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Research Article

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Impact of Arbuscular Mycorrhizal Fungi on the Growth Parameters and Nutrient Content on Different Tree Species

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ABSTRACT

Effect of arbuscular mycorrhizal fungi on five tree species i.e. Prosopis cineraria, Dalbergia sissoo, Eucalyptus tereticornis, Azadirachta indica and Ailanthus excels were studied at CCS Haryana Agricultural University Hisar. It was summarized that mycorrhizal inoculated plants have more survival percentage, root length, shoot length, total biomass, mycorrhizal colonization, sporocarp number and nutrient content (NPK) as compared to the non inoculated plants. Among the five tree species Dalbergia sissoo have more germination, shoot length, root length, collar diameter, mycorrhizal colonization, colonization and nutrient content as compared to other four tree species.

Keywords: *Prosopis cineraria, Dalbergia sissoo, Eucalyptus tereticornis, Azadirachta indica Ailanthus excels, arbuscular mycorrhiza*

INTRODUCTION

Forests provide foundations for life on earth through ecological functions, by regulating climate and water resources and by serving as habitats for plants and animals. They also furnish a wide range of essential goods such as food, fodder, fuel and medicines, in addition to opportunities for recreation, spiritual, renewal, includes the amelioration of soil chemical and physical properties, the induction of soil erosion, improved weed control. Mycorrhizae could contribute substantially to achieve better results. Arbuscular mycorrhizal fungi (AMF) 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 & Read, 1997). 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. 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 and protection of plants from radioactivity (Pande & Tarafdar, 2004 and Brahmaprakash & Sahu, 2012).

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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. AM fungi are eco-friendly renewable, cost effective and pollution free. Therefore, use of these beneficial microorganisms fungi provides an effective alternate to improve growth and nutrient status of plants. Raising of high quality elite seedlings in necessary to establish a good plantation. The apparent results of the beneficial microorganisms may not be evident under all natural conditions because of insufficient population naturally occurring in the soil (Powell & Daniel, 1978). Therefore, application of most suitable beneficial microorganisms becomes imminent in nursery conditions. Since very limited work is done on the use of AM fungi on different forest trees *i.e. Prosopis cineraria, Dalbergia sissoo, Eucalyptus tereticornis, Azadirachta indica* and *Ailanthus excels*. So the experiment was planned to see the effect of AM fungi on the above different tree species.

MATERIAL AND METHODS

The present study was conducted in polythene bags under green house condition at CCS Haryana Agricultural University, Hisar during 2013 and 2014. Arbuscular mycorrhizal fungi was isolated from rhizosphere of the old plantation by using Wet Sieving and Decenting method (Gerdemann & Nicolson, 1963). The spore isolated was multiplied in the trays and the further multiplied in pots using wheat and bajra for two seasons, plants were maintained by watering regularly. The stem of the plants were cut after 90 days. The staining of the roots was done to see the spores present in the roots. The inoculums consist of mixture of soil, spores and root fragments. Two weeks before planting, the sandy soil was autoclaved at 15 lb pressure for 1 hr. Soil contained 6.8 mg phosphorus (Olsen P) kg^{-1}. In amended with 11 mg P [Ca (H_2PO_4)] kg^{-1}.The sterilized soil in polythene bags was inoculated by placing the AM inoculums at a depth of 2-3 cm below the soil surface @ 20 g/kg of soil *i.e.* 200-250 spores and 1g root bits per kg soil. Different treatments were made *i.e.* inoculation with AM fungi and without AM fungi. The surface sterilized seeds (0.1% $HgCl_2$) were sown individually in polythene bags containing sterilized soil. Root colonization was recorded by the Phillips and Hayman (1970) method. Survival percentage, root length, shoot length, collar diameter and total biomass was recorded. The samples were analyzed for N, P, K contents according to the methods given by Kalra and Maynard (1994). The design used was CRD, four replications were made and ten plants in each replication were maintained. The data thus obtained were analyzed statistically for each of the treatments.

RESULTS AND DISCUSSIONS

Root colonization and Spore count

It is clear from the data that highest root colonization (54.0 and 62.67%) number of spores (73.0 and 85.0/100 g soil) were observed in *D. Sissoo*, followed by *P. cineraria* (41.82 and 45.0% root colonization and 60.00 and 64.33% spores/100 gm soil) and *E. tereticornis* (30.33 and 33.33% root colonization and 48.33 and 56.33 spores/100g soil) during 2013 and 2014 respectively.

Survival percentage

Maximum survival percentage of seedling was recorded in *D. Sissoo* in AM inoculated plants (96.87% and 98.80% during 2013 and 2014 respectively) followed by *E. tereticornis* (85.00 and 80.93% during 2013 and 2014 respectively) and minimum in *A. excelsa* (71.30 and 73.24% during 2013 and 2014 respectively) as compared to un inoculated plants. These findings are in accordance with those of Vanagamudi et al. (1993) who reported that seed inoculation of *Azadirachta indica* with AM fungi or *Azosprillium* or PSB significantly enhanced the seed germination of *Azadirachta indica.*

Root length and Shoot length

Root Length was maximum in *D. Sissoo* (25 cm, 27.35 cm during 2013 and 2014

respectively) followed by *E. tereticornis* (17.30 cm and 19.73 cm during 2013 and 2014 respectively) and minimum in *A. exaelsa* (12.07 cm and 14.38 cm during 2013 and 2014 respectively). In case of shoot length same trend was recorded. The collar diameter was maximum in *D. Sis*soo (3.82 mm and 3.98 mm in 2013 & 2014 respectively) followed by *E. tereticornis* (2.75 mm and 2.86 mm during 2013 and 2014 respectively) and minimum in *P. cineraria* (1.03 mm and 1.03 mm during 2013 and 2014 respectively) as compared to un inoculated plants. Similar results were obtained by Kumar et al. (2008) they studied in a nursery condition, the interaction between arbuscular mycorrhizal fungus, *Glomus geosporum*, *Azotobacter chroococcum*, and a mycorrhiza helper bacterium (MHB), *Bacillus coagulans*in soil and their consequent effect on growth and nutrition of *Melia azedarach* seedlings. Triple inoculation of *G. geosporum*, *A. chroococcum*, and *B. coagulans* resulted in maximum plant biomass, biovolume and quality index of *M. azedarach* seedlings. They further reported that the triple inoculation with *G. geosporum* + *A. chroococcum* + *B. coagulans* proved to be the best microbial consortium for inoculating *M. azedarach* at nursery level in order to get healthy and vigorously growing seedlings.

