REVIEW
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Benefits accruing to plants due to microbial symbiosis with them are known since the early days of human civilization. Knowledge has thus progressed to identify the two most prevalent symbiotic systems of the root-nodule bacteria and the mycorrhizae almost in all of the higher plants. Subsequently, scientific researches have been made to apply and understand the effects of such inoculants mainly to our agricultural crops. The practice is now well established in the case of root-nodule bacterium - the *Rhizobium* and its allied genera such as *Bradyrhizobium*, *Azospirillum* and *Herbaspirillum* (Bagyaraj, 1996) where the prepared inocula are now commercially available for some of them. This has taken care in part the provision of nitrogen for good plant growth in agriculture. Studies to develop inocula with application technology in the case of mycorrhizae that are known to accelerate nutrient uptake by plants especially for phosphorus, zinc, and aluminium have been undertaken in the last three decades or so. Some success has been achieved for certain plantation tree species of both the temperate and sub-tropical evergreen forests (Marx, 1980).

With the realization of the need to undertake massive
tree programmes the worldover, for increased biomass production and reforestation of the waste-lands, researches on application of the biofertilization practice to plantation tree species has gathered impetus and the information obtained on this aspect of plant biotechnology is being reviewed here.

ASSOCIATION STUDIES:

A. RHIZOBIUM:

The earlier descriptions of nodule formation on certain leguminous tree and shrubs are given by Spratt (1919) and Lechtova Trnka (1931). They suggested that the nodules on the roots of woody species are different only in minor degrees from the nodules of herbaceous plants. However, in recent times a number of studies have been made on several tree species of leguminosae which include recording of plant-Rhizobium association manifested in the form of root nodules.

Kidby (1966) and Goodchild & Bergessen (1966) studied the form of nodules in certain species and observed that it was determined primarily by the host but modified by the effectiveness of the associated Rhizobium.

Basak and Goyal (1975, 1980a) studied 25 species of tree legumes of desert area belonging to genera Acacia, Albizia, Bauhinia, Colophospermum, Dichrostachys, Leucaena, Paltophorum and Prosopis for their ability to produce nodules from the native rhizobia and reported that only 19 out of 25 species could produce nodules. They further noted that nodulation varied from site to site. Basak and Goyal (1980b) showed that Rhizobium
isolates from these legumes belonged to cowpea group of rhizobia with comparatively high tolerance to salt and ability to grow at higher temperatures. These isolates showed promising effect on other cultivated legumes as well.

Jayaraman et al. (1985) observed ecological adaptation in certain nodulating tree species in Western Ghat regions of Tamilnadu. They reported that elsewhere nodulating species of Bauhinia, Cassia, Delonix and Tamarindus, when growing at lower elevations did not produce nodules. In their study data was recorded on the morphological characteristics of root nodules like, nodule shape, position on the root, colour, surface and size (diameter/length/width) to exhibit ecological effects on the symbiosis.

Chen and Thornton (1940) reported that the effective nodules have a much greater volume of bacterial zone than the ineffective ones, and they function for nitrogen fixation for longer times. These Rhizobium isolates belonged to different serotypes, and they did not show cross reaction with the native population of Rhizobium (Lal and Khanna, 1993).

Fred et al. (1932) and Norris (1965) used the criterion of acid and alkali production under standard conditions to divide rhizobial strains into two groups i.e. fast growers and slow growers (corresponding with the rate of growth). Vincent (1962) reported that the fast growers have a mean generation time of 2-4 hr. and from relatively large colonies in 3-5 days which generally produce a large amount of free flowing gum. The slow growers on the other hand have a mean generation time of 6-8 hr.
yield colonies in 7-10 days and produce less gum which is dense and sticky.

Sanginga et al. (1989) reported that, *Rhizobium* isolates from *L. leucocephala, Sesbania rostrata, S. grandiflora* and *S. punctata* were fast grower and acid producers whereas the isolates from *Acacia albida*, were slow growing and alkali producers. However, Basak and Goyal (1975) recorded that isolates from *Acacia tortilis* were slow growing and acid producer, but Balasundaram (1987) observed that the strain isolated from *A. tortilis* from south India was fast growing.

Basak and Goyal (1975) have characterized the rhizobial strains isolated from *Acacia senegal, A. tortilis, Albizia lebbek, Prosopis cineraria* and *P. juliflora* to show that they belong to cow pea group.

