GROWTH AND NUTRIENT UPTAKE OF MYCORRHIZAL MAIZE IN SOIL OF DIFFERENT DEPTHS OVERLYING COAL FLY ASH[1]

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Abstract. Application of topsoil over phytotoxic mine wastes is often practiced to establish perennial plant communities on minespoil areas. China has a very large human population to feed and attempts are made to remediate such areas by growing arable crop plants, but efforts to establish agricultural crops often fail. It is not clear if this is due primarily to insufficient depth of topsoil or if other factors such as soil microbial activity can influence plant establishment and growth. Here we report a preliminary outdoor pot experiment that compared the influence of two arbuscular mycorrhizal (AM) fungi, *Glomus mosseae* (Nicol. and Gerd.) Gerdemann and Trappe and *Glomus versiforme* (Karsten) Berch, on the growth and nutrient uptake of maize (*Zea mays* L.) grown in different depths of soil layer overlying coal fly ash. Three depths (5, 7 and 10 cm) of sterilized sieved and air-dried calcareous loam (Ustarents) with low available P status from a coal mining area were placed over three depths (10, 8 and 5 cm) of fly ash in plastic plant pots to give a total substrate depth of 15 cm. Non-mycorrhizal controls and plants inoculated with *G. mosseae* were grown in all three substrate mixtures. Plants inoculated with *G. versiforme* were grown in two of the substrates (10 and 8 cm of soil with 5 and 7 cm of fly ash). Two maize seedlings were transplanted in the soil layer of each pot and grown for 8 weeks with regular adjustment of water content to 70-90% of field capacity. There were five replicates of each treatment in a randomized block design. Plant root and shoot dry matter yields were determined and sub-samples were milled and dry ashed by standard methods and subjected to multi-element analysis using inductively coupled plasma-atomic emission spectroscopy (ICP-AES). The proportion of plant root length colonized by the AM fungi was determined on washed root sub-samples by standard methods. Stained roots were examined for AM fungal infection by the gridline intersection method. Data were tested by analysis of variance and mean values compared by least significant difference at the 5% level.

Substantial AM fungal colonization was observed in the roots of the mycorrhizal treatments (39-54% of root length colonized), but there was no significant

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difference between the two AM fungi or the different soil/fly ash depth combinations. Root colonization by both AM fungi increased host plant growth compared with non-mycorrhizal controls, with *G. mosseae* giving higher yields of maize than *G. versiforme* at the same depths of soil. Increasing soil depth led to increased plant yields. Mycorrhizal plants absorbed more nutrients than non-mycorrhizal controls, but translocated less Na to the shoots. These preliminary results indicate that arbuscular mycorrhizae may make a substantial contribution to successful crop establishment in soils overlying areas of coal fly ash. The AM fungi gave higher plant yields, greater uptake of plant nutrients and may have protected the plants against excessive accumulation of Na in the shoots when grown in soil overlying coal fly ash. The data indicated that the maximum soil depth studied (10 cm) was required for satisfactory plant growth. However, under field conditions greater depths may be advisable. Further work is required to determine the optimum soil depth under field conditions.

Our preliminary data indicate that successful growth of maize is possible in soil overlying coal fly ash and can be improved by colonization of the roots by AM fungi. It is therefore advisable to ensure that field remediation strategies include conditions that favour fungal growth and the development of arbuscular mycorrhizae using either indigenous or inoculated AM fungi.

Additional Key Words: arbuscular mycorrhiza, mine soil, plant growth, plant nutrition, phytoremediation.