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INFLUENCE OF ROOTSTOCKS AND APPLING MYCORRHIZAL VACCINE ON THE GROWTH OF MAIDEN TREES AND TREES THERE YEARS AFTER PLANTING OF 'WOODII' CULTIVAR

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Abstract. In the experiment, carried out between 2005–2007, the influence of the application of two rootstocks and mycorrhizal vaccine on the growth of maiden trees and the trees of 'Woodii' cultivar in the third year after planting them into the ground was compared. A higher percentage of maiden trees was obtained on *Prunus tomentosa* rootstock when mycorrhizal vaccine was applied as well. The applied rootstocks did not differ the growth of maiden trees in a nursery. Also the use of mycorrhizal vaccine did not cause any significantly stronger growth of maiden trees on both rootstocks, what is more they even reduced the sum of the lengths of lateral shoots. The reaction of rootstocks was differentiated. The considered rootstocks, however, influenced all the parameters of growth of trees in the third year after planting. Stronger growth of 'Woodii' cultivar trees was observed on the *Prunus cerasifera* rootstock compared with those growing on *Prunus tomentosa*. However, the trees growing on the *Prunus cerasifera* rootstock bloomed poorer than those on *Prunus tomentosa*. Application of mycorrhizal vaccine increased the thickness of the tree trunk and the diameter of crowns of 'Woodii' cultivar trees, but it did not influence their flowering and fruiting.

Key words. rootstocks, mycorrhizal vaccine, ornamental trees of 'Woodii' cultivar, growth

INTRODUCTION

In the latest years, more and more deciduous trees, especially those that have colourful leaves through the whole vegetative period, are being planted in gardens and urban green areas. One of such trees is *Prunus cerasifera* in its 'Woodii' cultivar. This plant has medium, purple-red leaves, that keep their colour till the end of its vegetative period [Seneta and Dolatowski 1997]. Additionally, the trees of this cultivar are resistant well

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to drought, which is a big advantage for their use in green areas. In a nursery production the above mentioned cultivar is propagated through grafting on *Prunus cerasifera* rootstock. In a nursery a growth of maiden trees is dependant on various factors, among others, on the type of the applied rootstock [Gąstoł and Poniedziałek 1998, Webster and Hollands 1999], the quality of the soil, fertilization and on the way the maiden trees are cherished.

Recently a big interest has been also put on the use of mycorrhizal fungi [Cordier et al. 1996, Kubiak 2005, Badura 2007, Breś et al. 2007, Krupa 2007, Księżniak 2007, Kubiak 2007, Świerczyński and Stachowiak 2007]. Mycorrhizal fungi can support the growth of trees, especially after planting the trees into their final location. In new biotopic conditions, when the plant is exposed to physiological dangers and an attack of pathogenic micro-organisms the coexistence with fungi can make the process of adaptation easier [Księżniak 2007]. Ability of mycelium to gain the nutrients unaccessible, but necessary to plant growth and development, enables to reduce the fertilizer application just to 50% of dose recommended until now. An important role is credited to the ability of mycorrhizal fungi to neutralizing effects of heavy metals and other toxic substances on the plants [Kubiak 2005, Krupa 2007]. The studies being carried out enable to identify the biological phenomenon of mycorrhize as a fertilizer, biological preparation and regulator. Various mycorrhize functions and their impact on natural environment are being recognized more and more extensively. Special attention is paid to reduction of chemical plant protection and the pest control. The research results obtained until now indicate the necessity of further studies because of rising costs of fertilization, plant protection and natural environment protection [Kubiak 2005].

The aim of the experiment was the evaluation of the growth of maiden trees and the trees of 'Woodii' cultivar in the third year after planting on two rootstocks. At the same time, the influence of mycorrhizal vaccine on the growth of maiden trees and the trees in this cultivar was examined.

