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Arbuscular Mycorrhizal fungal strain dependant variation in root colonization, spore population, growth promotion and yield response of Flue Cured Virginia tobacco (*Nicotiana tabacum*)*

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Arbuscular mycorrhizal (AM) fungal species vary in their mycorrhizal efficiency towards plant hosts (Smith and Read 2008). The endophytes colonize roots and enhance plant growth by enhancing the nutrient uptake, which results in increased yield (Maiti 2011). Selection of an efficient AM species/isolate for inoculum production is an important step towards adopting mycorrhizal inoculation technology in crop production (Marleen *et. al.* 2011). Present study is to find out the variation in plant growth and phosphorus nutrition promotion efficiency of six common AM fungal species with respect to AM responsive host tobacco *(Nicotiana tabacum* L.) in vertisols. Tobacco has been found to be highly compatible for AM association (Subhashini and Padmaja 2010). However, AM fungi may vary in spore germination and root colonization potentiality according to host and endophyte species, which affect the nutrient uptake and plant growth (Smith *et al.* 2009). The soil samples examined from different tobacco soils of India confirmed the presence of *Glomus* and *Acaulospora* species, out of which *Glomus fasciculatum* was the most common. The present investigation is to compare the root colonization, spore population and plant growth responses in Flue Cured Virginia (FCV) tobacco inoculated with five species of *Glomus* and one species of *Acaulospora.*

The experiment was conducted for two years in tobacco variety VT 1158 in Traditional Black Soils (TBS) of Katheru during 2008-09 and 2009–10 using six different AM fungi, viz. *Glomus mosseae,* G. *fasciculatum,* G. *constrictum,* G. *intraradices, Glomus* spp.(local isolate), *Acaulospora laevis*. All the cultures except *Glomus* spp. (local isolate) were obtained from the Tata Energy Research Institute, New Delhi. The inoculum of these mycorrhizal endophytes was multiplied on maize *(Zea mays)* in pots having sterilized soil. The physico-chemical characteristics of the experimental soil are pH of 7.6, E.C-2.95, O.C - 0.41%, available P - 14 kg/ha, K - 633 kg/ha. The experiment was conducted in a completely randomized block design with seven treatments and four replications. Recommended doses of fertilizers (RDF), viz. 50 kg N for TBS and 10 kg each of KP were used per hectare.

A thin layer of mycorrhizal inoculum containing 40 spores was placed 4 cm below the seedlings in TBS where tobacco variety VT 1158 was transplanted. After 120 days of transplantation the roots of tobacco plants were chopped off and the spore density in 100 g soil was determined. To measure the colonization, root samples were collected at 30 days intervals up to 120 days of transplanting. The roots were thoroughly washed in tap water and cut into pieces of about 10 mm in length. The roots were stained and the extent of root colonization was measured. The proportion of length of each segment containing vesicles, arbuscules and mycelium of the mycorrhizal fungus was estimated to the nearest 10 per cent. Data were recorded as frequency distribution from samples containing 50 root segments in each treatment. The percentage of the root length with mycorrhizal colonization in the samples was then calculated from frequency distribution at 30, 60, 90, and 120 days after transplanting.

The shoot and root length, green leaf weight, cured leaf weight, bright leaf and grade index of the plants were recorded at 120 days after transplanting. Then plants were oven dried at 80°C for 48 hours to estimate the dry weight of the plants and phosphorus by vanidomolybdate method. All the observations per plant recorded are average of four plants.

The observation pertaining to relative per cent root colonization of tobacco of six different AM fungi, the strain *Glomus* spp (local isolate) showed maximum root colonization in tobacco followed by G. *intraradices* and *Acaulospora laevis* at all the four periods of plant growth. *Glomus* spp (local isolate) gave 22.00, 45.67, 64.66 and 79.00%

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colonization while G. *intraradices* gave 16.33-77.33 per cent AM colonization (Table 1). Maximum spores 445/100g soil were recorded in rhizosphere soil from the plots inoculated with *Glomus* spp (local isolate) followed by *G. intraradices* (431 spores). Comparatively the spore population of *G. mosseae* inoculated plots was less in number to that of other *Glomus* species. Only 313 and 340 spores/100 g soil was estimated in the plots inoculated with *G. fasciculatum* and *G. constrictum.* Probably the quick and high degree of root colonization in case of *G. intraradices* may produce higher spore count in soil. The maximum plant growth was observed in *Glomus* spp. (local isolate) and *G. intraradices* inoculated plots (Table 2). Except for G. *mosseae* on an average the root dry weight of plants was also significantly higher in all the AM fungi inoculated plots when compared to control. The maximum of 42.66 and 41.00 g root dry weight was observed for the plants inoculated with *Glomus* spp (local isolate) *and G. intraradices* as compared to 33.00 g root dry weight in uninoculated plants.

