Short Communication

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Effect of arbuscular mycorrhizal inoculation on growth of *Stylosanthes seabrana*

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Abstract
Effect of ten arbuscular mycorrhizal (AM) fungi on growth of *Stylosanthes seabrana* was studied in alfisol and vertisol with and without autoclaving under green house conditions, for identification of suitable AM inoculants. AM inoculations significantly increased plant growth and phosphorus (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%. Increase in above mentioned parameters can be attributed to the increase in soil volume explored for nutrients/water uptake by mycorrhizal plants as compared to non-mycorrhizal ones. The studied parameters were significantly higher in vertisol than in alfisol, which could be due to higher fertility level of vertisol. Substrate sterilization did not affect plant height, shoot and root dry weights and P uptake plant^{-1}. Mycorrhizal dependency of *S. seabrana* grown in sterile soil was significantly higher than those grown in non-sterile soil. Thus, the results showed that AM inoculants increased growth and biomass of *S. seabrana*.

Keywords: Arbuscular mycorrhizal fungi, Inoculation, *Stylosanthes seabrana*

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 at ICAR-Central Agroforestry Research Institute (CAFRI) and ICAR-Indian Grassland and Fodder Research Institute, Jhansi. It can be grown as sole pasture crop and along with compatible grasses/ legumes on a variety of soils (Gunasekaran *et al*., 2013; Meena *et al*., 2014). For its year round production, intensive cutting approach is generally employed. Under such conditions, plant demands large amount of soil nutrients for better productivity (Hayishi, 1996), 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 (Yaragoppa *et al*., 2003). 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 group of soil microorganisms, mobilize phosphates and make available to the plants, which indirectly increases their growth (Shukla *et al*., 2012). AM fungi have proved their usefulness in plant production but the progression of its use is very slow. 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; present study was carried out to identify the suitable AM fungi for *S. seabrana* in common soil types of central India.

A factorial experiment on effect of AM inoculations on growth of *S. seabrana* was carried out at CAFRI, Jhansi (24°112 N latitude and 78°172 E longitude), India under green house conditions. It consisted of three factors *viz*., AM inoculations, potting substrate and substrate sterilization. Ten AM fungi (*Acaulospora mellea*, *A. scrobiculata, Glomus aggregatum*, *G. arborense, G. cerebriforme*, *Paraglomus occultum*, *Rhizophagus diaphanus*, *R. fasciculatus, R. intraradices* and *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, pH= 6.3 (1:2.5 H_2O), EC= 0.043 dS cm^{-1}, organic C= 0.58%, Olsen P= 5.6 kg ha^{-1}) and vertisol (clay loam, pH= 7.2 (1:2.5 H_2O), EC= 0.135 dS cm^{-1}, organic C= 1.0%, Olsen P= 16.9 kg ha^{-1}). Both the soils were used with (sterile soil) and without autoclaving (non-sterile soil). 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 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).

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. The increase in above mentioned parameters 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 (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 (Jha *et al*., 2014).

All studied 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 clay soils are more fertile and have higher ion exchange capacity than sandy soils (alfisol). However, 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).

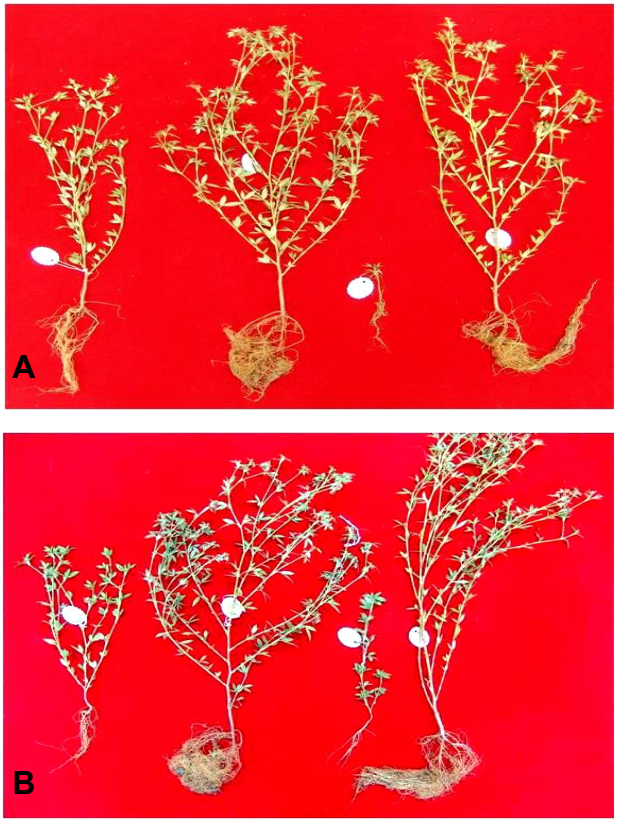

Fig 1. Effect of AM inoculation on root development of *Stylosanthes seabrana*, grown in alfisol (A) and vertisol (B) with and without autoclaving. –M, control (non-mycorrhizal plant); +M, mycorrhizal plant.