Nutrient Content

Nitrogen content of soil and leaves were more in AM inoculated plants as compared to un inoculated plants. The maximum nitrogen in leaves of *D. Sisso*o was 0.85 and 0.89 in 2013 and 2014 respectively which was significantly more as compared to un inoculated plants followed by *Procopis cineria* (0.69 and 0.72 in 2013 and 2014 respectively) and it was minimum in *E. tericornis* (0.43 and 0.46 in 2013 and 2014 respectively). Similar trend for the P was also observed it was maximum in D. *sissoo* (0.050 and 0.052 during 2013 and 2014 respectively and minimum in *E. tericornis* (0.031 and 0.029 during 2013 and 2014 respectively). The potash content was also maximum in *D. sissoo* (1.29 and 1.33 during 2013 and 2014 respectively) and it was minimum in the *A. indica* (0.99 and 1.11 during 2013 and 2014 respectively). VA mycorrhizal plants have been reported to have higher concentration of nitrogen than non-mycorrhizal plants (Kaushik et al. 2000) also reported that VA inoculation significantly increased the plant growth and vigor in *A. indica* and *D. Sisso*o seedlings). Similar trend was recorded in P and K in soil and leaves. The results revealed that all the tree species were significantly higher in mycorrhizal inoculated plants than non inoculated plants. Kaushik et al. (2003) reported that *Glomus mosseae* inoculation significantly increased number of nodules in both the tree species but to varied extent. VAM inoculation significantly increased N, P and K concentration of roots and shoot in both the tree species whereas P fertilization increased P in shoots of *A. nilotica*. Roots exhibited significantly higher N and in P *A. nilotica* and P and K in Dalbergia sissoo seedlings these are same results as our findings. Similar findings were reported by Zambrano and Diaz (2008) that *Glomus* sp. and Azospirillam had significant effect on germination of *Gmelina arborae* seeds. Other studies indicated that bio inoculants such as AM fungi and PGPR have significant effect on seed germination and plant growth parameters and nutrients contents of many plant species (Singh et al., 2003, Verma et al., 2008, Zambrano & Diaz, 2008, Singh et al., 2011). The better seed germination of all the selected tree species in the present study with the application of bio-inoculants may be due to modification of soil environment surrounding the seed by inoculation with AM fungi. These findinds are in accordance with those of Budi and Setyaningsih (2013) who reported that conducted an experiment to determine the effect of biochar on the seedling quality index and growth of neem tree seedlings and AMF development grown on ultisol soil medium. The results showed that neem seedling quality index was improved by interaction of AMF fungi and biochar amendment. The growth of neem seedling was significantly increased by interactions of arbuscular mycorrhizal fungi and biochar. The combination treatment of

Glomus tunicatum and biochar 10% gave best results of height and diameter, respectively, as compared to control plant, while the combination treatment of *Gigaspora margarita* and biochar 10% gave the best result of shoot dry weight, and root dry weight as compared to control plant. The mycorrhizal root colonization was increased with increasing biochar added, but decreases when 15% of biochar was applied. N, P, and K uptake of 12 weeks neem seedling old was higher and significantly increased as compared to control plant.

Table 1: Effect of AM on Root colonization and growth parameters and nutrient content in different tree species

Tree species	Root colonization %		No. of spores/100 g of soil		Survival percentage		Biomass (g)				Nitrogen (leaves)				Phosphors (Leaves)				Pottash (Leaves)			
	2013	2014	2013	2014	2013	2014	2013		2014		2013		2014		2013		2014		2013		2014	
	AM+	AM+	AM+	AM+	AM+	AM+	AM+	AM-	AM+	AM-	AM+	AM-	AM+	AM-	AM+	AM-	AM+	AM-	AM+	AM-	AM+	AM-
D.Sisso	54.00	62.67	73.0	85.0	96.87	98.80	28.03	10.67	35.50	15.40	0.85	0.62	0.89	0.67	0.055	0.035	0.052	0.033	1.29	1.02	1.33	1.04
E.tereticornis	30.33	33.33	48.33	56.33	85.00	86.80	10.76	4.83	15.95	7.50	0.43	0.34	0.46	0.37	0.031	0.027	0.029	0.025	1.1	0.96	1.13	0.97
P. cineraria	41.82	45.00	60.00	64.33	80.93	83.35	1.83	10.20	2.49	1.57	0.69	0.65	0.72	0.67	0.045	0.031	0.042	0.029	1.2	0.89	1.25	0.94
A. indica	27.76	29.53	49.33	56.00	81.67	82.65	7.70	2.93	10.29	4.39	0.63	0.44	0.67	0.47	0.045	0.036	0.044	0.035	0.99	0.82	1.11	0.85
A. exaelsa	29.07	36.03	47.00	52.33	71.30	73.24	4.10	1.90	6.72	3.01	0.55	0.36	0.59	0.37	0.039	0.028	0.038	0.027	1.01	0.87	1.09	0.88

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