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EFFECT OF *Glomus fasciculatum* ON THE GROWTH AND YIELD OF *Dolichos lablab* AS INFLUENCED BY THE APPLICATION OF PHOSPHATE FERTILIZER

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Abstract

Arbuscular mycorrhizal fungi (AMF) are a key component for plant survival and create an intimate link between plant roots and the soil. The major role of AMF is to supply Phosphate (P) in infected plants, because P is an extremely immobile element in soil. Several species of mycorrhizal fungi especially *Glomus fasciculatum* can be used for P uptake and translocation in *Dolichos lablab*. A pot culture experiment was conducted to study the inoculation effect of *G. fasciculatum* on the growth and yield of *D. lablab* as influenced by different levels (0 %, 25 %, 50 %, 75 % and 100 %) of P fertilizer. The maximum yield was obtained in 75 % of the P level followed by 50 % and 100 % P levels. The increasing amount of P fertilizer decreases the *G. fasciculatum* population. The *D. lablab* yield was increased at 75 % of P level followed by 50 % and 100 %.

Key words: *Glomus fasciculatum*, *Dolichos lablab*, P fertilizer and AM fungi.

1. Introduction

Legumes are important sources of proteins, carbohydrates, dietary fiber and minerals consumed worldwide. This is a tropical vein plant from the legume family and it is widely grown in Africa, India and Indonesia. *D. lablab* is one of the lesser-known legumes of arid and semiarid land. It is a well known vegetable among the Indians. It is commonly called as lablab bean, bonavist bean, hyacinth bean and Indian butter bean (Tamil – Avarai). Genus – *Dolichos*, species – *lablab*, family – Leguminaceae. This vegetable which was not so famous is good for diabetics and a good source of fiber. It is also popular as a nitrogen fixing green manure to contribute the soil nitrogen and improve soil quality. It is a garden vegetable crop and used acts an intercrop in India and Australia as a weed suppressor and soil erosion retardant.

Mycorrhizae (Allen, 1992; Harrison, 1997; Smith and Read, 1997) are mutually beneficial intimate relationship between diverse fungi and crop roots. Most of the plants (more than 90 % of all know species) are infected with atleast one type of mycorrhizae, and it also plays an important and decisive role in the phosphorus uptake of plants. AMF takes the nutrients (especially phosphorus) which are in the available forms and transfer to crop plants. In 1959, Baylis from New Zealand was the first to suggest that the beneficial mycorrhizal effect was mediated by P uptake. Gerdeman also demonstrated that non-mycorrhizal plants exhibited severe phosphorus deficiency symptoms and had significantly lower P concentration and higher K and Mg concentrations than mycorrhizal plants.

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The organic phosphates applied to soil as a fertilizer is rapidly converted to unavailable forms with low solubility. Soluble P was released from insoluble phosphates by a variety of solubilization reaction involving rhizosphere microorganisms. Mycorrhizal plants can take up more P than non-mycorrhizal plants. Legumes are relatively high P requirement for nodule development and nitrogen fixation. Normal levels of nodulation may depend on the presence of mycorrhizal fungi. Several species of mycorrhizal fungi especially *G. fasciculatum* was used for P uptake and translocation in *D. lablab*.

2. Materials and Methods

The soil used for conducting the pot culture experiment was obtained from the garden land of the Experimental Farm, Department of Microbiology and Biochemistry, Nadar Saraswathi College of Arts and Science, Theni, Tamil Nadu. *D. lablab* (Avarai) seeds were obtained from the Orchard, Department of Horticulture, Annamalai University, Annamalai Nagar, Tamil Nadu has been used in the present study. The P fertilizer was supplied as Single Super Phosphate (SSP) as per the recommended doses in the pot culture experiments. The dose of P fertilizer per pot was worked out on the soil weight basis keeping the base of their recommended doses *viz*., 50 kg P_2O_5/ac for *D. lablab*. Live arbuscular mycorrhizal spores were inoculated in root tissues of the plant.

A pot culture experiment was conducted to study the inoculation effect of *G. fasciculatum* on the growth and yield of *D. lablab* as influenced by different level of P fertilizer.

