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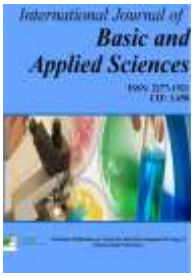

Full Length Research Paper

Selection of Efficient AM Fungi for Two Experimental Plants to Understand the Growth Response

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ARTICLE DETAILS

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ABSTRACT

Arbuscular mycorrhizal (AM) fungi found in rhizosphere of several vascular plants and have important roles on sustainable agriculture as well as agricultural ecosystems management. The beneficial effect of indigenous AM fungi on the nutrition of agricultural plants depends on both the abundance and type of fungi present in the soil. However, the potential for employing AM fungi on a wide scale in agriculture is dependent on the development of crop-growth-promoting strains of AM, which are superior to native soil population of AM fungi. Therefore, experiment is necessary to understand the AM fungi suitable for fiber yielding plants present in the rhizosphere of the crop with the advancement of civilization, the use of plant fibers has gradually increased and their importance today is very great.

1. Introduction

Application of mycorrhizal biotechnology to crop production has the potential to reduce inputs such as pesticides or fertilizers and insure the sustainability of agro ecosystems (Hamel, 1996; Chandrasekaran M *et al.,* 2019). As many reports have proved that AMF inoculation is effective to increase crop yield under experimental conditions (Sharma S 2017). Therefore, it is necessary to select efficient AM fungi for the inoculation to the crop plants. Arbuscular mycorrhizal association can be characterized as inducible mutualistic symbiosis involving bi-directional transfer of resources (Smith and Gianinazzi-Pearson, 1988). The plant receives minerals from fungi in return for carbon products from photosynthesis, lipids and protection (Strck *et al.,* 2003). The AM fungi are obligate partners; while most plants are facultative (Smith and Giarl, 1988). Benefits of AM fungi to the host are numerous, growth and photosynthetic rates increases with mycorrhizal colonization in some species (Arain, et al., 2009; Sadhana B. 2014). Arbuscular mycorrhizal plants often have resistance to biotic and other abiotic challenges (Bayat *et al.,* 2009; Kuila D, Ghosh S. 2022 and Tonssaint *et al.,* 2007).

The combined benefit to the plant leads to more vigorous productive, adaptable and competitive individuals. With the advancement of civilization, the use of plant fibers has gradually increased and their importance today is very great. The objective of this experiment is to compare the effectiveness of common AM fungal species associated with fiber yielding plants and to check the efficacy of AM fungal species.

1.1 Objective

The objective of this experiment is to compare the effectiveness of common AM fungal species associated with fiber yielding plants and to check the efficacy of AM fungal species.

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2. Materials and method

3.1 Soil and plant materials

The physical and chemical soil characteristics used for pot experiment were tested in soil testing laboratories at Jalavahini Management Private Limited, Dharwad district, India . The soil was steam sterilized for one hour on two consecutive days. Fibre yielding plants seeds were collected from Seed Development Unit, University of Agricultural Sciences, Dharwad, India. Seeds were germinated in small plastic cups containing sterilized soil. Before sowing, the seeds were surface sterilized in 2% sodium hypochlorite and washed in distilled water for 2-3 times.

Table 1. The physico-chemical characteristics of soil used for experiments.

Parameters	Results
Soil	Sandy loam
pH (1:2.5)	8.1
Conductivity (Fc) us/cm	320
Moisture (%)	4.86
Total organic carbon (%)	1.71
Nitrogen (%)	0.08
Potassium (%)	7.94
Phosphorus (%)	4.52
Magnesium (%)	0.121
Calcium (%)	0.472
Zinc (ppm)	3.86
Copper (ppm)	0.03
Manganese (ppm)	0.97
Iron (ppm)	8.24

3.2 Experimental design

The experimental pots were filled with growth media (soil and sand in 3:1 ratio). The soil based AM fungal inoculum (10 g) containing AMF infected root bits, mycelia and spore/sporacarps (250-300/10g inoculum) was placed as a thin layer just 2 cm below the soil surface. The seeds of all the experimental plants were surface sterilized by keeping them in 1% mercuric chloride solution for 2 to 3 min and then wash thrice with distilled water. Then these surface sterilized seeds were sown in the pre-prepared pots. The control treatment is maintained without any AM fungal inoculum the details of the treatments are as mentioned below.

