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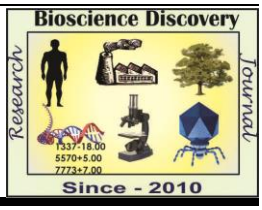

Selection of efficient am fungi species for mustard plant – *brassica junceae* (l.) Zern and coss and its effect on growth, biomass yield and nutrient uptake

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Abstract

The agricultural practices of soil management need special attention in the relation to the roots of different plants with the different techniques used. Because the health of plants is dynamically linked to the use of micro-organisms considered beneficial to plants. Among the arbuscular mycorrhizal fungi (AMF) are important, as they colonise to the roots of most plants, forming symbiotic association in natural ecosystems and ecosystems changed by man. In the present study, ten AM fungi were screened, to know the suitable AMF for Mustard plants (*Brassica junceae)* at laboratory condition. Out of ten AM fungi nine were exotic and one indigenous AM fungus G*lomus macrocarpum* influenced best inoculant for Mustard by enhanced plants growth, biomass yield, chlorophyll content in leaves, per cent root colonization, spore number,. N.P.K. and Zn, Cu uptake in shoot and roots. *Gigaspora morgarita* and *Scuitellospora nigra* are the second and third suitable fungi for Mustard plants over the (Control) non-inoculated plants. The other AM fungi *Acculospora mellea, A. trappei,Glomus arborease, G. mosseae, Rhizophagus fasciculattus, Solerocystis dussii* and *Scutellospora verrucosa* were moderately influenced on plants growth biomass yield and nutrients content in shoots and roots compared to (Control) non-inoculated plants. However, the plorine content in roots, shoot/root ratio were higher than that of AM fungi inoculated plants. It may be concluded that indigenous AM fungus *Glomus macrocarpum* can be selected as an efficient AMF strain for the improvement of Mustard plants at green house condition and, we have successfully inoculated AM fungi for Mustard plants as it belongs to the family brassicaceae, this family was disputed by many workers. Therefore, there is a need for the selection of a suitable AM fungi for agriculture and horticultural plants.

INTRODUCTION

Management of mycorrhizae and associated beneficial microorganisms in agriculture programmes comprising three major components i.e., protection of indigenous soil communities, selection of beneficial efficient microorganism and evaluating their merits. There is a need for the integration of inoculation programmes in agricultural research. In order to derive maximum benefits from mycorrhization of any crops plants, it is imperative to use and then selection efficient beneficial microorganisms. In recent, days among the most studied one is mycorrhizal fungi, they are key components of soil microbiota. These fungi are obligate symbioants and are non host specific (Bonfante-Fasolo, 1987; Aher. 2003). Their association with plant roots indirectly resist penetration by nematodes. The mycorrhizal

symbiosis has multiple beneficial impact on nutrient cycling and plant stress tolerance (Gerdemann, 1967; Vander Heiaden *et al*., 2015), thus helping the plant in its growth and production. It is well known that AM fungi improve the growth of plants by providing a layer absorptive surface compared with root hairs and thus help in the absorption of relative immobile ions in soil (Baggaraj, 1992; Lakshman, 1996, 2010; Garcia *et al.*, 2016). Plants performance for particular AM fungal species determines the growth response to an endophyte. And therefore, different species of AM fungi have different growth promotional effect on particular plant species (Munkvold *et al.,* 2004; Lakshman and Geeta Patil, 2004; Kavatagi and Lakshman, 2014; Vijetha *et al.,* 2015). When, considering AM Fungi in inoculation, it is important to examine several different species of AM fungi for their effect on plant growth.

Arbuscular mycorrhizal fungi are known for a broad range of functions, but are characterized by two major benefits are first, AM colonize roots, improving plant nutrition by transferring poorly available nutrients, mainly phosphate (P) from the soil to the plant, and plant provide essential carbohydrates to the fungi in order to complete their life cycle (Smith and Read, 1997; Lakshman, 2009). Macronutrients such as Nitrogen, Phosphorus Potassium and micronutrients can also be more easily acquired through the AM Fungi (Wang, 1993; Kohl and Hinder Heijiden, 2016, Linlin *et al.*, 2019). This results in positive growth responses of the AM fungi inoculated plants, especially in nutrient poor soils. (Smith and Read, 1997; Fester and Sewars, 2011). Plants colonized by AM fungi may directly or indirectly acquire protection against pathogens. (Gallou *et al.,* 2011; Jacott *et al.,* 2017). However, the mechanisms involved in bio-protection have not been clearly identified (Azcon-Angular and Berea, 1996; Smith and Smith, 2011). Other functions also well known to symbiotic association and possibly related to an improved nutrition are drought resistance (Johson e*t al.,* 1884; Subramaniyan and Charest, 1997; Jones and Hodge, 2009; Cameron *et al.,* 2013). The biological potential of AMF to promote plant growth and nutrient in many disciplines of plant biology could also be extended to the cultivation of medicinal herbs. However, inoculation is necessary where, the fungi have been eliminated or their populations reduced by pesticide application, fumigation erosion or other forms of soils disturbance.

