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# Effect of Mycorrhizal Fungi on the Growth of *Ailanthus excelsa* Seedlings Grown in Different Potting Media under Nursery Condition

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**A B S T R A C T**

An experiment was conducted in nursery condition in Department of Forestry, CCSHAU, Hisar. Pots were filled with different soils media containing field soil (FS), farm yard manure (FYM) and pond silt (PS) were inoculated with two mycorrhizal fungi *i.e. Glomus intraradices* (G.I) sand *Acaulospora scrobiculata* (A.S). Seeds of *Ailanthus excelsa* were sown in pots for studied growth parameters *i.e* shoot and root length, collar diameter, number of leaves, root and shoot biomass and root colonization, mycorrhizal dependency and seedling quality index after three and six months of seeds sown in the pots and found that potting media containing FS + FYM with individual mycorrhiza fungi performed better than other treatments.

## Introduction

*Ailanthus excelsa* (Roxb) commonly called "Tree of Heaven" belongs to the family Simaroubaceae. It is a deciduous multipurpose tree grows well in arid and semi arid regions, its grows well in all types of soil but performed better in porous sandy-loams soil. Its leaves can feed to ruminant animals in the month of April to June and November to January in drought condition. It is one of the most important tree species in arid ecosystem to sustain the productivity of animals like goat and sheep (Jat *et al.,* 2011). It is cultivated for anti-erosion purposes in arid and semi arid regions of the country. It is usually absent in heavy clay soils, water logged area and high rainfall area with poor drainage.

For the successful plantation of Ardu in arid and semi arid region, it is necessary that its roots can be inoculated with mycorrhizal fungi before planting out from nursery because these fungi play an important role in increases the absorption area of trees roots and solubilize the essential plant nutrients.

Arbuscular mycorrhizal fungi (AMF) are obligate biotrophs, which can form mutualistic symbioses with the roots of plant

species (Giovannetti, 2008). AMF symbiosis can develop extra-radical mycelia, which disperse outside the roots to have access to a greater quantity of water and soil minerals for the host plants. In return, these mycorrhizal fungi receive plant carbohydrates for the completion of its life cycle (Genre and Bonfante, 2010). These fungi are associated with enhance the growth of many plant species by increased in nutrients uptake resulting in increased growth of plants (Miransari, 2010), the beneficial effects of AMF in improving tolerance to environmental stress conditions (Dell'Amico *et al.,* 2002). The mycorrhizae help to enhance the growth of seedlings and survivals under nursery conditions are well documented (Guissou *et al.,* 2016).

keeping in view the above facts the experiment was conducted to study the effect of mycorrhizal fungi on the seedlings of *Ailanthus excelsa* grown in different potting media under nursery condition.

## Materials 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 $48^0$C 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* (G.I) and *Acaulospora scrobiculata* (A.S). 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/colonization in roots of *Ailanthus excelsa* seedlings were described previously by Phillips and Hayman, (1970).

### Mycorrhizal evaluation in roots

Roots of mycorrhizal segments were stained by following the procedure of Phillips and Hayman (1970). Infested roots of *Ailanthus excelsa* with AM fungi were cut into small pieces about 2cm in length and heated at $90^0$C in 10% KOH solution 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.

### Preparation of soil

Field soil (FS) were collected from Balsamand Research Farm, CCSHAU, Hisar and mixed with well rotted Farm Yard Manure (FYM) and pond silt (PS) in 1:1:1 ratio. These potting mixtures were autoclaved at $120^o$C for 30 minutes for disinfectant. Seeds of *Ailanthus excelsa* collected from plus tree at Balsamand 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 and six months of sowing i.e. shoot and root length, collar diameter, number of leaves, root and shoot biomass and AM fungi root Colonization Index (CI), Mycorrhizial dependency (MD) and seedlings quality index (SQI).