1. *Crotalaria juncea* L.
    A. Uninoculated control (UIC)
    B. Mycorrhizal (*Slerocystis dussi*) inoculated
    C. Mycorrhizal (*Acaulospora laevis*) inoculated
    D. Mycorrhizal (*Gigaspora margarita*) inoculated
    E. Mycorrhizal (*Glomus fasciculatum*) inoculated
2. *Hibiscus cannabinus* L.
    a. Uninoculated control (UIC)
    b. Mycorrhizal (*Slerocystis dussi*) inoculated
    c. Mycorrhizal (*Acaulospora laevis*) inoculated
    d. Mycorrhizal (*Gigaspora margarita*) inoculated
    e. Mycorrhizal (*Glomus fasciculatum*) inoculated

All the experimental pots were arranged incompletely randomized block design with triplicate per treatment. The experimental pots were kept free of weeds, insects, pets, rodents etc. the pots were watered every alternate day and 10 ml of Hoagland solution without P was given to each seedling at the interval of 15 days.

*3.3 Analysis of growth parameters***:**

Plants were harvested after 60, 90 and 120 days after sowing. The plants parameters like shoot and root length, fresh weight of shoot and root, shoot and root dry weight, stem diameter and number of leaves, the per cent root colonization, spore number per 50 g soil, and phosphorus uptake in shoot were recorded. After the harvest, experimental plants shoot and root was oven dried at 70^0C until a constant weight was obtained to determine the dry weight.

3.4 Determination of Mycorrhizal Root colonization

The per cent root colonization was evaluated microscopically followed by clearing of roots in 10% KOH and staining with 0.05% trypan blue in lactophenol according to method described by Phillips and Hayman (1970). The following formula was used to calculate the root colonization (Giovannetti and Mosse, 1980).

$$\text{Per cent mycorrhizal colonization} = \frac{\text{Number of root segments colonized}}{\text{Total number of root segments examined}} \times 100$$

3.5 Determination of AM fungal spores

Spores were separated from the soil by wet sieving and decanting technique (Gerdemann and Nicolson, 1963). 50 g of soil was mixed with water. The mixture was pour through different sieve size (250, 106, 45µm). After, several times of sieve washing the supernatant was collected in Petri dish and spores counted under binocular-microscope.

3.6 Determination of Fiber content

Smallholder plots are usually harvested by hand. The plants are cut at 2 to 3 cm above the soil and left on the ground to dry. The cut, *Crotalaria juncea* L., and *Hibiscus cannabinus* L., is laid in swathes to dry for up to four days.

3.7 Phosphorus content

The phosphorus content in the shoots was determined by the vanado-molybdate phosphoric acid yellow color method outlined by Jackson (1973).

3.8 Statistical Analysis

Analysis of variance (ANOVA) was performed on all data and the means were separated using Duncans multiple Range Test (DMRT), with the help of SPSS student version-9 software.

3. Results

The different AM fungi such as *Glomus fasciculatum, Gigaspora margarita, Acaulospora laevis* and *Sclerocystis dussii* were inoculated to test their efficacy on four fiber yielding plants. All the plant species inoculated with different AM fungi showed increased growth parameters over the control plants. The experimental results revealed that, not only the growth parameters of four experimental plants were increased but also the nutrient uptake and mycorrhizal status was significant compared to non-mycorrhizal plants.

The growth parameters of all the experimental plants were determined at 60, 90 and 120 days after sowing. Initially slowly increased growths were observed but after 95 days significantly increased growth rate had been recorded. The greater values for growth parameters shoot length, fresh weight of shoot, dry weight of shoot, root length, fresh weight of root, dry weight of root, stem diameter, number of flowers, numbers of fruits and increased "P" uptake were recorded in experimental plants with inoculation AM fungus *Glomus fasciculatum* over the reaming treatments. Where as, plants inoculated with *Gigaspora margarita* and *Sclerocystis dussii* have shown to the less but they have significant values when compared to control plants. The intermediate growth rate had been recorded in plants inoculated with AM fungus *Acaulospora laevis.* It indicates that, the AM fungus *Acaulospora laevis* was the second best efficient indigenous AM fungus for the fiber yielding plants. (Table. 2-3).

