Bioscience Discovery, 02 (2):256 -260, June 2011 ISSN: 2229-3469 (Print)

INFLUENCE OF AM FUNGI AND RHIZOBIUM ON THE GROWTH AND NUTRIENT UPTAKE OF *LENS ESCULENTA*

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Received: 25 Oct. 2010, Revised: 06 May 2011

ABSTRACT

Green house pot experimental Studies were undertaken on *Lentil lens esculata* Moench (Lentil) by using *Glomus fasciculatum and Rhizobium leguminosarum* plants dry wt. percent of mycorrhizal colonization spore number, nitrogen content of nodules, No. of nodules have been counted. The result revealed ioculation with *Rhizobium* increased the total nitrogen content of shoot and root (Table 3). It is interesting to note the increase in the shoot and root nitrogen content due to inoculation with *G. fasciculatum* alone. Plants inoculated with both the organisms contained higher amounts of nitrogen and phosphorus in their roots compared to the plants inoculated separately with either *Rhizobium* or G. *fasciculatum*. Inoculation with *Rhizobium* is known to improve growth, total biomass, nodulation and nitrogen fixation in *Lentil esculata* is very significant. Increased nodulation, mycorrhizal colonization dry weight and phosphorus in plants inoculated with *G. fasciulatum* plus *Rhizobium* compared to single inoculation with either organism is clearly evident from the present study. Further *G. fasciculatum* only inoculation improved nodulation by indigenous rhizobia and *Rhizobium* only inoculation improved the colonization of roots by native mycorrhizal fungi.

Key words: *Lentil lens esculata*, Rhizobium, AM Fungi (*Glomus fasciculatum*), Nodules and biomass productions.

INTRODUCTION

Several hard wood trees are infected with vesicular-arbuscular mycorrhizas as a microsymbiont (Kormanik 1986; Lakshman 2009). Significance of VA-mycorrhizal fungi a plant growth, and nutrients uptake by tree species was reported earlier (Mosse 1977b; Nalini *et al.* 1986). These fungi increase phosphorus uptake of plants growing in phosphorus deficient soils (Tinker 1975; Powell and Daniel 1978; Majunath *et al.* 1984; Lal and Khanna 1992; Lakshman 1992), mainly through increased surface area of absorption. Therefore, there has been increasing interest on the possible use of VA-mycorrhizal fungi and *Rhizobium* together, to improve growth and nodulation in legumes. Investigations on interaction between VA-mycorrhizal fungi and *Rhizobium* have shown that dual inoculation improves nodulation, nitrogen fixation and plant growth (Habish and Khairi 1970; Hayman 1978 and 1986).

Lentil lens esculata Moench is a slender branched annual legume grown for its seeds. Being rich in protein, they are considered as essential, because of its percentage of protein. It is commonly consumed as a nutritious dal. unripened pods are used as a given vegetable and the dry plants, husk and broken grains as good cattle feed. Response of *lens esculata* to inoculation with indigenous mycorrhizal fungi and *Rhizobium* is presented in this paper.