The various combination of potting mixture filled in polybags were Contol (only FS), FS + G.I, FS + A.S, FS + FYM (1:1), FS oil + PS (1:1), FS + FYM + G.I (1:1), FS + FYM + A.S (1:1), FS + PS + G.I (1:1), FS + PS+ A.S (1:1), FS + PS + FYM + G.I (1:1:1), FS + PS + FYM + A.S (1:1:1) and FS + PS + FYM + A.S + G.I (1:1:1) and observations on root colonization were recorded by the procedure given by Giovannetti and Mosse (1980).

## Mycorrhizal dependency (MD)

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 (NM) given by Plenchette*et. al*. (1983).

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

## Seedling quality index (SQI)

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

$$\text{Seedling quality index (SQI) (g/cm/mm)} = \frac{\text{Total dry weight of plant (g)}}{\frac{\text{Plant height (cm)}}{\text{Collar diameter (mm)}} + \frac{\text{Shoot dry weight (g)}}{\text{Root dry weight (g)}}}$$

## 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 root growth parameters of *Ailanthus excelsa* like root length, fresh root weight and dry root weight were found significantly higher in treatment containing FS + FYM+A.S whereas, shoot parameters like shoot length, fresh shoot weight dry shoot weight, collar diameter and number of leaves were found significantly higher in treatment containing FS + FYM + G.I as compared with control after three and six months of growth of *Ailanthus excelsa* seedlings and other treatments under studied. Growth parameters of *Azadirachta indica* was found significantly higher when treated with mycorrhiza fungi over control reported by Banerjee *et. al* (2013). Basumatary *et. al*., (2014) 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) in apple seedlings treated with AM fungi. Chen *et al.,* (2017) observed that Pistacia seedlings growth was improved when inoculated with *G. mosseae*. Similar observation were also reported by Chu (1999) 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). 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). IIangamudali and Senarathne (2016) 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). AM fungi improve seedlings growth and survival reported by Mwangi *et al.,* (2017).

In this experiment significantly higher growth after three and six months of *Ailanthus excelsa* were recorded with potting media containing FS + 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) 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). Mulugeta (2014) 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) in yellow poplar seedlings, Bhasotiya and Tandel (2017) in *Ailanthus excelsa* seedlings.

The data pertaining to colonization index (CI), mycorrhizal dependency (MD) and seedling quality index (SQI) is given in Table-2. The significantly higher values of colonization index reported in FS + FYM+ G.I followed by FS + FYM+ A.S at harvest and found minimum in dual inoculated treatment i.e., FS + PS + FYM + A.S + G.I after three and six months of seedlings growth. The AM fungi inoculated seedlings recorded greater root colonization than uninoculated plant in *Acacia nilotica* (Mehrotra *et al.,* 1999) in *Tecomela undulata*. Similar result also reported by Bi *et al.,* (2018) who found higher colonization index in *Rhizophagus intraradices* than *Funneliformis mosseae* and dual inoculation in *Amygdalus pedunculata*.

Saritha *et.al,*. (2014) also found highest colonization of sapota plant treated with *Glomus mosseae* than control. Jasper *et al.,* (1989) observed maximum colonization in *Glomus sp*. inoculated plants than *S. calospora* whereas no inoculation was found in uninoculated plants of *Acacia sp*. Kaushik *et al.,* (2000) found that *Glomus mosseae* inoculation on root pathogens in *Acacia nilotica* and *Dalbergia sissoo* seedlings decreased the disease intensity and increased the N, P, K content in roots and shoots. The mycorrhizal percentage of re-watered plants was similar to that of well-watered individuals.

