

Identification, clonal multiplication and microbial association of *Leucaena* hybrids (Low seed yielder) compared to *Eucalyptus* and *Acacia* hybrids for optimizing land productivity”

Under Agroforestry system when tree crop is taken on new sites, some of the microbial inoculants or mycorrhizal fungi are not available. There fore productivity is going to be decreased in some of the areas where first time tree crop such as Subabul, *Eucalyptus* and *Acacia* are taken. Hence there is a need of applying biofertiliser/microbial inoculants to increases the productivity of plantations in such type of lands.

Biofertilisers such as nitrogen fixers (*Azotobacter* and *Azospirillum*) and Phosphorus solubilizer are known to support sustainable agriculture by stimulating plant growth and improving soil productivity. Mycorrhizal association is known to increase growth and yield of crops by enhanced uptake of non-available nutrients (Zinc, Copper, Sulphur and Potassium), resistance to drought and protecting plants against root invading nematodes and pathogenic fungi by producing phytohormones. Generally mycorrhizal fungi releases gibberellins, auxins (IAA), cytokinins, vitamins that increases root let size and longevity. Cytokinin regulates cell division, cell differentiation and senescence in plant tissue and help in mobilise plant nutrients. Plants colonising VAM fungi were able to absorb more Phosphorous while growing in soils amended with insoluble Phosphorous such as rock phosphate, bone meal, Tri-Calcium Phosphate (TCP) and apatite by modifying rhizophere pH through the exudations. The fungi can absorb and translocate Phosphorous from beyond nutrition depletion zone around plant root by its extra-matrical hyphae ramifying in soil, significantly increases the surface area of absorption of diffusion limited nutrients and water. It appears that physical exploration of soil by ramifying hyphae is the main mechanism by which VAM fungi improve nutrient uptake of host plants.

The effect of various microbial inoculants and VAM fungi on *Acacia*, *Eucalyptus* and Subabul seedlings was studied by procuring the Biofertilisers and VAM inoculants from University of Agricultural Sciences, Bangalore and Dharwad and was inoculated to the seeds and sown in the nursery beds. The seedlings were transplanted to poly bags and observation was taken after 6 months in the nursery and 2 years after planting in the field.

The biofertilizer and VAM inoculants used were

| Biofertilisers | VAM Inoculants |
|-----------------------|-----------------------------|
| <i>Azospirillum</i> | <i>Glomus fasciculatum</i> |
| <i>Azotobacter</i> | <i>Glomus mossae</i> |
| <i>P – solublizer</i> | <i>Gigaspora margarita</i> |
| | <i>Gigaspora aggregatum</i> |

Effect of inoculants of VAM fungi on plant growth biomass, per cent root colonization and P content in *Acacia* hybrid seedlings in nurseries.

The VAM stains of various species were inoculated to seeds and polybags containing *Acacia* seedlings and observation was recorded after 6 months in the nursery. All the plants, which were treated with VAM cultures, show substantial increase in plant height, biomass and Phosphorus content. How ever highest plant height of 23.8 cm, shoot and root dry weight of 478 mg and 72 g, P-content of 0.41 per cent and mycorrhizal root colonization of 85 per cent were obtained by inoculation with *Gigaspora margarita*. This was followed by *Glomus fasciculatum* and *Glomus mossae* (details are shown in table given below). Similar result was reported by Selvaraj *et al*, 1994 in *Acacia* seedlings.

| VAM fungi | Plant Height (cm) | Shoot Dry weight (mg/pl) | Root Dry weight (mg/pl) | Total P (%) | Root colonization (%) |
|-----------------------------------|-------------------|--------------------------|-------------------------|-------------|-----------------------|
| <i>Glomus fasciculatum</i> | 23.8 | 440 | 69 | 0.39 | 80 |
| <i>Glomus mossae</i> | 20.6 | 286 | 47 | 0.49 | 55 |
| <i>Gigaspora margarita</i> | 23.9 | 478 | 72 | 0.41 | 85 |
| <i>Gigaspora aggregatum</i> | 17.2 | 215 | 412 | 0.25 | 43 |
| Control | 12.6 | 168 | 29 | 0.19 | 5 |

Effect of inoculation of Ectomycorrhizal fungi on plant growth, biomass, root colonization and P content in Eucalyptus seedlings in nursery.

