THE INFLUENCE OF MYCORRHIZAL FUNGI ON THE GROWTH AND YIELDING OF PLUM AND SOUR CHERRY TREES

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ABSTRACT

The experiment was conducted in the Experimental Station in Baranowo near Poznań between 2007-2009. The influence of mycorrhizal fungi on the growth and yield of the plum tree cultivar – 'Čačanska Lepotica' and sour cherry tree cultivar – 'Schattenmorelle' was estimated. Three years after planting, the plum trees had bigger vigour of growth, expressed by TCSA, in a combination with mycorrhizal fungi. Sour cherry trees did not differ in growth after the use of mycorrhizal fungi. A higher yield of fruits was harvested from plum and sour cherry trees inoculated with a mycorrhizal fungi. Productivity of mycorrhized trees, calculated according to the cross-sectional area of the trunk, was higher than in the control. The use of mycorrhizal fungi had no influence on fruit mass of the investigated species of fruit trees.

Key words: mycorrhizal fungi, plum, sour cherry, growth, yield, fruit size

INTRODUCTION

There has been a tendency for intensification of fruit tree cultivation, mainly in order to obtain the highest yield from a unit of an area. One such possibility for high yield is the use of mycorrhizal fungi by introducing inoculum into a plant root system. Arbuscular mycorrhizal fungi increase plant nutrient uptake, especially phosphorus and several microelements (Schubert and Lubraco, 2000; Calvet et al., 2004; Kubiak, 2005). One of the many advantages of a mycorrhizal fungi is that the fungi induce plant tolerance to biotic stresses (Dehne, 1982; Barea et al., 1996) and abiotic stresses (Parke et al., 1983; Stahl et al., 1998; Schreiner et al., 2001; Borkowska, 2002; Shi et al., 2002; Aleksandrowicz-Trzcińska, 2004; Swaty et al., 2004). Additionally, mycorrhizal fungi can play an important role in the process of plant adaptation to new habitats and new conditions in the final location of the orchard (Księżniak, 2007). Positive effects on survival and growth were observed after mycorrhizal inoculation in micropropagated plants and rootstocks (Granger et al., 1983; Branzanti et al., 1992; Fortuna et al., 1992; Rapparini et al., 1994; Grange et al., 1997; Borkowska et al., 2008). On the other hand, some authors reported negative influence or lack of influence on plant productivity after mycorrhization (Dosskey et al., 1990; Colpaert et al., 1992; 1996; Conjeaud et al., 1996; Eltrop and Marschner, 1996; Correa et al., 2008). The aim of the present studies was an evaluation of the influence of mycorrhizal fungi on the growth and yielding of young plum and sour cherry trees in an orchard.

MATERIAL AND METHODS

The studies were carried out in the Experimental Station in Baranowo between 2007-2009. The experiment was set up in the randomized block design and done in four replications with 5 trees planted per plot (there were 20 trees in each combination). The combinations with mycorrhizal fungi were separated from the control combination by three additional trees. All fruit trees were cultivated in one row only. The studies used: a cultivar of 'Čačanska Lepotica' plum tree grafted on *Prunus tomentosa* (Thunb.) rootstock and a cultivar of sour cherry tree 'Schattenmorelle' grafted on *Prunus mahaleb* (L.) rootstock.

In the spring of 2007, one-year-old maiden plum and sour cherry trees, equal in respect to measured growth features, were planted into an orchard, in 4 x 2.5 m spacing (1000 trees ha^{-1}). In June of the first year of tree growth, mycorrhizal fungi produced by Mykoflor in a dose of 1,000 units per 1 plant, was introduced into the tree root systems. In combination with mycorrhizal fungi, a half dose of fertilizers was used and no phosphorus was added. The yield of the trees was evaluated within two years. Ripe fruits were collected four times. The yield from each tree was weighed, and the mass of randomly chosen fruits was checked. The circumference of each tree trunk was measured at a tree height of 30 cm above the ground. The height of the trees and the width of their crowns were measured with a pole in two directions (east-west and north-south). The vigour of growth was estimated on the basis of trunk cross-sectional area (cm^{-2}) calculated from the measurement of the tree trunk circumference and canopy volume. All the measurements of the plum and sour cherry tree vigour of growth were conducted in autumn 2009. Productivity of individual trees was calculated on the basis of the yield of fruit per 1 cm^{-2} of the trunk cross-sectional area and 1 m^{-3} of canopy volume. The significance of differences between means was evaluated according to Duncan's multiple range t-test at p = 0.05.

All the trees in the experiment were trained as a spindle and pruned after fruiting. The trees were not irrigated except for the year 2008 when the orchard was irrigated twice because of a drought. Agro-technical practices followed guidelines for commercial orchards. Chemical pest and disease controls were carried out in accordance with current recommendations of the Orchard Protection Program. During the first two years after planting, no herbicides were used, whereas in the next years herbicides were applied. Plum trees growing on *Prunus tomentosa* were supported with wooden poles till the moment they entered the fructification period.

RESULTS AND DISCUSSION

The studied mycorrhizal fungi significantly influenced vegetative growth of the plum trees expressed by the trunk cross-sectional-area (TCSA). Plum trees inoculated with a mycorrhizal fungi had greater TCSA than the control combinations (Tab. 1). On the other hand, the use of mycorrhizal fungi did not significantly differentiate the vigour of growth of sour cherry trees (Tab. 2). The lack of the mycorrhizal fungi's influence on the growth of sour cherry trees may be the result of their weaker growth in comparison with plum trees.

