African Journal of Biotechnology Vol. 10(51), pp. 10425-10430, 7 September, 2011
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.2207
ISSN 1684–5315 © 2011 Academic Journals

Full Length Research Paper

Mycorrhizal association of some agroforestry tree species in two social forestry nurseries

Pavan Kumar Pindi

Department of Microbiology, Palamuru University, Mahabubnagar 509001, Andhra Pradesh, India.
E-mail: pavankumarpindi@gmail.com.

Accepted 5 May, 2011

Mycorrhizal colonization of different agroforestry tree species in two social forestry nurseries was investigated. Percentage of Arbuscular mycorrhizal (AM) infection, number of resting spores and AM fungi species varies both in tree species as well as in two different nurseries. This variation is attributed to various factors such as mycorrhizal status and other management practices. In both nurseries, *Glomus* species dominated in all tree species followed by *Sclerocystic, Gigaspora, Acaulospora, Scutellospora and Entrophospora*. Interestingly, *Azadirachta indica* and *Terminalia catappa* have shown maximum and minimum infection respectively in both nurseries. Certainly, mycorrhizae could contribute substantially to achieve better results.

Key words: Arbuscular mycorrhizal fungi, agroforestry tree species.

INTRODUCTION

Agroforestry has considerable potential, not as the only way to improve agricultural production, but as one important way to enhance and maintain overall productivity of the small upland farm, the agricultural unit that is becoming more prevalent in many parts of the world. Certainly, mycorrhizae could contribute substantially to achieve better results. The benefits of agroforestry includes the amelioration of soil chemical and physical properties, the induction of soil erosion, improved weed control and increased availability of fuel wood and/or fodder (Chin and Huxley, 1996). Arbuscular mycorrhizal fungi (AMF), belonging to the phylum *Glomeromycota*, are obligate symbiotic fungi forming mutualistic associations with the roots of most land plants. Increased access to low-mobility soil mineral nutrients has been considered to be the main beneficial effect of AMF on their host plants (Smith and Read, 1997). Though late, the importance of AM fungi in nursery management and in revegetation efforts of various types of lands has been realized and of late, it has become an integral part of all stages of afforestation programmes. A rapid production of tree seedlings in the nurseries and a high survival rate after planting is important for reversing the current degradation of natural forests, woodlands and shrublands in the tropics. An efficient production of seedlings of exotic tree species would permit the allocation of more resources to the establishment of indigenous tree species. The other functions attributed to AM fungi include production of plant growth hormones, protection of host roots from pathogens, uptake of heavy metals, salinity tolerance, uptake of radionuclides and protection of plants from radioactivity (Selvaraj et al, 2004, 2005). Nursery studies have repeatedly shown increases in the quality of seedlings with mycorrhizae, as compared to those without mycorrhizae. Endomycorrhizal deficiencies may result from soil fumigation or from fungicide application that eliminate or drastically reduce soil populations of the fungi. Inoculation with AM fungi has become a common practice in citrus nurseries in the USA due to the reduction of the fungal population, resulting from soil sterilization and the consequent decreasing tree growth (Powell, 1984). A successful nursery operation depends on many factors: selection and development of a suitable site; efficient supervision and administration; adequate planning; forecasting and control procedures; orderly timing of operations and use of appropriate cultural methods; and protection from pests, diseases and other damages.

MATERIALS AND METHODS

The investigations embodied in this work were carried out in the Department of Microbiology, Palamuru University, Mahabubnagar. Laboratory experiments were carried out under uniform laboratory conditions. Twenty seven agro-forestry nursery plants were collected from two social forestry nurseries of Mahabubnagar district (A.P), and brought to the experimental field attached to the laboratory. Three months old seedlings were used for the quantitative and qualitative estimation of AM fungi. Root system was thoroughly washed in slow running tap water and the feeder roots were collected. Philips and Hayman (1970) method was employed to clear and stain the roots for mycorrhizal association. Percentage of infection was calculated by the method and formula suggested by Giovanetti and Mosse (1980). AM resting spores in the rhizosphere soil were extracted by wet sieving and decanting method of Gerdemann and Nicolson (1963). The resting spores were identified by referring the manual of Schenk and Perez (1988). The data generated for the number of spores and percentage (%) infection was subjected to statistical analysis using Smith's Statistical Package (SSP) version 2.80.

