



EFFECT OF FARM YARD MANURE APPLICATION ON PHOSPHORUS USE EFFICIENCY, BIOMASS PRODUCTION AND YIELD OF FRENCH BEAN (*PHASELOUS VULGARIS* L.) VARIETIES IN AN ALFISOL

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Abstract

A study conducted to understand the differential response of French bean varieties to phosphorous fertilization under acidic alfisols at Bangalore conditions suggested that French bean varieties have unique genetic properties that regulate their response to different phosphorous levels. Results have showed differences in pod yield amongst six genotypes of French bean. The highest pod yield was observed in Arka Komal. A positive relationship was observed between the available phosphorus and phosphorus use efficiency (PUE). Soil available phosphorous was reduced in 100% NPK applied plots without farm yard manure (FYM). On the other hand the available phosphorous increased in the plots, which were applied with 50% NPK along with FYM. Pod yield did not show any relationship with biomass production and PUE. The higher rate of PE and AE was positively correlated with higher yielding varieties.

Key words : Farm yard manure (FYM), French bean (*Phaseolous vulgaris* L.), Phosphorus use efficiency (PUE), genotypes.

Introduction

In order to advance in crop yields, breeding of varieties which are efficient in nutrient uptake is one of the main objectives of modern plant breeding programmes. The differences in genetic makeup of plant species have lead to differences in absorption, translocation and utilization of nutrient amongst different genotypes and varieties. Phosphorus is a component of the two compounds, which involves in most significant energy transformation in plants ADP and ATP. ATP is synthesised from ADP through respiration and photosynthesis, which contains high energy phosphate group that drives most biochemical's process requiring energy. Further phosphorous involves in uptake of nutrients, cell division, root development, flowering fruits and seed formation.

French bean is an important short duration leguminous pod vegetable, which is a rich source of protein, calcium and iron is being grown worldwide. The average recovery of fertilizer N by French bean crop is as low as 27.9 per cent. Much of the phosphorus applied accumulates in the soil in less available forms. Therefore, it is pertinent to screen different genotypes or varieties, which efficiently utilize the applied phosphorus in the soil. In

order to achieve higher yields under optimum low fertility conditions, there is a need to evaluate genotypes for higher nutrient use efficiency. In French beans (Srinivas and Naik, 1988) phosphorus fertilization with 80 kg P₂O₅ recorded significantly higher yield (144q ha⁻¹) as compared to control (88 q ha⁻¹). In a study on French bean, seed yields were high when P at 100 kg ha⁻¹ and K at 25 kg ha⁻¹ were applied as observed by Kohli *et al.* (1991). Differences in P absorption and translocation amongst varieties have been observed in French bean by Lindgren *et al.* (1977). Production of dry matter per unit of phosphorus served as a better parameter by (Gabelman and Gerloff, 1983) to evaluate the French bean lines for P utilization.

Materials and Methods

A pot culture study was conducted to assess the utilization efficiency of different varieties of French bean. The experiment was carried out in the greenhouse, College of Agriculture, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bangalore (Karnataka), India. The experiment was laid out in a randomized block design with 12 treatments and three replications. Six varieties of French bean were selected for the study among them Arka Komal and contender, which were

released and notified varieties served as standard checks (control). The remaining four varieties *viz.*, IIHR-220, IIHR-909, Tweed Wonder and Pant Anupama were pre-released varieties, which were undergoing multi-location trials for their performance all over the country. The fertilizer levels imposed were: F_1 –100% recommended dose of NPK (@ 62.5 kg N:100 kg P_2O_5 :75 kg K_2O /ha) without FYM. F_2 – 50% recommended dose of NPK (@ 31.25 kg N: 50 kg P_2O_5 : 37.5 kg K_2O /ha) + FYM @ 25 tones/ha.). Two plants pot^{-1} were maintained, adequate irrigation was given to maintain the pots at field capacity. Nitrogen was applied at two split doses, whereas P and K were applied as basal dose. Recommended plant protection measures were adopted to control pests and diseases. Both soil and plant samples were collected at 64th day of crop growth and phosphorous was estimated as described by Jackson (1973). Fresh pods were harvested twice.

Plant weight was recorded by taking the entire plant material was oven dried and dry weights of stem, roots, leaves and fruits were recorded.