Borkowska (2007) claims that a positive influence of mycorrhizal fungi on the growth of trees may be seen only after a few years of tree vegetation. In the first year of the tree growth in an orchard, it may happen that the mycorrhizal fungi will use some of the nutritive products that could nourish the tree's own growth. As a result, at the beginning of the co-existence between the plant and the fungi, the plant does not benefit as much from the symbiosis as it does in the next years. In the case of *Pinus silvestris* there was a 2-3 times stronger growth of plants in the succeeding year after the use of mycorrhizal fungi (Kubiak, 2007). In our study, however, this type of growth using mycorrhizal fungi did not occur. It should be noted, though, that in his experiment soil conditions were really unfavorable for plant growth. In the present experiment, soil conditions were conducive to plant growth. Sometimes a decreased growth of mycorrhizal plants may result from N-limited conditions (Correa et al., 2008). Fortuna et al. (992), Rapparini et al. (1996) and Monticelli et al. (2000) also obtained very promising growth results of various rootstocks for fruit trees after the use of arbuscular mycorrhizal fungi.

The results of the sum of fruit yields in two fructification years depended on the mycorhizal inoculum used. The yield of fruit from the 'Čačanska Lepotica' and 'Schattenmorelle' cultivars growing on rootstocks, after the use of mycorhizal vaccine, was significantly higher than in the control combination. (Tab. 1 and 2).

Table 1. Growth and cropping of plum fruit trees of the 'Cacanska Lepotica' cultivar, after inoculation with mycorrhizal fungi

Combination	Trunk cross-sectional area in autumn 2009 [cm ^{2}]	Canopy volume [m^3]	Cumulative yield 2008-2009 [kg per tree]	Yield efficiency		Mean fruit weight of 100 fruits [kg]
				[kg cm^{-2}]	[kg m^{-3}]	
Control	30.7 a*	9.3 a	29.2 a	0.95 a	3.3 a	2.42 a
Mycorrhizal fungi	33.6 b	10.0 a	33.8 b	1.00 b	3.4 a	2.46 a

*Means followed by the same letter in the columns are not significantly different at p = 0.05

Table 2. Growth and cropping of sour cherry trees of the 'Schattenmorelle' cultivar, after inoculation with mycorrhizal fungi

Combination	Trunk cross sectional area in autumn 2009 [cm^2]	Canopy volume [m^3]	Cumulative yield 2008-2009 [kg per tree]	Yield efficiency		Mean fruit weight of 100 fruits [g]
				[kg cm^{-2}]	[kg m^{-3}]	
Control	20.4 a*	4.9 a	25.2 a	1.23 a	5.1 a	496.7 a
Mycorrhizal fungi	20.3 a	5.0 a	27.5 b	1.35 b	5.5 a	499.0 a

*For explanations, see Table 1

Yield efficiency of plum and sour cherry trees depended on the mycorhizal inoculum used. A higher yield efficiency was obtained after the use of mycorhizal inoculum (Tab. 1 and 2), but only the one expressed by yield per 1 cm^{-2} of trunk cross-sectional area. Such a difference was not noticed when the yield was calculated for 1 m^{-3} of the canopy volume.

The applied mycorhizal inoculum did not significantly differentiate the mean fruit weight of plum and sour cherry trees (Tab. 1 and 2). The mean mass of the 'Čačanska Lepotica' plum cultivar in the present experiment was smaller than the one found by Sosna (2010). However, the mass of 100 fruits of the sour cherry 'Schattenmorelle' cultivar was similar to that obtained by Krupa et al. (2001).

Thus far, the existing results of the use of the mycorhizal inoculum are promising. However, studies need to be continued in order to find additional influence of the mycorhizal inoculum on the further growth and fruiting of trees.

CONCLUSIONS

1. The used mycorhizal inoculum induced the growth of plum trees but did not differentiate the vigour of growth of sour cherry trees.
2. Fruit trees had higher yield and yield efficiency per 1 cm^{-2} of TCSA after the use of mycorhizal vaccine.
3. The applied mycorhizal inoculum had no influence on the size of fruits.

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WPŁYW SZCZEPIONKI MIKORYZOWEJ NA WZROST I PLONOWANIE DRZEW ŚLIWY I WIŚNI

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STRESZCZENIE

Doświadczenie przeprowadzono w Stacji Doświadczalnej w Baranowie koło Poznania w latach 2007-2009. W sadzie oceniano wpływ szczepionki mikoryzowej na wzrost i owocowanie drzew śliwy 'Cacanska Lepotica' oraz wiśni 'Łutówka'. W ciągu trzech lat po posadzeniu drzewa śliwy miały większą siłę wzrostu wyrażoną polem przekroju poprzecznego pnia w kombinacji ze szczepionką mikoryzową. Po zastosowaniu szczepionki mikoryzowej drzewa wiśni nie były zróżnicowane we wzroście. Wyższy plon owoców zebrano z drzew śliwy i wiśni inokulowanych szczepionką mikoryzową. Produktywność mikoryzowanych drzew w przeliczeniu na pole przekroju poprzecznego pnia była wyższa niż kontrolnych. Zastosowanie szczepionki mikoryzowej nie miało wpływu masę owocu rozpatrywanych gatunków drzew owocowych.

Słowa kluczowe: szczepionka mikoryzowa, drzewa śliwy i wiśni, wzrost, owocowanie, wielkość owoców