RESULTS AND DISCUSSION

Nursery studies have repeatedly shown increase in the quality of seedlings with endomycorrhizae, as compared to those without endomycorrhizae. Tropical trees inoculated with AM fungi have shown increased nutrient uptake and growth, withstanding the transplant shock, hostile conditions like drought resistance and survival (Michelson and Rosendahl, 1990). The fundamental importance of the mycorrhizal associations in restoration and to improve revegetation is well recognized (Reynolds et al., 2006). This foregone discussion emphasizes the significance of mycorrhizae at the nursery stage. In the present study, an attempt has been made to determine the mycorrhizal status of twenty nine agroforestry tree species, in two social forestry nurseries, keeping in mind the possible role of AM fungi in the sapling field establishment and further to evaluate the possible application of AM fungal technology in the agroforestry.

The results (Table 1) revealed that, all the agroforestry tree species saplings, without any exception, showed the mycorrhizal association. However, the percentage of colonization, type of association and the number of resting spores in the rhizosphere varied from species to species. The percentage of infection for the same species varied in two nurseries. A critical perusal of Table 1 reveals a significant variation in the symbiotic association and growth of the plants. Mycorrhizal colonization, in different agroforestry tree species ranged between 46 and 95% in Gadwal and 41 and 89% in Shadnagar nurseries. Resting spore population in rhizosphere was found to be directly proportional to mycorrhizal root colonization. Interestingly, *Azadirachta indica* have shown maximum infection in both nurseries and *Diospyros melanoxylon* in Gadwal *and Eucalyptus tereticornis* in Shadnagar nursery showed minimum infection, respectively. The number of resting spores also differed from species to species. In contrast to percentage of infection, a lot of quantitative variation was observed in spore density (Figures 1 and 2). In most of the cases, direct correlation was observed between the percentage of infection and number of propagules in the rhizosphere (Figures 3 and 4). Contrarily, Mago and Mukerji (1994) observed a negative relationship between percent infections and AM fungal propagules in the rhizosphere. Saplings grown in nursery-I have shown more infection and spore density than those grown in nursery-II. This variation can be attributed to various factors such as physico-chemical characteristics and mycorrhizal status of the soil that is used for raising the saplings, the treatment of soil such as, the use of farmyard manure (FYM), fertilizers and various other management practices. Such differential mycorrhizal colonization of same species has been reported under different agro-edaphic regions Ravi et al. (1995), Mohan and Verma (1995) and Srivastava and Babu (1995). Mycelial colonization was found in all the species. Arbuscular colonization was found only in few species. This may be due to the fact that the arbuscules are very short lived and found only in very young feeder roots and owing their digestion in the mature or old roots. Hirrel et al. (1978) stated that the absence of arbuscules could indicate a non-functional mycorrhizal association or a non-symbiotic colonization of roots by hyphae of a nearby mycorrhizal plant.

Excluding *A. indica*, a Meliaceae member, legume group of plants belonging to Fabaceae, Caesalpinoidae and Mimosoidae have shown more infection. *Tectona grandis* (Euphorbiaceae), a very valuable timber yielding plant, has also exhibited a high amount of infection. Myrtaceae, Rutaceae, Annonaceae and Rhamnaceae members are moderately associated with mycorrhizae. Newman and Reddell (1987), while reviewing the distribution of mycorrhizae among the families of vascular plants, found that though the percentage species with mycorrhizal infection varied, no family was consistently non-mycorrhizal. Variation in the percentage of mycorrhizal infection in the species of different families and within the family has earlier been reported by Rachel et al. (1989), which has been attributed to the non specificity of the AM vis-a-vis the taxonomic affiliation of the host.