MATERIALS AND METHODS

Seeds of Mustard plant (*Brassica iunceae*) were procured from University of Agricultural Science, Dharwad – 580008. Department of Horticulture plants, cultivation centre. Seeds were washed in lukewarm water, surface sterilization of seeds was done by keeping them in 2% of Sodium hypochlorite to ensure the early breakdown of seed dormancy. Then, these seeds were sown in the earthern pots measuring about (25x30) cm diameter cfilled with 8 kg of soil mixed with growth media of sand:soil: FYM, (1:2:1) in ratio (v/v) were used for each pot. AM Fungal inoculums (15g) 5g. of highly colonized root bits of host plant *Zea mays* L., and 10g of rhizospore soil contain hyphae, sporocarps and AMF spores approximately 180 - 200/25g soil. All the ten AM fungi were cultured aseptically in separate earthern pots by using Mize (*Zea may* L.) as potential host.

Host plant used for mass multiplication of all the ten AM fungal species served as AM fungal inoculae. Host plants were maintained in polyhouse in the Department of Botany, Karnatak University, Dharwad – 580003. Physico-chemical characteristics of the soil used for the experimental pots (Table 1).We have travelled different parts of the Dharwad District and scanned most important dominated AM Fungal strains, and they were isolated and identified by using identification of AM Fungi manual proposed by (Scenck, and Parez, 1990; Prasad and Rajesh, 1999; Wang and Liu , 2017).

The control treatment was not provided with any AM Fungal inoculums.All the experimental pots were arranged in (RBD) randomized block design in triplicates. Inoculation was placed just 5 cm below the surface of the growth media. Plants were watered on alternate days to maintain moisture level. 15 ml of Hongland solution without P was treated for each plant at the interval of 15 days. Experimental pots were kept free of weeds irrigated properly. Observation was recorded at a period of 45 and 90 days intervals.

Experimental plants first harvest was done at 45 days after sowing and second harvest was done after 90 days after sowing.The harvested plants were subjected for analysis of growth parameter such as shoot length, root length, fresh weight of both root and shoot. Dry weight of root and shoot was determined after drying at 70^{C} for 48 hours under hot air oven.

Table 1: AM Fungi used for the present experiments were as:

No of AMF	AM Fungal Spores	Collection places and Host Plants
T_1	*Acaulospora mellea* Spain& Schenck.	Kalghataghi, Maize cultivated land.
T_2	*Acauilospora trappei* Ames & LInderman.	Mundgod Finderm MIllet cultivated land.
T_3	*Gigasopora margarita* bEcker & Hall.	Kundagol – Sugarcane cultivated land.
T_4	*Glomus arborease* McGee.	Bada Forest area.
T_5	*Rhizophagus fasciculatus* (Thaxter, Walker & Koske).	Tadasa Agricultural land.
T_6	*Glomus macrocarpum* – Tisane/Tulasage.	Karnatak University, Botanical Garden.
T_7	*Glomus mosseae (Nico. &n Gerd)MGerdeman & Trappe.*	Beluru Agricultyural field.
T_8	*Sclerocystis dussii (Pat.) V. Hionn.*	Navalagund Sorghum cultivated land.
T_9	*Seutellospora rigra* (Redhead) Walker & Sanders.	Mansur Chilli cultivated land.
T_{10}	*Sculellospora vericosa* (Koske & Walker) Walter & sanders.	Kittur Cotton Cultivated Land.

***T_1**=*Acaulospora mellea*. **T_2** =Aca*ulospora trapopei*, **T_3** =*Gigaspora margarita*. **T_4** = *Glomus arbgorease* **T_5**. = *Rhizophagus fasciculatus*, **T_6** =-*Glomus macorpcarpum.* **T_7** = *Glomusmoosseae*, **T_8**= *Elerocystis, dussii*, **T_9** = *Scutellospora nigra*, **T_{10}** = *Scutellospora verrucosa*.