Narayan & Mong (1979) also characterized the rhizobial strain being of cow pea group from *Dalbergia sissoo*.

Jamaluddin et al. (1995) have studied the relative effectiveness of different strains of rhizobium on *Albizzia lebbek* to record greater shoot length, girth, number of nodules, fresh & dry weight and N content with homologous strains as compared to the heterologous ones.

B. MYCORRHIZA:

Mycorrhiza refers to the symbiotic association between a group of root inhabiting fungi and roots of higher plants. Of the several kinds of mycorrhizae, the vesicular-arbuscular mycorrhizae (VAM) are the most prevalent type occurring in plants of
diverse habitats. The VA-mycorrhizal associations have been reported to occur with forest tree species by many investigators (Mohan Kumar & Mahadevan, 1987; Nalini et al., 1987; Byra Reddy et al., 1987; Srinivas et al., 1986; Koske, 1988; Thapar & Vijayan, 1990; Raman & Gopinathan, 1992; Thapar et al., 1992; Hariram & Santhaguru, 1993; Narayana Bhat et al., 1994; Vijaya et al., 1994; Ali et al., 1995; Dhungana et al., 1996; Gupta & Ali, 1996; Uniyal & Thapar, 1997.

In most of the surveys made in natural forests of humid tropics, association of VAM was found to be predominant (Thapar and Khan, 1973; Tupas & Sajise, 1978; De Alwis & Abeynayake, 1980; Gunatilleke & Maheswaram, 1987). Plant of sub-tropical evergreen montane forest of N.E. India also showed association of VAM fungi (Sharma et al., 1986). Lucy chong (1988) has observed that VAM fungi are more dominant in tropical conditions than in the sub-tropical ones. She has also recorded that all the 25 tree species examined were VA-mycorrhizal in Sarawak.

Redhead (1975) surveyed 66 plant species from the forests of Nigeria and found the mycorrhizal association in 59 species. Ragupathy & Mahadevan (1993) examined 737 plant species from 21 families of angiosperms and 4 species of Pteridophytes for mycorrhizal association where only 372 species showed infection. The quantum of % root colonization ranged from 10% to 90%. In their study 35 species of plants had mycorrhizal colonization higher than 75%.

Occurrence of mycorrhizal fungi in the tropical forest trees of Tamilnadu, was examined by Mohan Kumar & Mahadevan (1987). They found VAM associations in 131 out of 178 of plant
species. According to Shamsuddin (1979), 99 of 200 species of Malaysian forest trees screened had mycorrhizal association. De Alwis & Abeynayake (1980) reported endotrophic mycorrhizal association in 53 out of 63 tree species examined from Sri Lanka. In point Calimore Reserve Forest (Thanjavur District) Kannan & Lakshminarsimhan (1988) have examined 48 plant species belonging to 32 families for their mycorrhizal associations. They were classified as nonmycorrhizal (18 species), occasional mycorrhizal (5 species) and consistently mycorrhizal (25 species). Ahmad (1983) reported a frequent occurrence of the VAM association in the leguminaceous tree species found in Malaysia.

The intensity of VAM infection varied among different plant species collected from the same place as well as within the same plant species collected from different locations (Rani & Mukerji, 1987). In case of Tectona grandis % infection varied in response to its regional distribution. Raman & Gopinathan (1992) recorded 80% in tropical forest of Southern India; Thapar et al. (1992) reported 15-80% in Dehradun regions; 88% infection is reported from Nilgiri region by Narayana Bhat et al. (1994); while Verma and Jamaluddin (1995) observed 25-95% root colonization in teak from different sites of Central India. Santhaguru et al. (1995) observed no infection in 5 leguminous tree species viz. Albizzia lebbek, Bauhinia tomentosa, Cassia siamea, Prosopis spicigera and Tamarindus indica in Alagar hills region. Thapar & Vijayan (1990) and Thapar et al. (1992) have reported a frequency of VAM infection of 92% in Michelia champaca and Toona ciliata. A low degree of infection between 1-5% was recorded by
them in Albizzia lebbeck, Grewia robusta, Madhuca longifolia, and a medium degree of 40% in Terminalia arjuna, Dalbergia sissoo, Acacia auriculiformis, Emblica officinalis & Acacia nilotica. Uniyal & Thapar (1997) studied the response of Acacia nilotica, of thirteen different seed origin, to inoculation with VAM fungi with the result of 46% to 96% of root colonization in them, which suggested that VAM infectivity was not affected by the native of seed origin in this system. Among the 44 plant species investigated by Hariram & Santhaguru (1993) VAM infection was found in 95.45% of them in varying degrees of infection. Mathur and Vyas (1994) recorded 42-68% VAM colonization in 5 different root samples of Prosopis cineraria collected from different arid and semi-arid regions of Thar desert.