Glomus is associated with all the host species. In different hosts, it is represented by as much as fourteen species and many of the hosts harboured more than one species. Similarly, the percentage of *Glomus* resting spores out numbered the resting spores of all the genera

Table 1. Arbuscular mycorrhizal association of different agroforestry tree species in two social forestry nurseries.

S.No	Plant species	Family	Gadwal nursery-I		Shadnagar nursery-II	
			Percentage of infection	No. of spores/100 g soil	Percentage of infection	No. of spores/100 g soil
1	*Acacia nilotica*	Mimosoideae	71	151	56	91
2	*Acacia melanoxylon*	Mimosoideae	74	182	62	132
3	*Albizzia lebbeck*	Mimosoideae	85	251	69	199
4	*Annona squamosa*	Annonaceae	63	123	63	161
5	*Azadirachta indica*	Meliaceae	95	291	89	271
6	*Cassia siamea*	Caesalpinioideae	81	280	79	301
7	*Dalbergia sissoo*	Fabaceae	63	104	64	179
8	*Dendrocalamus strictus*	Poaceae	63	98	73	178
9	*Diospyros melanoxylon*	Ebenaceae	46	86	60	119
10	*Emblica Officinalis*	Euphorbiaceae	64	151	65	203
11	*Eucalyptus tereticornis*	Myrtaceae	66	118	41	99
12	*Gliricidia maculate*	Fabaceae	84	226	66	142
13	*Leucaena leucocephala*	Mimosoideae	82	233	49	138
14	*Mangifera indica*	Anacardiaceae	70	115	48	119
15	*Murraya koenigii*	Rutaceae	62	145	43	92
16	*Peltophorum pterocarpus*	Caesalpinoideae	74	218	61	169
17	*Polyalthia longifolia*	Annonaceae	56	163	56	141
18	*Pongamia pinnata*	Fabaceae	80	208	59	119
19	*Psidium guava*	Myrtaceae	52	106	53	135
20	*Punica granatum*	Myrtaceae	59	151	63	129
21	*Sapindus emerginatus*	Sapindaceae	72	151	58	145
22	*Saraka indica*	Caesalpinoideae	48	100	60	171
23	*Sesbania grandiflora*	Fabaceae	75	191	77	199
24	*Syzygium cuminii*	Myrtaceae	69	114	58	171
25	*Tamarindus indica*	Caesalpinoideae	58	117	50	121
26	*Tectona grandis*	Verbenaceae	81	218	69	199
27	*Zizyphus mauritiana*	Rhamnaceae	54	115	47	93
	*F-values		0.031	0.0014	0.034	0.0015

*Values are mean of three replicates and significant at P <0.05.

put together. *Entrophospora* was found to be associated with a few species only. The number of species recorded for this genus was also the least.

Generally, in both nurseries, *Glomus* species dominated in all the species followed by *Gigaspora, Sclerocystis, Acaulospora, Scutellospora* and *Entrophospora* in descending order of dominance. The slight variation in the distribution of AM fungi can be attributed to the characteristics of the soil. Mosse (1972) reported that, the specificity in AM fungi may be determined more by interactions between fungal strains and soil than between the fungus and the host plant. Endomycorrhizal deficiencies may also occur in new seedling production areas with insufficient population of appropriate endomycorrhizae.

Conclusion

Mycorrhizae could contribute substantially to achieve better results in revegetation programmes. Inoculations of forestry nursery saplings with AM fungi are being recognised (Huang et al., 1985). The beneficial effects of mycorrhizae are not only confined to the nursery but also carried to the field. Nursery management practices vary from place to place and affect the mycorrhizal

