RESEARCH ARTICLE

Potential of Arbuscular Mycorrhizal (AM) Fungi in Reclamation of Wastelands

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Manuscript details:

Date of publication 18.10.2014

Available online on
http://www.ijlsci.in

ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

Editor: Dr. Arvind Chavhan

Cite this article as:
Naqvi Nikhat (2014) Potential of Arbuscular Mycorrhizal (AM) Fungi in Reclamation of Wastelands., *Int. J. of Life Sciences,* Special Issue A2: 48-50.

Acknowledgement
The author is thankful to CSIR, New Delhi for financial assistance.

ABSTRACT

India has wide tracts of arid, semiarid and wastelands. There is a need to bring these arid, wastelands which are lying unutilized due to various constraints, under cultivation by adopting intensive reclamation measures. Forestry and wasteland development plays a vital role in socio-economic, rural development of a country besides maintaining ecological stability. Microbe-assisted phytoremediation is very effective and an innovative technology for restoration of biodiversity of degraded land. It provides number of benefits namely high survival rate of plants, increase in biomass. Mycorrhizal fungi are a critical component of healthy soil biology. Mycorrhiza is symbiotic association between fungus and roots of the higher plants. Out of the seven different types of mycorrhiza, arbuscular mycorrhiza (AM) is most important ecologically and economically. In view of importance of AM to improve water relations, growth and survival of trees especially in degraded wastelands, establishment of AM plants may be critical to vegetation efforts. There is growing awareness that Multipurpose Tree Species (MPTS) can play a prominent role not only in meeting the increasing demand for fodder, food and fuel wood but also in sustainable agricultural practices. The present paper explores the possibility of using Mycorrhizal technology as a good package to remove all constraints associated with reclamation of wastelands. In preliminary field trials conducted at a semi- arid site at Asola (40 Kms from Delhi) various multipurpose tree species like *Acacia catechu, A. nilotica, Prosopis juliflora, Albizzia lebbeck* showed improved and better growth, increased survival rate and establishment when they were inoculated with AM fungi as compared to control. Mycorrhizal technology seems to provide sustainable, economical and healthy answer to reclamation of wastelands.

Keywords: Wastelands, phytoremediation, reclamation, AM fungi, multipurpose tree species.

INTRODUCTION

The intense exploitation of natural forests in the sub-humid to arid tropics is leading to degradation of stable ecosystems. The resulting changes in abiotic and biotic soil properties make the re-establishment of vegetation difficult. In India, out of total geographical area of 328.05mha, about 37.4% of area of arid zone has been classified. NRSA (National Remote Sensing Agency) places wastelands in the country at 63.85mha. These large areas of land in country called wastelands are degraded and lying unutilized. There is potential for the development of vegetation cover in these areas. In view of increasing shortage of plant resources due to population explosion, it has become imperative that all wastelands are put to use by developing vegetation cover.

The main stress imposed on vegetation by arid environments is due to lack of water and mineral nutrients. The availability of relatively immobile nutrients, such as P, is lowered when soil water potential decrease. The effects of mycorrhizal fungi on growth and establishment of tree seedlings in such environments cannot be overlooked. Mycorrhiza is symbiotic association between fungus and roots of the higher plants. It is now well known that in a natural ecosystem, most plants will have a well-developed mycorrhizal association. Mycorrhizal fungi are a critical component of healthy soil biology. Out of 7 different types of mycorrhiza, *Arbuscular Mycorrhizal* Fungi (AMF) belonging to the phylum Glomeromycota are most important ecologically and economically. It can adapt to a wide range of conditions and can be found in extreme habitats. The hyphae of AM fungi serve as extensions of the root systems and are both physiologically and geometrically more effective organs of absorption than the root themselves (Naqvi and Mukerji 2000). In view of importance of AM fungi in improving water relations, growth and survival of tree species, establishment of mycorrhizal plants may be critical to vegetation efforts (Bainard *et al*., 2011).

