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Research Article

EFFECT OF *ACAULOSPORA SCROBICULATA* AND *GLOMUS INTRARADICES* ON THE GROWTH OF *AILANTHUS EXCELSA* SEEDLINGS

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Abstract: Pot experiment was conducted in nursery condition of Department of Forestry, CCSHAU, Hisar. Soil of potting media inoculated with two mycorrhizal fungi i.*e. Glomus intraradices* and *Acaulospora scrobiculata* with different treatments and growth parameters *i.e*. seed germination percentage, shoot and root length, collar diameter, number of leaves, root and shoot biomass and root colonization, mycorrhizal dependency and seedling quality index were observed after three months of *Ailanthus excelsa* seeds were sown in the experimental pots and found that potting media containing field soil + FYM with individual mycorrhiza performed better than other treatments.

Keywords: *Acaulospora scrobiculata, Glomus intraradices, Ailanthus excelsa, Potting media*

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Introduction

Ailanthus excelsa (Roxb), belongs to the family Simaroubaceae is a lofty deciduous tree, commonly called "Tree of Heaven". It is a versatile tree that it has become the first choice in many agro and social forestry programs due to its well adaptation to arid and semi-arid climatic conditions with annual rainfall of about 400mm; furthermore, it requires minimum care and grows well in all types of soil but best in porous sandy-loams soil [1]. For these regions, it is cultivated as an avenue tree for its deep shade and can be used for anti-erosion purposes in many parts of the country. It is native to Central India and in the northern part of the Peninsula. The tree is indigenous to central and southern India and is distributed in Madhya Pradesh, Gujarat, some costal districts of Andhra Pradesh, Orissa. It is usually absent in heavy rainfall areas, in clayey soils with poor drainage and waterlogged areas. It is well recognized that these fungi play an important role in solubilizing the essential plant nutrient, enhanced the resistance to soil borne pathogens like attacks of nematode and increased tolerance of soil stress factors to the associated trees [2]. Arbuscular mycorrhizal fungi (AMF) are obligate biotrophs, which can form mutualistic symbioses with the roots of around 80% of plant species [3]. AM symbiosis can establish extraradical mycelia, which disperse outside the roots to have access to a greater quantity of water and soil minerals for the host plants. In return, the symbiosis receives plant carbohydrates for the completion of its life cycle [4]. The AMF are important in agriculture [5], which colonizes the root system of most cultivated crop and plant [6]. These fungi are associated with enhance the growth of many plant species by increased in nutrients uptake like Nitrogen, Phosphorous, Potassium, Calcium, Magnisium, Manganese, Copper and Zinc resulting in increased growth of plants [7], the beneficial effects of AMF in improving tolerance to environmental stress conditions such as water stress [8], in some plant species are widely reported and overcome the transplant shock and synergistic interaction with beneficial micro-organisms such as N-fixers and P- solubilizers [9]. Hyphae of mycorrhiza explore a larger volume of soil and increase the phosphate solubilization from unavailable sources in the soil [10]. The mycorrhizae help to enhance the growth of seedlings and survivals under nursery conditions are well documented [11]. Keeping in view the experiment was conducted with different potting media inoculated with AMF *i.e*., *Glomus intraradices* and *Acaulospora scrobiculata*.

Material and Methods

Climate and Weather

The climate of Hisar (Haryana) is semi-arid with hot and dry desiccating winds accompanied by frequent dust storms with high velocity in summer months, severe cold during in winter months and humid warm during monsoon rainy season. The mean monthly maximum and minimum temperature sometimes exceeds 48ºC in hot summer days. Relative humidity varies from 5 to 100 percent, while temperature below freezing point accompanied by frost in winter is usually experienced in this region.

Mycorrhizal inoculum

AMF under studied were multiplied in sterile soil through inoculation of wheat plant roots separately with *Glomus intraradices* and *Acaulospora scrobiculata*. Soil and rootlets from root horizon of *Glomus intraradices* and *Acaulospora scrobiculata* inoculated wheat plants were used to inoculate *Ailanthus excelsa* seeds in twelve treatments with various potting media. Mycorrhizal evaluation in roots of *Ailanthus excelsa* seedlings were described previously by Phillips and Hayman, (1970) [12].

Mycorrhizal evaluation in roots

Roots of mycorrhizal segments were stained by following the procedure of Phillips and Hayman (1970). Infested roots with AM fungi were cut into small pieces about 2cm in length and heated at 90ºC in 10% KOH solution (10g KOH in 100 ml distilled water) for an hour over the hot plate, afterwards these root pieces of each treatment were washed with fresh KOH solution and immersed in 10% H_2O_2 solution for 30 minutes. These rootlets were washed with distilled water to remove hydrogen peroxide and HCl contamination. Finally, these rootlets were stained by simmering for 10 minutes in 0.05% trypan blue and examined under microscope for presence of hyphae, vesicules or arbuscules or any combination of these structures AM fungi.