Table 2. Physico-Chemical characteristic of the soil used for the pot experiments.

Parameters	Values
Salt exture	Sandy loam
pH	6.60
Soil moisture	29.11
Organic matter.	0.84
E.C. Minhc/cm^2	1.47
P (%)	0.39
K (%)`	2.94
Zn (%)	1.82
Cu (%)	1.01
Mg (%)	1.05
Pb (%)	0.41

Elemental concentration is in mg/Kg soil. Each value is the mean of 12 samples.

All the growth parameters were measured in triplicate. AM fungal spores were recovered from the rhizosphere soil of the inoculated with different AM fungi, by adopting wet-sieving and decanting method described by (Gerdemann and Nicolson, 1963). Mycorrhizal spore number /25g. of rhizoseric soil were estimated. All the ten strains of AM Fungi were asceptically maintained in separate earthern pots by growing in viabnle host Maize *Zeamays L.* The per cent root colonization was evaluated microscopically followed by clearing of roots in 10% KOH and staining with 0.05% try pan blue in lactophenol according to method described by (Phillips and Hayman, 1970). The following formula was used to calculate their root colonization according to (Grovanneth and Mosse, 1980).

$$\text{Root colonization (\%)} = \frac{\text{Number of colonized segments}}{\text{Total number of segments exa}} \times 100$$

Organic matter of the soil was analysed following the procedure of Walkley and Black (1934). Phosphorus content of shoots were determined colorimetricaly by the Vanadomylbdate phosphoric yellow colour method of Jackson (1973). Nitrogen content of shoots were analysed by the microk jeldahl method (Bremner, 1960). For the root samples zn, cu and mg was analysed by using 5011 USA made automatic absorption spectyrometer. Chlorophyll content in leaves were estimated by the procedure of Ronen and Goidun (1984).

Table 3. Screening of an Efficient AM Fungi for Mustard Plant (*Brassica junceae)* on its growth, biomass, root/shoot ratio, per cent root colonization spore number and N.P.K.uptake in shoots at 45 days.

AM Fungi Species	Shoot Length (cm)	Root Length (cm)	Shoot F.W. (g)	Shoot D.W. (g)	Root F.W. (g)	Root D.W. (g)	Root/Shoot ratio (%)	Per cent root colonization	AMF Sores/ 25 g.soil.	Shoot nitrogen (%)	Shoot phosphorus (%)	In Shoot potassium (%)
T_0	9.8a	7.3b	2.2a	0.91a	0.72a	0.39b	0.74b	0.00	0.00	0.74a	0.05	1.03a
T_1	23.4b	18.20c	8.1d	3.2d	1.1b	0.52c	0.77c	39.5d	7.30b	0.84c	B	1.14c
T_2	23.0d	19.3c	8.5c	3.5b	1.2bc	0.53d	0.84a	42.0a	69.0c		0.11d	1.15a
T_3	29.4c	21.1d	9.0b	4.2c	1.3ab	0.54e	0.72d	45.1b	76.0d	0.85b	0.12b	1.14d
T_4	25.3c	19.0ac	8.3 a	3.3ab	0.98d	0.50ab	0.75b	43.0c	69.0d	0.88cd	0.14c	1.16a
T_5	27.5g	19.5b	8.4c	3.4c	1.1a	0.51c	0.71e	43.1c	71.0bc	0.83b	0.12b	1.17c
T_6	31.1b	21.2c	9.2c	4.4d	1.4b	0.55d	0.68d	48.1db	77.0a	0.91c	0.13ab	1.18b
T_7	26.2c	18.4d	8.3a	3.3a	1.0c	0.50b	0.70c	41.4d	6/8.0c	0.91a	0.14d	1.14c
T_8	25.4d	17.4e	9.0b	.2b	1.1a	0.52a	0.6/8b	42.1b	73.0e	0.90b	0.12a	1.17b
T_9	28.3a	20.0b	8.5d	3.5c	1.2d	0.53c	0.71a	44.0c	72.0g	0.84d	0.13bc	1.13b
T_{10}	25.1	18.3c	8.4c	3.4c	0.98c	0.50e	0.73g	41.3a	76.0b	0.82b	0.12a	1.16c