Raising fast growing, nitrogen fixing Multipurpose Tree species on wastelands for firewood, fodder, timber and non-timber forest produce can play a vital role in socio-economic and rural development of a country apart from its role in maintaining ecological stability. The survival and growth of these tree seedlings on adverse sites are relatively low and can be improved with AM fungal inoculation (Wulandri *et al*., 2014). Mycorrhizal plants are less susceptible to wilting and transplant shock in low levels of soil moisture. These fungi are believed to improve the water relations of host plants by increasing hydraulic conductivity, increasing transpiration rate and lowering stomatal resistance or altering the balance of plant hormones. These changes could be secondary responses to better P nutrition or mediated via direct mycorrhizal effects. The literature strongly supports the fact that AM fungi are integral component of sustainable tropical forestry (Dodd 2000). The potential of AM fungi in increasing the growth, survival and biomass production of tree is well recognized, though not well exploited. Present study was carried out to test the efficacy of *Glomus macrocarpum* in improving the growth and survival of *Acacia nilotica* in nursery and subsequent transplantation in stressed site.

MATERIALS AND METHODS

Experimental Site:The investigation was carried out in experimental field located at Asola, Mehrauli, Delhi that represents typical semi- arid zone of India. The area is rocky with sparse xerophytic vegetation. Soil texture, sandy loam; pH 8.2; Electrical conductivity, 0.23 and nutrients (organic carbon, 0.56; phosphorus, 12.8 Kg/ha; and potassium, 499 Kg/ha)

***Pretreatment of seeds*:** To soften the seed coat, initially seeds were pretreated with sulphuric acid for 10 minutes and thereafter soaked in hot water followed by soaking in gradually cooling water. Then seeds were sown in polythene bags to raise seedlings. Each seedlings was treated with +*Glomus macro-carpum.* The untreated seedlings served as control. For mycorrhizal inoculation, 30g soil based inoculum and colonized roots were placed as a layer below seeds in each polythene bag. The plants of 90 days old were transplanted in field.

***Growth studies*:** The observations were made at an interval of 30 days at three different growth periods and growth parameters such as root length; shoot length; root dry weight; shoot dry weight were measured.

Mycorrhizal status (a) *Percent mycorrhizal colonization in roots*-Technique of Philips and Hayman (1970) was used for finding the percent colonization. *(b) AM fungal spore isolation*-Gerdemann and Nicolson (1963) technique of wet sieving and decanting technique was used for isolating AM fungal spore. After 90 days, the plants were transplanted at experimental site at Asola.

RESULTS AND DISCUSSION

AM fungal inoculation resulted in an appreciable increase in all the growth parameters *i.e*. root length, shoot length, root and shoot dry weight in *Acacia nilotica*. The importance of AM fungi in promoting growth of tree species has been demonstrated in nursery conditions (Fig. 1, 2, 3, 4). Mycorrhizal structures present in roots included mycelium, vesicles and arbuscules (Fig 5). The first step in any AM fungal inoculation program is identification of sites which are likely to respond to inoculation. The initial step involves identifying the limitations to plant growth in a particular soil and determine whether mycorrhizal fungi can help the plants to overcome the restrictions in growth.

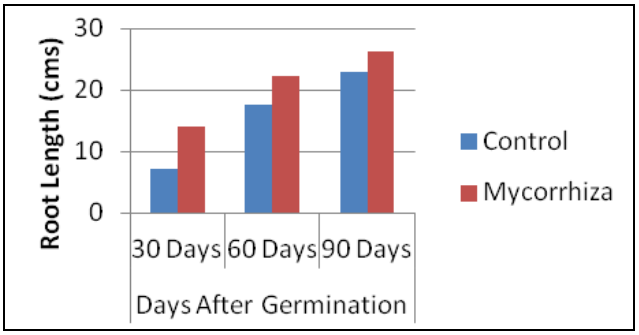

Fig. 1: Effect of Arbuscular Mycorrhizal inoculation on root length of *Acacia nilotica*

