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# INFLUENCE OF TRACE ELEMENTS ON AM FUNGAL COLONIZATION AND GROWTH OF TWO AGROFORESTRY TREES

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Influence of trace elements (zinc, nickel, copper, manganese, cadmium and lead) on AM colonization of *Albizzia lebbeck* and *Acacia nilotica* was investigated. Cobalt, nickel and lead inhibited the colonization of *Glomus fasciculatum*. On the other hand, zinc promoted root infection by *G. fasciculatum*. Addition of nickel caused significant decrease in spore population of *G. fasciculatum* in the rhizosphere of *A. lebbeck*, while it was toxic and caused significant decrease in spore population of *G. fasciculatum* in the rhizosphere of *A. nilotica*. Addition of different heavy metals also resulted in the change, the availability of other nutrients to both the plants under investigations. Thus AM fungi have great potential for exploitation in the reclamation of heavy metal polluted soils.

**Keywords :** *Acacia nilotica;* Agroforestry; *Albizzia lebbeck*; AM fungi; Trace elements; Trees.

## Introduction

Metal toxicity in soils near metal smelters or where effluents are discharged into the soil is a serious limitation to vegetation growth. Both trees and AM fungi have been reported to have variable tolerance against metal pollution[1-3]. Tolerance to cadmium is reported to increase due to the inoculation of *Amanita muscaria*[4-6]. On the other hand, decreased colonization of AM fungi in soils with high concentration of metals was reported[7]. The AM fungal infection of grasses was reported to be adversely affected by the presence of zinc. Similarly, the presence of manganese[8] resulted in poor colonization of AM fungi and poor growth of *Acacia mangium*. Sujan Singh[9] has excellently reviewed the role of AM fungi in alluviating soil pollution due to heavy metals and stressed the need to undertake extensive survey of such extreme soils. In the present investigations efficacy of some AM fungi in overcoming the metal toxicity towards two agroforestry trees was studied.

## Materials and Methods

Two agroforestry trees (*Albizzia lebbeck* and *Acacia nilotica*) were selected for these studies. *Glomus fasciculatum* maintained on bajra was employed as AM inoculum. *G. fasciculatum* was multiplied in earthen pots.

Sand soil mixture (1:1) was sterilized at 15 lbs pressure for two consecutive days for 30 minutes each day. The autoclaved soil mixture was filled in small sterilized pots. Different metal salts (1 mg/100 g soil) were added to the soil to study the influence of AM colonization and growth of test plants. Suitable controls were maintained. The inoculum containing root pieces and resting spores of *G. fasciculatum* present in the soil were placed just below the soil surface and seeds of test plants were sown. The pots thus prepared were watered uniformly at regular intervals. Hogland nutrient solution without phosphorus was employed. The pots were placed under the uniform day light. At the end of 45 days of growth, small pieces of roots were taken out from the center of the pot and examined for mycorrhizal infection. The feeder roots of the test plant were collected, washed and immediately preserved in FAA (Formalin :acetic acid :alcohol 1:1:8). The clearing and staining of roots was done by the method suggested by Phillips and Hayman[10] and the percentage of root colonization was calculated by the formula suggested by Giovannetti and Mosse[11]. Resting spores of AM fungi consisting of sporocarps, chlamydospores, azygospores and soil-borne vesicles were extracted by wet sieving and decanting method[12-13]. Resting spores were identified with the help of key provided by Schenck and Perez[14]. Influence of AM fungi on heavy metals tolerance of plants was also assessed.

## Results and Discussion

Table 1 reveals that the inoculation of *G. fasciculatum* promoted the growth and development of *A. lebbeck* to a significant level. The percentage of root infection was inhibited to a significant level in the presence of metals like Co, Ni and Pb. The inhibition of root infection was maximum in the presence of Co. Zn promoted the maximum root infection, followed by Mn, while it was least in Ni. The effect of other minerals was intermediate. Maximum spore population was recorded in *G. fasciculatum* inoculated plants than in control plants. Similarly spore population of *G. fasciculatum* decreased in the presence of Ni followed by Pb. Ni was toxic to *G. fasciculatum*. The growth and biomass production of *A. lebbeck* was also adversely affected by the presence of these metals. Ni was most toxic.