Sharma et al. (1986) investigated the status of mycorrhizae in subtropical forest ecosystem of Meghalaya and observed that eighteen tree species were endomycorrhizal, five ectomycorrhizal, two ericoid and one with ectendo-mycorrhizal association. Rachel et al. (1989) investigated VA-mycorrhizal infection in different angiospermic plant species in semiarid soils of Andhra Pradesh. In all 30 plant species representing 20 angiospermic families were investigated for mycorrhizal association. The results of this study were positive for 29 plant species and negative in respect of Solanum surattense.

Ali et al. (1995) have reported that most of the tree species, distributed in the tropical forests of Raipur in Central India, were VA-mycorrhizal.

A number of studies have been done for preliminary screening of different VAM fungi in forest soils and rhizospheres
of tree species in India and elsewhere. Thapar & Khan (1985a) surveyed forest soils in 21 locations spread over 8 states of India for occurrence and frequency of distribution of the VA- mycorrhizal fungi. They isolated 15 species belonging to 4 genera of Endogonaceae i.e. Acaulospora, Gigaspora, Glomus and Sclerocystis. Spores of Glomus macrocarpum were the most widely distributed in these places which was followed by Sclerocystis spp., Gigaspora gigantia and Acaulospora spp.

Durga et al. (1990) obtained a fair distribution of Acaulospora laevis, Glomus caledonium, G. fascioulatum, G. mosseae, G. multicaule, G. tortuosum, Scutellospora gregaria and Sclerocystis rubiformis in the teak forests of Andhra Pradesh. Work on survey of VAM occurrence in five desert regions of Rajasthan was initiated by Shanker et al. (1990). They have isolated fourteen species of different VAM fungi belonging to six genera i.e. Endogone (2 spp.), Gigaspora (2 spp.), Glomus (6 spp.), Sclerocystis (2 spp.), Scutellospora (1 sp.), and Acaulospora (1 sp.). The dominant VAM species here was Glomus macrocarpum that showed a uniform distribution in all the rhizosphere samples.

Srinivas et al. (1988) isolated, 4 Acaulospora, 6 Glomus and 1 Gigaspora species from Coimbatore, Periyar and Nilgiri districts of Tamilnadu.

The VAM fungi associated with Leucaena spp. in South India belonged to 4 species of the genus Glomus (Nalini et al., 1987; Byra Reddy et al., 1987). In the rhizosphere soil of Azadirachta indica in nurseries and plantation sites of different parts of Rajasthan, Glomus spp. is dominant with an exception of
Sclerocystis in some plantations. Among the Glomus species, Glomus fasciculatum was predominant (Mohan et al., 1995).

Ali et al. (1995) have reported 22 species of VAM fungi from the Tropical forest soils in Central India. Taxonomically, they belong to the genera Glomus, Gigaspora, Acaulospora Sclerocystis and Enterosphora; Glomus was widely distributed in comparison of the others.

Mohan Kumar and Mahadevan (1988) have observed that VAM spores in their distribution frequency have a direct relationship with the seasonal variation of climates altitude and the depth of soil in the Kalakad reserve forest in Tamilnadu. Raman and Gopinathan (1992) also recorded maximum spore population during late winter seasons, and maximum root colonization during summer season in tropical forest soils of Southern India. They reported isolation of fourteen VAM species belonging to 5 genera namely, Acaulospora, Enterosphora, Gigaspora, Glomus and Sclerocystis. Among them Acaulospora pilastata, Enterosphora columbiana, Glomus heterosporum and Sclerocystis coremoides were said to be new species from the Indian soils.