MATERIAL AND METHODS

The studies were conducted at the Experimental Station in Baranowo of the University of Life Sciences in Poznań in the years 2005-2007. The experiment was set up in random blocks design, in four replications, with 50 rootstocks planted per plot. Maiden trees of 'Woodii' cultivar were produced in a nursery on two rootstocks: (*Prunus cerasifera* Ehrh.) and (*Prunus tomentosa* Thunb.). During the first year of the production of maiden trees, in June, mycorrhizal vaccine in a dose of 1,000 units per 1 plant was introduced into the root systems of half rootstocks per plot. At the end of the second year, the number of obtained maiden trees, compared with the number of budded rootstocks, was calculated. The following measurements and observations were conducted in autumn, after the end of the vegetative period: height of maiden trees (cm), their thickness (mm) – 30 cm above the ground, number of lateral shoots and sums of their lengths. The measurements and observations were performed on 15 randomly chosen maiden trees per plot

In the second part of the experiment, in spring 2005, trees of 'Woodii' cultivar were planted into their final place, in randomised block, in four repetitions, eight plants per plot. In June 2005 one dose per tree of mycorrhizal vaccine, manufactured by Mykoflor, was introduced into the root systems of the trees. In 2007 the number of flowers and fruits on a tree was counted. In autumn of the same year height (cm), size of the crown (cm, average value – height and width along and across row) and thickness (mm) of the trunk of trees were measuremed.

Statistical analysis of the results was carried out with the use two-factor variance analysis, using Duncan's test at the confidence level $\alpha = 0.05$. The data presented in tables are connected with the growth of maiden trees and they are the mean values of two-year measurements.

RESULTS

The percentage of the obtained maiden trees of 'Woodii' cultivar depended on the rootstock and the application of mycorrhizal vaccine. A significantly bigger percentage of the obtained maiden trees was noted for *Prunus tomentosa* rootstock rather than for *Prunus cerasifera*. Also the use of mycorrhizal vaccine caused significantly better efficiency of maiden trees than its lack (tab. 1).

Table 1. Influence of rootstock and mycorrhizal vaccine on the percentage of obtained maiden trees of 'Woodii' (average value for the years 2006–2007)

Tabela 1. Wpływ podkładki i szczepionki mikoryzowej na procent otrzymanych okulantów odmiany 'Woodii' (średnia wartość dla lat 2006–2007)

Rootstock Podkładka	Mycorrhizal vaccine Szczepionka mikoryzowa	Lack of mycorrhizal vaccine Brak szczepionki mikoryzowej	Average value for rootstock Średnia wartość dla podkładki
Prunus cersifera	56.4 ab *	47.7 a	51.9 a
Prunus tomentosa	67.6 c	58.4 bc	63.1 b
Average value for vaccine Średnia wartość dla szczepionki	62.1 b	52.9 a	

*Means followed by the same letters do not differ significantly at $\alpha = 0.05$.
*Średnie oznaczone tymi samymi literami nie różnią się miedzy sobą przy $\alpha = 0,05$.

The height and thickness of the maiden trees did not depend on the rootstock and the application of mycorrhizal vaccine. A little bit thicker maiden trees were obtained on Prunus cerasifera rootstock than on *Prunus tomentosa*, but the results did not differ significantly (tab. 2).

The used rootstocks and mycorrhizal vaccine did not significantly differentiated the number of lateral shoots of 'Woodii' cultivar. The biggest number of lateral shoots was obtained on *Prunus tomentosa* rootstock without mycorrhizal fungi (tab. 3).

Table 2. Influence of rootstock and mycorrhizal vaccine on the height (cm) and the thickness (mm) of maiden trees of 'Woodii' cultivar (average value for the years 2006–2007)
Tabela 2. Wpływ podkładki i szczepionki mikoryzowej na wysokość (cm) i grubość (mm) okulantów odmiany 'Woodii' (średnia wartość dla lat 2006–2007)

	Rootstock Podkładka	Mycorrhizal vaccine Szczepionka mikoryzowa	Lack of mycorrhizal vaccine Brak szczepionki mikoryzowej	Average value for rootstock Średnia wartość dla podkładki
Height Wysokość cm	*Prunus cerasifera*	166.2 a *	183.6 a	174.9 a
	Prunus tomentosa	179.1 a	174.3 a	176.7 a
	average value for vaccine średnia wartość dla szczepionki	172.7 a	179.0 a	
Thickness Grubość mm	*Prunus cerasifera*	18.9 a	19.4 a	19.2 a
	Prunus tomentosa	17.4 a	17.0 a	17.2 a
	average value for vaccine średnia wartość dla szczepionki	18.2 a	18.2 a	

* Explanation: see Table 1.
* Objaśnienie: patrz tabela 1.