Mycorrhizal parameters like per cent colonization, and spore number were determined at 60, 90 and 120 days. The mycorrhizal root colonization was found to be varied in each experimental plant it was less in beginning (at 45-60 days) but steadily increased after 90 days. It was observed that at 120 there was maximum colonization. The maximum per cent mycorrhizal colonization (PMC) was recorded in *Corchorus capsularis* L., and very least PMC was observed in the roots of *Gossypium hirsutum* L., whereas, intermediate PMC was recorded in *Hibiscus cannabinus* L., and *Crotalaria juncea* L.,

AM fungal spore number was recorded in all experimental plants. It was found to be highest at 120 days and least was noticed at 60 days, with increase in duration the spore number was increased. Maximum AM fungal spore number was observed in the rhizosphere soils of the experimental plants inoculated with *Glomus fasciculatum* and it was least in plants inoculated with *Slerocystis dussii*, whereas,, moderate spore number was noticed in plants inoculated with *Acaulospora laevis* and *Gigaspora margarita*. Among the plant species, the maximum number of AM fungal spores was found in the rhizospheric soils.

The plants were also analyzed for its nutrient continent in shoot, particularly phosphorus. All the AM fungal inoculated plants have shown increased nutrient content when compared to control plants. Maximum increased P uptake was observed in plants inoculated with *Glomus fasciculatum.* The moderately increased P Uptake in shoots was estimated in plants inoculated with *Gigaspora margarita* and it was least in plants inoculated with *Acaulospora laevis* and *Sclerocystis dussii.* Among all

mycorrhizal inoculated plants, *Hibiscus cannabinus* L. had shown significantly increased P uptake over the reaming three fiber yielding plants. The least increased P uptake was reported in mycorrhizal *Gossypium hirsutum* L., whereas, the moderate P uptake was estimated in the reaming two plant species.

The fiber content in all the inoculated and control plants was measured (Table. 2-5). The fiber content in the mycorrhizal plant was greater when compared to control plants (Fig. 2.11). Among all the mycorrhizal plants, the plants inoculated with *Glomus fasciculatum* have shown maximum fiber yield. The least increased fiber content was recorded in plants inoculated with *Sclerocystis dussii*. It can be evident from the above results that, AM fungus *Glomus fasciculatum* was found more efficient and the next best species for the inoculation to the fiber yielding plants was *Acaulospora laevis*. Fiber yield was considerably more in inoculated plants. All the experimental plants have shown increased fiber yield, but with *Glomus fasciculatum* fiber yield was maximum.

Table: 3. The effect of AM fungi on the Fiber yield (g/plant or fruit) of *Crotalaria juncea* L. and *Hibiscus cannabinus* L. at different interval plants at 60, 90 and 120 days after sowing.

Treatments	***Crotalaria juncea* L.**	***Hibiscus cannabinus* L.**
Uninoculated (UN)	3.500±0.057e	2.100±0.115e
Slerocystis dussii (SD)	4.433±0.088d	3.267±0.066d
Acaulospora laevis (AL)	5.400±0.115c	4.400±0.115c
Gigaspora margarita (GM)	6.066±0.088b	5.600±0.115b
Glomus fasciculatum **(**GF)	7.966±0.120a	6.733±0.371a

Values represent the mean ± SD. Means followed by the same letter within a column are not significantly P= 0.05 according to DMRT.

4. Discussion

In present study mycorrhizal parameters like per cent root colonization and extra matricular spore count were higher in plants inoculated with AM. The influence of *Glomus fasciculatum* was highest on per cent colonization and spore number in fiber yielding plants; similar observations were also made by Reena and Bagyaraj (1990) in their studies with *Calliandra calothrysus* inoculated with four different VA mycorrhizal fungi. So naturally the fungus having higher root colonization will be better adapted and absorb more nutrients and thus better growth. Rani and Bhaduria (2001) Michail Orfanoudakis, *et al.,* (2010), Mulla (2002), Mulani (2002), Lakshmipathy *et al* (2003) observed higher colonization and up take of more nutrients in medicinal plants. The results from this study indicated that, potential benefits could be obtained from the AM fungi in production of fiber yielding plants for their better use in future. It is concluded from the present experiments that the inoculation of fiber yielding plants *Crotalaria juncea* L. and *Hibiscus cannabinus* L., and inoculated with *Glomus fasciculatum,* seems to be a great boon to the botanist to minimize manure dosage in improving the growth, biomass production and the fiber content in fiber yielding plants by inoculating biofertilizer and bioinoculant like AM fungi.

