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Effect of *Glomus fasciculatum* and Plant Growth Promoting Rhizobacteria on Growth and Yield of *Ocimum basilicum*

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Abstract : A pot culture experiment was carried out to study the effects of inoculation with Glomus fascicuJatum and Plant Growth Promoting Rhizobacteria (pGPR) namely *Bacillus megaterium* and *Pseudomonas fluorescens* on growth and biomass of *Ocimum basilicum* under glass house conditions. Single and dual inoculations increased the growth and biomass, compared to uninoculated plants. The consortium of all the three organisms was found superior in enhancing plant height, number of branches, herbage yield, and phosphorus content Mycorrhizal colonization and spore numbers in the root zone soil were significantly increased in *G. fasciculotum* inoculated treatment and its combination with PGPR.

Introduction

Ocimum basilicum, commonly known as sweet basil, belongs to the family Lamiaceae. It is used as an important source of essential oil. The herb, leaves and seeds are used in indigenous system and homoeopathy. An infusion of the plant is used for treating cephalalgiagouty joints and as a gargle for bad breath. The oil is extensively employed in several European countries and USA for flavoring of food stuffs, confectionary, condiments and in toiletry products such as mouth washes and dental creams (Farooqi and Sreeramu, 2001). Role of Arbuscular Mycorrhizal Fungi (AMF) and Plant Growth Promoting Rhizobacteria (PGPR) in improving plant growth including medicinal plants have been well documented (Lakshman, 1992; Murthy *et al.*,1998). PGPR produces plant growth promoting substances and contribute to a greater extent to sustainable yield and quality of medicinal plants. Arbuscular mycorrhiza increase plant growth by increasing uptake of nutrients especially phosphorus and other micronutrients. Sharma *et al.* (1997) reported significant increase in growth and yield of ginger inoculated with AMF. *Coleus barbotus* inoculated with *G. fasciculatum* and other beneficial bacteria increased the growth and yield (Earanna *et al.*,2001). Beneficial effects of AMF and PGPR growth and herbage yield of *Phyllanthus amarus* has been reported by Earanna *et al.*(2003). This study reports the influence of arbuscular mycorrhizal fungus, *G. fasciculatum* and \ PGPR on growth and biomass of *Ocimum basilicum*.

Material and Methods

Arbuscular mycorrhizal fungi are obligate symbionts. Hence, the *G. fasciculatum* inoculum was multiplied in the roots of Rhodes grass and the rhizosphere soil along with roots was used as the inoculum. Pure culture of B.megaterium and *P. fluorescens* were grown in nutrient broth for 6 days. Ocimum basilicum seedlings were obtained from the Department of Horticulture, University of Agricultural Sciences, GKVK, Bangalore. Pots were filled with sand and soil mix (1:1 w/w) and watered one day prior to planting. A planting hole was made at the center of the pot to enable inoculation and planting. Twenty grams of *G. fasciculatum* (19 spores /g soil), 10 ml each of *B.megaterium* (4.8x 10^8CFU/ ml) and *P .fuorescens* (3.2x 10^8 CFU/ml),. respectively were added into the planting hole, as per the treatment details given in table 1. One month old *Ocimum basilicum* seedlings (one seedling lpot) were planted and watered as and when required during the growth period. Observations for plant height and numbers of branches were recorded before harvest. The plants were harvested on 90 days after planting and the fresh weight of shoot and root was recorded. The dry weight of shoot and root was recorded after constant drying the samples at 60°C for 6 days in a hot air oven. Phosphorus content was estimated by vanadomolybdate yellow colour method (Jackson, 1973). Mycorrhizal root colonization was determined by grid line intersection method (Giovannetti and Mosse, 1980) after staining the roots with 0.02% acid fucshin The chlamydospore numbers in the root zone soil were estimated by wet sieving and decantation method (Gerdemann and Nicolson, 1963).