Similarly, Mathur and Vyas (1994) also reported distribution of seven VAM species namely, Glomus fasciculatum, G. mossaeae, G. constrictum, Gigaspora margarita, Scutellospora calospora, Acaulospora morrowae and Sclerocystis rubiformis in rhizosphere soil of Prosopis cineraria from different locations of arid and semi-arid regions of the Thar desert.
APPLICATION

A. RHIZOBIUM:

In relation to plant growth, most effective and competitive rhizobial inoculum improved survival and establishment of seedling in field condition (Sanginga et al., 1989; Balasundarum and Mohamed Ali, 1987).

The response of legume trees to inoculation with Rhizobium have been assessed in various pot and field trials (Subbarao et al., 1986, Tilak, 1985). The rhizobial inoculation of root stumps improved nodulation and plant biomass of red sanders treated with IBA (Reddy and Rajsekhar, 1994).

The effect of seed bacterization with Rhizobium and Azotobacter chroococcum on some fast growing tree species viz. L. leucocephala, P. juliflora, C. Siamea, Gmelina arborea and Eucalyptus camaldulensis in nursery has been investigated by Meshram et al., (1992, 1994). They have reported improvement in germination percentage, seedling health and percent survival in the field of the inoculated ones over the control.

Balaji and Rangarajan, (1985) have observed that ADC2 rhizobial strain was most efficient for Samania saman, A. nilotica and L. leucocephala, which increased shoot dry weight compared to two other rhizobial strains (ANM.11 and ECM.1). Mallesha & Bagyaraj (1990) has reported, TAL1145 is to be most efficient Rhizobial strain for Leucaena.

Balaji & Rangarajan (1985) have reported increase in shoot dry weight over control by 21% in Acacia nilotica, 36% in Samania saman and 36% in L. leucocephala on inoculation with
Rhizobium. Sangings et al. (1989) found that *Rhizobium* strain IRC 1045 and IRC 1050 were most effective for survival of *Leucaena leucocephala* in the field for 1 year after establishment in Nigerian soil. Perwaringam and Kadir (1989) showed a significant difference on growth, nodulation and nitrogen fixing activity of *Erythrina orientalis*, inoculated with different *Rhizobium* strains over control.

Renodulation and nitrogen fixing potential of *Acacia nilotica* inoculated with *Rhizobium* isolates was studied by Lal and Khanna (1993). They observed that only *Rhizobium* inoculated plants produced increased biomass as compared to control and dual (*Rhizobium* + VAM) inoculations.

Out of 35 *Rhizobium* isolates of *Acacia nilotica* screened, for salt-tolerance, two isolates; ANG 4 and ANG 5, were found to be highly salt-tolerant (850 mm NaCl) (Lal & Khanna, 1994) and can nodulate and fix N₂ in saline soil.

Prasad et al. (1984) observed that, rhizobial culture inoculation in laboratory and nursery conditions on *Leucaena* seedling, enhanced the plant height and growth.

Colonna et al. (1991) measured 4-5 times more N, P and Mg increased in *Acacia senegal* plant inoculated with *rhizobium* supplemented with phosphorus over control unsterilized soil.

**B. VAM FUNGI**

The beneficial effects of inoculation of soil with vesicular arbuscular mycorrhizal (VAM) fungi on growth of tree
spp. have been reported by several workers (Kormanik et al., 1982; Thapar and Khan, 1985b; Byra Reddy and Bagyaraj, 1988; Bagyaraj et al., 1989; Srinivas et al., 1988). The positive response of VAM singly on plant growth specially on different tree species has been reported on Eucalyptus tereticornis, Leucaena leucocephala, Acacia nilotica var. indica and Casuarina equisetifolia (Srinivas et al., 1988; Singh et al., 1991); Santalum album L. (Kuswanto, 1995); Tectona grandis, Terminalia and Dalbergia (Manoharachary and Rao, 1991); Acacia saligna (Habte & Aziz, 1985; Borges & Chaney, 1988); Tectona grandis (Durga and Gupta, 1995; Verma & Jamaluddin, 1995; Sumana & Bagyaraj, 1994); Leucaena leucocephala (Narayana Bhat et al., 1993; Manjunath et al., 1989; Nalini et al., 1987); Araucaria cunninghamii (Thapar & Khan, 1985); Terminalia bellerica (Lakshman, 1992); Caesalpinia eriostachys, Cordia alliodora, Ipomoea walcottiana and Pithecolobium mangense (Huante et al., 1993); Sesbania aculeata (Sharma et al., 1990); Prosopis (Singh et al., 1991; Uniyal & Thapar, 1995); Peltophorum pterocarpum (Ragupathy & Mahadevan, 1995); Dalbergia sissoo (Sumana & Bagyaraj, 1994; Agrawal & Chauhan, 1995). Selvaraj et al. (1996) analysed growth and productivity of different arbuscular mycorrhizae inoculated in tropical tree seedlings i.e. Acacia leucophloea, A. mangium, A. nilotica, Delonix regia, Derris indica and Tamarindus indica observed specificity of fungal symbionts to stimulate host to a significant growth response. There is wide variation among and within different species of VAM fungi in their ability for promoting growth of trees (Byra Reddy and Bagyaraj, 1988). They studied the effect of seven VAM fungi
upon four hawaiian giant cultivars (K8,KZ8,K67 and K72) of Leucaena. The studies revealed that most efficient VAM species for each tree species & cultivar would need to be selected in order to obtain maximum benefits from VAM inoculation in tree crops.