Table 3. Influence of rootstock and mycorrhizal vaccine on the number and the sum of length of lateral shoots (cm) of maiden trees of 'Woodii' cultivar (average value for the years 2006–2007)
Tabela 3. Wpływ podkładki i szczepionki mikoryzowej na liczbę i sumę długości pędów bocznych (cm) okulantów odmiany 'Woodii' (średnia wartość dla lat 2006–2007)

	Rootstock Podkładka	Mycorrhizal vaccine Szczepionka mikoryzowa	Lack of mycorrhizal vaccine Brak szczepionki mikoryzowej	Average value for rootstock Średnia wartość dla podkładki
Number of lateral shoots Liczba pędów bocznych	*Prunus cerasifera*	17.7 a *	20.7 a	19.2 a
	Prunus tomentosa	19.1 a	18.7 a	18.9 a
	average value for vaccine średnia wartość dla szczepionki	18.4 a	19.7 a	
Sum of length of lateral shoots Suma długości pędów bocznych cm	*Prunus cerasifera*	602.3 a *	794.7 d	698.5 a
	Prunus tomentosa	730.7 c	689.0 b	709.9 a
	average value for vaccine średnia wartość dla szczepionki	666.5 a	741.8 b	

* Explanation: see Table 1.
* Objaśnienie: patrz Tabela 1.

The presence of mycorrhizal fungi significantly diminished the average sum of the length of' lateral shoots of maiden trees. The rootstocks did not affect much this feature of the growth of the trees. A better result of this parameter was obtained on *Prunus*

tomentosa with the application of mycorrhizal vaccine. On the other hand on *Prunus cerasifera* a worse result was obtained for mycorrhizal vaccine (tab. 3).

In the third year after the trees were planted into the ground he height of the trees depended only on the rootstock. Significantly higher trees were obtained on *Prunus cerasifera* than on *Prunus tomentosa*. The application of mycorrhizal vaccine did not affect the height of the trees (tab. 4).

Table 4. Influence of rootstock and mycorrhizal vaccine on the height (cm) and the thickness (mm) and the size of crown (cm) of trees of 'Woodii' cultivar (in the year 2007)

Tabela 4. Wpływ podkładki i szczepionki mikoryzowej na wysokość (cm), grubość (mm), oraz rozmiar korony (cm) drzew odmiany 'Woodii' (w roku 2007)

	Rootstock Podkładka	Mycorrhizal vaccine Szczepionka mikoryzowa	Lack of mycorrhizal vaccine Brak szczepionki mikoryzowej	Average value for rootstock Średnia wartość dla podkładki
Height Wysokość cm	*Prunus cerasifera*	315.5 b *	297.5 b	306.5 b
	Prunus tomentosa	238.2 a	226.3 a	232.3 a
	Average value for vaccine Średnia wartość dla szczepionki	261.9 a	276.8 a	
Thickness Grubość mm	*Prunus cerasifera*	57.8 c *	52.9 b	55.4 b
	Prunus tomentosa	39.8 a	35.7 a	37.7 a
	Average value for vaccine Średnia wartość dla szczepionki	48.8 b	44.3 a	
Size of crown Rozmiar korony cm	*Prunus cerasifera*	243.8 d *	211.3 c	227.5 b
	Prunus tomentosa	175.0 b	155.0 a	165.0 a
	Average value for vaccine Średnia wartość dla szczepionki	209.4 b	183.1 a	

* Explanation: see Table 1.
* Objaśnienie: patrz Tabela 1.

Both the applied rootstock and mycorrhizal vaccine influenced the growth and size of crowns of 'Woodii' cultivar. On *Prunus cerasifera* thicker trees were obtained and their crowns had bigger dimentions than the threes growing on *Prunus tomentosa*. Also the presence of mycorrhizal fungi significantly increased the thickness and size of the tree crowns (tab. 4).