Results and Discussion

Results of growth and yield parameters are presented in table 1. The plant height was significantly increased in all the inoculated treatments, compared to uninoculated control. There were no significant differences between the single and dual inoculations except Gf+Bm treatment. But, the consortium of all three organisms significantly increased the plant height. Similarly, the highest branch number was observed in the triple inoculation treatment which is followed by the dual inoculations, Gf+Pf and Gf+Bm. This indicates that the three organisms together could enhance the growth of plants. Increased growth may be due to better uptake of nutrients and production of plant growth promoting substances in the rhizosphere. These observations are in conformity with the earlier works of Earanna *et al*. (2003) who obtained higher plant height, numbers of branches and leaves in *Phyllanthus amarus* inoculated with *G. fasciculatum* and PGPR. Further, the triple inoculation treatment recorded significantly the highest fresh weight and dry weight, which was followed by the dual inoculation of Gf + Pf and of + Bm, respectively. This has further indicated the efficiency of microbial consortium in enhancing growth and biomass of plant. In general, all the inoculated plants recorded significantly increased biomass compared to uninoculated treatment. Arpana (2000) recorded higher biomass in *Andrographis paniculata* inoculated with *G. mosseae* and *Trichoderma harzianum*.

Phosphoros (P) uptake of shoot and root was influenced due to inoculation with *G. fasciculation* and PGPR (Table 2). Single inoculations increased the P content of both root and shoot compared to uninoculated plants. Dual inoculations further enhances P content. However, the triple inoculation found superior among all. This can be attributed to the mycorrhizal fungus and *B. megaterium*, which mobilize and solubilise P in soil respectively, so that the plants could uptake nutrients efficiently. This upholds the earlier observations made for *Coleus aromatius* inoculated with arbuscular mycorrhiza and PGPR (Earanna *et al*.,2001). Mycorrhizal root colonization and chlamydospore numbers in the root zone soil were significantly increased in the *G. fasciculatum* inoculated treatment and its combination with PGPR. Non mucorhhizal treatments showed lesser root colonization and spore numbers. This indicates the efficiency of the inoculated AM fungus against native AM fungi present in soil. The results are in agreement with the earlier observations made for different medicinal plants (Arpana (2000; Earanna and Bagyaraj, 2004). This study suggests that the inoculation with *G. fasciculatum* and the two PGPR can improve the growth and biomass of *Ocimum basilicum*. The consortium of all the three organisms resulted in maximum growth and biomass.

Table 1. Influence of *G. fasciculatum and* PGPR on growth and biomass of *O. basilicum*

Treatments	Plant height (cm)	Number of branches	Fresh weight (g/plant)	Dry weight (g/plant)
Uninoculated control	52.05^{c}	7.07^{e}	46.03^{g}	26.30^{e}
Glomus fasciculatum (Gf)	57.04^{cd}	10.00^{cd}	56.06^{dc}	32.05
Pseudomonas fluorescens (Pf)	57.00^{cd}	9.33$_{d}$	54.26^{e}	30.50^{d}
Bacillus megaterium (Bm)	56.92^{cd}	9.67$_{d}$	54.56^{e}	30.46^{d}
Pf + Bm	56.89^{cd}	9.33^{d}	58.06^{cd}	32.57^{c}
Gf + Bm	61.12^{b}	11.33^{bc}	60.64^{bc}	35.17^{bc}
Gf +Pf+Bm	63.53^{a}	15.00^{a}	65.92^{a}	40.12^{a}

Means with the same superscript do not differ signficantly at p= 0.05 level by Duncan's Multiple Range Test.

Table 2. Influence of *G. fasciculatum and* PGPR on phosphorus content and mycorrhizal parameters of *O. basilicum*

Treatments	Phosphorus content (mg/plant)		Mycorrhizal root colonization (%)	Spore number / 25g soil
	Shoot	Root		
Uninoculated control	2.01^{c}	1.96^{e}	46.03^{d}	26.30^{e}
Glomus fasciculatum (Gf)	2.42^{b}	2.77^{d}	63.06^{a}	72.05^{a}
Pseudomonas fluorescens (Pf)	2.08^{c}	2.75^{d}	34.26^{d}	28.50^{de}
Bacillus megaterium (Bm)	2.70^{c}	2.75^{d}	30.96^{d}	37.66^{e}
Pf + Bm	2.47^{b}	3.25^{b}	48.06^{cd}	32.57^{c}
Gf + Pf	2.59^{b}	3.54^{b}	61.76^{b}	67.03^{a}
Gf + Bm	2.61^{b}	3.57^{b}	61.64^{b}	75.17^{a}
Gf +Pf+Bm	3.05^{a}	3.83^{a}	65.92^{a}	78.12^{a}

Means with the same superscript do not differ signficantly at p= 0.05 level by Duncan's Multiple Range Test.

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