*** Mean Values followed by the same letter within a column do not differ significantly at p = 0.05 by NNOVA.**

F.W. = Fresh weight, D.W. = Dry weight. T_0 = (Control). N.I. – Non-Inoculated. T_1 – *Acaulospora mellea*, T_2. *Aaulospora trappei*, T_3. *Gigaspora margarita* T_4 – *Glomus arborease*, T_5. *Rhizophagus fasciculatus*, T_6. *Glomus macrocarpum*, T_7. *Glomusm mosseae*, T_8. *Sclerocystis dussii*, T_9. *Scutellospora nigra*, T_{10}. *Scutellospora verrucosa.*

Table 4. Screening of an Efficient AM Fungi for Mustard Plant (*Brassica junceae)* on its growth, biomass, root/shoot ratio, per cent root colonization and spore number and N.P.K. uptake in shoots at 90 days.

AM Fungi species	Shoot Length (cm)	Root Length (cm)	Shoot F.W. (g)	Shoot D.W. (g)	Root F.W. (g)	Root D.W. (g)	Root/Shoot ratio (%)	Per cent root colonization	AMF Sores/ 25 g soil.	Shoot nitrogen (%)	Shoot phosphorus (%)	Shoot potassium (%)
T_0	27.5b	19.4a	4.3b	2.1a	1.1b	0.64a	0.70c	0.00	0.00	0.72b	0.11a	1.13a
T_1	42.6c	34.1d	12.6a	3.5b	1.9c	0.85b	0.80d	61.0e	94.0g	1.47b	0.25a	1.51c
T_2	43.0d	33.2c	12.5c	3.47d	1.7e	0.83d	0.77c	62.2d	98.0b	1.54d	0.24c	1.54b
T_3	46.3ab	32.2b	12.1d	3.3bc	2.1bc	0.93a	0.69ab	64.1c	109.0d	2.03b	0.28c	2.13d
T_4	42.4c	34.4b	11.9bc	2.84b	1.8d	0.89c	0.81d	61.3d	89.0b	1.62	0.25	1.62g
T_5	43.5e	33.2e	12.0ab	3.2c	1.7ab	0.83b	0.76g	61.6e	99.0c	1.82d	0.24c	1.39b
T_6	51.2b	34.0d	12.2c	3.7d	2.2ac	0.94d	0.66b	68.1c	106.0d	2.19a	0.31b	2.15c
T_7	42.2c	32.1a	11.8b	2.96e	1.6c	0.82b	0.76c	59.4ab	103.0b	1.83	0.19	2.11d
T_8	41.5d	30.0b	10.2e	2.97b	1.7e	0.83a	0.72d	57.2e	102.00a	1.7c	0.21d	1.72a
T_9	44.1e	31.0b	12.0c	3.2a	2.0d	0.87ab	0.70c	63.1d	101.00c	2.12d	0.24b	2.12c
T_{10}	39.8g	31.2a	11.4d	2.93g	1.8b	0.84g	0.78e	61.4c	98.0d	1.69c	0.27a	2.14b

*** Mean Values followed by the same letter within a column do not differ significantly at p = 0.05 by ANNOVA.**

F.W. = Fresh weight, D.W. = Dry weight. T_0 = (Control). N.I. – Non-Inoculated. T_1 – *Acaulospora mellea*, T_2. *Aaulospora trappei*, T_3. *Gigaspora margarita* T_4 – *Glomus arborease*, T_5. *Rhizophagus fasciculatus*, T_6. *Glomusm macrocarpum*, T_7. *Glomusm mosseae*, T_8. *Sclerocystis dussii*, T_9. *Scutellospora nigra*, T_{10}. *Scutellospora verrucosa.*

Table 5. Screening of an efficient AM Fungi for Mustard Plant (*Brassica junceae)* on its Chlorophyll content in leaves, proline, zn, cu and mg uptake in root at 45 days.