Table-1 *Germination and growth parameters of Ailanthus excelsa seedlings grown in different potting media inoculated with mycorrhizal fungi*

Treatments	Germination (%)	Root length (cm)	Fresh root weight (g)	Dry Root Weight (g)	Shoot Length (cm)	Fresh shoot weight (g)	Dry shoot weight (g)	Collar diameter (mm)	Number of leaves/ plant
Contol (only field soil),	69.20	08.40	0.25	0.11	11.60	0.71	0.18	1.57	2
Field soil + *Glomus intraradices*	70.60	10.50	1.04	0.36	15.20	1.42	0.42	2.87	3
Field soil + *Acaulospora scrobiculata*,	70.50	19.80	1.16	0.41	14.40	1.24	0.38	2.95	4
Field soil + FYM (1:1),	73.30	16.30	0.48	0.19	13.30	0.67	0.23	2.53	3
Field soil + Pond silt (1:1)	70.20	10.11	0.41	0.16	12.60	0.58	0.19	2.34	3
Field soil + FYM + *Glomus intraradices* (1:1),	74.50	18.96	1.95	0.68	21.10	1.84	0.65	3.72	5
Field soil + FYM + *Acaulospora scrobiculata* (1:1),	76.40	27.50	2.32	0.84	20.00	1.62	0.56	3.42	4
Field soil + Pond silt + *Glomus intraradices* (1:1),	70.20	18.10	1.56	0.51	17.50	1.41	0.49	2.67	3
Field soil + Pond silt+ *Acaulospora scrobiculata* (1:1),	70.40	19.70	1.68	0.56	15.20	1.28	0.38	2.75	3
Field soil + Pond silt + FYM + *Glomus intraradices* (1:1:1),	71.60	18.50	1.52	0.54	19.50	1.58	0.53	3.34	4
Field soil + Pond silt + FYM + *Acaulospora scrobiculata* (1:1:1)	71.40	19.80	1.87	0.66	18.50	1.44	0.49	2.77	3
Field soil + Pond silt + FYM + *Acaulospora scrobiculata* + Glomus *intraradices* (1:1:1)	71.40	9.80	0.56	0.14	12.50	0.88	0.22	2.22	3
CD at 5%	03.34	02.34	0.14	0.11	01.89	0.15	0.09	0.62	NS

Table-2 *Colonization index, Mycorrhizal dependency and Seedling quality index of Ailanthus excelsa seedlings grown in different potting media inoculated with mycorrhizal fungi*

Treatments	Colonization Index (%)	Mycorrhizal Dependency (%)	Seedling Quality index (g/cm/mm)
Contol (only field soil),	-	-	0.018
Field soil + *Glomus intraradices*	19.88	66.67	0.067
Field soil + *Acaulospora scrobiculata*,	18.13	67.09	0.068
Field soil + FYM (1:1),	-	-	0.032
Field soil + Pond silt (1:1)	-	-	0.028
Field soil + FYM + *Glomus intraradices* (1:1),	33.75	80.45	0.105
Field soil + FYM + *Acaulospora scrobiculata* (1:1),	33.13	81.43	0.096
Field soil + Pond silt + *Glomus intraradices* (1:1),	26.25	74.00	0.070
Field soil + Pond silt+ *Acaulospora scrobiculata* (1:1),	24.38	72.34	0.070
Field soil + Pond silt + FYM + *Glomus intraradices* (1:1:1),	31.25	75.70	0.087
Field soil + Pond silt + FYM + *Acaulospora scrobiculata* (1:1:1)	30.88	77.39	0.079
Field soil + Pond silt + FYM + *Acaulospora scrobiculata* + *Glomus intraradices* (1:1:1)	18.88	27.78	0.025
CD at 5%	2.41	5.78	0.005

