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Effect of arbuscular mycorrhize on growth and productivity of *Stylosanthes seabrana*

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Introduction

Stylosanthes seabrana, an important range legume was introduced in India in the year 1998 through ACIAR-ICAR joint project. It has given good results under agroforestry/silvopastoral systems and can be grown as sole pasture crop or along with compatible grasses/legumes on a variety of soils. For its year round production, intensive cutting approach is generally employed. Under such conditions, plant demands large amount of soil nutrients for better productivity, which are generally applied as inorganic fertilizers (Chandra *et al.*, 2006).

In soils with low nutrient contents especially phosphorus (P), large amount of phosphatic fertilizers are required for establishment and growth of legumes. P is often a growth-limiting factor for plant growth and legumes are poor scavengers of P. In soils, P may present in sufficient amounts but much of it is poorly available to plants because of less solubility of phosphates of calcium, aluminum and iron. Arbuscular mycorrhizae (AM), an important soil microorganism mobilize phosphates and make available to the plants, which indirectly increases their growth (Jha *et al.*, 2012). AM fungi have proved their usefulness in plant production, How even the efficiency of AM inoculants can be affected by properties and texture of the potting substrates (Herrera-Peraza *et al.*, 2011). Since, reports on effect of AM inoculations on growth and productivity of *S. seabrana* are very scarce in literature; hence, present study was carried out to identify the suitable AM inoculants for *S. seabrana*.

Materials and Methods

A factorial experiment on effect of AM inoculations on growth and productivity of *S. seabrana* was carried out at ICAR-Central Agroforestry Research Institute, Jhansi (24°11′ N latitude and 78°17′ E longitude), India under net-house conditions. It consisted of three factors viz., AM inoculations, potting substrates and substrate sterilization. Ten inoculants (*Acaulospora mellea*, *A. scrobiculata*, *Glomus aggregatum*, *G. arborense*, *G. cerebriforme*, *G. diaphanum*, *G. fasciculatum*, *Paraglomus occultum*, *Rhizophagus intraradices*, *Simiglomus hoi*) along with control (un-inoculated) were included in the study. All mycorrhizal treatments were imposed in two common soil types of central India i.e. alfisol (sandy loam: occurs in upland areas; EC= 27.0–42.7 μS cm^{-1}, Olsen P= 4.0– 5.6 kg ha^{-1}) and vertisol (clay loam, occurs in lowland areas; EC= 57.2– 189.4 μS cm^{-1}, Olsen P= 5.6–23.4 kg ha^{-1}). Both the soils were used as natural (non-sterilized soil; NSS) and sterilized soil (SS). Thus, a total of 44 (11×2×2) treatments were employed in the study, and each treatment was replicated four times. Plants (one per replicate; 176 seedlings) were harvested after three months and observations were taken on plant height (cm), shoot and root dry weights (g), and P uptake (mg) $plant^{-1}$ (Jackson, 1973). Mycorrhizal dependency (MD) was calculated in terms of plant growth as [(M – NM)/M] × 100, using dry weights of individual mycorrhizal plants (M) and mean dry weight of corresponding non-mycorrhizal (NM) plants (Plenchette *et al.*, 1983). The data were analyzed using a three-way analysis of variance (ANOVA) by SYSTAT (version 12).

Results and Discussion

AM inoculations significantly increased plant growth (Table 1, Fig. 1&2) and P uptake. Plant height was increased by 73-98%, shoot dry weight by 68-121%, root dry weight by 109-237%, P content of host tissues by 11-46% and P uptake $plant^{-1}$ by 78-239%, over control. Comparative increase in these can be attributed to the increase in soil volume explored for nutrients/water uptake by mycorrhizal plants as compared to non-mycorrhizal ones, which leads to improved plant biomass (Jha *et al.*, 2012; Shukla *et al.*, 2012). MD of various inoculants ranged between 40.1-60.7%. It could be due to their coarse root systems (Chandra *et al.*, 2006). Plants having coarse root systems are more mycotrophic than those with highly branched root systems.

Table 1 Summary table of three-way ANOVA, assessing the effects of AM inoculations (AMI), potting substrates (PS) and substrate sterilization (SS) as main and interactive effects on growth, phosphorus (P) uptake and mycorrhizal dependency.