**Table 1.** Interaction of metals and AM fungi and their effect on growth of two forest tree species.

| Name of the treatment | Percentage of infection | No. of spores/ 100 g soil | Height of the plant (cm) | Biomass (g) | | Phosphorus content (mg/plant) | |
|---|---|---|---|---|---|---|---|
| | | | | Fresh wt. | Dry wt. | Shoot | Root |
| ***A. lebbeck*** | | | | | | | |
| Zn + *G. fasciculatum* | 63.6 | 113 | 38.5 | 8.8 | 4.6 | 0.26 | 0.39 |
| Co + *G. fasciculatum* | 33.2 | 116 | 31.6 | 6.7 | 4.2 | 0.23 | 0.42 |
| Ni + *G. fasciculatum* | 32.4 | 98 | 24.5 | 4.5 | 2.2 | 0.38 | 0.39 |
| Cu + *G. fasciculatum* | 41.2 | 119 | 30.5 | 3.8 | 2.5 | 0.26 | 0.38 |
| Mn + *G. fasciculatum* | 58.6 | 128 | 34.4 | 6.3 | 3.2 | 0.34 | 0.63 |
| Cd + *G. fasciculatum* | 36.3 | 113 | 27.2 | 2.5 | 1.4 | 0.54 | 0.43 |
| Pb + *G. fasciculatum* | 40.8 | 112 | 32.0 | 6.4 | 3.9 | 0.28 | 0.36 |
| *Glomus fasciculatum* | 68.6 | 148 | 52.5 | 10.2 | 6.2 | 0.49 | 0.62 |
| Control (Normal soil) | 64.2 | 132 | 43.2 | 9.2 | 5.6 | 0.43 | 0.56 |
| ***A. nilotica*** | | | | | | | |
| Zn + *G. fasciculatum* | 67.8 | 146 | 71.0 | 18.8 | 10.3 | 0.42 | 0.36 |
| Co + *G. fasciculatum* | 43.7 | 112 | 61.0 | 12.8 | 8.4 | 0.38 | 0.44 |
| Ni + *G. fasciculatum* | 33.2 | 109 | 60.0 | 10.5 | 7.2 | 0.23 | 0.34 |
| Cu + *G. fasciculatum* | 47.9 | 123 | 72.0 | 16.5 | 10.2 | 0.43 | 0.54 |
| Mn + *G. fasciculatum* | 60.2 | 136 | 70.0 | 18 | 10.2 | 0.56 | 0.63 |
| Cd + *G. fasciculatum* | 53.2 | 120 | 65.0 | 14.2 | 11.2 | 0.68 | 0.53 |
| Pb + *G. fasciculatum* | 41.3 | 116 | 49.2 | 12.5 | 7.2 | 0.52 | 0.68 |
| *Glomus fasciculatum* | 77.9 | 153 | 78.1 | 18.2 | 14.8 | 0.74 | 0.82 |
| Control (Normal soil) | 68.2 | 143 | 64.1 | 16.3 | 12.1 | 0.63 | 0.73 |

Zn - Zinc; Co - Cobalt; Ni - Nickle; Cu - Copper, Mn - Manganese; Cd - Cadmium; Pb - Lead

**Table 2.** Physico-chemical characteristics of soils treated with different metals.

| Name of the treatment | Soil texture | pH | EC mho/cm | Organic matter | Available phosphorus $P_2O_5$ | Available potassium kg/hect |
|---|---|---|---|---|---|---|
| Zn + *G. fasciculatum* | SCL | 8.9 | 0.20 | 0.18 | 19 | 498 |
| Co + *G. fasciculatum* | SCL | 8.5 | 0.19 | 0.16 | 18 | 256 |
| Ni + *G. fasciculatum* | SCL | 8.5 | 0.30 | 0.9 | 12 | 543 |
| Cu + *G. fasciculatum* | SCL | 8.7 | 0.21 | 0.14 | 14 | 519 |
| Mn + *G. fasciculatum* | SCL | 8.6 | 0.35 | 0.23 | 20 | 415 |
| Cd + *G. fasciculatum* | SCL | 7.9 | 0.31 | 0.11 | 15 | 610 |
| Pb + *G. fasciculatum* | SCL | 8.6 | 0.29 | 0.13 | 19 | 397 |
| *Glomus fasciculatum* | SCL | 8.5 | 0.23 | 0.21 | 18 | 537 |
| Control (Normal soil) | SCL | 7.8 | 0.16 | 0.12 | 17 | 317 |

SCL = Sandy clay loam

The uptake of phosphorus was also adversely affected in the presence of metals which varied with metal present in the rhizosphere soil. Almost similar trend was observed with *A. nilotica.* Ni was more toxic than rest of the metals. It was responsible for maximum decrease of spore population in the rhizosphere soil of *A. nilotica*, while Zn and Mn were least toxic. Mn was also responsible for decreasing the efficiency of *G. fasciculatum* in the absorption of phosphorus by *A. nilotica.* Similar observations were made on the decreased metal toxicity by employing AM fungi to different plants studied by them[15-19].

Table 2 reveals that the available phosphorus increased in the presence of Mn, Pb and Zn, while cobalt failed to influence the available phosphorus. Ni followed by Cu and Cd were responsible for decreasing the available phosphorus. Similarly the available potassium also changed in the presence of these metals. Cd and Ni were responsible for enhancing the available potassium, while Pb and cobalt were responsible for decreasing the available potassium. Rest of the metals affected available potassium to an intermediate degree. The organic matter content of the soil increased in the presence of Mn, while it decreased in the presence of Ni followed by Cd, Pb and Cu in a descending order. EC of rhizosphere was also adversely affected in the presence of different metals. The EC increased in the presence of Mn, Cd, Ni and Pb, while it decreased in the presence of Co, Cu and Zn. However, the pH of the soil was not much affected by the presence of these metals. From the present investigations it can be concluded that the AM fungi have great potential for exploitation in the reclamation of heavy metal polluted soil and revegetation of hostile waste lands.

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