Screening of efficient AM fungus to improve plant growth yield and biomass production of Tomato (*Solanum lycopersicum* L)

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**ABSTRACT**

The different arbuscular mycorrhizal (AM) fungi were evaluated for their symbiotic response with *Solanum lycopersicum* L (Var.Vaibhav) under greenhouse conditions. Four AM fungi were used *Rhizophagus fasciculatus* (Thaxt.) C.Walker&A.Schußle, *Gigaspora margarita* Becker & Koske, *Sclerocystis dussi* (Patouillard) von Hohnel and *Acaulospora laevis* Gerd & Trappe. All the inoculated seedlings showed significant results over control after 30, 60 and 90 days of inoculation. *Solanum lycopersicum* L (Var.Vaibhav) seedlings raised in the presence of AM fungi showed higher Shoot length, fresh weight of shoot, dry weight of root, dry weight of root, number of leaves, number of flowers and number of fruits, compared to non-inoculated control plants. The possible second influenced AM fungus was *Gigaspora margarita*, *Sclerocystis dussi* and *Acaulospora laevis*, the third and fourth respectively. *Rhizophagus fasciculatus* appeared to be the most promising AM fungus for inoculating for overall growth and biomass production of Tomato. Considering the various plant growth parameters and nutritional status of the plants, it was observed that *Rhizophagus fasciculatus* the best AM symbiont for tomato plants compared to the others used under this experiment.

**Key words:** Plant growth, Tomato, biomass, greenhouse, *Acaulospora laevis*, spore number.

**INTRODUCTION**

Arbuscular mycorrhizas are the mutualistic symbiosis between fungi in the phylum glomeromycota and most terrestrial plant roots (Smith and Read, 2008). Vegetable crops that require a nursery stage can benefit from AMF inoculation, thus its use has been incorporated into horticultural practices (Evans, 1997). Mycorrhizal symbiotic association increases the supply of mineral nutrients to the plant, particularly those whose ionic forms have a poor mobility rate or those which are present in low concentration in the soil and thus promote plant growth (Erco-lin and Reinhardt, 2011). Mycorrhizas involve plant exchange of photosynthates in return for fungal exchange of mineral nutrients. The convergence of so many unrelated forms of mycorrhizas is a testament for the mutual benefits of these trading partnerships. It is known mycorrhizal colonization effect plant growth and development owing to plant nutrition elements that are provided by mycorrhizae in a lot of plant types. (Cavagnara et al., 2006; Singh et al., 2008; Lakshman, 2009, 2012). Thus, mycorrhizal symbioses physically and chemically structure the rhizosphere, and they impact communities and ecosystems (Cardon and Whitbeck, 2007). Arbuscular mycorrhizal fungi are obligate symbionts that colonize the roots of most cultivated plant species.
Mycorrhizal symbiosis can be found in nearly all types of ecological situations and most plant species are able to form this symbiosis naturally (Smith and Read, 1997; Lakshman and Kadam, 2011). The purpose of the present research was screening for *S. lycopersicum* L., (Var. Vaibhav) that showed higher biomass and shoot and root growth on arbuscular mycorrhizal fungi. Presently, the use of AMF application as a biofertilizer has been recommended with the aim of increasing productivity and reducing fertilizer use.

**MATERIALS AND METHODS**

**Procurement of seeds**

The soil physical and chemical characteristic used for pot experiments were estimated as per Jackson (1973). The soil: sand (3:1 v/v) mixture was filled into 17.5 cm diameter pots containing 4 kg of soil. The seeds of *Solanum lycopersicum* L., (Var. Vaibhav) were collected from Namdhari seed company Bangalore, India. Seeds were surface sterilized by treating with 1% sodium hypochlorite for 2-3 min before sowing and after germination uniform seedlings were made one per pot.