Parameters	**Shoot height (cm)**		**Shoot dry weight (g)**		**Root dry weight (g)**		**P content of host tissue (µgg^{-1})**		**P uptake per plant (mg)**		**Mycorrhizal dependency (%)**	
	F ratio	*P* value	F ratio	*P* value	F ratio	*P* value	F ratio	*P* value	F ratio	*P* value	F ratio	*P* value
AMI	29.583	***	6.822	***	5.572	***	5.555	***	13.137	***	2.038	**
PS	57.830	***	74.997	***	12.058	***	74.539	***	83.435	***	460.960	***
SS	0.014	0.906	0.455	0.501	1.130	0.290	7.054	***	0.046	0.831	39.118	***
AMI × PS	6.723	***	3.906	***	1.679	0.092	1.205	0.293	1.456	0.163	2.294	0.021
AMI × SS	2.498	***	1.096	0.370	2.156	**	4.893	***	3.176	***	1.433	0.182
PS × SS	4.286	**	16.971	***	11.436	***	23.449	***	1.632	0.204	80.487	***
AMI × PS × SS	2.648	***	1.215	0.287	2.297	**	1.700	0.087	2.215	**	1.755	0.084

*** $P<0.01$, ** $P<0.05$

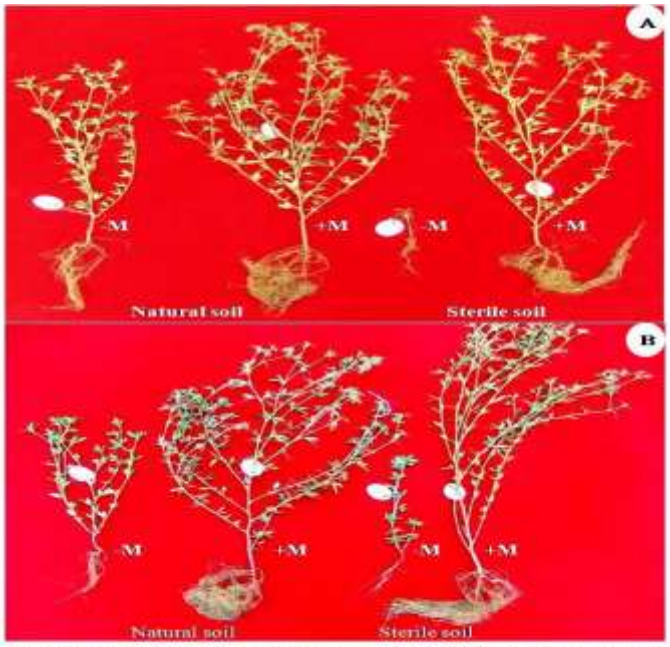

Fig. 1 Effect of AM inoculation on root development of *Stylosanthes seabrana*, grown in alfisol (A) and vertisol (B) under natural (non-sterile) and sterile soil conditions. –M, control (non-mycorrhizal plant); +M, mycorrhizal plant

Pooled means of all recorded parameters, except MD were significantly higher in vertisol (Fig. 2). It could be due to higher fertility level of vertisol. Carrenho *et al.* (2007) have suggested that clayey soils are more fertile and have higher capacity for adsorbing ions from soil solution than sandy soils (alfisol). But significantly higher value of MD was recorded in plants grown in alfisol, which can be explained on the basis of low fertility of alfisol. Less fertile soils generally limits plant development and increase their dependence on AM symbiosis (Carrenho *et al.*, 2007).

Substrate sterilization did not affect plant height, shoot and root dry weights and P uptake^{-1} (Table 1). It might be due to low microbial contents of used NSS. The natural soils (i.e. NSS) generally contains complex microbial communities such as mycorrhiza helper bacteria (*Bacillus, Pseudomonas* etc.), which modulates AM symbiosis and help plants in terms of growth and nutrient management. P content in *S. seabrana* was significantly higher in SS than in NSS. This can be due to increased nutrients release or nutrients availability as a consequence of decomposition of available soil biota killed by the process of autoclaving, elimination of plant pathogens and microbial competitors for inorganic nutrients (Zhang *et al.*, 2011). Further, the dependency of *S. seabrana* grown in SS was significantly higher than those grown in NSS. Since, the growth of un-inoculated plants in SS was almost stunted and MD was calculated on the basis of dry biomass of mycorrhizal and non-mycorrhizal plants; hence reflected higher MD value in SS than NSS.

Fig. 2 Effect of AM inoculation on growth of *Stylosanthes seabrana*, grown in vertisol under natural (non-sterile) and sterile soil conditions. C, control (un-inoculated)

Conclusion

Results showed that all tested AM inoculants increased growth and biomass of *S. seabrana* in studied soil types of central India (MD ranged from 40.1-60.7%), which indicated that any one of the inoculants could be used for *S. seabrana*.

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