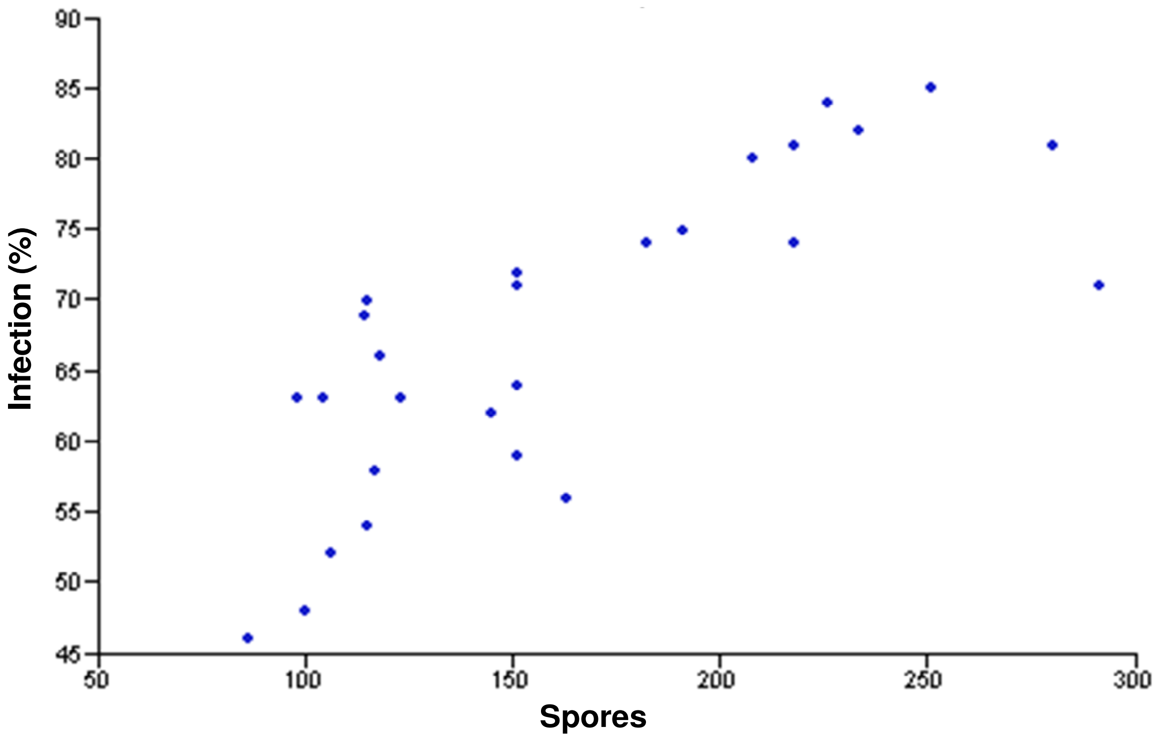

Figure 1. Scatter diagram of infection (%) against number of spores in Gadwal nursery plants.