**Inoculation of AM fungi**

The four AM fungal species were collected from Agricultural Microbiology Laboratory, University of agricultural sciences, Dharwad, India. *Rhizophagus fasciculatus* (Thaxt.) C.Walker & A.Schuüler, *Gigaspora margarita* Becker & Koske, *Sclerocystis dussi* (Patouillard) von Hohnel and *Acaulospora laevis* Gerd & Trappe., were mass multiplied in 32 cm diameter containing 8 kg using sterilized sand : soil (1:1 v/v ) mixture as the substrate and (*Sorghum vulgare* L.) Jowar as the host. After 30 days of growth, shoots of Jowar were chopped and the inoculum containing spores root bits was air dried. 10 g mixed inoculums of the mycorrhiza was applied to the planting area a depth of about 2 cm to the pots except non-inoculated control before sowing seeds.

**Treatments and experimental design**

The experiment was completely randomized with three replication of each treatment and noninoculated control without inoculum was maintained. The treatments were as follows.

A. Non-inoculated control
B. *Rhizophagus fasciculatus* (Thaxt.) C. Walker & A. Schuüler
C. *Gigaspora margarita* Becker & Koske
D. *Sclerocystis dussi* (Patouillard) von Hohnel
E. *Acaulospora laevis* Gerd & Trappe.

The pots were treated with 10 ml of Hoagland solution without P at an interval of 15 days. The plants were exposed to sunlight and were kept free of weeds and irrigated properly. The plants were harvested after 30, 60 and 90 days. The percentage of mycorrhizal infection was evaluated microscopically followed by clearing of roots in 10 % KOH, neutralized in 2% HCL and stained with 0.05% trypan blue in lactophenol according to method described by (Phillips and Hatman, 1970) and percent root colonization was calculated as mentioned below (Giovannetti and Mosse, 1980).

\[
\text{Percent of root colonization} = \frac{\text{No of root bits colonization}}{\text{Total number of root bits observed}} \times 100
\]

The AM fungal spores were counted in 50 g of soil by wet sieving and decanting (Gerdemann and Nicolson, 1963). The growth parameters like Shoot length, fresh weight of shoot, dry weight of root, dry weight of root, number of leaves, number of flowers and number of fruits, shoot and dry weight were determined after drying the plant samples in a hot air oven at 70°C for 1 hr.

**RESULTS AND DISCUSSION**

The selection of AM fungal species such as *Rhizophagus fasciculatus*, *Gigaspora margarita* *Sclerocystis dussi* and *Acaulospora laevis*, have clearly proved an increased shoot length, fresh and dry weight of shoot, root length, fresh and dry weight of root, number of leaves, number of flowers, number of fruits, root colonization, spore number and stem diameter the results of vaibhav variety (Table, 1). The symbiotic response of *Rhizophagus fasciculatus*, *Gigaspora margarita*, *Sclerocystis dussi* and *Acaulospora laevis* on plant growth of *Solanum lycopersicum* L. (Var. Vaibhav). The table 1 depicts that after 30 days the plants inoculated with *Rhizophagus fasciculatus* showed significant growth than all other treatments like *Gigaspora margarita*, *Sclerocystis dussi*, *Acaulospora laevis* and non-inoculated control (Figure, 1).
Figure 1: Showing symbiotic response of Rhizophagus fasciculatus, Gigaspora margarita, Sclerocystis dussi and Acaulospora laevis on plant growth of Solanum lycopersicum L., (Var. Vaibhav).

Figure 2: Showing effect of different AMF species on Solanum lycopersicum L., (Var.Vaibhav). (a) Dry weight of shoot (b).Dry weight of root, and (c). Percent of root colonization
### Table 1: Showing effect of *Rhizophagus fasciculatus*, *Gigaspora margarita*, *Sclerocystis dussii* and *Acaulospora laevis* on growth characteristics, of *Solanum lycopersicum* L. (Var. Vaibhav) for 30, 60, and 90 days. SL-shoot length, FWS-fresh weight of shoot, DWS-Dry weight of shoot, RL-Root length, FWR-Fresh weight of root, DWR-Dry weight of root, NL-Number of leaves, NF<sub>w</sub>-Number of flowers, NF<sub>r</sub>-Number of fruits, PC-percent of root colonization, SN-Spore number, SD-Stem diameter.