Byra Reddy and Bagyaraj (1988); Bagyaraj et al. (1989) reported Glomus mosseae, a local isolate was the best VA-mycorrhizal fungus for Leucaena to obtain healthy, vigorously growing seedlings in oxisols and vertisols. The Leucaena leucocephala infected with Glomus macrocarpum and G. fasciculatum had better growth and were well established in wastelands (Mukerji and Jagpal, 1987).

For the Dalbergia latifolia Sumana and Bagyaraj (1994) tested efficiency of eight different VAM fungi and found Glomus leptotichum and Glomus fasciculatum as best & effective VAM fungi to improve the plant growth. Reddy et al. (1996) screened 13 different VAM fungi for symbiotic efficiency against two Citrus aurantifolia Swingle (Acid lime) and found Glomus macrocarpum & G. mosseae (Local) to be the best fungi for inoculation.

Among the 9 different VA mycorrhizal fungi Glomus leptotichum was the best in increasing the biomass of Tectona grandis (by 40%) over uninoculated control (Ranjan and Bagyaraj, 1994). Thapar and Khan (1985) reported that VAM inoculated seedlings of Araucaria cunninghamii showed an increase of 65% in height and 155% in oven dry weight. Srinivas et al. (1988) reported that inoculation with Glomus fasciculatum increased the height of Acacia nilotica by 135.6% over control followed by Glomus epige-
um. Under nursery conditions *Glomus fasciculatum* was also found to increase biomass of *Ailanthus excelsa*, *Azadirachta indica* and *Parkinsonia aculeata* seedlings (Kandaswamy et al., 1987).

Vasantha Krishna and Bagyaraj (1991) investigated, *Glomus mosseae* was best efficient VAM inoculum for *Casuarina equisetifolia* seedling in the nursery stage.

*Tamarindus indica* seedling responded best to inoculation with *Gigaspora margarita* (ICRISAT) followed by *Glomus fasciculatum* (Reena and Bagyaraj, 1990), increased P content and biomass.

**VAM INOCULUM PRODUCTION**

With the realization of the importance of mycorrhizae for plant growth, effective and suitable techniques to produce VAM inoculum in sterile environment has been developed by different scientists.

The pot culturing technique was first used by Mossae (1953) who produced a pure inoculum of *Glomus mosseae* on the roots of potted strawberry plants growing in sterilized soil in the green house.

Sreenivas and Bagyaraj (1987, 88) have produced inoculum of *Glomus fasciculatum* in "Pot culture" on Rhode’s grass (*Chloris gayana* : Kunth) with the host plant grown in Perlite-Soilrite mixture (1:1 V/V).

Sreenivas and Bagyaraj (1990) latter reported that the inoculum potential was maximum at 80 ppm N applied as ammonium nitrate which was the best level and source of N for mass produc-
tion of *Glomus fasciculatum*.

Raja and Mahadevan (1995) have reported that *Kalanchoe pinnata* is an ideal host plant with vermiculite substrate for mass multiplication of *Glomus aggregatum, G. mosseae* and *Gigaspora margarita*.

Singh (1990); Singh et al. (1992) have described optimized plant growth parameters for large scale VAM production, in terms of Light intensity - 10-15 K Lux; photoperiod at 14 hrs a day; temperature 28-30°C pH of substrate 6.5-7.0; humidity 70-80%; and container size L 55 cm x B 30 cm x H 21 cm. They developed inoculum of *Glomus aggregatum, G. fasciculatum, G. mosseae* and *Gigaspora margarita* as a pure culture with Bahia and Guinea grass grown in non-organic substrate soilrite-perlite (1:1 v/v).

