7 f	14.5 e	13.5 d	12.3 c	14.0 c
Redhaven	8.8 a	8.6 a	8.4 a	8.1 a	8.5 a
Reliance	14.5 e	12.5 c	11.8 c	10.2 b	12.2 b
Mean value for rootstock	15.0 d	13.9 c	13.1 b	11.5 a	

*For explanations, see Table 1

Table 6. Percentage of maiden peach trees compatible with the norm (height over 100 cm, diameter of trunk over 12 mm, number of lateral shoots over 4)

Cultivar	Rootstock				Mean value for cultivar
	Rakoniewicka seedling	Hui-hun-tao	Siberian C	Minnesota seedling	
Harbinger	96.5 i *	96.4 i	95.8 hi	88.5 e	94.7 c
Royalvee	95.9 hi	92.7 f	92.3 f	81.4 c	91.2 b
Redhaven	74.3 b	72.4 b	73.5 b	66.5 a	71.7 a
Reliance	94.6 gh	93.8 fg	92.7 cdf	85.4 d	92.0 b
Mean value for rootstock	91.9 c	90.4 b	89.8 b	81.1 a	

*For explanations, see Table 1

trees are produced on generative rootstocks one should also consider differentiated growth habit of these trees.

The vigour of a particular rootstock and a cultivar had a significant impact on quality of the maiden peach trees. The highest percentage of maiden peach trees compatible with the norm was noted for 'Harbinger' cultivar on Rakoniewicka seedling rootstock and the lowest for 'Redhaven' on Minnesota seedling. Maiden peach trees grew stronger on Rakoniewicka seedling, and therefore more trees met the requirements of the norm. Also, 'Harbinger' maiden peach trees grew stronger than the trees of the remaining cultivars, thus a bigger percentage of these trees was consistent with the norm (Tab. 6).

Taking into consideration the vigour of maiden peach trees growing on individual rootstocks it must be acknowledged that Minnesota seedling rootstock distinguishes itself significantly with the growth retardation of the trees in a nursery, comparing with the remaining rootstocks studied. Nowadays trees of a reduced vigour are preferred in an orchard production. Such advantages of 'Siberian C' as a rootstock as: the improvement of the tree survival rate and delaying the flowering period, which reduces the risk of damage of flowers by spring frosts, had been earlier confirmed by Hołubowicz and Bojar (1998, 1999). Bearing in mind good results obtained in a nursery, as well as those obtained by other authors (Carrera and Gomez-Aparasi, 1998) in an orchard, there is a need for further studies on this rootstock.

CONCLUSIONS

1. A higher percentage of maiden peach trees was obtained on 'Siberian C' and Minnesota seedling rootstocks and for 'Reliance' and 'Royalvee' cultivars.
2. The vigour of the maiden peach trees depended on a rootstock. A stronger growth was observed on Rakoniewicka seedling and 'Hui-hun-tao', a weaker one on Minnesota seedling.
3. Maiden peach trees of 'Harbinger' cultivar grew the strongest while of 'Redhaven' the weakest.

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PRZYDATNOŚĆ SZKÓŁKARSKA CZTERECH PODKŁADEK W PRODUKCJI OKULANTÓW BRZOSKWINI

Sławomir Świerczyński i Aleksander Stachowiak

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

W doświadczeniu przeprowadzonym w latach 2005-2007 oceniono przydatność szkółkarską Siewki Minnesota jako podkładki dla brzoskwini. Jednoroczne okulanty odmian: 'Harbinger', 'Royalvee', 'Redhaven', 'Reliance' produkowano w szkółce na czterech podkładkach: Siewka Rakoniewicka, 'Siberian C', 'Hui-hun-tao' i Siewka Minnesota. Najwyższy procent okulantów uzyskano na podkładkach 'Siberian C'

i Siewka Minnesota. Okulanty brzoskwini otrzymane na podkładce Siewka Minnesota miały najsłabszy wzrost, a na podkładce 'Siberian C' charakteryzowały się średnimi wartościami parametrów wzrostu. Na podkładkach Siewka Rakoniewicka i 'Hui-huntao' okulanty brzoskwini rosły najsilniej. Wzrost okulantów odmiany 'Harbinger' był najsilniejszy, podczas gdy wzrost okulantów odmiany 'Redhaven' był najsłabszy niezależnie od zastosowanej podkładki. Procent okulantów zgodnych z normą zależał od siły wzrostu podkładki i najwyższy otrzymano na Siewce Rakoniewickiej.

Słowa kluczowe: podkładki, okulanty brzoskwini, wzrost, wydajność, jakość