T_0 : Control

T_1 : *G. fasciculatum* + 0 % P_2O_5

T_2 : *G. fasciculatum* + 25 % P_2O_5

T_3 : *G. fasciculatum* + 50 % P_2O_5

T_4 : *G. fasciculatum* + 75 % P_2O_5

T_5 : *G. fasciculatum* + 100 % P_2O_5

The biometric observation *viz*., mycorrhizal spore number, root colonization per cent of AM fungi, plant height, nodule number and P content of the plant were determined on 15, 30 and 45 DAS

Arbuscular mycorrhizal spores were estimated from rhizosphere soil by Wet sieving and Decanting method (Gerdemann and Nicolson, 1963). The spores were cleaned of soil particles by sucrose density gradient centrifugation method and washed with distilled water (Mertz *et al*., 1979). This spore suspension was counted with stereo zoom microscope during counting. Per cent root colonization by AM fungi was determined after staining the roots with tryphan blue as described by Phillips and Hayman (1970) with slight modification.

$$\text{Per cent AM fungi root infection} = \frac{\text{Number of AM positive (+) segments}}{\text{Total number of segments observed}} \times 100$$

The height of the *D. lablab* was measured from the ground level to the tip of the growing plant. The total number of matured nodules was counted from each treatment. The P content of the plant was estimated using Vanadomolybdate method (Jackson, 1973).

3. Result and Discussion

A preliminary survey was taken upto study the mycotrophy of *D. lablab*. The mycorrhizal status of rhizosphere soil sample was studied by estimating the per cent root colonization and AM fungal spore number after inoculate the *G. fasciculatum* on 15, 30 and 40 DAS.

The AM spore population increased with the increase in the age of the plant. The maximum was observed at 45 DAS. Application of P at different levels *viz*., 0, 25, 50, 75 and 100 per cent recorded the AM spore number (163.89, 168.0, 159.0, 148.0, 101.3 and 85.66 per 100 g of rhizosphere soil). The lowest spore number in 100 per cent P_2O_5 level (85.66 per 100 g of soil). The colonization of *G. fasciculatum* in *D. lablab* root at 45 DAS in control shows highest (38.16) followed by 25 % P_2O_5 (35.20). The per cent root colonization reduced with the increasing level of P and the per cent gradually decreased of root

colonization at 50 %, 75 % and 100 % of P_2O_5 level were respectively are presented in Table - 1.

Inoculation of *G. fasciculatum* at 50 % significantly increased the plant height than the control. At different levels of P application the maximum plant height was observed at 75 % P application (36.46 cm) and increased plant height was noticed with increased in the levels of P application. The plant height observed at 0, 25, 50, 75 and 100 % of P_2O_5 were 27.16, 30.56, 35.76, 36.46 and 34.33cm respectively under *G. fasciculatum* inoculated *D. lablab* plants. The data are presented in Table - 2.

The nodule number of *D. lablab* increased with the increased levels of P fertilizer. At all the three intervals of observations the P content at different levels *viz*., 0, 25, 50, 75 and 100 % recorded the increase in nodule number of 20.44, 22.88, 25.21,27.22 and 30.66 in the rhizosphere region of plant root respectively. Nodule number was more in 100 % P_2O_5 (30.66 %) and the lowest in the control (18.29 %) are shown in Table - 3.

At 60 DAS, the uptake of P was the maximum. The maximum level was observed in the 75 % P (5.19 %) and followed by 50 % and 100 % of P level were 4.63 % and 4.49 % respectively. The minimum level of P uptake was by control plant (2.11 %). The P uptake was increased at the increased level of P_2O_5 (Table - 4).

At different levels of P application, the minimum yield was obtained at 75 % (497 kg ac^{-1}) followed by 100 % (495 kg ac^{-1}) and 50 % (493 kg ac^{-1}) P levels of the yield of *D. lablab* was more (or) less similar. The results revealed that the inoculation effect of *G. fasciculatum* was influenced by the application of graded levels of P fertilizer, to develop a technology for treatment for AM fungi in *D. lablab* are shown in Table - 5.

The inoculation of VAM fungi significantly increased the nodulations, nitrogenase activity, per cent root colonization and spore number in cluster bean, mung bean and moth bean (Tarafdar and Rao, 1997). Inoculation of plants with AM fungi can stimulate nodulation and nitrogen fixation by legumes (Mosse, 1981). Inoculation of *G. fasciculatum* increased the nodulation, shoot N and P concentration, shoot dry matter and seed yield in soy bean plants Srinivasan *et al*. (1995).

However, the effect appears to operate indirectly through increased P uptake because the response to inoculation can be completely overcome by increasing P supply (Abort and Robson, 1977; 1982). AM fungi which constitute important group of microorganism are ubiquitous throughout the world and are known to improve the plant growth through better uptake of P and other nutrients. It was generally accepted that the plant growth was enhanced because the fungal hyphae explore the soil outside nutrition depletion zones and absorb ions especially P from soil solution and around roots and transfer them to plants (Hayman and Mosse, 1972).

Higher levels of soluble P have negative effect on VA mycorrhizal colonization in wheat (Ryan, 1994). On this basis 75 and 100 % of P_2O_5 decrease the fungal spore and the root colonization. In the 50 % P_2O_5 level the fungal colonize are survived and the plant uptake the phosphorus content in from the soil. But, both 100 and 50 per cent level yield are similar moderate increase P availability can maintain or elevate VA mycorrhizal colonization (Habte and Fox, 1993; Lue *et al*., 1994).