The fruiting bodies of the ecto-mycorrhizal fungus *Pisolithus tinctorius* were collected from old eucalyptus plantations and mixed in cow dung slurry. It is inoculated by dipping the seedling roots in cow dung slurry and transplanted into Polybags and observation was recorded after 6 months. The ecto-mycorrhizal inoculation substantially increases the plant height, biomass, root colonization and P content in the seedlings of *Eucalyptus*. The plant height of 26.6 cm was recorded over control of 11.5 cm, which was more than 100 per cent increase over control. A shoot dry weight of 518 mg which was three fold greater than control, similarly trend was observed in root dry weight and P content also. Similarly Natarajan (1999) observed similar trend in Eucalyptus species associated with *Pisolithus tinctorius*.

| Species | Treatment | Plant Height (cm) | Shoot Dry weight (mg/pl) | Root Dry weight (mg/pl) | Total P (%) | Root colonization (%) |
|---------------------------|-----------|-------------------|--------------------------|-------------------------|-------------|-----------------------|
| <i>Eucalyptus</i> species | VAM fungi | 26.6 | 518 | 84 | 0.44 | 86 |
| | Control | 11.5 | 171 | 30 | 0.10 | 2 |

Effect of different biofertilizer inoculants on Subabul

Effect of different biofertilizer inoculants were studied by treating the subabul seedlings planted in the field and observation was recorded after 2 years. It is very clear that microbial inoculation resulted in increased height as well as girth in subabul. A maximum height of 6.26 m and maximum girth of 15.4 cm were recorded due to inoculation with Azospirillum G3 stain. Where as control yielded only 4.9 m height and 12 cm girth. The second best treatment was Azotobacter, which produced 6.2 m height and 15.0 cm girth.

| Sl. No. | Treatments | Height (m) | Girth (cm) |
|---------|-------------------------------|-------------|-------------|
| 1 | Control | 4.90 | 12.0 |
| 2 | Azotobacter spp. | 6.20 | 15.0 |
| 3 | P – Solubilizer | 5.80 | 14.4 |
| 4 | Azospirillum spp. | 6.20 | 13.6 |
| 5 | Azospirillum G3 strain | 6.26 | 15.4 |
| | CD @ 5 % | NS | NS |
| | S.Em ± | 0.734 | 1.497 |

Effect of different VAM inoculants on *Acacia*:

There is a tremendous increase in plant height and girth of the trees treated with mycorrhiza than the control. The maximum height of 7.8 m and 32 cm girth was reported from the trees treated with *Gigaspora margarita*. The increase in height was by 80 per cent and 100 per cent in case of girth over the control. This is followed by *Glomus fasciculatum*, thus *Gigaspora margarita* is found to be preferred fungus for *Acacia* seedlings.

| VAM fungi | Plant Height (m) | GBH (cm) |
|-----------------------------------|------------------|-----------|
| <i>Glomus fasciculatum</i> | 7.30 | 27 |
| <i>Glomus mossae</i> | 6.10 | 24 |
| <i>Gigaspora margarita</i> | 7.80 | 32 |
| <i>Gigaspora aggregatum</i> | 5.90 | 18 |
| Control | 4.35 | 15 |

Field performance of *Eucalyptus pellita* and *Eucalyptus* clones inoculated with *Pisolithus tinctorius* at Kuluwalli, Karnataka.