MATERIALS AND METHODS

The experiments were conducted in glass house. The soil was sandy loam with pH 5.7, phosphorus deficient (2.5 mg of NH_4 + HCL extractable phosphorus per kg soil) and practically devoid of microorganisms. Earthen pots of 35 cm diameter were filled with 10 kg sterilized soil. The sand : soil mixture containing the extramaterical chlamydospores, hyphae and infected segments of *Chloris gayana* Kunch, infected with *Glomus fasciculatum* (Thaxter, Sensu and Gerd.) Gerd and Trappe and grown for 365 days served as mycorrhizal inoculum. Inoculum contained 467 chlamydospores per 100 g. A thin layer of inoculum (100 g.) was placed 2 cm below the surface sowing the seeds. Cultures of *Rhizobium leguminosarum,* was obtained from microbiology department University of Agricultural Sciences Dharwad. Species *of Rhizobium* was done by treating with the seeds of *Lentil esculata* in broth culture before sowing. There were five treatments 1. Uninoculated control 2. Inoculated with *G. Fasciculatum* 3. Inoculated with *Rhizobium leguminosarum* 4. Inoculated with both *R. leguminosarum and G. fasciculatum,* each with four replications. Two seedlings were maintained per pot. The plants were harvested for 366 days after sowing. Mycorrhizal spores in the soil were estimated by wet sieving and decanatation technique (Gerdemann and Nicolson 1963). The percentage mycorrhizal colonization of roots was determined after clearing the roots with 10% KOH and staining with 0.05% Trypan blue (Philips and Hayman 1970). Dry weights of shoots, roots and nodules were recorded after drying to constant weight at 70°C. Total nitrogen content in shoot, root and nodules were determined by microkjeldahl method (Bremner 1960). Phosphorus content was determined colorimetrically by Vanadomolybdate phosphoric, yellow colour method outlined by Jackson (1973).

RESULT S AND DISCUSSION

Dry weight of shoot and root, per cent mycorrhizal colonization as influenced by inoculation with *G. fasciculatum* and *R. leguminosarum* are presented in Table 1. Although the plants inoculated with both the organisms recorded the highest dry weight of shoot and root, they did not significantly differ from the plants inoculated with either *G. fasciculatum* or *Rhizobium*. Inoculation with *G. fasciculatum* significantly increased the mycorrhizal root colonization and spore numbers in soil. Inoculation with *Rhizobium* improved root colonization by native mycorrhizal fungi. Results on number dry weight and nitrogen content of root nodules as influenced by inoculation with *G. fasciculatum* and *Rhizobium* are presented in Table 2. The differences in the number of nodules were not significant. The dry weight and nitrogen content of nodules in plants inoculated with both *G. fasciculatum* and *Rhizobium* were higher compared to uninoculated plants. Inoculation with *G. fasciculatum* considerably improved nodulation by rhizobia and had significant effect, on dry weight and nitrogen content of nodules.

Table 1. Dry weight of shoot and root, percent mycorrhizal colonization of root and mycorrhizal spores in soil as influenced by inoculation with *G. fasciculatum* and *R. leguminosarum* on *Lentil esculata* for 40 days.

Treatment	Dry weight (g/plant)		% Colonization	Spares per 50 g soil
	Shoot	Root		
Main effects				
g	2.61	1.67	5.37	49
G	3.76	2.32	43.56	132
r	2.83	1.60	67.3	71
R	3.57	2.51	46.7	82
LSD at p = 0.05	0.63	0.41	62.2	11
Interaction effects				
gr	2 03	1.08	33.5	40
Gr	3.78	2.11	62.7	109
gR	3.20	2.30	54.2	56
GR	3.86	2.71	73.1	143
LSD at p = 0.05	0.89	0.57	74.0	16

Inoculation with *Rhizobium* increased the total nitrogen content of shoot and root (Table 3). It is interesting to note the increase in the shoot and root nitrogen content due to inoculation with *G. fasciculatum* alone. Plants inoculated with both the organisms contained higher amounts of nitrogen and phosphorus in their roots compared to the plants inoculated separately with either *Rhizobium* or G. *fasciculatum*.

Inoculation .with *Rhizobium* is known to improve growth, total biomass, nodulation and nitrogen fixation in *Lentil esculata* is very significant. Increased nodulation, mycorrhizal colonization dry weight and phosphorus in plants inoculated with *G. fasciulatum* plus *Rhizobium* compared to single inoculation with either organism is clearly evident from the present study. Further *G. fasciculatum* only inoculation improved nodulation by indigenous rhizobia and *Rhizobium* only inoculation improved the colonization of roots by native mycorrhizal fungi. These results bring out a synergistic interaction between *G. fasciculatum* and *Rhizobium* with, nitrogen fixation and phosphorus uptake in *Lentil esculata.* is findings in other woody legumes (Hogberg and Kvarnstron 1982; Daft *et al.* 1985). That arbuscular mycorrhizal fungi can have important effects on nodulation and nitrogen fixation. As previously reported for *Acacia* sp., (Habish and Khairi 1970; Roskeski *et al.*

Table 2. Number, dry weight and nitrogen content of nodules as influenced by inoculation with *G. fasciulatum and R. Leguminosarum* on *Lentil esculata* for 40 days.