Green leaf weight, cured leaf weight, bright leaf and grade index of the plants recorded were significantly higher in *Glomus* spp (local isolate) and *G. intraradices* inoculated plants as compared to the plants inoculated with other AM fungi (Table 2). Green leaf weight, cured leaf weight, bright leaf and grade index of the plants recorded ranged from 11 416–14 650 kg/ha, 1 875–2 441 kg/ha, 480–1 371 kg/ha, and 1 242–2 027 respectively.

Least root colonization by AM fungi was observed in the seedlings maintained in uninoculated plots. G. *intraradices* gave maximum and quick colonization of tobacco roots (Subhashini and Padmaja 2009). Riedel *et al.* (2008) also recorded that tobacco is the most compatible host for the development of AM association with *G. intraradices.* Similar increase in growth and yield of field grown wheat crop was observed due to the inoculation of *G. intraradices (*Javadi *et al.* 2009). The mycorrhizal symbiosis is known to increase the plant biomass by enhancing the nutrient uptake (Baslam *et al*. 2009). The phosphate nutrient is greatly released and become available to the plants in presence of AM fungi. Similar root length, shoot length as well as increased level of nutrient and yield was observed in forage maize due to inoculation of *G. intraradices* (Abasi *et al.* 2011). Since

Table 1 Effect of inoculation of six AM fungi on spore population and root colonization of tobacco in TBS

Treatment	Root colonization (%) after 30 days	Root colonization (%) after 60 days	Root colonization (%) after 90 days	Root colonization (%) after 120 days	P content (%) after 120 days
Glomus mosseae	10.00	14.33	21.00	40.00	0.21
G. *fasciculatum*	16.00	29.33	46.33	57.33	0.23
G. *constrictum*	14.67	25.67	42.33	57.00	0.22
G. *intraradices*	16.33	40.00	59.67	77.33	0.24
Glomus spp (local isolate)	22.00	45.67	64.66	79.00	0.24
Acaulospora laevis	15.67	32.66	51.00	69.66	0.22
Control	1.33	4.00	5.67	15.66	0.20
S Em±	1.11	1.50	1.45	1.81	0.01
CD at 5%	3.41	4.61	4.44	5.56	0.02
CV%	14.01	9.50	6.04	5.60	5.29

Table 2 Effect of inoculation of six VAM fungi on plant growth spore population in TBS

Treatment	Plant height (cm)	Root dry weight (g)	Green leaf (kg/ha)	Cured leaf (kg/ha)	Bright leaf (kg/ha)	Grade index	Spore population/ 100 g soil
				120 days			
Glomus mosseae	128.00	33.36	12416	2091	1025	1373	255
G. *fasciculatum*	137.66	37.0	12740	2220	1243	1666	313
G. *constrictum*	138.33	38.0	13486	2173	1215	1688	340
G. *intraradices*	142.00	41.0	14225	2457	1241	1803	431
Glomus spp. (local isolate)	146.66	42.66	14650	2441	1371	2027	455
Acaulospora laevis	142.33	39.33	13500	2241	1202	1661	362
Control	109.00	33.00	11416	1875	480	1242	39
S Em±	1.33	0.85	162.0	56.75	34.46	53.89	14.97
CD at 5%	4.06	2.62	497.1	174.16	105.75	165.39	45.94
CV%	1.70	3.91	2.12	4.45	5.37	232.85	8.26

Glomus spp (local isolate) and *G. intraradices* produced symbiotic relationship with tobacco seedlings very quickly and at early stage as compared to other AM fungi, maximum plant growth was observed with the inoculation of *Glomus* spp (local isolate) and *G. intraradices.*

SUMMARY

An experiment was conducted to evaluate the variability and performance of six AM fungi on plant growth promotion and phosphorus nutrition efficiency of FCV tobacco. Four species of *Glomus* and one species of *Acaulospora* were obtained from TERI and compared with native strain of *Glomus* sp. The VAM species were multiplied *in situ* on *Zea mays*. Later the inoculum was applied @ 40 spores/plant at the time of transplanting in RBD with untreated controls. Observations were recorded after 120 DAT. The results revealed that local isolate of *Glomus* spp significantly improved spore population and root colonization since early crop phenologies. The yield parameters were also significantly improved. Among TERI isolates *G. intraradices* performed at par with the local isolate. The definitive results suggest ample scope to utilize VAM in integrated nutrient management of tobacco.

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