Preparation of soil

Soil were collected from Balsam and Research Farm, CCSHAU, Hisar and mixed with well-rotted FYM (Farm Yard Manure) and pond silt in 1:1:1 ratio. These potting mixtures were autoclaved at 120ºC for 30 minutes for disinfectant. Seeds of *Ailanthus excelsa* collected from plus tree at Balsam and Research Farm were sown about 2-3 cm deep in polybags of 1 kg capacity with mixing of 10g/kg inoculums of AM fungi include rhizospheric soil and roots to studied the growth parameters were studied after three months of sowing *i.e.* seed germination percentage, shoot and root length, collar diameter, number of leaves, root and shoot biomass and AM fungi root colonization, Mycorrhizial dependency, seedlings quality index. The various combination of potting mixture filled in polybags were Contol (only field soil), Field soil + *Glomus intraradices*, Field soil + *Acaulospora scrobiculata*, Field soil + FYM (1:1), Field soil + Pond silt (1:1),Field soil + FYM + *Glomus intraradices* (1:1), Field soil + FYM + *Acaulospora scrobiculata* (1:1), Field soil + Pond silt + *Glomus intraradices* (1:1), Field soil + Pond silt+ *Acaulospora scrobiculata* (1:1), Field soil + Pond silt + FYM + *Glomus intraradices* (1:1:1), Field soil + Pond silt + FYM + v (1:1:1) and Field soil + Pond silt + FYM + *Acaulospora scrobiculata*+ *Glomus intraradices* (1:1:1) and observations on root colonization were recorded by the procedure given by Giovannetti and Mosse (1980) [13].

Mycorrhizal dependency

Study of Mycorrhizal dependency was calculated in terms of plant growth using dry weights of individual plants (M), and mean dry weight of corresponding non-mycorrhizal plants given by Plenchette *et. al*. (1983) [14].

Mycorrhizal dependency (%) = [(M-NM)/M] × 100

Seedling quality index

Seedling quality index calculated using plant height plant dry weights and collar diameter using formula outlined by Dickson (1960) [15].

Seedling quality index (g/cm/mm) = Total dry weight of plant (g) / [Plant height (cm) / Collar diameter (mm)] + [Shoot dry weight (g) / Root dry weight (g)]

Statistics analysis

Seedlings of *Ailanthus excelsa* were maintained in nursery condition in CRD with twelve treatments inoculated with two AM fungi. Ten replications with three plants per replications were used for each treatment. Statistical procedures were carried out with the Software Package OPSTAT developed by CCSHAU, Hisar with significant differences were based on 5%.

Results and Discussion

The perusal of data in [Table-1] indicated that germination percent of *Ailanthus excelsa* seeds sown in different potting mixture varied from 69.20 to 76.40%. Significantly higher germination percentage were recorded in the treatment containing higher quantity of organic matter (FYM) with field soil *i.e*., Field soil + FYM+ *Acaulospora scrobiculata* (76.40%) followed by Field soil + FYM + *Glomus intraradices* (74.50%) and Field soil + FYM (73.30%) as compared with control (69.20%) these results were correlated with the finding of Ahmadloo *et al* (2012) [16] that the germination percent of *Cupressus arizonica* and *Cupressus sempervirens* seeds was better in cattle manure + decompose litter contain potting mixture. Gehlot *et al* (2014) [17] also reported that germination percentage of *Ailanthus excelsa* seeds was recorded higher in potting media contains soil and FYM. Bhasotiya and Tandel (2017) [18] also recorded that the mixture of soil:sand:FYM in 2:1:1 ratio is best in the germination of *Ailanthus excelsa* seeds. Maximum germination of *Dalbergia sissoo, Prosopis cineraria* and *Acacia nilotica* was recorded in potting media containing different quantity of FYM with other media reported by Singh *et al* (2000).

Growth parameters of *Ailanthus excelsa* like root and shoot length, fresh and dry weight of roots and shoots, collar diameter, number of leaves per plant was found significantly higher in treatment contains field soil + FYM+ *Acaulospora scrobiculata* followed by field soil + FYM + *Glomus intraradices*. Growth parameters of *Azadirachta indica* was found significantly higher when treated with mycorrhiza fungi over control reported by Banerjee *et al* (2013) [19]. Basumatary *et. al*., (2014) [20] also reported that increase in growth parameters like shoot length, diameter and biomass yield in rubber tree seedlings inoculated with *Acaulospora* and *Glomus* over control. Similar observation also reported by Berdeni *et. al*., (2018) [21] in apple seedlings treated with AM fungi. Chen *et al*., (2017) [22] observed that pistacia seedlings growth was improved when inoculated with *G. mosseae*. Similar observation also reported by Chu (1999) [23] in *E. oleracea* seedlings inoculated with *Scutellispora gilmorei*. Application of *Rhizofagus clarum* and *Glomus etunicatum* in dry matter production of star fruit reported by Filho *et. al*., (2017) [24]. Maximum increase in leaf area, shoot length, collar diameter was found in tree species treated with *Glomus mosseae* over control investigated by Ghosh and Verma (2011) [25]. Ilangamudali and Senarathne (2016) [26] found that number, volume, and dry weight of primary, secondary, tertiary and quaternary root was increased in coconut seedlings treated with mycorrhizae. AM fungi inoculated plants had better growth than uninoculated plants observed by Mohan and Sandeep (2015) [27]. AM fungi improve seedlings growth and survival reported by Mwangi *et. al*., (2017) [28].