5. Conclusion

The greater values for growth parameters shoot length, fresh weight of shoot, dry weight of shoot, root length, fresh weight of root, dry weight of root, stem diameter, number of flower and increased "P" uptake were recorded in experimental plants with inoculation AM fungus *Glomus fasciculatum* over the reaming treatments. The plants inoculated with *Glomus fasciculatum* have shown maximum fiber yield. The least increased fiber content was recorded in plants inoculated with *Sclerocystis dussii*. It can be concluded that, AM fungus *Glomus fasciculatum* was found to be more efficient for the growth and yield of the experimental plants and the next best species for the inoculation to the fiber yielding plants was *Acaulospora laevis*.

6. References

Arain, G., Saleem, A., Arnason,T and Charest (2009). Root colonization by an Arbuscular mycorrhizal (AM) fungus increases growth and secondary metabolism of purple cone flower. *Echinacea purpurea* (L) Moench. *Journal of Agricultural and food chemistry*. 57:2255-2258.

Bayat, F., Mirlohi, A and Khodambashi, M (2009). Effects of endophytic fungi on some drought tolerance mechanisms of tall fescue in a hydroponics culture. *Russian journal of plant physiology*. 56:510-516.

Chandrasekaran M, Chanratana M, Kim K, Seshadri S, Sa T. 2019. Impact of arbuscular mycorrhizal fungi on photosynthesis, water status, and gas exchange of plants under salt stress-a meta-analysis. Frontiers in Plant Science 10(10):457.

Hamel, C (1996). Prospect and problems pertaining to the management of Arbuscular mycorrhizae in agriculture. *Agric. Ecosys. Environ*. 60:197-210.

Jackson, M.L.(1973) Soil Chemical Analysis, Prentice Hall of (Jackson 1973). India Pvt.Ltd., New Delhi

Kuila D, Ghosh S. 2022. Aspects, problems and utilization of Arbuscular Mycorrhizal (AM) application as bio-fertilizer in sustainable agriculture. Current Research in Microbial Sciences 3:100107

Michail Orfanoudakis, Christopher, T., Wheeler and John, E., Hooker., (2010). Both the arbuscular mycorrhizal fungus Gigaspora rosea and Frankia increase root system branching and reduce root hair frequency in Alnus glutinosa. *Mycorrhiza.* 20:117–126.

Mulani, R. M., Rajendra, R. P. and Manjusha Dinkaran. (2002). Occurrence of VAM in the roots of *Phyllanthus fraternus* Webster. *Mycorrhiza News*, 14(2): 11-14.

Mulla, R.F. (2002). VA- mycorrhizal studies in some important medicinal plants. Ph.D thesis Karnatak university Dharwd, India.

Philips, J. H. and Hayman, D. S. (1970). Improved procedures for clearing roots and staining parasitic and vesicular – arbuscular mycorrhizal fungi for rapid assessment of infection. *Transactions of the British Mycological Society*, 55: 158-161.

Rani, V. and Bhaduria, S. (2001). Vesicular Arbuscular mycorrhizal association with some medicinal plants growing on alkaline soils of Manipuri district, Uttar Pradesh. *Mycorrhiza News*, 13(2): 12-13.

Reena, J. and Bagyaraj, D.J. (1990). Growth stimulation of *Tamarindus indica* by selected VA mycorrhizal fungi. *World J Microbiol Biotechnol,* 6:59–63.

Sadhana B. 2014. Arbuscular mycorrhizal fungi (AMF) as a biofertilizers—a review. International Journal of Current Microbiology and Applied Sciences 3(4):384–400

Sharma S, Prasad R, Varma A, Sharma AK. 2017. Glycoprotein associated with Funneliformis coronatum, Gigaspora margarita and Acaulospora scrobiculata suppress the plant pathogens in vitro. Asian Journal of Plant Pathology 11:199–202

Smith , S.E and Gianinazzi-Pearson, V (1988). Physiological interactions between symbionts in Vesicular- Arbuscular mycorrhizal plants. Aunual Review of plant physiology and plant molecular biology. 39:221-244.

