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EFFECT OF INOCULATION WITH SYMBIOTIC ENDO- AND ECTOMYCORRHIZAL FUNGI ON CONTENT OF BASIC MINERAL NUTRIENTS IN SWEET CHERRY LEAVES

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Abstract: There is an increasing interest in organic production all over the globe due to the desire of mankind for sustainable development and preservation of agroecosystems for future generations. Mycorrhization fully meets organic standards and is a natural way to increase the efficiency of agricultural production. Our task was to determine the content of basic mineral nutrients in sweet cherry leaves by root inoculation with symbiotic endo- and ectomycorrhizal fungi. The results of our research show that in the absence of fertilizers and irrigation, inoculation with endomycorrhizal fungi significantly decreased leaf P and K uptake. Endo-ectomycorrhiza, like endomycorrhiza, reduced leaf P, but significantly increased leaf K uptake in the second year of the study.

Keywords: *Prunus avium L.*, *Prunus mahaleb*, organic orchard, mycorrhizal fungi, leaf nutrient status.

Green agricultural production is a need in Ukraine, given the declining soil fertility and low efficiency of agriculture [1]. Mycorrhization is a natural way to increase the efficiency of agricultural production, as it saves on mineral fertilizers and irrigation water [2]. The positive effect of mycorrhiza on plant productivity has been confirmed by many studies around the world on a variety of crops, including fruit trees [3]. But there are also reports of insignificant or negative impact of mycorrhiza on moisture and the content of basic mineral nutrients in plants [4-9]. Thus, the effect of mycorrhization on the physiological parameters of plants is insufficiently studied. Sweet cherry is the dominant fruit crop of Zaporizhia region and, especially, Melitopol district. Therefore, we are interested in developing an effective organic technology for growing sweet cherry at our region. The mycorrhization of sweet cherry trees can become one of the elements of this technology, given that sweet cherry (Prunus avium L.) and its rootstock (Prunus mahaleb) are able to form a symbiosis with mycorrhizal fungi [10,11]. But today little is known about the impact of mycorrhiza on the physiological parameters of sweet cherry trees in the Southern Steppe of Ukraine. The aim of this study was to investigate the effect of endo- and ectomycorrhizal root inoculation on the content of basic mineral nutrients in sweet cherry leaves.

The experiment was conducted in an organic orchard of sweet cherry (Prunus avium L.) cultivar Dilemma/Prunus mahaleb planted in 2011 at 7 × 5 m. The work was conducted in the southern steppe of Ukraine (Melitopol district, Zaporizhia region). The soil cover of the investigated area is the chestnut soils, which are very low-humus. The research site is located in the Steppe zone, in the second agro-climatic region, which is characterized as arid and very warm. The orchard floor was kept under "live mulch" (natural herbs, mowed 4 times during the growing season and the clippings were left on the ground for decomposition). The scheme of the experiment was as follows: 1) Control - without inoculation; 2) Inoculation of sweet cherry roots with MycoApplay Superconcentrate 10 (root inoculation with endomycorrhizal fungi); 3) Inoculation of sweet cherry roots with MycoApplay Micronized Endo / Ecto (root inoculation with endo-ectomycorrhizal fungi). Any other management was identical in each treatment. Synthetic mineral fertilizers and chemical plantprotection products were not used. Leaves for analysis were collected in the first decade of August, with the full development of the leaf surface. The dried leaf tissues were ground and the content of basic nutrients (N, P and K) was analyzed by conventional methods [12,13]. Biochemical analysis was performed in three biological replicates. The results were compared by Student's t test, significant differences were determined at a level of P <0,05. All data were analyzed using Microsoft Excel 2010 [14].

The results of our study show that the content of total nitrogen in sweet cherry leaves by inoculation of roots with endo- and ecto-mycorrhizal fungi did not differ significantly from control (without inoculation) and was 71-74% of the optimal supply of this nutrient. The content of phosphorus and potassium in the leaves of sweet cherry in all treatments of the experiment was also significantly lower than the optimal values - respectively, 34-48% and 41-55%. But the phosphorus content in the leaves of control trees was significantly higher than the level of insufficient supply of this element. In the variants with endo- and ecto-mycorrhizal root inoculation, the phosphorus content in the leaves was significantly lower than control (without inoculation) and corresponded to the indicator of insufficient supply of plants with these elements. The potassium content in the variant with root inoculation with endomycorrhizal fungi was significantly lower than the control variant and even lower than the level of insufficient supply of this element. During inoculation of roots by endo-ectomycorrhizal fungi, the potassium content in the leaves was significantly higher than control variant (without inoculation) and corresponded to the level of insufficient supply of plants with this element. The significant decrease in the content of basic nutrients in sweet cherry leaves in all variants of the experiment (compared to the optimal level of supply of sweet cherry trees in southern Ukraine) occurred, in our opinion, for several reasons: first, low nutrient content in the soil; secondly, the lack of mineral fertilizers; third, the lack of watering; fourth, keeping the soil under "living mulch". At the same time, the potassium content decreased the most, probably due to its consumption by competitive vegetation - natural herbs, which acted as "living mulch". Such patterns have long been known and well described in the scientific literature: "living mulch" in the orchard leads to a deficiency of nutrients in the leaves of fruit trees [15,16]. The negative effect on the phosphorus content in sweet cherry leaves, which we observed when inoculating the roots with endo- and ecto-mycorrhizal fungi, seems interesting. There are numerous reports of a positive effect of mycorrhiza on the absorption of nutrients by plants [3]. But in unfavorable living conditions, mycorrhizal fungi are able to compete with plants for nutrients and become consumers instead of a source [4-9]. For example, fungi can reabsorb phosphorus released on the periarbuscular surface, controlling its entry into partner plants [17-19]. But with inoculation of roots by endo-ectomycorrhizal fungi, the potassium content in sweet cherry leaves increased compared to control (without inoculation). Which indicates a positive effect of endo-ectomycorrhizal inoculant on potassium intake by a symbiotic plant. A similar effect is described by K. Garcia and S.D. Zimmermann [20]. It remains an open question what species of fungi caused such a positive effect, because the inoculum includes 4 species of endomycorrhizal (Glomus intraradices, Glomus mosseae, Glomus agregatum, Glomus etunicatum) and 7 species of ectomycorrhizal (Rhizopogon villosulus, Rhizopoglepogon luteolus, Pisolithus tinctorius; Scleroderma cepa, Scleroderma citrinum) fungi.

We can recommend for farmers who grow sweet cherries using organic technology in the South of Ukraine to combine mycorrhization of trees with the use of organic and permitted by organic standards mineral fertilizers and drip irrigation of trees, which will provide optimal conditions for full functioning mycorrhizal symbiosis.

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