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INFLUENCE OF MYCORRHIZAE AND PHOSPHATE MOBILIZING BACTERIA ON P NUTRITION OF SOME VEGETABLE CROPS

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Abstract

Plant species may differ in phosphorus efficiency. Phosphorus efficiency of plants may arise from enhanced ability of roots to acquire P from the soil or/and from high ability of shoots to produce yield per unit P acquired. This research was aimed at studying P efficiency of plants (carrot, onion, and leek), and to elucidate morphological root characteristics, and mycorrhizal fungi hyphae influencing P efficiency of the species. Five experiments were carried out in Hanover University - Germany to achieve the aims mentioned above. First experiment was carried out to evaluate the response of carrots plants to the inoculation by two strains of A-mycorrhizal fungi (*Glomus intraradices* M49 and M301). The shoot yield of the carrot inoculated with mycorrhizal strain 49 was increasing significantly in comparison with the other mycorrhizal strain (M301). On the other hand, there was no significant difference in hyphae length between two strains of mycorrhizal fungi. These results indicated that carrot inoculated with mycorrhizal strain 49 had higher P efficiency than carrot inoculated with the other mycorrhizal strain (301). The second and the third experiments were aimed to evaluate the response of carrot plant at narrow and wide range of available P in soil with and without mycorrhizal fungi. These experiments were conducted in a growth chamber with five levels of P (61, 88, 130, 162, and 218 mg P-CAL kg soil^{-1} in the second experiment and 20, 39, 69, 169, and 332 mg P-CAL kg soil^{-1} in the third experiment), with 12 replicates in each. Carrot inoculated with mycorrhizal fungi attained more than 80% of its maximum yield in both experiments at the lowest level of P. whereas carrot without mycorrhizal fungi reached only 50% and 5% in the second and the third experiments respectively at the same level of P. This indicated that carrot with mycorrhizae was P-efficient compared to carrot without mycorrhizae. Predicted P uptake by a mechanistic simulation model revealed that mycorrhizal hyphae contributed about 61% and 84% (in the second and the third experiments respectively) to the total P uptake at the lowest P level. The relationship between the observed and predicted P uptake at the lowest P level of carrot with and without mycorrhizae revealed that model parameters explained nearly 3/5th of the total P uptake in second experiment, but only 1/5th that of carrot inoculated with mycorrhizae in third experiment. This showed that the P uptake of carrot inoculated with mycorrhizae in the third experiment was strongly under-predicted, therefore, it was hypothesized that carrot inoculated with mycorrhizae may have the ability to mobilize and take up soil P additionally by other mechanisms such as exudation of organic acid by both roots and mycorrhizal hyphae. The forth experiment was aimed to evaluate the activity of mycorrhizae and phosphorus dissolving bacteria at two levels of available P in soil (61 and 218 mg P-CAL kg soil^{-1}) and the interaction between them. At low P level, dual inoculation with arbuscular mycorrhizal fungi (AMF) and phosphate dissolving bacteria (PDB) significantly increased plant growth and P accumulation in plant tissue. No significant difference in plant growth, root length, and P uptake were observed between dual inoculation with PDB and AMF, and inoculation with AMF alone at low P level. Therefore, mycorrhizal fungi were more effective in increasing plant growth, root length, and P uptake than inoculation with PDB. At high P level, the inoculation with AMF and PDB had no effect on plant growth. The fifth experiment was aimed to compare the response of onion and leek plants to the inoculation with mycorrhizae at two levels of P. In this experiment, it was observed that, plants inoculated with mycorrhizal fungi had higher P use efficiency compared to the other plants without mycorrhizal fungi. Based on the results of the present study, we can recommend that plants inoculated with mycorrhizal fungi are high P efficiency comparing to plants without mycorrhizae.

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