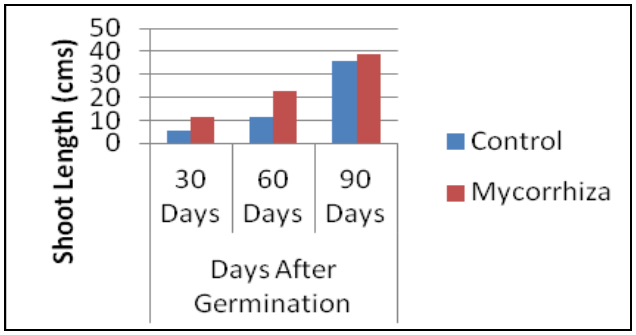

Fig 2: Effect of Arbuscular Mycorrhizal inoculation on shoot length of *Acacia nilotica*.

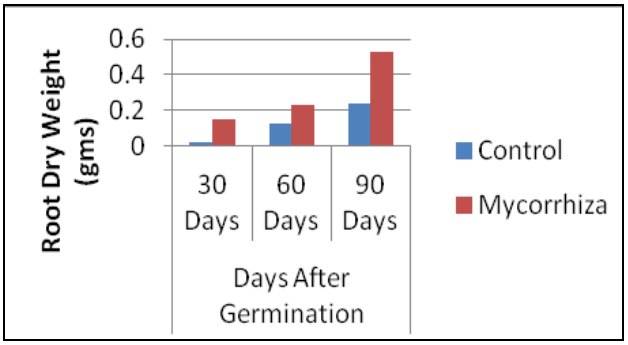

Fig. 3: Effect of Arbuscular Mycorrhizal inoculation on root dry weight of *Acacia nilotica*.

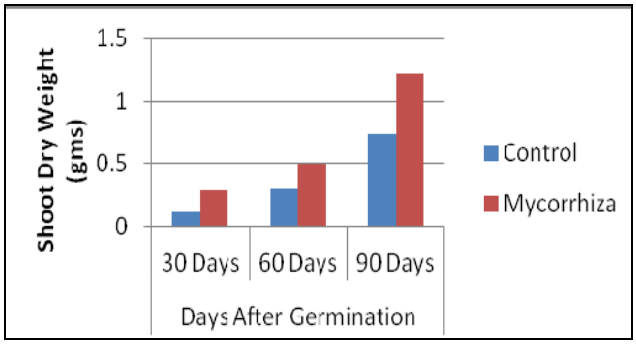

Fig. 4 : Effect of Arbuscular Mycorrhizal inoculation on shoot dry weight of *Acacia nilotica*

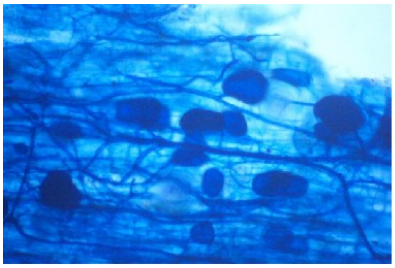

Fig. 5: Cleared roots of *Acacia nilotica* showing internal hyphae and oval vesicles

Fig. 6: Mycorrhizal plants transplanted at Experimental site at Asola.

Present study suggests the possibility of increasing productivity and growth rate of plants by mycorrhizal inoculation (Fig. 6). This may be due to its nutrient absorptive capacity and disease resistance (Olagunju *et al*., 2014). Soil type also affects mycorrhiza in arid and semiarid condition. Increased rooting length and depth associated with AM colonization may influence drought resistance of host plants. Nursery inoculation programs are beneficial because it results in early colonization of the plants by mycorrhiza. Reclamation and revegetation of degraded lands with MPTS such as *Leucaena leucocephala* and *Prosopis juliflora* have been successful in some arid and semi-arid regions of the world (Chaubey *et al*., 2014).

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