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COMPARATIVE EFFECT OF TWO VA-MYCORRHIZAL SPECIES ON BIOMASS OF NINE PLANT SPECIES GROWN ON IRON ORE MINE REJECTS

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Abstract

Mycorrhizae play a vital role in wasteland development programme. The role of Vesicular-arbuscular mycorrhizal fungi in stimulating plant growth through enhanced nutrient and water uptake on wastelands is now widely recognized.

The present study reports the effect of two VAM species viz., *Glomus fasciculatum* and *Glomus mosseae* on total biomass of nine tree species. viz., *Delonix regia, Tamarindus indica, Acacia farnesiana, Acacia mangium, Adenanthera pavonina, Albizzia lebbeck, Leucaenea leucocephala, Samanea saman* and *Ziziphus jujuba* grown in iron ore mine rejects.

The results indicate that inoculation with both the VAM species was beneficial and increased the total biomass when compared to control plants in all the species. Six plant species viz., *Delonix regia, Tamarindus indica, Acacia farnesiana, Adenanthera pavonina, Leucaenea leucocephala* and *Samanea saman* inoculated with *Glomus mosseae* showed higher biomass as compared to plants inoculated with *Glomus fasciculatum*. In two species *Acacia mangium* and *Albizzia lebbeck* inoculation with either VAM species did not show significant differences in biomass production. The lone species viz., *Ziziphus jujuba* showed higher biomass production when inoculated with *Glomus fasciculatum* as compared to the plants inoculated with *Glomus mosseae*. It may be concluded that inoculating plant species with appropriate VAM fungi would help to increase the growth and biomass.

Key Words: VAM, biomass, mine rejects.

The VA mycorrhizal fungal symbiont becomes a major interface between the soil and the plant. They play a vital role in uptake of nutrients and water and have received great deal of attention in the recent years. They have a fundamental role in rehabilitation of many disturbed lands.

The major damage of mining is to soil and vegetation, and these must therefore, be restored. Since plants cannot grow without a satisfactory soil, it is the soil to which attention should be paid (Bradshaw 1989). The choice of species in revegetating various mined areas is extremely difficult in Indian conditions as the mines are scattered all over the country over varied types of soil, climate and rainfall. So, the requirement of each site has to be carefully considered for choice of species. Soil fertility is a major factor which regulates plant growth. Several investigators have reported nitrogen and phosphorus as limiting factors for plant growth in mine spoils.

The beneficial effects of mycorrhizae on plant growth have often been related to the increase in the uptake of immobile nutrients especially phosphorus.

Inoculating seedlings with pure cultures of mycorrhizal fungi have been found to increase mycorrhizal formation on mine spoils or sites where the mycorrhizal fungi required by the seedlings do not occur naturally (Amaranthus & Perry 1987, Danielson 1988).

Establishment of functional fungal biomass on land disturbed by mining may be critical for restoration of nutrition cycling and in particular phosphorus uptake by plants (Call & McKell 1982). Mycorrhizal plants are more efficient to draw nutrition from soil particularly in fertile soils, as compared to non-mycorrhizal plants. This is due to the hyphae of the fungal symbionts which penetrate large volumes of soil and obtain scarce elements especially phosphorus which they pass out onto the plants in exchange in photosynthesis.

The present work was aimed to study the effect of two VAM species viz., *Glomus mosseae* and *Glomus fasciculatum* on the total biomass (dry weight basis) of nine plant species viz., *Delonix regia, Tamarindus indica, Acacia farnesiana, Acacia mangium, Adenanthera pavonina, Albizzia lebbeck, Leucaena leucocephala, Samanea saman* and *Ziziphus jujuba*.

Material and Methods

Analysis of mine wastes:

Twenty iron ore reject samples were taken in a stratified random manner from the mining site. Samples were taken from a depth of 15 cm, sieved through a mesh and air-dried before being analysed.

TABLE 1 - SOME PROPERTIES OF IRON ORE MINE REJECTS OF GOA

Properties	Mean (S.D.)
pH	6.02 (0.18)
EC (ms cm-1)	0.051 (0.012)
Total N	93.2* (NA)
Available N	3.8* (NA)
P	1.5 (NA)
SO_4-S	<0.1 (NA)
Ca	1.76 (0.80)
Mg	0.92 (0.55)
K	0.76 (0.26)
Na	2.60 (0.54)
Cu	<0.05 (NA)
Fe	<0.1 (NA)

Concentrations in $\mu g.g^{-1}$ oven dry spoil; NA = Not applicable; S.D. = Standard deviation; EC = Electrical conductivity; * = Mean of two replicates taken from bulked sample.

Soil texture was determined by the Hydrometer method of Day (1965) after dispersion in Na-hexametaphosphate. The pH was measured in 0.01 M $CaCl_2$. Electrical conductivity (EC) and Cation concentration were measured by Atomic Absorption Spectrophotometry. Minerals (available) nitrogen was determined after extraction in 2N KCl (Bremner 1965). Phosphorus was detrmined using the method of Olsen & Dean (1965). Total water soluble sulphate sulphur was measured turbidimetrically (ADAS 1981). All analysis were carried out on air-dried material but results are expressed on an oven-dry (105°C) weight basis after correction for moisture content.

