The Role of Arbuscular Mycorrhizae in the Growth and Zinc Uptake of Wheat Plant Grown on a Calcareous Soil Contaminated with Zinc

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ABSTRACT

Pot experiment was carried out at the green house of Faculty of Agriculture (Saba bacha), Alexandria University. The experiment was conducted to study the influence of various arbuscular mycorrhizal fungi(AMF) species as a bioremediation agent for soil contaminated with Zinc. Wheat plant(*Triticum aesitivum*) - Giza 168 was grown on a calcareous soil and supplemented with six Zn addition levels of 0, 2, 4,6,8 and 10 mM kg^{-1} soil in the form of $ZnSO_4.7HO_2$. Four AM fungal inocula namely *Glomus spp* (mixed), *Glomus intraradiaces*, *Glomus macrocarpium*, and *Glomus fasciculatum*, the first one was isolated from contaminated soil and were applied to the soil. The plants were collected after 60 days from sowing. Mycorrhizal colonization rate, plant dry weight (DW), Zn concentrations and Zn uptake were determined and uptake efficiency, translocation efficiency and phytoextraction efficiency were calculated. The *Glomus spp*-treated plants had higher mycorrhizal colonization rates than other inoculation-treated plants. All mycorrhizal species increased shoot and root DW, *Glomus spp* (mixed) was more effective than the others. Mycorrhizal plants accumulated more zinc in roots, however appeared a large reductions in shoots. The use of AM fungal for phytoremediation of the contaminated soil lead to more absorption of zinc in plant. The comparisons of the four AM fungal species indicate that the AM fungal represented by *Glomus spp* (mixed) showed a beneficial effect in phytoremediation of Zn-contaminated soils.

Key words: arbuscular Mycorrhizal; zinc contamination; phyoremediation; calcareous soil

INTRODUCTION

Ecosystems have been contaminated with heavy metals due to various human and natural activities. The sources of metals in the soil are diverse, including burning of fossil fuels, mining and smelting of metalliferous ores, municipal wastes, fertilizers, pesticides, sewage sludge amendments, and the use of pigments and batteries. All these sources cause accumulation of metals in our agricultural soils and pose threat to food safety issues and potential health risks due to soil-to- plant transfer of metals (Khan, 2005). One of these metals is zinc.

Zinc is involved in plant enzyme function, carbohydrate metabolism, protein synthesis, and tryptophan and indole acetic acid synthesis (Marschner, 1995).When soil Zn concentrations become elevated, foliage becomes chlorotic, plants exhibit altered photosynthetic physiology, and growth is reduced Borkert *et al.*, (1998)

The remediation of contamineted soils is important because these usually cover large areas that are rendered unsuitable for agricultural and other human use. Conventional soil remediation practices in the past have relied mainly on the excavation of the contaminated soil. However, physical displacement, transport and storage or alternatively soil washing are expensive procedures and leave a site behind devoid of any soil microflora. In contrast plants offer an inexpensive and sustainable on-site approach (Kramer, 2005), which relates to heavy metal detoxification mechanisms (Hall, 2002). Arbuscular mycorrhizal (AM) fungi occur in the soil of most ecosystems, including polluted soils. In some cases mycorrhizal plants can show enhanced uptake and root-to-shoot transport (phytoextraction) while in other cases AM fungi contribute to heavy metal immobilization within the soil (phytostabilization). The significance of AM fungi in soil remediation has lately been recognized (Gaur and Adholeya, 2004). Galli et al. (1994) suggested that AM fungi can play a crucial role in protecting roots from heavy metals, the efficiency of protection, however, differs between distinct isolates of AM and different heavy metals.

The aims of this work were 1) to assess the ability of four AM species to colonize wheat plant grown on Zn contaminated calcareous soil; 2) to evaluate the influence of the tested mycorrhizal species on plant growth and uptake of Zn by wheat plants grown on soils across a gradient of Zn concentrations from uncontaminated to potentially toxic levels and; 3) to confirm whether AM fungi can be applied as an aid in amelioration toxicity produced by Zn contamination under calcareous soil conditions.

MATERIALS AND METHODS

1. Soil

Surface calcareous soil sample (0-15 cm) was collected from El- Nubaria region at km 59 Alexandria –Cairo desert road. This sample was air-dried, ground to pass to 2mm sieve and thoroughly