Drought had promoted leaf shedding in *Dalbergia sissoo,* in all the stressed conditions of mycorrhizal and non-mycorrhizal seedlings. Shukla *et al.,* (2017) found higher colonization in bio-inoculated mycorrhizal *Acacia nilotica, Casuarina equisetifolia, Eucalyptus tereticornis* and *Dalbergia sissoo* plants. The mycorrhizal dependency found highest in FS + FYM + *Acaulospora scrobiculata* which is statistically at par with FS + FYM+ *Glomus intraradices.* Giri *et al.,* (2005) 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) in *Gmelina arborea,* Jha *et al.,* (2017) in *Jatropha curcas* L. Shukla *et al.,* (2012) in *Eucalyptus tereticornis.*

**Table.1** Growth parameters of *Ailanthus excelsa* seedlings after six months of sowing

| Treatments | After 3 months | | | | | | | | After 6 month | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Root length (cm) | Fresh root weight (g) | Dry Root eight (g) | Shoot Length (cm) | Fresh Shoot weight (g) | Dry Shoot weight (g) | Collar diameter (mm) | Number of leaves/ plant | 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 FS),** | 08.40 | 0.25 | 0.11 | 11.60 | 0.71 | 0.18 | 1.57 | 2 | 11.20 | 0.81 | 0.31 | 18.50 | 1.36 | 0.47 | 2.83 | 3 |
| **FS + G.I** | 10.50 | 1.04 | 0.36 | 15.20 | 1.42 | 0.42 | 2.87 | 3 | 15.40 | 1.51 | 0.64 | 19.30 | 1.43 | 0.49 | 3.01 | 5 |
| **FS + A.S** | 15.80 | 1.16 | 0.41 | 14.40 | 1.24 | 0.38 | 2.95 | 4 | 25.90 | 1.90 | 0.82 | 23.50 | 2.89 | 1.03 | 3.56 | 6 |
| **FS + FYM (1:1)** | 16.30 | 0.48 | 0.19 | 13.30 | 0.67 | 0.23 | 2.53 | 3 | 17.30 | 2.07 | 0.98 | 24.60 | 3.40 | 1.22 | 3.62 | 5 |
| **FS + PS (1:1)** | 10.10 | 0.41 | 0.16 | 12.60 | 0.58 | 0.19 | 2.34 | 3 | 12.20 | 2.92 | 1.37 | 23.50 | 2.90 | 1.04 | 3.79 | 5 |
| **FS + FYM + G.I (1:1)** | 18.90 | 0.95 | 0.68 | 21.10 | 1.84 | 0.65 | 3.72 | 5 | 27.40 | 5.87 | 2.59 | 37.60 | 11.65 | 4.13 | 7.12 | 8 |
| **FS + FYM + A.S (1:1)** | 27.50 | 2.32 | 0.84 | 20.00 | 1.62 | 0.56 | 3.42 | 4 | 36.30 | 6.23 | 3.38 | 32.60 | 8.38 | 2.66 | 6.90 | 7 |
| **FS + PS + G.I (1:1)** | 18.10 | 1.56 | 0.51 | 17.50 | 1.41 | 0.49 | 2.67 | 3 | 20.40 | 3.02 | 1.46 | 29.40 | 5.66 | 1.81 | 4.28 | 5 |
| **FS + PS + A.S (1:1)** | 19.70 | 1.68 | 0.56 | 15.20 | 1.28 | 0.38 | 2.75 | 3 | 25.10 | 4.18 | 1.82 | 26.10 | 4.18 | 1.24 | 5.12 | 5 |
| **FS + PS + FYM + G.I (1:1:1)** | 18.50 | 1.52 | 0.54 | 19.50 | 1.58 | 0.53 | 3.34 | 4 | 22.50 | 5.45 | 1.85 | 31.20 | 7.94 | 2.50 | 5.64 | 6 |
| **FS + PS + FYM + A.S (1:1:1)** | 19.80 | 1.87 | 0.66 | 18.50 | 1.44 | 0.49 | 2.77 | 3 | 24.80 | 5.68 | 2.11 | 30.50 | 7.66 | 2.42 | 6.04 | 5 |
| **FS + PS + FYM + A.S + G.I (1:1:1)** | 09.80 | 0.56 | 0.14 | 12.50 | 0.88 | 0.22 | 2.22 | 3 | 12.30 | 1.23 | 0.74 | 22.40 | 2.75 | 0.98 | 3.44 | 4 |
| **CD at 5%** | **02.34** | **0.14** | **0.11** | **01.89** | **0.15** | **0.09** | **0.62** | **NS** | **01.68** | **0.57** | **0.15** | **01.56** | **0.69** | **0.19** | **0.55** | **2.57** |

