



Response of french bean (*Phaseolus vulgaris* L.) varieties to phosphorus levels in the active Tista Flood Plain

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Abstract

Farmers are mostly face problem in the context of their cultivation to select right variety with proper levels of fertilizer especially phosphorus for better yield of French bean (legume crops). An experiment was conducted in the field of Fulgach village under Lamonirhat district at the northern region of Bangladesh during November 2014 to February 2015 to assess the effect of phosphorus levels on the growth, yield attributes and yield of French bean (*Phaseolus vulgaris* L.) varieties. The experiment was conducted maintaining randomized complete block design consisting three French bean varieties, viz. V₁ - BARI Jhar Sheem-1, V₂ - BARI Jhar Sheem-2 and V₃ - Nick and four levels of phosphorus viz. P₀, P₂₀, P₄₀ and P₆₀ kg phosphorus ha⁻¹, respectively replicated thrice. Varieties showed significant results on growth and yield attributes except number of branches plant⁻¹ but phosphorus exhibited significant results of all growth and yield attributes except number of seeds pod⁻¹. Varieties combined with phosphorus given significant results of all the parameters. Highest pod yield (22.70 t ha⁻¹) was obtained from BARI Jhar Sheem-2 while lowest (16.64 t ha⁻¹) from BARI Jhar Sheem-1. Highest dose of phosphorus @ 60 kg ha⁻¹ gave highest pod yield (22.12 t ha⁻¹), where as lowest (18.82 t ha⁻¹) was obtained in control. Apparently, the highest value of pod yield (24.40 t ha⁻¹) was found from the combination of BARI Jhar Sheem-2 with 60 kg ha⁻¹ phosphorus and lowest (15.23 t ha⁻¹) from the combination of BARI Jhar Sheem-1 with control treatment.

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Introduction

French bean (*Phaseolus vulgaris* L.) is a vital leguminous vegetable crop that grown during *rabi* season which is a native of central and South America. French bean has a possibility to meet a large share of vegetables demand in Bangladesh. It has many synonyms whereas in Bangladesh name Farashi Sheem (Rashid, 1993). It is used as vegetables when pods are immature and tender as well as seeds are also used as pulse. It is rich in protein, calcium, iron and vitamins. Both its pods and seeds are nutritionally rich having 22-25% protein in its dry seeds and 1-2.4% in green pods. It is widely cultivated in temperate and sub-tropical regions and also in many parts of the tropics. French beans are grown intensively in the areas of Eastern Africa, North and Central America, South America, Eastern Asia, Western and South Eastern Europe. Brazil is the largest French bean producer throughout the world. French bean is an important introduced vegetable in Bangladesh. There is no statistics about the area and production of this crop but it is cultivated in some districts such as Sylhet, Cox's Bazar, Chittagong Hill Tract and some other parts of Bangladesh during winter. In the recent years, it has been started to cultivate in different areas of the country for its green pods, dry pulse as well as fodder. It is gaining popularity in our country mainly because of its demand as an export commodity. Bangladesh presently earns foreign currency by exporting fresh horticultural products. French bean can contribute as the big share of export market.

Phosphorus is an important nutrient for all crops in general and legumes in particular. Phosphorus deficiency is considered as one of the major constraints to successful production of legume. The most obvious effect of phosphorus is on the root system of plants. It promotes early root formation and foundation of lateral and healthy root system. Singh and Singh (1990) reported that green pod yield of French bean increased with phosphorus application. Varietal performance is also the major factor that enhances yield and productivity of crop. Vegetative growth, total and exportable yields as well as pod quality of French bean is greatly affected by the genotype (Mawqoud *et al.*, 2005).

Keeping these points in mind the present study was undertaken to evaluate the influence of phosphorus levels on the growth, yield attributes and yield of French bean varieties.

Materials and methods

The research work was conducted in the field of Fulgach village under Lalmonirhat district at the northern region of Bangladesh during November 2014 to February 2015 to evaluate the proper level of phosphorus on growth, yield components and yield of French bean varieties. The initial soil having pH - 5.85, organic matter - 1.29%, nitrogen - 0.07%, phosphorus - 18.35 ppm, potassium - 0.24 mg 100 g⁻¹ of soil, respectively. The experiment was conducted in the randomized complete block design (RCBD) with three replications. Treatments consisted with three varieties namely, V₁ - BARI Jhar Sheem-1, V₂ - BARI Jhar Sheem-2 and V₃ - Nick (released by Lal Teer Seed Limited) of French bean and four levels i.e. P₀ - Control, P₂₀ - 20 (45.8 kg P₂O₅ ha⁻¹), P₄₀ - 40 (91.6 kg P₂O₅ ha⁻¹), P₆₀ - 60 kg phosphorus ha⁻¹ (137.4 kg P₂O₅ ha⁻¹) of phosphorus, respectively. Two seeds were sown at each hill on 12 November 2014 maintaining at a spacing of 30 cm × 20 cm row to row and hill to hill, respectively. Manures (Cowdung @ 10 t ha⁻¹) and fertilizers like urea, potassium and dolomite @ 120 : 60 : 1235 kg ha⁻¹ were applied as per the treatments. Entire amount of cowdung, dolomite, phosphorus, half of urea and potassium were applied during final land preparation. The rest half of nitrogen and potassium were applied in two equal splits after 20 and 35 DAS (days after sowing) of seeds. In general, market grade boron and zinc were applied as foliar spray @ 1g litre⁻¹ of water at 20 and 40 DAS. Plots were kept weed free and crop received three irrigations during crop period. Pods were harvested at tender stage through hand pickings and weighed to estimate the yield of fresh pods. Plant height, number of branches plant⁻¹, pod length, pod breadth, number of pods plant⁻¹, number of tender seeds pod⁻¹, pod weight plant⁻¹ and pod yield were recorded from randomly selected five plants for growth parameters and ten plants for yield estimation avoiding border effect. Collected data on various parameters were analyzed by MSTATC statistical package program.