Glasshouse trials:

Polyethelene bags (15 cm X 25 cm) were filled up with pure iron ore mine waste soil (IMWS). Seeds of nine plant species viz., *Delonix regia, Tamarindus indica, Acacia farnesiana, Acacia mangium, Adenanthera pavonina, Albizzia lebbeck, Leucaena leucocephala, Samanea saman* and *Ziziphus jujuba* were soaked for 24 hr in water and sown separately in vermiculite. Adequate water and sufficient light was provided. The germinated seedlings after a week were transferred to the polyethelene bags after adding 2g VAM inoculum containing 20 spores (approx.)/g soil and other infective VAM propagules was applied to 2-3 cm below the germinated seedlings.

There were two treatments viz., *Glomus mosseae* (Nicol & Gerde). Gerdemann & Trappe and *Glomus fasciculatum* (Thaxter sensu Gerdemann) Gerdemann & Trappe and control which contained pure

iron ore mine reject. Three replicates of each treatment were made. All the polybags were watered whenever necessary. The plants were harvested 120 days after sowing. Mycorrhizal % colonization of the roots was determined by clearing the roots with KOH and staining with trypan blue (Phillips & Hayman 1970). Dry-weights of plants were recorded after drying to a constant weight.

Results and Discussion

The pH of the reject dumps was found to be 6.02 (0.18) with an EC value of 0.005 (0.012) (MS cm^{-1}). All the plant macro and micro-nutrients analyzed were in very low levels (Table 1).

TABLE 2 - EFFECT OF TWO VAM SPECIES ON TOTAL DRY WEIGHT (SHOOT AND ROOT) OF SOME PLANT SPECIES GROWN IN IRON ORE MINE REJECTS

Plant species	Treatment	Total dry wt. (g)
Delonix regia	C	1.42 (0.10)
	GM	4.05 (0.31)
	GF	2.28 (0.14)
Tamarindus indica	C	1.86 (0.06)
	GM	2.54 (0.25)
	GF	1.93 (0.43)
Acacia farnesiana	C	0.22 (0.03)
	GM	1.00 (0.13)
	GF	0.64 (0.06)
Acacia mangium	C	0.12 (0.00)
	GM	0.38 (0.03)
	GF	0.35 (0.03)
Adenanthera pavonina	C	0.82 (0.09)
	GM	1.56 (0.06)
	GF	1.37 (0.10)
Albizzia lebbeck	C	0.24 (0.02)
	GM	0.86 (0.12)
	GF	0.84 (0.17)
Leucaena leucocephala	C	0.31 (0.03)
	GM	0.75 (0.09)
	GF	0.74 (0.05)
Samanea saman	C	0.44 (0.07)
	GM	2.36 (0.26)
	GF	0.89 (0.10)
Ziziphus jujuba	C	0.35 (0.04)
	GM	0.43 (0.04)
	GF	0.78 (0.07)

C = Control; GM = *Glomus mosseae*; GF = *Glomus fasciculatum* Values in the bracket indicate standard deviation. Mean of the three replicates.

Electrical conductivity (EC) indicated that there was no likelihood of salinity problems. All the plant macronutrients (N,P,K,Ca,Mg and S) were present in very low levels, and lack of N, P, and K would severely limit plant growth. The plant micronutrients (Fe, Mn, Cu and Zn) were also at low levels, some possibly low enough to cause deficiency symptoms in some plants. None of the metals were present at concentrations likely to be toxic to plants. Nutrient deficiencies are widely reported as a major limitation, particularly in terms of a low or a complete lack of organic matter and nitrogen in the mining wastes. Cope (1962) reported the deficiency of phosphorus as a common feature of mine wastes. Smith and Bradshaw (1970) stated that micronutrient deficiencies are frequently encountered in the mine wastes.

The results depicting the effect of two VAM fungi on the total biomass (dry wt. basis) of nine plant species have been depicted in Table 2. From the results it is observed that all the plant species taken up for the study showed higher total biomass when inoculated with *Glomus fasciculatum* or *Glomus mosseae* over uninoculated plants growing in pure mine rejects.

In the present study, it was seen that plants inoculated with *Glomus mosseae* showed a significant increase in growth in eight plant species as compared to plants grown in pure mine rejects (control). However, in case of *Ziziphus jujuba*, plants inoculated with *Glomus fasciculatum* proved to be more efficient as compared to plants inoculated with *G. mosseae*.

It has been reported that the ability to produce rapid and extensive infection is one of the factors contributing to the effectiveness of vesicular-arbuscular mycorrhizal (VAM) fungus at increasing nutrient uptake (Abbott & Robson 1981). The increase in phosphorus uptake by mycorrhizal plants may either be due to external hyphae decreasing the distance of diffusion of phosphorus to root surface (Abbott & Robson 1982) or to a greater efficiency of mycorrhizal roots in absorbing phosphorus from lower concentration in the soil solution (Mosse et al. 1973). The mycorrhizal fungi scavenge the phosphorus in the soil by extending their hyphae beyond the root hair and phosphorus depletion zone (Sanders & Tinker 1971). Evidences for increased uptake of Zn, Cu, Mn and Fe have been reported earlier (Krishna & Bagyaraj 1984).

It was seen that the plants grown in pure rejects showed very poor growth as compared to those which were innoculated with two VAM fungi. It is also interesting to note that out of nine species, in eight species *Glomus mosseae* appears to be the best mycorrhizal inoculant. Increase in growth and total biomass production of inoculated plants shows the positive role of VAM in promoting better plant development which will help in the successful establishment of revegetation in degraded mine leads.

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