Treatment	Nodules per plant	Nodules dry weight per plant (mg)	Nodule nitrogen per plant (mg)
Main effects			
	14.6	97.3	3.52
G	36.4	164.5	6.62
r	23.1	102.81	3.90
R	28.6	159.35	6.31
LSD at p = 0.05	NS	50.15	1.74
Interaction effects			
gr	11.5	66.00	2.53
Gr	37.6	143.25	5.30
gR	22.4	137.14	4.71
GR	38.0	199.64	7.96
LSD at p = 0.05	NS	70.90	2,52

Table 3. Nitrogen and phosphorus content of shoot and root as influenced by inoculation with *G. Fasciulatum* and *R. Leguminosarum* on *Lentil esculata* for 40 days.

Treatment	Total nitrogen (mg/plant)		Total phosphorus (mg/plant)	
	Shoot	Root	Shoot	Root
Main effects				
g	53.7	14.2	5.37	3.30
G	90.2	27.6	7.56	5.04
r	68.1	17.8	5.96	3.36
R	78.5	28.9	6.99	4.98
LSD at p = 0.05	12.3	4.5	1.18	0.83
Interaction effects				
gr	40.1	10.3	4.53	2.30
Gr	93.4	26.2	7.91	4.44
gR	65.6	21.6	6.20	4.31
GR	88.5	32.1	7.74	5.69
LSD at p = 0.05	16.5	6.4	1.69	1.18

G = Glomus inoculated; g : Glomus not inoculated-
R = Rhizobium inoculated; r = Rhizobium not inoculated
g = Mean of gr and of R
G - Mean of GR and GR
r - Mean of gr and Gr
R - Mean of gr and GR

1986) suggests that the colonization with efficient indigenous mycorrhizal fungi significantly improve phosphorus nutrition nodulation and nitrogen fixation by rhizobia. This agrees with results with other plants (Sidhu and Behl 1990; Mridhal *et al.* 1995) and is consistent with the view that mycorrhizae not only enhance uptake of phosphorus but also of other ions. It is clear that nodulations by *Rhizobium* depends on adequate mycorrhizal colonization or available P supply. The present results confirm and support to other studies (Powell *et al.* 1978; Cruz *et al.* 1988; Mosse 1976). Bagyaraj *et al.* (1989) suggested that nodulation was negligible when plant P concentration was below 0.2 per cent. This agrees with the results reported here, particularly with the number and size of nodules. The present study suggests that dual inoculation with selected indigenous mycorrhiza *G. fasciculatum* and *Rhizobium* will help the growth of *Lentil esculata* in phosphorus deficient soils. Inspite of other species of mycorrhizae. Because of the difficulties in raising mycorrhizal inoculum, it is now generally, accepted that mycorrhizal inoculation has more practical utilization in transplanted crops rather than directly field sown crops (Mosse 1988). Hence, it can be conducted that legume inoculation with arbuscular mycorrhizal fungi in phosphate fixing soils was successful, since it is not only improved plant growth and nutrition but also enhanced the activity of *Rhizobium* applied as inoculant. Field inoculation with VA-mycorrhiza may, therefore, be worth trying particularly in legumes, since as it was stated by (Sprent 1986; Janardhana *et al.* 1990; Lakshman 1996). Plants with dual symbiotic association posses both nutritional and ecological advantages to compensate nutrient deficient situations, and the establishment of these association can be improved by inoculation with its mutualistic partners *Rhizobium* and mycorrhizal fungi.

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