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ESTIMATION OF INTERSTOCK AND INTERMEDIATE STOCK USEFULNESS FOR SUMMER PEAR CVS. BUDDED ON TWO ROOTSTOCKS

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ABSTRACT

In order to increase the profitability of pear production, a greater density of weak growing trees per area unit should be planted. In Poland, the most frequently used pear dwarfing rootstocks are quince clones. The main disadvantage of them is a physiological incompatibility with some cultivars. The aim of this study was to evaluate the effect of the rootstock, interstock, and intermediate stock on growth and productivity of two summer pear cultivars, which are not compatible with the quince rootstock. Two-year-old pear trees of 'Radana' and 'Clapp's Favourite' cvs of different compositions were planted in the spring 2006. The following combinations were evaluated: 'Radana' and 'Clapp's Favourite' on Caucasian pear seedlings, 'Radana' and 'Clapp's Favourite' on quince SI with an intermediate stem piece of 'Doyenne du Comice' and 'Radana' on Caucasian pear with 'Pyrodwarf' interstock. Up to the 6th year after planting, trees of 'Radana' grafted on Caucasian pear seedlings and on quince with intermediate stock yielded better than 'Radana' trees composed of Caucasian pear seedling and 'Pyrodwarf' interstock. 'Clapp's Favourite' in all combinations had significantly heavier fruits. The highest crop efficiency index had 'Radana' on quince with 'Doyenne du Comice' intermediate stock.

Key words: pear, quince, interstock, intermediate stock, 'Pyrodwarf'

INTRODUCTION

The most popular rootstock used in Poland for pear tree production is seedling of Caucasian pear (*Pyrus communis* var. *caucasica*). Its greatest advantages are high cold resistance and good compatibility with popular cultivars. However, this rootstock has a drawback of vigorous growth and late fruit bearing. That is why it is recommended for cultivars characterized by weak growth and on sandy soils (Bielicki 2005; Bielicki and Czynczyk 2006; Sosna 2007). Intensive pear orchards require trees produced on weakly growing rootstocks. For this purpose clones of quince (*Cydonia oblonga*): MA, MC and S1 are used, which can retard growth by 30% to 60% in comparison to trees grafted on Caucasian pear seedlings. However, quince rootstocks have low cold resistance and are incompatible with some cultivars, such as 'Clapp's Favourite' and 'Williams Bon Chrétien' (Jacob and Webster 2002; Bielicki 2005; Bielicki *et al*. 2010). Quince S1, which has been selected in Poland, has better cold hardiness and stronger growth than quince MA (Lewko *et al*. 2006; Łysiak 2006). Physiological incompatibility can be avoided by using double grafting with intermediate stock of 'Beurre Hardy' or 'Doyenne du Comice'. Pears grafted on quince grow weaker, start bearing fruits earlier, and produce larger fruits (Łysiak 2006; Sosna 2007). Trees growing on Caucasian pear seedling have strong growth, which can be reduced by proper interstock, for example 'Pyrodwarf' of German origin ('Old Home' x 'Bonne Luis d`Avranches'). It is a dwarf vegetative rootstock with a high cold hardiness (Lepsis *et al*. 2004; Haak *et al*. 2006, 2007). 'Pyrodwarf' induces low

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vigour, high yield efficiency, uniform fruit size and good graft compatibility with wide spectrum of pear cultivars (Jacob and Webster 2002). The purpose of the interstock is to reduce tree growth, increase fruit yield and quality, and delay time of flowering (Mielke and Sugar 2004).

The aim of this study was to evaluate the usefulness of an interstocks and an intermediate stock for summer pear cultivars, which are not compatible with quince.