The average number of flowers on a tree depended on the rootstock. A significantly bigger number of flowers was noted on *Prunus tomentosa* than on *Prunus cerasifera*. The influence of the mycorrhizal vaccine on the number of flowers was not important (tab. 5).

The number of fruits on a tree was not much differentiated by a rootstock and mycorrhizal vaccine (tab. 5).

Table 5. Influence of rootstock and mycorrhizal vaccine on the number of flowers and fruits of trees of 'Woodii' cultivar (in the year 2007)

Tabela 5. Wpływ podkładki i szczepionki mikoryzowej na liczbę kwiatów i owoców drzew odmiany 'Woodii' (w roku 2007)

	Rootstock Podkładka	Mycorrhizal vaccine Szczepionka mikoryzowa	Lack of mycorrhizal vaccine Brak szczepionki mikoryzowej	Average value for rootstock Średnia wartość dla podkładki
Number of flowers Liczba kwiatów	*Prunus cerasifera*	193.5 a *	234.0 a	213. 8 a
	Prunus tomentosa	478.0 b	617.0 b	547.5 b
	Average value for vaccine Średnia wartość dla szczepionki	335.8 a	425.5 a	
Number of fruits Liczba owoców	*Prunus cerasifera*	119.5 a *	158.0 a	138.8 a
	Prunus tomentosa	129.0 a	178.0 a	153.5 a
	Average value for vaccine Średnia wartość dla szczepionki	124.3 a	168.0 a	
Percentage of obtained fruits Procent otrzymanych owoców	*Prunus cerasifera*	61.5 b *	67.5 b	64.5 b
	Prunus tomentosa	27.0 a	28.8 a	27.9 a
	Average value for vaccine Średnia wartość dla szczepionki	44.3 a	48.2 a	

* Explanation: see Table 1.
* Objaśnienie: patrz Tabela 1.

The percentage of obtained fruits compared with the number of flowers was determined only by the rootstocks. On the rootstock *Prunus divaricata* was obtained bigger percentage than *Prunus tomentosa* (tab. 5)

DISCUSSION

In literature one can find opinions that *Prunus tomentosa,* as a rootstock, blends well with plum trees cultivars [Tretjak 1983, Michev 1990, Karychev and Jankova 1999, Świerczyński 2001]. The percentage of obtained maiden trees of 'Woodii' cultivar on this rootstock in the conducted experiment, confirms these claims.

The percentage of obtained maiden trees was depended on the applied rootstock. A similar dependence was observed by Gąstoł and Poniedziałek [1998]. Such influence of a rootstock on a final number of maiden trees was not confirmed by Grzyb and Sitarek [1996].

Taking into consideration a bigger percentage of the obtained maiden trees after the application of mycorrhizal vaccine it should be concluded that it can be connected with a better blending of buds with a rootstock after a budding process and their better winter survival, something that mycorrhizal fungi could have influenced.

In the discussed experiment maiden trees obtained on *Prunus tomentosa* had the height and thickness not different of those on *Prunus cerasifera*. It is not consistent with the results of Karychev and Jankova [1999], who obtained much weaker growth of plum maiden trees on *Prunus t*omentosa.

The used rootstocks did not influence the results of height and thickness of maiden trees of 'Woodii' cultivar. Also Grzyb and Sitarek [1996] did not notice any influence of the rootstock on weakening of power of growth of plum maiden trees in a nursery. But Gąstoł and Poniedziałek [1998] observed differences in the growth of plum maiden trees depending on the applied rootstock. The differences between the above mentioned experiments can result from the fact that different rootstocks were compared and that in the considered experiment an ornamental cultivar of *Prunus cerasifera*, not cultivated cultivars that were studied by the above mentioned authors, were examined.

Aplication of mycorrhizal vaccine did not influence significant differentiation of the results of height and thickness of 'Woodii' maiden trees. Borkowska [2007] claims that a positive influence of mycorrhizal vaccine on the growth of the trees may be seen only after a few years of the tree vegetation.