Stract, D., Festa, T., Hause, B., Sc Wiemann W and Watter, M.H (2003). Arbuscular mycorrhiza biological, chemical and molecular aspects. *Journal and chemical Ecology,* 29:9-13.

Toussaint, J.P., Smith, F.A and Smith, S.E (2007). Arbuscular mycorrhizal fungi can induce the production of phytochemical in sweet basil irrespective of phosphorus nutrition. *Mycorrhiza.* 17:291-297.

Table: 1. Effect of AM fungi on growth parameters of *Crotalaria juncea* L., phosphorus uptake in shoot and per cent mycorrhizal colonization, spore number at 60, 90 and 120 days after sowing.

Treatments	SL	FWS	DWS	RL	FWR	DWR	STD	PC	NFL	NFR	SP	P-uptake
60 DAYS												
Uninoculated (UN)	27.80 ±0.100e	9.000 ±0.400e	3.833 ±0.066e	10.10 ±0.404e	2.666 ±0.120e	0.966 ±0.024e	1.033 ±0.033e	0.000 ±0.000e	0.00 ±0.000	0.00 ±0.000	0.000 ±0.000e	0.050 ±0.000e
Slerocystis dussii (SD)	32.76 ±0.088d	10.56 ±0.20d	4.533 ±0.176d	13.16 ±.0176d	3.800 ±0.100d	1.166 ±0.033d	1.033 ±0.033d	32.00 ±0.000d	0.00 ±0.000	0.00 ±0.000	74.66 ±1.763d	0.080 ±0.000d
Acaulospora laevis (AL)	34.33 ±0.133c	11.13 ±0.066c	5.266 ±0.120c	13.13 ±0.033c	4.000 ±0.057c	1.866 ±0.033c	1.100 ±0.057c	39.00 ±0.577c	0.00 ±0.000	0.00 ±0.000	83.66 ±1.453c	0.090 ±0.000c
Gigaspora margarita (GM)	35.80 ±0.100b	12.63 ±0.088b	6.600 ±0.115b	13.76 ±0.088b	4.166 ±0.033b	1.600 ±0.115b	1.200 ±0.057b	44.66 ±1.333b	0.00 ±0.000	0.00 ±0.000	86.66 ±1.201b	0.100 ±0.00b
Glomus fasciculatum (GF)	39.63 ±0.088a	14.76 ±0.088a	9.666 ±0.120a	18.76 ±0.088a	4.766 ±0.088a	2.033 ±0.033a	1.5000 ±0.057a	53.33 ±0.666a	0.00 ±0.000	0.00 ±0.000	115.0 ±2.081a	0.120 ±0.000a
90 DAYS												
Uninoculated (UN)	35.76 ±0.088e	12.76 ±0.088e	7.633 ±0.088e	17.30 ±0.450e	4.200 ±0.230e	2.066 ±0.033e	1.066 ±0.066e	0.000 ±0.000e	0.333 ±0.333e	0.000 ±0.000e	0.000 ±0.000e	0.070 ±0.000e
Slerocystis dussii (SD)	43.63 ±0.088d	18.33 ±0.033d	10.40 ±0.115d	20.70 ±0.264d	6.600 ±0.115d	3.600 ±0.115d	1.233 ±0.033d	47.33 ±0.881d	0.666 ±0.333d	0.000 ±0.000d	94.00 ±1.154d	0.110 ±0.000d
Acaulospora laevis (AL)	45.76 ±0.088c	20.60 ±0.115c	11.23 ±0.202c	24.20 ±0.503c	8.100 ±0.057c	4.066 ±0.066c	2.033 ±0.033c	50.33 ±1.154c	1.000 ±0.000c	0.666 ±0.333c	113.0 ±1.527c	0.100 ±0.000c
Gigaspora margarita (GM)	48.56 ±0.176b	23.60 ±0.057b	12.50 ±0.057b	25.23 ±0.145b	9.033 ±0.218b	4.400 ±0.115b	1.333 ±0.066b	54.66 ±0.666b	1.666 ±0.333b	0.333 ±0.333b	121.6 ±1.201b	0.130 ±0.000b
Glomus fasciculatum (GF)	53.70 ±0.057a	26.93 ±0.284a	14.53 ±0.176a	30.63 ±0.088a	11.96 ±0.185a	5.766 ±0.088a	1.766 ±0.088a	66.00 ±1.201a	2.666 ±0.333a	1.333 ±0.333a	147.6 ±0.881a	0.150 ±0.000a
120 DAYS												
Uninoculated (UN)	47.56 ±0.202e	24.76 ±0.088e	13.43 ±0.272e	26.66 ±0.185e	10.60 ±0.115e	5.166 ±0.033e	1.700 ±0.057e	0.000 ±0.000e	3.333 ±0.666e	2.000 ±0.577e	0.000 ±0.000e	0.080 ±0.000e
Slerocystis dussii (SD)	54.66 ±0.185d	29.66 ±0.185d	18.16 ±0.033d	30.76 ±0.088d	13.26 ±0.066d	6.466 ±0.066d	1.866 ±0.033d	54.33 ±0.333d	4.666 ±0.667d	3.333 ±0.333d	137.6 ±1.527d	0.130 ±0.000d
Acaulospora laevis (AL)	60.46 ±0.120c	34.76 ±0.088c	21.00 ±0.351c	34.76 ±0.088c	15.20 ±0.057c	7.866 ±0.033c	2.066 ±0.033c	72.66 ±0.667c	7.666 ±0.881c	4.333 ±0.333c	150.3 ±1.527c	0.150 ±0.000c
Gigaspora margarita (GM)	57.00 ±0.033e	31.50 ±0.152a	20.13 ±0.371a	32.30 ±0.200a	15.06 ±0.318a	7.066 ±0.088a	2.033 ±0.033a	81.66 ±0.666a	6.000 ±1.154a	5.333 ±0.666a	141.6 ±8.736a	0.140 ±0.000a
Glomus fasciculatum (GF)	67.83 ±0.300d	37.76 ±0.088b	24.66 ±0.185b	40.13 ±0.033b	17.76 ±0.088b	10.20 ±0.057b	2.133 ±0.033b	64.00 ±0.577b	9.666 ±0.333b	7.000 ±0.577b	178.3 ±6.027b	0.170 ±0.000b