MATERIALS AND METHODS

The experiment was conducted in the years 2006-2011 in the Fruit Experimental Station located in Samotwór near Wrocław. The two summer cultivars: 'Radana' and 'Clapp`s Favourite', were used. Both cultivars are characterized by strong growth and high yielding, but 'Clapp`s Favourite' comes into bearing much later, especially when grafted on pear seedlings. They were grafted on Caucasian pear seedlings, on quince S1 with an intermediate stock (about 10 cm long) of 'Doyenne du Comice' and 'Radana' on Caucasian pear with 'Pyrodwarf' interstock (about 10 cm long). The trees were planted with the spacing of 3.5 x 1.5 m (1905 trees ha^{-1}) and formed as a spindle crown. Herbicide fallow was maintained in the tree rows, while the interrows were grassed down. The experiment has been set up using the randomised block design with six replications and five trees per experimental plot.

In the year 2008, an evaluation of blossoming was performed on the basis of the number of flowers on a tree. In the subsequent years, during the full bloom, the intensity of blossoming has been determined on each experimental tree using a six-grade arbitrary scale, where 0 meant a tree without flowers and 5 - very abundant blossoming. An evaluation of yielding has been performed for all the trees in the subsequent years of the studies. In order to determine an average weight of a fruit, 20 randomly selected fruits were weighed for each tree. In autumns, growth vigour of the trees was evaluated on the base of trunk circumference, the number and length of annual shoots and the height and range of the canopy. The yield efficiency index, which is the ratio of the sum of the yields over the years to the final cross-sectional area of the trunk, was also calculated in the last year of the trial.

The results were analysed statistically using the ANOVA (analysis of variance) for the randomized blocks. For assessing significance of differences between means, Fisher's test was used at the significance level $\alpha=0.05$.

RESULTS AND DISCUSSION

The trees had the first flowers in the 3rd year after planting, except of 'Clapp's Favourite' on Caucasian pear seedlings (Table 1). The highest number of flowers was found in the treatments, where cultivars were grafted on quince S1 with 'Doyenne du Comice' intermediate stock. In the years 2009 to 2011 the trees blossomed averagely or poorly. In 2009 'Radana' on quince and in the next year 'Clapp's Favourite' on quince had the highest intensity of blossoming. In 2011, there were no significant differences in blossoming between experimental combinations. Strong frosts, up to -24 °C during the winter 2010/2011 caused poor flowering and buds damage in both cultivars. Additionally, spring frost in 2011 (up to -5 °C), which occurred from May 3 to 6, during the full bloom of 'Radana' and the end of bloom of 'Clapp's Favourite' trees, damaged the flowers, especially of 'Clapp's Favourite'. Trees of both cultivars grafted on quince SI with intermediate stock bore fruits the earliest (Table 2). Cultivar 'Radana' on quince SI had the highest yield in the third and the fourth year after planting. In 2010, all 'Radana' trees produced the highest yield, regardless of the type of rootstock. During the last year of the study (2011), all pears yielded at the same level and there was no significant difference in the yield between analysed combinations. Based on the six years of research it can be concluded that cultivar 'Radana' yielded better than 'Clapp's Favourite', and that the 'Pyrodwarf' interstock was less beneficial then other combinations. Iglesias *et al*. (2003) stated that use of 'Doyenne du Comice' intermediate stock may lead to yielding reduction, which was not confirmed in our experiment with 'Radana' and 'Clapp's Favourite'. The fruit weight depended on the cultivar only; the tree compositions

had not influence on this trait (Table 2). Significantly heavier fruits were produced by the trees of 'Clapp's Favourite'. Grafting on Caucasian pear seedlings resulted in the largest trunk cross-section area, number and length of shoots and canopy volume and the lower crop efficiency coefficient in 'Clapp's Favourite' (Table 3). According to Haak *et al*. (2006) and Maas (2006), pear trees on 'Pyrodwarf' rootstock are characterized by stronger growth in relation to the trees on quince rootstock. Castro and Rodriguez (2002), Kviklys (2005), Sosna and Czaplicka (2007) and Stern *et al*. (2007) also proved that the trees grafted on pear seedlings were characterized by more vigorous growth than these grafted on quince clones. The highest crop efficiency coefficient was noted for both cultivars grafted on Q1 with 'Doyenne du Comice' intermediation. Up to the sixth year after planting, there were no physiological incompatibility symptoms among analysed combinations, and there were no trees damaged by winter frost.