The increasing amount of P fertilizer (100 %) decreases the *G. fasciculatum* population. The *D. lablab* yield was increased at 75 % of P level followed by 50 % and 100 %. They are more or less similar to each other. The result revealed that 50 % of 'P' fertilizer can be saved by *G. fasciculatum* inoculation.

Table - 1: Effect of *G. fasciculatum* inoculation on the AMF spore number and per cent root colonization of *D. lablab*

T. No	Treatments	Number of AM fungal spore (per 100g of soil)			Root colonization		
		Sampling period in days			Sampling period in days		
		15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS
T_0	Control	70.57	110.68	163.89	23.43	29.52	35.73
T_1	*G. fasciculatum* + 0 % P_2O_5	78.33	116.0	168.0	25.9	31.66	38.16
T_2	*G. fasciculatum* + 25 % P_2O_5	73.67	109.6	159.0	23.66	28.30	35.20
T_3	*G. fasciculatum* + 50 % P_2O_5	69.00	99.67	148.0	20.53	25.16	32.30
T_4	*G. fasciculatum* + 75 % P_2O_5	62.00	89.00	101.3	18.43	23.36	29.50
T_5	*G. fasciculatum* + 100 % P_2O_5	57.00	73.30	85.66	15.13	20.33	27.66
	SED	3.76	4.39	2.54	1.40	1.26	2.92
	CD (p = 0.05)	7.55	8.83	5.11	2.82	2.53	5.88

Table - 2: Effect of G. *fasciculatum* inoculation on the plant height of *D. lablab*

T. No	Treatments	Plant height (cm)		
		Sampling period in days		
		30 DAS	45 DAS	60 DAS
T_0	Control	16.75	20.98	25.34
T_1	*G. fasciculatum* + 0 % P_2O_5	18.83	23.83	27.16
T_2	*G. fasciculatum* + 25 % P_2O_5	19.66	26.66	30.50
T_3	*G. fasciculatum* + 50 % P_2O_5	20.00	30.16	35.76
T_4	*G. fasciculatum* + 75 % P_2O_5	22.66	31.10	36.46
T_5	*G. fasciculatum* + 100 % P_2O_5	29.90	27.66	34.33
SED		3.38	1.38	1.38
CD (p=0.05)		6.80	2.77	2.97

Table - 3: Enumeration of number of root nodules in the rhizospheric region of *D. lablab*

T. No	Treatments	Number of nodules		
		Sampling period in days		
		30 DAS	45 DAS	60 DAS
T_0	Control	10.89	14.78	18.29
T_1	*G. fasciculatum* + 0 % P_2O_5	12.53	16.55	20.44
T_2	*G. fasciculatum* + 25 % P_2O_5	15.98	18.99	22.88
T_3	*G. fasciculatum* + 50 % P_2O_5	18.55	21.71	25.21
T_4	*G. fasciculatum* + 75 % P_2O_5	19.44	23.11	27.22
T_5	*G. fasciculatum* + 100 % P_2O_5	20.44	23.22	30.66
SED		1.63	1.39	4.29
CD (p = 0.05)		3.28	2.81	8.63

Table - 4: Effect of G. *fasciculatum* on phosphorus content of the plant *D. lablab*

T. No	Treatments	Phosphorus content (%) Sampling period in days		
		30 DAS	45 DAS	60 DAS
T_0	Control	0.62	1.26	2.11
T_1	*G. fasciculatum* + 0 % P_2O_5	0.92	1.82	2.72
T_2	*G. fasciculatum* + 25 % P_2O_5	1.51	2.95	3.98
T_3	*G. fasciculatum* + 50 % P_2O_5	1.96	3.61	4.63
T_4	*G. fasciculatum* + 75 % P_2O_5	2.33	3.76	5.19
T_5	*G. fasciculatum* + 100 % P_2O_5	2.41	3.40	4.49
SED		0.23	0.37	0.29
CD (p = 0.05)		0.47	0.75	0.59

Table - 5: Effect of G. *fasciculatum* on the yield of *D. lablab*

T. No	Treatments	Yield (kg /ac^{-1})
T_0	Control	378
T_1	*G. fasciculatum* + 0 % P_2O_5	413
T_2	*G. fasciculatum* + 25 % P_2O_5	461
T_3	*G. fasciculatum* + 50 % P_2O_5	493
T_4	*G. fasciculatum* + 75 % P_2O_5	497
T_5	*G. fasciculatum* + 100 % P_2O_5	495
SED		2.92
CD (p=0.05)		5.88

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