Note: 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, STD: Stem Diameter, PC: per cent of mycorrhizal colonization, NFL: Number of Flowers, NFR: Number of fruits, SP: Spore Number, P: Phosphorous. Values represent the mean ± SD. Means followed by the same letter within a column are not significantly P= 0.05 according to DMRT

Table: 2. Effect of AM fungi on growth parameters of *Hibiscus cannabinus* L. , phosphorus uptake in shoot and per cent mycorrhizal colonization, spore number at 60, 90 and 120 days after sowing.

Note: 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, STD: Stem

Treatments	SL	FWS	DWS	RL	FWR	DWR	STD	PC	NFL	NFR	SP	P-uptake
60 DAYS												
Uninoculated (UN)	18.50 ±0.057e	4.300 ±0.057e	1.300 ±0.057e	7.366 ±0.088e	1.633 ±0.033e	0.926 ±0.006e	1.233 ±0.033e	0.000 ±0.000e	0.000 ±0.000	0.000 ±0.000	0.000 ±0.000e	0.050 ±0.000e
Slerocystis dussii (SD)	23.66 ±0.088d	12.40 ±0.057d	3.833 ±0.033d	10.33 ±0.088d	2.366 ±0.120d	1.333 ±0.088d	1.433 ±0.033d	34.33 ±1.453d	0.000 ±0.000	0.000 ±0.000	71.33 ±1.763d	0.080 ±0.000d
Acaulospora laevis (AL)	26.53 ±0.145c	13.46 ±0.066c	4.600 ±0.650c	12.40 ±0.057c	2.600 ±0.115c	1.600 ±0.000c	1.766 ±0.033c	39.66 ±0.333c	0.000 ±0.000	0.000 ±0.000	82.33 ±2.185c	0.08 ±0.000c
Gigaspora margarita (GM)	29.46 ±0.145b	14.53 ±0.088b	4.533 ±0.176b	13.43 ±0.033b	2.766 ±0.033b	1.733 ±0.033b	1.633 ±0.066b	41.00 ±0.577b	0.000 ±0.000	0.000 ±0.000	97.33 ±1.763b	0.090 ±0.000b
Glomus fasciculatum (GF)	36.56 ±0.120a	17.70 ±0.152a	6.966 ±0.120a	15.70 ±0.057a	3.133 ±0.066a	1.933 ±0.033a	2.066 ±0.033a	51.66 ±1.453a	0.000 ±0.000	0.000 ±0.000	127.6 ±1.333a	0.110 ±0.000a
90 DAYS												
Uninoculated (UN)	28.76 ±0.088e	10.40 ±0.057e	3.366 ±0.088e	10.73 ±0.120e	4.233 ±0.133e	1.766 ±0.088e	1.533 ±0.066e	0.000 ±0.000e	0.000 ±0.000e	0.000 ±0.000	0.000 ±0.000e	0.070 ±0.000e