Krishna et al. (1985), Mosse (1981), Azcon and Ocampo (1981) and Menge et al. (1978) have reported that numerous plants are totally dependent for their sustenance on VA-mycorrhizae. Further they have reported that plants like *Sorghum, Sudan grass, Cenchrus ciliaris, Maize, Ground nut, Allium cepa* and few others were identified as the alternate or collateral hosts which help in the maximum multiplication of VA mycorrhizal fungi.

**EFFECT OF DUAL INOCULATION ON PLANT GROWTH**

In recent times, dual inoculation of grain, forage and tree legumes with VA-mycorrhiza and *Rhizobium* for synergistic benefit is being experimentally attempted and emphasized (Cluett
and Boucher, 1983; Manjunath and Bagyaraj, 1984; Singh et al., 1988; Rangarajan et al., 1988).

Positive effects of combined inoculation of VAM and Rhizobium on growth responses have been reported on Acacia mellifera, Acacia nilotica, Leucaena leucocephala (Rangarajan et al., 1988; Punj and Gupta, 1988; Gupta and Punj, 1990, Mallesha & Bagyaraj, 1990; Thapar & Uniyal, 1996); Acacia auriculiformis and Acacia mangium (De La Cruz et al., 1991); Acacia cruscarpa, Lespedeza, Entolobium saman and Albizzia lebbek (Prabakaran et al., 1994; Kaushik & Kaushik, 1995); Prosopis juliflora (Lal et al., 1990; Singh et al., 1991) and Dalbergia sissoo (Niranjan et al., 1990). Dual inoculation with Rhizobium and VA-mycorrhizal fungi not only enhances the nutrient content in the above ground plant material but also seems to provide a well balanced and regulated nutrient supply with improved efficiency of the biosynthetic processes taking place in the plants having established legume Rhizobium mycorrhizal association.

Hogberg and Kvarnstrom (1982) reported the Leucaena in association with an effective strain of Rhizobium can fix 110 kg of N/ha/year. Enhanced growth due to Rhizobium and mycorrhizal association have also been reported by Roskoski et al., (1986) and Mukerji and Jagpal (1987).

Niranjan et al., (1990) were reported that, shoot and root length, dry weight, chlorophyll content and total plant protein content were much better in VAM and Rhizobium treated plant than the untreated ones in Dalbergia sissoo. The maximum growth was recorded in the dual inoculated plants.

Kormanik et al., (1982); Thapar and Khan (1985b) also
reported the beneficial effect of VAM fungal inoculation on tree species. Thapar et al. (1990) revealed that none of the non-mycorrhizal seedlings grew as fast as those with VAM fungus in saline soil. The effect of VAM fungi on growth of A. nilotica was positive but this trend was not noticed with *Rhizobium* alone as well as with dual inoculation. Thapar & Uniyal (1996) has observed that, VAM fungi (*Glomus macrocarpum*) and *Rhizobium* inoculation improved height of *Acacia nilotica* 17.8% and 50.5% in sodic and amended sodic soil respectively. The dry biomass increased & 166.7% increase was observed with VAM inoculation.

Sharma et al., (1990) also observed that, dual inoculation with *Rhizobium* and VAM exhibited better height growth and dry biomass production as compared to only *Rhizobium* or VAM treated plants in *A. nilotica*.

Verma et al., (1994) reported that, inoculation of VAM fungi and *Rhizobium* singly or in combination is equally or more beneficial over use of chemical fertilizers in raising the seedlings of *A. nilotica*.

Sengupta and Choudhari (1995) has also reported in *Sesbania grandiflora* significantly higher root and shoot dry matter yield in the inoculated plants over control.

*Rhizobium* and endomycorrhizae improve the quality of seedling of tree in nursery stage (Kormanik, 1980; Behl, 1990) which promote the survival and growth of transplanting stock.

Shivaram and Rai (1990) have found that a combined inoculation of the mix pasture (VAM + *Rhizobium*) had shown a significant increase in dry matter production by 19% and in N &
P uptake as well.

This is the state of art in the subject that has been considered relevant in the context of this study made with the objective of using microbial symbionts of tree species for success in plantation efforts.