**Table.2** Colonization index, Mycorrhizal dependency and Seedling quality index of *Ailanthus excelsa* seedlings after six months of sowing

| Treatments | After 3 months | | | After 6 month | | |
|---|---|---|---|---|---|---|
| | Colonization Index (%) | Mycorrhizal Dependency (%) | Seedling quality index (g/cm/mm) | Colonization Index (%) | Mycorrhizal Dependency (%) | Seedling quality index (g/cm/mm) |
| **Contol (only FS),** | - | - | 0.020 | - | - | 0.065 |
| **FS + G.I** | 19.88 | 62.82 | 0.077 | 26.50 | 30.97 | 0.092 |
| **FS + A.S** | 18.13 | 63.29 | 0.071 | 24.88 | 57.84 | 0.122 |
| **FS + FYM (1:1)** | - | - | 0.033 | - | - | 0.172 |
| **FS + PS (1:1)** | - | - | 0.032 | - | - | 0.237 |
| **FS + FYM + G.I (1:1)** | 33.75 | 78.20 | 0.113 | 41.25 | 88.39 | 0.627 |
| **FS + FYM + A.S (1:1)** | 33.12 | 79.29 | 0.096 | 39.35 | 87.09 | 0.561 |
| **FS + PS + G.I (1:1)** | 26.25 | 71.00 | 0.070 | 33.75 | 76.15 | 0.254 |
| **FS + PS + A.S (1:1)** | 24.38 | 69.15 | 0.070 | 32.50 | 74.51 | 0.286 |
| **FS + PS + FYM + G.I (1:1:1)** | 31.25 | 72.90 | 0.087 | 38.13 | 82.07 | 0.400 |
| **FS + PS + FYM + A.S (1:1:1)** | 30.88 | 74.78 | 0.079 | 36.25 | 82.78 | 0.440 |
| **FS + PS + FYM + A.S + G.I (1:1:1)** | 18.88 | 19.44 | 0.031 | 24.38 | 54.65 | 0.151 |
| **CD at 5%** | **02.41** | **05.78** | **0.005** | **02.90** | **05.25** | **0.059** |

Singh and Chugh, (2019) found that seedlings of plants *i.e*., *P.cineraira, D. sissoo, E. tereticornis, A. indica* and *A. excelsa* grown in pots inoculated with mycorrhizae fungi performed significantly better that uninoculated soils. Jha *et al.,* (2014) in *Pongamia pinnata*. Shukla *et al.,* (2013) 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 by Tsakaldimi *et al.,* (2009) and increase in quality index increases performance of plant Bayala *et al.,* (2009). Further, Kaushik *et al.,* (2003) reported that VAM inoculation increased N, P and K concentration in roots and shoot in *A. nilotica* and *D. sissoo*. Similar results were observed by Kumar (2020) that seedlings of *Dalbergia sisso* which were grown in the pots containing AM fungi performed significantly better in terms of growth parameters than the seedlings which were grown in the pots with un-inoculated soils in all water treatments under studied.

In conclusion based on above mentioned results it may be concluded that potting media containing FS + FYM + G.I had stimulatory effect on shoot parameters, colonization index, mycorrhizal dependency and seedling quality index and the potting media containing FS + FYM + A.S had stimulator effect on root parameters i.e., root length, fresh root weight and dry root weight. Further, it was also observed that combinations of both the mycorrhizae under studied in potting media had significantly poor effect on all the parameters after three and six months of *Ailantus exclesa* seedlings growth under studied. Potting media containing FS + FYM performed better than containing FS + PS with mycorrhiza inoculum also observed during experimentation. Finally, it was recorded that potting media containing FS + FYM with individual mycorrhizal fungi performed better than control and other treatments under studied.

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