The number of lateral shoots and the sum of their lengths did not depend on the applied rootstock. It speaks also for a similar power of growth of maiden trees growing on the considered rootstocks in a nursery. The difference can be noticed only in succeeding years of the tree growth.

A negative influence of the mycorrhizal vaccine on the number of lateral shoots was noticed in the experiment. The presence of mycorrhizal fungi diminished the length of lateral shoots. In the first year of the tree growth in a nursery it may happen that, for their own growth, the mycorrhizal fungi will use some of the nutritive products that could nourish the tree. As a result, at the beginning of the co-existence between the plant and the fungi the plant does not take much benefit from the symbiosis than in the succeeding years.

The growth of the trees in the third year after planting was differentiated by the applied rootstock. A significantly weaker growth of trees was observed on *Prunus tomentosa* rootstock. The results of thickness, height and size of crowns speak for it. A weaker growth of maiden trees growing in a nursery on this rootstock, noticed by Karychev and Jankova [1999] in the considered experiment was observed only in succeeding years of cultivation. Not always is the reduction in the power of growth, connected with the applied rootstock, observed in a nursery at once. Sometimes it can be seen after a few years.

The presence of mycorrhizal fungi did affect the thickness and size of tree crowns in the third year after planting. It was supported by Borkowska's [2007] statement about a positive influence of mycorrhizal fungi on the growth of the trees.

The applied rootstocks differentiated the number of flowers on a tree. *Prunus tomentosa*, as a weaker growing one induced a more intensive flowering than a stronger growing *Prunus cerasifera*. However, such a dependence was not observed in case of the number of set fruits. The application of mycorrhizal vaccine did not improve significantly the flowering and giving fruit.

CONCLUSIONS

1. Percentage of the obtained maiden trees was higher on *Prunus tomentosa* and with the use of mycorrhizal vaccine.

2. Influence of a rootstock and mycorrhizal vaccine on the growth of maiden trees was not significant.

3. Application of mycorrhizal vaccine reduced significantly the sum of the length of lateral shoots of maiden trees.

4. A stronger growth of the trees in the third year after planting was observed on *Prunus cerasifera.*

5. Presence of mycorrhizal fungi increased significantly the thickness and the size of tree crowns of 'Woodii' cultivar trees.

6. *Prunus tomentosa*, as a rootstock caused more intensive flowering of trees.

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WPŁYW PODKŁADKI I ZASTOSOWANIA SZCZEPIONKI MIKORYZOWEJ NA WZROST OKULANTÓW I DRZEW ODMIANY 'WOODII' W TRZECIM ROKU PO POSADZENIU

Streszczenie. W doświadczeniu przeprowadzonym w latach 2005–2007 porównano wpływ dwóch podkładek i zastosowanie szczepionki mikoryzowej na wzrost okulantów i drzew odmiany 'Woodii' w trzecim roku po posadzeniu. Wyższy procent okulantów otrzymano na podkładce *Prunus tomentosa* oraz przy zastosowaniu szczepionki mikoryzowej. Podkładki nie zróżnicowały wzrostu okulantów w szkółce. Zastosowanie szczepionki mikoryzowej nie spowodowało silniejszego wzrostu okulantów na obu podkładkach, a nawet zredukowało istotnie sumę długości pędów bocznych. Reakcja podkładek była zróżnicowana. Rozpatrywane podkładki wpłynęły na wszystkie paramerty wzrostu drzew w trzecim roku po posadzeniu. Silniej rosły drzewa odmiany 'Woodii' na podkładce *Prunus cerasifera* niż *Prunus tomentosa*. Drzewa na podkładce *Prunus cerasifera* słabiej jednak kwitły od tych na podkładce *Prunus tomentosa*. Zastosowanie szczepionki mikoryzowej zwiększyło grubość pnia i rozmiar koron drzew odmiany 'Woodii', a nie miało wpływu na ich kwitnienie i owocowanie.

Słowa kluczowe: podkładki, szczepionka mikoryzowa, drzewa ozdobne odmiany 'Woodii', wzrost

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