Phosphorus utilization efficiency parameters were calculated as under:

$$\text{Nutrient use efficiency ratio (NER)} = \frac{\text{Total dry matter (kg/ha)}}{\text{Total nutrient uptake (kg/ha)}}$$

$$\text{Nutrient transfer efficiency (NTE)} = \frac{\text{Nutrient in the fruit}}{\text{Nutrient in dry matter}}$$

$$\text{Physiological efficiency (PE)} = \frac{\text{Economic yield}}{\text{Total nutrient uptake}}$$

$$\text{Agronomic efficiency (AE)} = \frac{\text{Economic yield}}{\text{Nutrient applied}}$$

$$\text{Harvest index (HI)} = \frac{\text{Fruit dry weight}}{\text{Total dry weight}}$$

$$\text{Total uptake of nutrient (mg/plant)} = \frac{\text{Total dry matter (gm/plant)} \times \text{Concentration of nutrient (\%)}}{100}$$

Results and Discussion

Phosphorus content in soil and plant

Soil available phosphorus was significant among different treatments. At harvest stage (64 days), the soil available P ranged from 30 to 92 kg/ha. The P content in leaves and pods significantly varied among different varieties. The P content in leaves ranged between 0.064 per cent (T_4) and 0.085 per cent (T_{10}), on the other hand in pods the P content ranged from 0.050 per cent (T_3) to

0.100 per cent (T_8). Results showed that there was no positive relationship between yield and available P status in soil. Further, it is observed that even 50% recommended NPK along with FYM showed higher P content when compared with 100% NPK without FYM treatments. This suggests that vital role played by FYM in making available P to plant growth (Olsen *et al.*, 1970) (table 1).

Uptake, utilization and phosphorus efficiency use parameters

Significant differences were found in the uptake of P among different varieties of French bean. It was found lowest value of 9.41 mg plot was found in T_{12} , on the other hand, the highest value of 39.35 mg pot was observed in T_4 . In general, the uptake values were highest at F_1 levels than their counter parts in F_2 level.

Phosphorus use efficiency ratio (PER) significantly varied among different varieties. The lowest PER value (348.95) was observed in the variety Tweed wonder at F_1 level and the highest value (958.65) was observed in Pant Anupama variety at F_2 level. Phosphorus transfer efficiency (PTE) values ranged between 40.09 and 173.33 per cent. Highest Phosphorus Transfer Efficiency (PTE) was found in IIHR-909 variety at F_2 level and lowest at IIHR-220 at F_1 level.

Physiological efficiency (PE) differed significantly among the varieties. At F_2 level variety IIHR 909 recorded the highest value of 4337, on the other hand at F_1 level the variety tweed wonder recorded lowest value of 605, Agronomic Efficiency (AE) showed significant differences among the varieties the lowest value of 95 was recorded by the variety tweed wonder at F_1 level, whereas highest value of 363 was recorded by the variety Arka Komal at F_2 level. In general, it was observed that phosphorus use efficiency parameters were highest at F_2 level than at F_1 level. The results were supported by the earlier findings of Prasad and Singhania (1989). Whiteaker *et al.* (1976) observed similar P utilisation trend in a varietal screening experiment (table 1).

Dry matter, yield and harvest index

Fresh pod yield was found significantly different among the different varieties at both the fertilizer levels. The data is presented in table 2. In total fresh pod yield, Arka Komal recorded higher values both at F_1 and F_2 level than other varieties. On the other hand, the variety Tweed wonder recorded the lowest pod yield both at F_1 and F_2 levels. It was observed from the data that at F_2 level with 50% NPK and FYM, the variety Arka Komal performed better and produced second highest pod yield.

Table 1 : Effect of fertilizer levels with or without FYM on phosphorus content, uptake and phosphorus use efficiency parameters of French bean varieties.