AM Fungi Species	Chlorophyll a mg/g.	Chlorophyll b mg/g.	Total Chloro-phyll mg/g.	Proline Content in roots µ mole/tissue	root zn (%)	root cu (%)	root mg (%)
T_0	0.077b	0.016a	0.043b	0.931a	0.33b	0.41a	0.47d
T_1	0.138a	0.108c	0.246d	0.139a	0.94c	0.48b	0.32c
T_2	0.133d	0.106e	0.239b	0.114c	0.93ad	0.57a	0.34b
T_3	0.134c	0.117b	0.251a	0.115c	1.04b	0.54c	0.31d
T_4	0.129ac	0.107ab	0.236b	0.114b	0.92a	0.84b	0.33d
T_5	0.136d	0.110c	0.246d	0.109ac	0.91b	0.67d	0.32c
T_6	0.139d	0.114b	0.253e	0.117b	1.05c	0.62b	0.32ae
T7	0.128c	0.112c	0.237d	0.113c	0.88a	0.59ac	0.34b
T_8	0.134b	0.107a	0.229d	0.142a	0.86d	0.61b	0.36c
T_9	0.137a	0.113g	0.25c	0.112b	1.10d	0.66c	0.31a
T_{10}	0.130c	0.109e	0.239b	0.119d	0.89b	0.67d	0.33c

*** Mean Values followed by the same letter within a column do not differ significantly at p = 0.05 by ANNOVA.**

F.W. = Fresh weight, D.W. = Dry weight. To = (Control). N.I. – Non-Inoculated. T_1 – Acaulospora mellea, T_2. *Aaulospora trappei,* T_3. *Gigaspora margarita* T_4 – *Glomus arborease,* T_5. *Rhizophagus fasciculatus,* T_6. *Glomusm macrocarpum,*T_7. Glomusm mosseae, T_8. *Sclerocystis dussii,* T_9. *Scutellospora nigra,* T_{10}. *Scutellospora verrucosa.*

Table 6. Screening of an efficient AM Fungi for Mustard Plant (*Brassica junceae)* on its Chlorophyll content in leaves, proline, zn, cu and mg uptake in root at 90 days.

AM Fungi Sopecies	Chlorophyll a mg/g.	Chlorophyll b mg/g.	Total Chloro-phyll mg/g.	Proline Content in roots µ of mole/tissue	Root zn (%)	Root cu (%)	Root mg (%)
T_0	0.087a	0.062a	0.146b	1.030a	0.43b	0.71b	0.64a
T_1	0.198b	0.119a	0.317c	0.198d	1.02e	0.91b	0.149b
T_2	0.24a	0.161b	0.402d	0.202a	1.04b	0.86d	0.48d
T_3	0.231c	0.142c	0.375a	0.201c	0.99b	1.20c	0.47c
T_4	0.194d	0.115d	0.309b	0.189ab	1.11e	0.94e	0.51a
T_5	0.183b	0.124b	0.307a	0.210	1.13d	0.96d	0.23d
T_6	0.243g	0.174c	0.417c	0.204	1.14c	1.33ab	0.49b
T_7	0.204e	0.132a	0.336b	0.221ab	1.05a	1.11a	0.51c
T_8	0.196b	0.107b	0.313d	0.189c	0.98b	1.07b	0.52a
T_9	0.249d	0.140d	0.389b	0.203a	1.13e	0.93c	0.48d
T_{10}	0.226a	0.129c	0.355b	0.193c	1.15d	1.20b	0.55e

*** Mean Values followed by the same letter within a column do not differ significantly at p = 0.05 by ANNOVA.**

F.W. = Fresh weight, D.W. = Dryweight. To = (Control). N.I. – Non-Inoculated. T_1 – *Acaulospora mellea,* T_2. *Aaulospora trappei,* T_3. *Gigaspora margarita* T_4 – *Glomus arborease,* T_5. *Rhizophagus fasciculatus,* T_6. *Glomusm macrocarpum,* T_7. *Glomusm mosseae,* T_8. *Sclerocystis dussii,* T_9. *Scutellospora nigra,* T_{10}. *Scutellospora verrucosa.*

RESULTS AND DISCUSSION

The soil physic-chemical characteristics have shown that soil is Sandy loam with acidity, the organic materialism 84 per cent with lower phosphorus content (Table 4). In the present study, ten different AM fungal strains have been selected. These AM Fungal strains were collected from the rhizosphere of different crops of selected places; Kalaghatgi, Mundagod, Kundagol, Bada, Tadasa, Beluru, Navalagund, Mansuru and the University of Botanical Garden. The Botanical Garden AM Fungas Strain considered to be the indigenous one. *Glomus macrocarpum.* The remaining nine AM Fungal Strains were exotic. These three AM Fungal strains inoculated plants showed maximum value for mycorrhizal growth responsitvenes (MGR) was observed on Mustard plants (Table 4).