The analysis of variance for the characteristics under study was performed by F variance test and difference between the pairs of treatment means was compared using the Least Significant Difference (LSD) test (Gomez and Gomez, 1984). The meteorological data of the experimental site revealed that the maximum (25.61°C) and minimum temperature (14.34°C) and the crop received 50.1 mm rain showers during November to February.

Result and discussions

Varietal performance

Data on the effect of varieties on growth and yield parameters has been presented in Table 1.

There was significant differences among the varieties i.e. BARI Jhar Sheem-1, BARI Jhar Sheem-2 and Nick with respect to their plant height, pod length, pod breadth, number of pods plant⁻¹, number tender seeds pod⁻¹, pod weight plant⁻¹ and pod yield except number of branches plant⁻¹. Highest plant height (44.45 cm) was observed in BARI Jhar Sheem-1, while lowest (28.98 cm) with BARI Jhar Sheem-2. BARI Jhar Sheem-2 produced highest number of branches (6.88) plant⁻¹ and lowest (6.48) from BARI Jhar Sheem-1. These variations might be due to difference in genetical constituents.

Table 1. Main effect of variety on growth, yields attributes and yield of French bean.

Treatments	Plant height (cm)	No. of branches plant ⁻¹	Pod length (cm)	Pod breadth (cm)	No. of tender pods plant ⁻¹	No. of tender seeds Pod ⁻¹	Pod weight plant ⁻¹ (g)	Pod yield (t ha ⁻¹)
V ₁	44.45	6.48	16.17	0.80	24.83	6.22	101.00	16.64
V ₂	28.98	6.88	14.74	0.78	35.68	5.47	137.50	22.7
V ₃	29.11	6.83	14.84	0.79	34.11	5.50	135.00	22.54
LSD _{0.05}	1.75	0.57	0.67	0.009	3.61	0.29	8.96	1.42
CV%	6.05	10.07	5.26	1.41	13.54	6.05	8.51	8.1

* V₁ - BARI Jhar Sheem-1, V₂ - BARI Jhar Sheem-2, V₃ - Nick.

This result was in harmony with the findings of (Mawqoud *et al.*, 2005) where it was reported that the differences in vegetative growth of cultivars are mainly due to the genotype of each cultivar. Pod length differed among varieties which was highest (16.17 cm) for BARI Jhar Sheem-1 and lowest (14.74 cm) for BARI Jhar Sheem-2.

Wider pod was measured as 0.80 cm in BARI Jhar Sheem-1 and narrower pod (0.78 cm) from BARI Jhar Sheem-2. Among the varieties, BARI Jhar Sheem-2 produced highest number of pods plant⁻¹ (35.68) followed by Nick (34.11) and lowest (24.83) by BARI Jhar Sheem-1.

Table 2. Main effect of phosphorus on growth, yield attributes and yield of French bean.

Treatments	Plant height (cm)	No. of branches plant	Pod length (cm)	Pod breadth (cm)	No. of tender pods plant ⁻¹	No. of tender seeds pod ⁻¹	Pod weight Plant ⁻¹ (g)	Pod yield (t ha ⁻¹)
P ₀	30.34	5.73	14.48	0.78	28.7	5.56	112.70	18.82
P ₂₀	33.17	6.84	15.12	0.79	30.14	5.64	120.63	20.1
P ₄₀	36.12	7.22	15.63	0.80	33.28	5.82	132.00	21.73
P ₆₀	37.09	7.13	15.77	0.80	34.04	5.89	132.67	22.12
LSD _{0.05}	2.02	0.66	0.78	0.009	4.17	0.33	10.36	1.63
CV%	6.05	10.07	5.29	1.41	13.54	6.05	8.51	8.10

* P₀ - Control, P₂₀ - 20, P₄₀ - 40, P₆₀ - 60 kg phosphorus ha⁻¹.