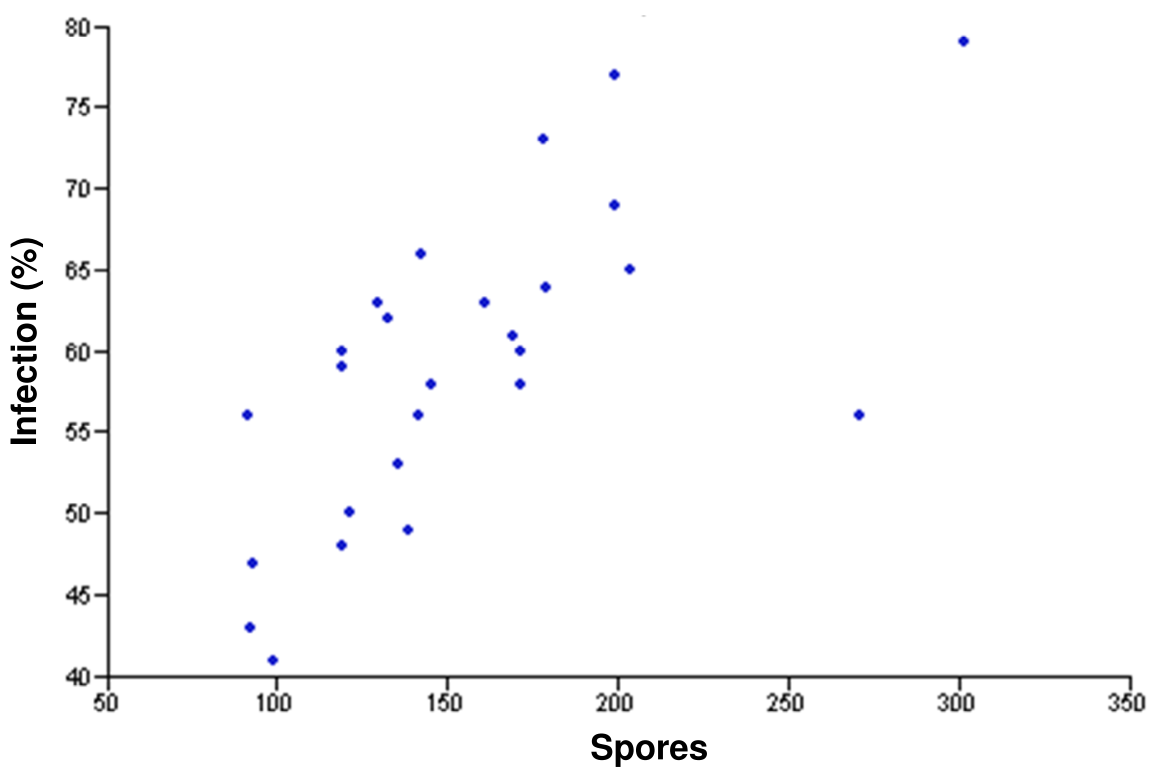

Figure 2. Scatter diagram of infection (%) against number of spores in Shadnagar nursery plants.