There was an improved plant growth, biomass yield, per cent root colonization, spore number and phosphorus, nitrogen and potassium uptake in shoots significantly increased. The root/shoot ratio was lower among mycoprrhizae Rhizospherem fasciculatus. *Glomus mosseae, Glomus arborease, Sclerocystis dussii, Scutellosporam nigra* and *Scuitellospora verrucosa* inoculated plants, when compared to noninoculated (Control) plant. The chlorophy a, b and total chlorophyll showed higher concentration in the leaves of the plants, which were inoculated with *Glomus macrorcarpum*. This was followed by other AM Fungal strains i.e., *Glomus marga*rita and *scutellospora nigra* second and third suitable strains for Mustard. The other AMF strains like, *Glomus mosseae*, *Glomus arbortease*, *Acaulospora mellea, Acaulospopra trappei Rhizophagus fasciculatus Sclerocystis dussii*, and *Scutellospora Veruacosa* favourably influenced on plant growth, increased chlorophyll content in leaves over the noninoculated (Control) Mustard plants (Table 2). There was an increased uptake of N.P.K. including micronutrients Zn and Cu in most of the AM Fungi inoculated plants over the (Control) non-inoculated plants. However, the higher proline and Mg content was documented in root tissue of all the non-inoculated plants of Musta4rd Plants over the AM Fungi inoculated plants (Table 32). And thus, the results clearly demonstrated that the best suited or most efficient strain *Glomus macrocarpum* may be commended for improving Mustard plants growth, biomass yield, N.P.K. and Zn and Cu uptake in shoots and roots respectively. The other two AM Fungi *Gigaspora margarital* and *Sclerocyst nigra* were most influenced mycorrhizal strains as second and third most suitable AM Fungal strains. By the inoculation *Glomus macrocarpum*, Mustard plant shoot and root dry matter yield, Nitrogen, Phosphorus and Potassium uptake was significantly influenced (Table 4). Similarly, micronutrients zinc concentration and copper concentration was increased trend was recorded in roots compared to (Control) non-inoculated plants. But mg Manganese concentration in then roots of (Control) non inoculated was increased trend was observed. Root/Shoot ratio per cent ratio was also lower in all inoculated with AM Fungi or *Glomus macrocarpum* compared to (Control) non inoculated Plants.(Table 5). Consequently, proline concentration was higher in the roots of (control) non inoculated plants compared to AM fungi or *Glomus macrocarpum* inoculatede plants. (Exceptionally, the inoculation *Acaulosopora trappei* and *Glomus arborease* influenced increaseed root/shoot per cent ratio on Mustard plants over the non-inoculated plants (Table 2). Chlorophyll content significantly increased in Plants by the inoculation of Glomus macrocarpum, it was followed by *Gigaspora margarita* and *Scutellospora nigra* as better influenced strains for Mustard plant. Per cent root colonization spore density was higher in the roots after the inoculation of *Glomus macrocarpum Gigaspora margarita* and *Scutellospora nigra*, when compared to *Acaul Spora mellea, trappei, Glomus arborease*, G. *Mosseae Rhizopghagus, fasciculatus*, *Selerocystis dussii* and *Scutellospora Verrucosa* inoculation, but favourably influenced and encouraged higher spore density was recorded. Over the (Control 1) non inoculated plants. And thus, we clearly confirm that local or indigenous *Glomus macrocarpum* is the best or efficient strain for (Var. Maladandi) Mustard Plants. As all nine AM fungi other than *G. macrocarpum* were not much influenced on Mustard plants.

The experimental plant showed positive responses to AM fungal inoculation irrespective of AM fungal species. But the extent significant improvement was varied with each AM fungus. This increased growth of mycorrhizal plants is due to dramatically increased absorption of mineral nutrition, particularly immobile nutrients by host plant from the soil. (Lakshman, 1996; Herrera Peraza *et al*., 2011). There are indirect evidences that shows mycorrizal roots are more efficient in nutrient acquisition than non-mycorrizal plants (Smith *et al.*, 2011; Merrld, *et al*., 2013). Mycorrhizal symbiosis in terrestrial ecosystems has effect on organic and inorganic plant nutrition,