Treatments	Varieties	Phosphorus uptake at 64 days (mg pot ⁻¹)	Soil available P(Kg ha ⁻¹) at 64 days	Phosphorus content (per cent)		Phosphorus use efficiency ratio (PUE)	Phosphorus transfer efficiency (PTE)	Physiological efficiency (PE)	Agronomical efficiency (AE)
				Leaves (64 days)	Pods				
100% NPK without FYM (F₁)									
T ₁	Arka Komal	17.71	43	0.078	0.077	574.5	88.5	3055	216
T ₂	IIHR-220	16.29	42	0.07	0.079	601.3	94.0	1753	112
T ₃	IIHR-909	22.94	30	0.071	0.050	409.3	40.1	1543	142
T ₄	Tweed wonder	39.35	47	0.083	0.088	348.9	61.9	605	95
T ₅	Pant Anupama	15.46	43	0.064	0.083	683.7	116.9	8111	140
T ₆	Contender	13.77	38	0.090	0.070	753.0	111.1	1696	98
50% NPK + FYM (25 t/ha) (F₂)									
T ₇	Arka Komal	12.02	7	0.074	0.072	892.3	138.5	3778	363
T ₈	IIHR-220	14.71	89	0.065	0.100	635.9	128.2	2390	253
T ₉	IIHR-909	9.65	85	0.070	0.078	941.3	173.3	4337	357
T ₁₀	Tweed wonder	10.69	92	0.085	0.080	911.2	148.1	2047	164
T ₁₁	Pant Anupama	11.75	59	0.074	0.070	958.7	142.9	2273	245
T ₁₂	Contender	9.41	73	0.081	0.075	791.3	131.6	2594	193
S. Em±		0.27	8.2	0.005	0.003	38.47	0.510	96.09	0.9
CD at 5%		0.80	24.7	0.016	0.010	112.84	1.51	281.9	2.7

Table 2 : Effect of fertilizer levels with or without FYM on total biomass, fresh pod yield (gm pot⁻¹) and harvest index of different French bean varieties.

Treatments	Varieties	Total dry matter (gm pot ⁻¹)	Fresh pod yield (gm pot ⁻¹)	Harvest index (per cent)
100% NPK without FYM (F₁)				
T ₁	Arka Komal	20.36	233.16	68.54
T ₂	IIHR-220	19.24	112.25	71.05
T ₃	IIHR-909	18.81	141.56	72.14
T ₄	Tweed wonder	27.71	95.32	38.44
T ₅	Pant Anupama	21.77	157.53	78.33
T ₆	Contender	21.86	152.32	62.97
50% NPK + FYM (25 t/ha) (F₂)				
T ₇	Arka Komal	23.13	181.65	78.91
T ₈	IIHR-220	18.85	126.80	65.87
T ₉	IIHR-909	21.45	178.22	79.34
T ₁₀	Tweed wonder	19.38	81.91	43.98
T ₁₁	Pant Anupama	23.99	122.30	46.75
T ₁₂	Contender	15.51	96.40	54.33
S. Em±		7.44	17.27	10.62
CD at 5%		NS	6.37	NS

It was observed from the results that the efficient varieties like Arka Komal and IIHR-909 have produced almost equal yields both at higher (F₁) and lower (F₂) fertility conditions. Similar results were observed in French bean by Haag *et al.* (1978) among 124 genotypes under low and high fertility conditions. Non significant results were observed in total biomass of plants. However, it was observed that in general the varieties, which yielded higher correlated with higher biomass accumulation. The similar results were observed in wheat where in the dry matter accumulation is positively correlated with corresponding NR activity by Bowerman and Godman (1971).

Harvest index is the ratio of economic yield to the total dry matter produced by the plant. The results observed were found to be non significant among different varieties. The varieties Arka Komal and IIHR-909 varieties, which had higher yield potential recorded higher percentage of harvest index. High harvest index is the characteristic of many to convert their biomass into grain. The highest harvest index was in case of IIHR-909, which had highest pod N per cent. Usually the grain N per cent and harvest index are positively correlated (Alagarswamy and Seetharama, 1983).

Conclusion

The study on utilization of efficiency of phosphorus by different French bean varieties showed significant differences in yield, P uptake and P utilisation parameters. The higher rate of PE and AE was positively correlated with higher yielding varieties. All the nutrient use efficiency parameters recorded higher values at F₂ level than their counter parts at F₁ level suggesting that application of fertilizer along with FYM was found to be more efficient in nutrient utilization than applying fertilizer alone without FYM. A stress has to be laid on the compulsory use of FYM as part of the nutrient package as to realise good yields and to maintain soil fertility and productivity.

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