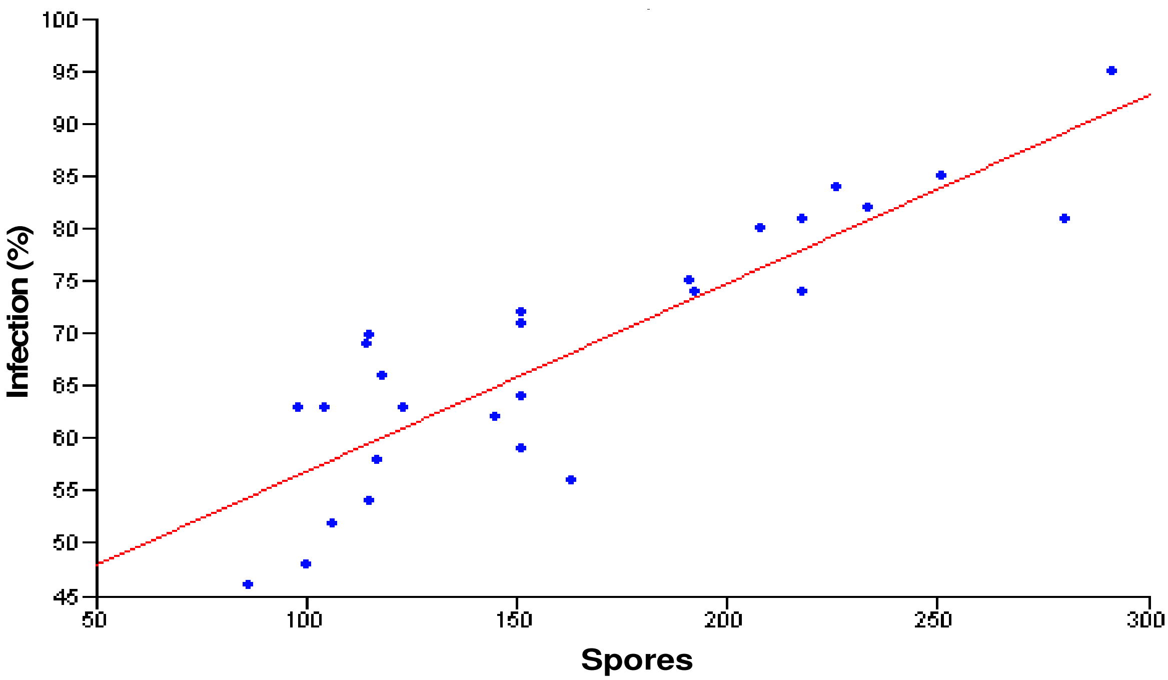

Figure 3. Simple regression analysis for Gadwal nursery plants- infection (%) against number of spores. The main regression line is shown in red. Spores of the lower infection (%) generally fell below the main regression line (they had negative residuals to root infection), thus contributing less spore production. Spores of the greater infection (%) generally rose above the main regression line (they had positive residuals to root infection), thus contributing more unique diversity.

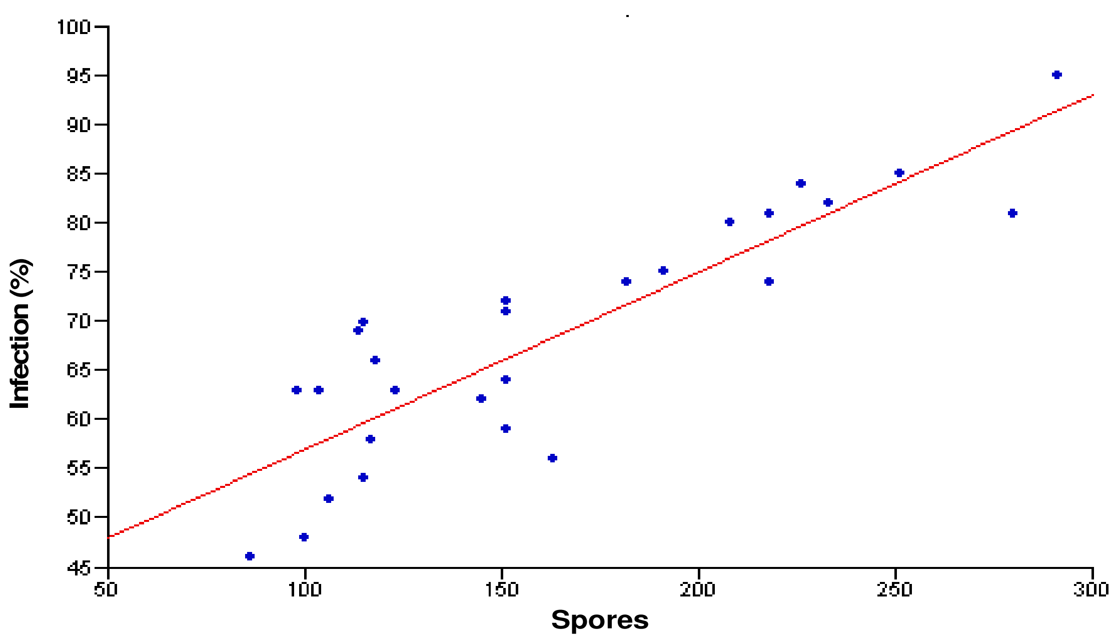

Figure 4. Simple regression of the Shadnagar nursery plants- infection (%) against number of spores. The main regression line is shown in red. Spores of the lower infection (%) generally fell below the main regression line (they had negative residuals to root infection), thus contributing less spore production. Spores of the greater infection (%) generally rose above the main regression line (they had positive residuals to root infection), thus contributing more unique diversity.

colonization. The present investigations on mycorrhizal colonization of 27 agroforestry tree species in social forestry nurseries revealed that the mycorrhizal colonization of same plant varied from nursery to nursery. The variation can be attributed to both the type of soil used for raising the seedlings and also nursery management practices. From the present investigations, it can be concluded that mycorrhizae seems to play an important role in the seedling growth and perhaps in the establishment of saplings in new habitats after transplantation. It also envisages the importance of meticulous nursery management practices that encourage the mycorrhizal colonization.

ACKNOWLEDGEMENTS

The author is grateful to Prof. Gopal Reddy, Vice-chancellor and Prof. K. Venkata Chalam, Registrar, Palamuru University for the encouragement and facilities provided.

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