acquisition, plant water relation and carbon cycle in plants (Cui and Nobel, 1992; Peterson *et al.*. 2017; Rothan Poszknowsi, 2017). Experiments were conducted under Greenhouse conditions with inoculation of ten different AM fungi. The results revealed that, there was significantly increased biomass production in plants inoculated with *s* perfomed well than other AM Fungi species. This is in agreement with the contribution of (Munkvold *et al.,* 2004; Kavatagi and Lakshman, 2009; Channabasava and Lakshman, 2010). Host preferences among arbuscular mycorrhizal fungi have been reported by earlier workers (Vinayak and Bagyaraj, 1990; (Manjunath *et al.*, 2001; Wu *et al*., 2002, Munkvold *et al.,* 2004) Hence, there is a need for selecting efficient AM fungi that can be used for inoculating different mycoptropic plant. Mycorrhizal dependency is the results of morphological and physiological plant traits modulated by the effectiveness of the mycorrhizal fungus involved. In this study the results showed that all the mycorrhizae inoculated plants have higher mycorrhizal dependency. These results are in consistence with the results of (Channabasava and Lakshman, 2010; Kurundawad and Lakshman, 2014; Shi *et al.,* 2016). The present findings supported the view, that such dependence was affected also by associated microorganisms which many enhance the mycorrhizal effect under limiting conditions among the selected ten AM fungi. Similar results were obtained by (Read *et al.,* 2003; Smith *et al.,* 2011; Rouphael *et al.,* 2015). The selected ten AM fungi for the inoculation influenced early established mycorrhizal colonization. AM fungal spore population in the rhizosphere of the experimental plant increased higher per cent mycorrhizal colonization was responsible to the improved plant growth parameters such as plant height, chlorophyll content in leaves, N.P.K. and Zn and Cu uptake over the noninoculated plants. Similar observatiuons were made by (Bagyaraj, 1992; Lakshman, 2009; Smith *et al*., 2011). In all the growth-phases, non-mycorrhizal Mustard plants increased concentration in roots and root/shoot(%) ratio % of showed higher value over the mycorrhizal plants and similar observations was documented by (Lakshman, 2010; Festers and Sawers, 2011; Lau & Lennon,2012).

The present work clearly indicated that the pre-innoculation with AM Fungi had significant role in promoting seedling growth and establishment of plants under experimental conditions. These findings are agreements with the reports of (Jeffries, 1987; Rouphael *et al.,* 2015; Garcia *et al.* 2016). Subramaniyan and Charest, 1997 and Verbrugen *et al.,* 2012), have reported that the AM fungal host specificity: There was no relationship between biomass production and per cent of mycoprrhizal colonization. Mustard plants showed maximum mycorrhizal colonization with *Glomus macrocarpum* followed by *Gigasora margarita* and *Scutellospora rigra* respectively.

Among the selected ten AM Fungi, G*lomus macrocarpum* was most influenced on (*Brassica juncea*) Mustard plants. The present findings clearly documented that other than host specificity indigenous AM fungus *G. macrocarpum* best or efficient strain than other nine AM Fungi. Those nine AM Fungi considered to be exotic do not influence much on plant growth, biomass yield and nutrient uptake on *Brassica junceae.* This finding also supported to the earlier workers contributions mainly of (Kloronomuos, 2003; Watts Williams *et al*., 2015; Sni *et al.,* 2016). AM fungal presence and clolonization was disproved in the members of Brassicaceae, Chenopodiaceae and amarantbaceae, etc., by early works (Mosse, 1981; Robson and Abbott, 1987, Liang Deng Guo, 2018). But in our present study, that disputed Brassicaceae member *Brassica junceae* not only posses AM fungal colonization with impressive spore density. And we have experimentally proved the growth responsebiomass yield and nutrients uptake was significantly improved to response to AM fungus *Glomus macrocarpum* inoculation. This study strongly support to the early workers contribution of (Lakshman *et al.* 2011; Aleman and Tiver, 2010; Zhao *et al.,* 2017; Ling-Dong Guo, 2018).

CONCLUSION:

Mustard plants (*Brassica junceae*) inoculated with AM fungi, showed positive growth response to AM Fuinal inoculation over the control treatment, but the rate of increased growth as varied with each AM fungal inoculate. Experimental results showed, that the *Brassica junceae* incoculated with *Glomus macrocarpum* showed significantly increased plant height and length, when compared to the non-inoculated experimental plant. *Gigaspora margarita* and *Sctellospora nigra* influenced second and third respectively as efficient strains.

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