<table>
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<th>Treatments</th>
<th>SL</th>
<th>FWS</th>
<th>DWS</th>
<th>RL</th>
<th>FWR</th>
<th>DWR</th>
<th>NL</th>
<th>NF&lt;sub&gt;w&lt;/sub&gt;</th>
<th>NF&lt;sub&gt;r&lt;/sub&gt;</th>
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<th>SN</th>
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</table>

Data represents means ± SE of 3 replicates; each experiment was repeated thrice. Mean separation within column by Duncan’s multiple range test at $P < 0.05$. 

**Note:** The table data underlines the biological significance and potential applications of mycorrhizal fungi in enhancing plant growth and health.
Plants inoculated with *Rhizophagus fasciculatus* promoted greater shoot length (16.11 cm), fresh (21.29 g) and dry weight of shoot (1.21 g), fresh (3.74 g) and dry weight of root (0.65 g), whereas (5.09 cm) of root length was effective (Figure, 2). The numbers of leaves (31.00) were significant, inoculated with *Rhizophagus fasciculatus*. The number of flowers and fruits were not recorded. The highest root colonization (40.33%), spore number (51.66) in 50 g soil was recorded in *Rhizophagus fasciculatus*.

After 60 days, the shoot length (45.46 cm) was highest inoculated with *Rhizophagus fasciculatus*. The effect of *Rhizophagus fasciculatus* was significant in fresh weight of shoot (95.39 g), dry weight of shoot (10.57 g), root length (8.48 cm), fresh (16.90 g) and dry weight of root (4.55 g). The numbers of leaves (70.33) were more in plants inoculated with *Rhizophagus fasciculatus*. The number of flowers, (8.33), fruits, (4.33) were significant inoculated with *Rhizophagus fasciculatus* showed higher number compared to *Gigaspora margarita* and *Sclerocystis dussii*. The plants inoculated with *Rhizophagus fasciculatus* (2.50 cm) and *Gigaspora margarita* (2.09 cm) was significant. The root colonization (51.33%), spore number (67.00) in 50 g of soil was recorded significant in plants inoculated with *Rhizophagus fasciculatus*. After 90 days, *Rhizophagus fasciculatus* which showed significant increase in fresh (198.20 g) and dry weight of shoot (18.45 g), root length (11.52 cm), fresh (21.27 g) and dry weight of root (3.19 g). The significance with *Rhizophagus fasciculatus* continued to show even in flowers (8.33), number of leaves (82.38), stem diameter (3.15 cm) and spore number (75.33) in 50 g of soil.

Tomato is recognized as a mycotrophic plant (Kubota *et al.*, 2005) and the usefulness of AMF inoculation in improving the fitness and vitality of tomato host has been described under stress conditions (Karagiannis *et al.*, 2002). Species and strains of AM fungi have differed to the extent by which they increase nutrient uptake and plant growth (McGraw and Schenck, 1981, Gracy Sailo and Bagyaraj, 2005). In the present study, mycorrhizal parameters, such as percent root colonization and extrametrical spores, were considerably higher in all the inoculated treatments compared to the uninoculated control treatment. The existence of host preference by AM Fungi has been investigated by several researchers which provide support for the argument that different AM Fungi produce markedly different levels of root colonization, growth rates and nutritional responses in some plant species compared to others (Helgason *et al.*, 2002; Vandenkooornhuyse *et al.*, 2003). The extent of colonization and the spore count varied with different AM fungi. However, (Declerk *et al.*, 1995), working with several banana cultivars and arbuscular mycorrhizal fungi, observed different growth promotional effects depending on the banana cultivar and the *Glomus* strain the quality of inoculum also is important. From besides some fungi have different colonization patterns and different effects on host plant growth with early works contribution of (Ortas *et al.*, 2002a,b; Ortas, 2008, 2009; Ortas and Varma, 2007; Lakshman, 2008), it is clear that different mycorrhizal species have different root colonization capacity and also have different influence on plant growth. Hence it can be concluded that tomato seedlings show varied responses to different AM fungi and *Rhizophagus fasciculatus* confers maximum growth benefits compared to all other fungi used in this study. Therefore, it can be concluded that *Solanum lycopersicium* L., (Var. Vaibhav) plants biomass and its yield can be improved by inoculating efficient strain Am fungus *R. fasciculatus* at nursery stage.

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LITERATURE CITED


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