Slerocystis dussii (SD)	37.96 ±0.233d	23.56 ±0.202d	8.266 ±0.409d	13.63 ±0.088d	6.266 ±0.120d	2.700 ±0.152d	1.833 ±0.066d	47.00 ±0.577d	1.333 ±0.333d	0.000 ±0.000	102.0 ±1.527d	0.100 ±0.000d
Acaulospora laevis (AL)	40.73 ±0.120c	28.66 ±0.120c	18.43 ±0.120c	14.90 ±0.404c	7.566 ±0.120c	3.400 ±0.115c	1.866 ±0.088c	53.66 ±0.881c	1.000 ±0.000c	0.000 ±0.000	115.3 ±1.763c	0.110 ±0.000c
Gigaspora margarita (GM)	43.76 ±0.088b	30.76 ±0.088b	12.96 ±0.233b	17.06 ±0.166b	8.466 ±0.176b	3.866 ±0.176b	1.900 ±0.057b	59.66 ±1.201b	1.666 ±0.333b	0.000 ±0.000	125.3 ±2.027b	0.130 ±0.000b
Glomus fasciculatum (GF)	64.86 ±0.033a	40.30 ±0.602a	23.50 ±1.732a	23.43 ±1.097a	14.56 ±1.126a	7.833 ±0.876a	2.066 ±0.033a	74.33 ±1.201a	2.666 ±0.666a	0.666 ±0.000a	150.6 ±3.844a	0.150 ±0.000a
120 DAYS												
Uninoculated (UN)	41.56 ± 0.202e	18.63 ±0.218e	5.600 ±0.300e	12.76 ±0.088e	5.066 ±0.033e	2.366 ±0.260e	1.700 ±0.152e	0.000 ±0.000e	0.666 ±0.333e	0.666 ±0.333e	0.000 ±0.000e	0.090 ±0.000e
Slerocystis dussii (SD)	53.36 ±0.622d	34.66 ±0.120d	17.76 ±0.088d	21.63 ±0.088d	9.700 ±0.404d	4.100 ±0.251d	2.066 ±0.088d	62.00 ±1.154d	1.666 ±0.333d	0.666 ±0.333d	133.3 ±4.255d	0.120 ±0.000d
Acaulospora laevis (AL)	61.83 ±0.033c	37.80 ±0.351c	17.33 ±0.120c	23.56 ±0.120c	10.60 ±0.321c	4.766 ±0.088c	2.100 ±0.057c	74.66 ±1.763c	2.333 ±0.333c	1.333 ±0.333c	144.3 ±2.728c	0.130 ±0.000c
Gigaspora margarita (GM)	64.80 ±0.057b	40.76 ±0.088b	21.10 ±0.472b	26.56 ±0.120b	12.96 ±0.393b	5.400 ±0.057b	2.166 ±0.066b	74.66 ±3.179b	4.000 ±0.577b	2.000 ±0.577b	158.6 ±4.910b	0.150 ±0.000b
Glomus fasciculatum (GF)	78.70 ±0.152a	46.50 ±0.173a	25.06 ±0.721a	30.96 ±0.185a	17.26 ±0.417a	7.866 ±0.185a	2.266 ±0.088a	89.66 ±1.201a	6.333 ±0.333a	3.333 ±0.333a	196.3 ±0.881a	0.180 ±0.000a

Diameter, PC: per cent of mycorrhizal colonization, NFL: Number of Flowers, NFR: Number of fruits, SP: Spore Number, P: Phosphorous. Values represent the mean ± SD. Means followed by the same letter within a column are not significantly P= 0.05 according to DMRT