Substrate sterilization did not affect plant height, shoot and root dry weights and P uptake plant^{-1} (Table 1). It might be due to low microbial contents of used non-sterile soil. The natural soils generally contains complex microbial communities such as mycorrhiza helper bacteria (*Bacillus*, *Pseudomonas* etc.), which modulates

Table 1. Summary 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	29.58	**	6.82	**	5.57	**	5.55	**	13.13	**	2.03	*
PS	57.83	**	74.99	**	12.05	**	74.53	**	83.43	**	460.96	**
SS	0.01	0.90	0.45	0.50	1.13	0.29	7.05	**	0.04	0.83	39.11	**
AMI×PS	6.72	**	3.90	**	1.67	0.09	1.20	0.29	1.45	0.16	2.29	0.02
AMI×SS	2.49	**	1.09	0.37	2.15	*	4.89	**	3.17	**	1.43	0.18
PS×SS	4.28	*	16.97	**	11.43	**	23.44	**	1.63	0.204	80.48	**
AMI×PS×SS	2.64	**	1.21	0.28	2.29	*	1.70	0.08	2.21	*	1.75	0.08

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

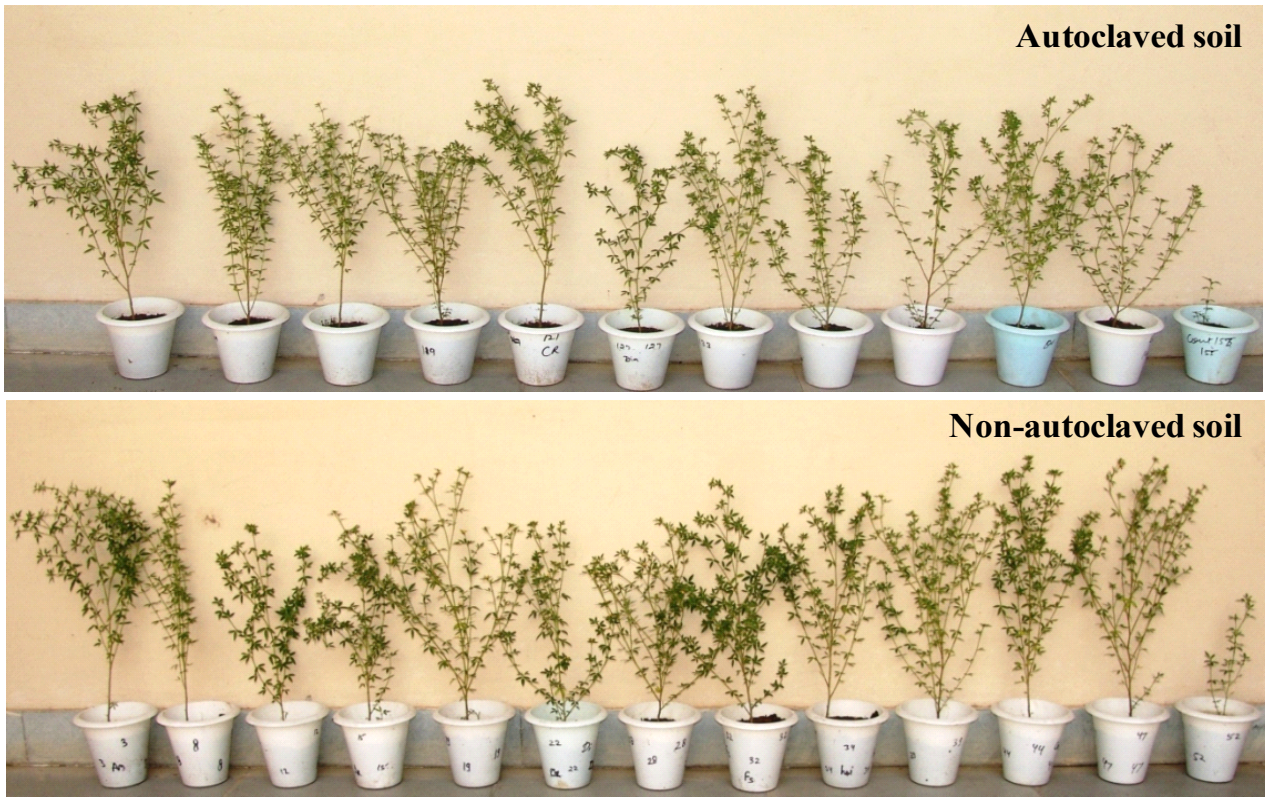

Fig 2. Effect of AM inoculation on growth of *Stylosanthes seabrana*, grown in autoclaved and non-autoclaved vertisol. C, control (un-inoculated).

AM symbiosis and help plants in terms of growth and nutrient management. P content in *S. seabrana* was significantly higher in sterile soil than in non-sterile soil. 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 sterile soil was significantly higher than those grown in non-sterile soil. Since, the growth of un-inoculated plants in sterile soil was almost stunted and MD was calculated on the basis of dry biomass of mycorrhizal and non-mycorrhizal plants; hence it reflected as higher MD value in sterile soil.

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

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