Observation on height and girth of *Eucalyptus* were taken after 2 years planting the field. Tremendous increase in height and girth was noticed due to inoculation with *P. tinctorius*. The average height of 100 trees was found to be 7.55 m, while in case of control it was 5.88 m. There was a 40 per cent increment in girth also (26.67 cm). Increase in growth and biomass of *eucalyptus* by *Pisolithus* has also been observed by Natarajan (1999). The inoculation of *Eucalyptus* clones with *P. tinctorius* resulted in about 60 per cent more height than the control both after one and two years of planting.

| Species | Treatment | Height (m) | Girth (cm) |
|--|-----------|------------|------------|
| <i>Eucalyptus pellita</i> | Control | 5.88 | 20.41 |
| | VAM fungi | 7.55 | 26.67 |
| <i>Eucalyptus</i> Clones (2 years old) | Control | 6.31 | 17.54 |
| | VAM fungi | 9.43 | 24.55 |
| <i>Eucalyptus</i> Clones (1 years old) | Control | 3.84 | 11.67 |
| | VAM fungi | 6.25 | 16.93 |

Effect of different Biofertilisers combinations on growth of subabul

In case of Subabul (low seed yielder), height and girth were improved due to inoculation with biofertilizers. The maximum height of 6.5 m was recorded from the trees treated with the Azatobacter + Azospirillum accounting to about 44 per cent increase over control. This was followed by the treatment P solubilizer + Azospirillum with 6.0 m and girth of 13.6 cm was observed

| Sl. No. | Treatment | Height (m) | Girth (cm) |
|---------|--|------------|-------------|
| 1 | Control | 4.5 | 12.4 |
| 2 | Azatobacter + Azospirillum | 6.5 | 13.0 |
| 3 | P – solubilizer + Azatobacter + Azospirillum G3 strain | 5.4 | 13.4 |
| 4 | P – Solubilizer + Azospirillum | 6.0 | 13.6 |
| 5 | Azatobacter + Azospirillum G3 strain | 5.7 | 12.6 |
| | CD @ 5 % | NS | NS |
| | S.Em ± | 7.16 | 1.924 |

Effect of different Biofertiliser combinations on growth of *Eucalyptus*

Eucalyptus seedlings also showed very good response to biofertiliser inoculation, the data revealed that the highest height of 7.46 m was obtained by P solubilizer + Azotobacter inoculation and highest girth of 21.8 cm was observed in three combination inoculants of Azotobacter + Azospirillum + P – Solubilizer. The second best treatment was P – Solubilizer + Azospirillum G3 strain inoculation with 7.42 m height and 19.8 cm girth after a period of 2 years of planting.

| Sl. No. | Treatment | Height (m) | Girth (cm) |
|---------|---|-------------|-------------|
| 1 | Control | 5.30 | 18.8 |
| 2 | P – Solubilizer + Azospirillum G3 strain | 7.42 | 19.8 |
| 3 | Azotobacter + Azospirillum G3 strain | 6.72 | 17.2 |
| 4 | Azotobacter + P – Solubilizer | 7.46 | 16.6 |
| 5 | Azotobacter + Azospirillum + P – Solubilizer | 7.40 | 21.8 |
| 6 | Azospirillum G3 strain | 7.40 | 15.4 |
| | CD @ 5 % | NS | NS |
| | S.Em ± | 0.954 | 2.575 |

Effect of different Biofertiliser combinations on growth of *Acacia* Hybrids

Increased height and girth in *Acacia* hybrid seedlings were noticed due to biofertiliser application. P solubilizer + Azospirillum G3 strain inoculation was found to be the best combination, which yielded 6.36 m height and 26.00 cm girth. The second best treatment was P solubilizer + Azospirillum inoculation with 6.28 m height and 24.60 cm girth. The increased in the height was over 32 per cent and girth was over 50 per cent when compared to control.

| Sl. No. | Treatment | Height (m) | Girth (cm) |
|---------|---|-------------|--------------|
| 1 | Control | 4.80 | 16.80 |
| 2 | Azospirillum + Azotobacter | 6.14 | 23.40 |
| 3 | Azotobacter + Azospirillum G3 strain | 6.18 | 20.60 |
| 4 | P – Solubilizer + Azospirillum G3 strain | 6.36 | 26.00 |
| 5 | P – Solubilizer + Azospirillum | 6.28 | 24.60 |
| | CD @ 5 % | NS | NS |
| | S.Em ± | 0.633 | 2.324 |