In this experiment significantly higher growth of *Ailanthus excelsa* were recorded with potting media containing FYM than other potting media indicating that organic matter play an important role in the survival and growth of seedlings of tree species. Ahmadloo *et al* (2012) found that cattle manure and decomposed litter play an important role in germination, shoot length, collar diameter *etc* of Cupressus species. Annapurna *et. al*., (2007) [29] also suggested that different ratio of sand, soil and compost effect the growth of *Santalum album* seedings. Seedlings quality of *Azadirachta indica* was found better when grown in potting mixture containing different ratio of organic matter reported by Biradar *et. al*., (2001) [30]. Mulugeta (2014) [31] suggested that survival and growth of seedlings were also affected by different potting mixtures containing organic matter. Similar observation also reported by Han *et. al*., (2016) [32] in yellow poplar seedlings, Bhasotiya and Tandel (2017) in *Ailanthus excelsa* seedlings.

The data pertaining to colonization index, Mycorrhizal dependency and Seedling quality index is given in [Table-2]. The significantly higher values of colonization index reported highest in Field soil+ FYM+ *Glomus intraradices* followed by Field soil+ FYM+ *Acaulospora scrobiculata* at harvest and found minimum in dual inoculated treatment *i.e*., Field soil+ Pond silt+ FYM+ *Acaulospora scrobiculata+ Glomus intraradices*. The AM fungi inoculated seedlings recorded greater root colonization than uninoculated plant in *Acacia nilotica* (Mehrotra *et. al*., 1999) [33] in *Tecomela undulata*. Similar result also reported by Bi *et. al*., (2018) [34] who found higher colonization index in *Rhizophagus intraradices* than *Funneliformis mosseae* and dual inoculation in *Amygdalus pedunculata* Pall. Saritha *et. al,* (2014) [35] also found highest colonization of spota plant treated with *Glomus mosseae* than control. Jasper *et. al*., (1989) [36] observed maximum colonization in *Glomus* sp. inoculated plants than *S. calospora* whereas no inoculation was found in uninoculated plants of Acacia sp. Shukla *et. al*., (2017) [37] found higher colonization in bio-inoculated mycorrhizal *Acacia nilotica*, *Casuarina equisetifolia*, *Eucalyptus tereticornis* and *Dalbergia sissoo* plants. The mycorrhizal dependency found highest in Field soil+ FYM +*Acaulospora scrobiculata* which is statistically at par with Field soil+ FYM+ *Glomus intraradices*. Giri *et. al*., (2005) [38] found highest mycorrhizal dependency when inoculated with *Glomus intraradices* in *C. siamea* seedling. Mycorrhizal dependency is extent at which a plant species relies on mycorrhizal symbiosis for producing maximum biomass at a given level of soil fertility reported by Barua *et al*., (2010) [39] in *Gmelina arborea*, Jha *et. al*., 2017 [40] in *Jatropha curca*s L. Shukla *et. al*., (2012) [41] in *Eucalyptus tereticornis*. Jha *et. al*., (2014) in *Pongamia pinnata*. Shukla *et. al*., (2013) [42] in *Dalbergia sissoo*. Seedling quality index reported highest in treatment Field soil+ FYM+ *Glomus intraradices* followed by Field soil+ FYM+ *Acaulospora scrobiculata* and found least in control. Seedling quality index can be a good indicator for the out-planting performance of nursery raised seedlings, better nutrient availability reported bt Tsakaldimi *et. al*., (2009) [43] and Turjaman, (2009), and increase in quality index increases performance of plant Bayala *et. al*., (2009) [44].

Conclusion

Based on above mentioned results it may be concluded that potting media containing field soil + FYM + *Glomus intraradices* followed by field soil + FYM + *Acaulospora scrobiculata* had better performance on growth parameters *i.e*., shoot and root length, collar diameter, number of leaves, root and shoot biomass and AM fungi root colonization in *Ailanthus excelsa* seedlings. Further, it was also observed that combinations of both the mycorrhizae namely *Glomus intraradices* and *Acaulospora scrobiculata* in potting media had significantly poor effect on all the parameters under studied. Potting media containing field soil + FYM performed better than containing field soil + pond silt with mycorrhiza inoculum also observed during experimentation.

Application of research: It was recorded that potting media containing field soil + FYM with individual mycorrhiza performed better than potting media containing field soil + FYM + pond silt with both the mycorrhizae inoculums.

Research Category: Forestry

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Cultivar / Variety / Breed name: Ailanthus excelsa

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