Table 1. Blooming of the pear trees

Treatment	Number of flowers per tree	Blooming intensity in 0-5 scale		
	2008	2009	2010	2011
'Radana'/CPS	0.9 a*	2.0 b	2.1 a	2.2 a
'Radana'/Q1 + 'Doyenne du Comice'	11.4 b	3.0 c	2.3 ab	1.7 a
'Radana'/CPS + 'Pyrodwarf'	1.1 a	1.6 ab	2.6 ab	2.4 a
'Clapp's Favourite'/CPS	0.0 a	1.0a	2.7 b	2.1 a
'Clapp's Favourite'/Ql + 'Doyenne du Comice'	6.7 ab	1.0 a	3.3 c	1.9 a

* Means followed by the same letter do not differ at p=0.05 according to Fisher's multiple range t-test; CPS - Caucasian pear seedling, Q1 - Quince S1

Table 2. Yielding and mean fruit weight of pear cultivars studied

Treatment	Yield (kg·tree^{-1})				Cumulative yield (kg·tree^{-1})	Mean fruit weight (g)
	2008	2009	2010	2011	2008-2011	2009-2011
'Radana'/CPS	0.0 a*	4.8 b	5.5 c	3.3 a	13.6 c	135 a
'Radana'/Q1 + 'Doyenne du Comice'	0.3 b	7.2 c	4.9 c	1.6 a	14.0 c	135 a
'Radana'/CPS + 'Pyrodwarf'	0.0 a	3.5 b	3.9 bc	2.7 a	10.1 b	137 a
'Clapp's Favourite'/CPS	0.0 a	0.8 a	1.3 a	1.7 a	3.8 a	212 b
'Clapp's Favourite'/Ql + 'Doyenne du Comice'	0.1 a	1.3 a	2.5 ab	2.5 a	6.4 a	217 b

* For explanations see Table 1

Table 3. Vegetative growth and crop efficiency coefficient (CEC) of pear cultivars studied

Treatment	Trunk cross-sectional area (cm^2)		Annual shoots tree^{-1} sum of 2006-2007		Canopy volume (m^3)	CEC (kg·cm^{-2})
	autumn 2011	increase 2009-11	number	length (cm)	autumn 2011	2006-2011
'Radana'/CPS	40.0 b*	18.5 b	27.5 c	968 b	3.7 bc	0.34 c
'Radana'/Q1 + 'Doyenne du Comice'	32.5 a	15.0 a	21.7 ab	647 a	2.8 a	0.43 d
'Radana'/CPS + 'Pyrodwarf'	33.8 a	14.5 a	18.9 a	655 a	3.1 ab	0.30 c
'Clapp's Favourite'/CPS	34.5 a	15.4 a	24.4 bc	910 b	4.1 c	0.11 a
'Clapp's Favourite'/Ql + 'Doyenne du Comice'	31.5 a	13.5 a	22.2 ab	764 a	3.2 ab	0.20 b

* For explanations see Table 1

CONCLUSIONS

Up to the sixth year after planting the trees of both cultivars grafted on quince S1 with intermediate stock have grown weaker and had significantly higher yielding index in comparison to the trees grafted on Caucasian pear seedlings. The type of the rootstock had no influence on the yield and mean fruit weight.

The application of 'Pyrodwarf' interstock for 'Radana' cultivar decreased both tree growth and its yielding. However, it had no effect on the mean fruit weight.

Growth vigour of 'Radana' trees was similar to 'Clapp's Favourite', though this cultivar had smaller fruits and gave earlier and higher yields.

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