It was noted that the highest number of tender seeds pod⁻¹ (6.22) was recorded from BARI Jhar Sheem-1 and the lowest (5.47) from BARI Jhar Sheem-2. Pod weight (137.50 g) plant⁻¹ obtained the highest for the variety BARI Jhar Sheem-2 followed by Nick (135.00

g) while the lowest (101.00 g) from BARI Jhar Sheem-1. The highest green pod yield (22.70 t ha⁻¹) was found from BARI Jhar Sheem-2 which was statistically similar with Nick and the lowest (16.84 t ha⁻¹) was found from BARI Jhar Sheem-1.

The results are corroborated with the findings of Shukla *et al.* (2006). Their findings revealed that number of pods per plant had a positive contribution to yield.

Effects of phosphorus

Results on growth and yield attributes of French bean were significantly influenced except number of seeds pod⁻¹ due to the effect of phosphorus (Table 2). 60 kg phosphorus ha⁻¹ produced highest of all yield attributes i.e. pod length (15.77 cm), pod breadth (0.80 cm), number of tender pods plant⁻¹(34.04), number of tender seeds pod⁻¹ (5.89) and pod weight plant⁻¹ (132.67 g), respectively and plant height (37.09 cm) but highest number of branches plant⁻¹ was obtained from 40 kg phosphorus ha⁻¹ while lowest of all growth components i.e. plant height (30.34 cm) and number of branches plant⁻¹ (5.73), respectively

and yield attributes i.e. pod length (14.48 cm), pod breadth (0.78cm), number of tender pods plant⁻¹ (28.7) , number of tender seeds pod⁻¹ (5.56) and pod weight plant⁻¹ (112.70 g) was found from control. Phosphorus application at the rate of 60 kg ha⁻¹ performed better than 40 kg ha⁻¹ contributing most of the characters which influenced the highest pod yield. The result is in harmony with the findings of Moniruzzaman *et al.* (2008).

The maximum pod yield (22.12 t ha⁻¹) was found with the application of 60 kg ha⁻¹ phosphorus and it was minimum with control (18.82 t ha⁻¹) but there was no significant difference in the pod yield between 60 and 40 kg ha⁻¹ phosphorus. Phosphorus application @ 20, 40, 60 kg ha⁻¹ increased pod yield by 6.8, 15.64 and 17.53%, respectively over the control.

Table 3. Combined effect of variety and phosphorus on growth and yield attributes of French bean.

Treatments	Plant height (cm)	No. of branches per plant	Pod length (cm)	Pod breadth (cm)	No. of tender pods plant ⁻¹	No. of tender seeds pod ⁻¹	Pod weight plant ⁻¹ (g)	Pod yield (t ha ⁻¹)
V ₁ P ₀	38.40	5.40	14.97	0.79	22.63	6.13	91.43	15.23
V ₁ P ₂₀	44.23	6.80	15.90	0.80	24.77	5.93	97.57	16.23
V ₁ P ₄₀	47.93	6.93	16.87	0.80	26.40	6.33	107.67	18.00
V ₁ P ₆₀	47.23	6.80	16.93	0.81	25.53	6.47	107.33	17.90
V ₂ P ₀	26.17	6.00	14.23	0.77	32.27	5.27	127.00	21.23
V ₂ P ₂₀	27.83	6.80	14.73	0.78	32.80	5.47	131.33	21.87
V ₂ P ₄₀	29.83	7.47	14.90	0.79	38.00	5.53	145.33	23.30
V ₂ P ₆₀	32.10	7.27	15.10	0.79	39.67	5.60	146.33	24.40
V ₃ P ₀	26.47	5.80	14.23	0.77	31.20	5.27	119.67	20.00
V ₃ P ₂₀	27.43	6.93	14.73	0.78	32.87	5.53	133.00	22.20
V ₃ P ₄₀	30.60	7.27	15.13	0.79	35.43	5.60	143.00	23.90
V ₃ P ₆₀	31.93	7.33	15.27	0.79	36.93	5.60	144.33	24.07
LSD _{0.05}	3.50	1.14	1.35	0.01	7.23	0.58	17.98	2.83
CV%	6.05	10.07	5.26	1.41	13.54	6.05	8.51	8.10

* V₁ - BARI Jhar Sheem-1, V₂ - BARI Jhar Sheem-2, V₃ - Nick, P₀ - Control, P₂₀ - 20, P₄₀ - 40, P₆₀ - 60 kg ha⁻¹ phosphorus.

Combined effects of variety and phosphorus

All attributes of growth and yield of French bean were significantly influenced by the combined effect of varieties and phosphorus levels (Table 3). The tallest plant (47.93 cm) was found from BARI Jhar Sheem-1 combined with 40 kg phosphorus ha⁻¹ and lowest (26.17 cm) from BARI Jhar Sheem-2 combined with control. It was observed that the highest number of branches plant⁻¹ (7.47) was found from BARI Jhar

Sheem-2 combined with 40 kg phosphorus ha⁻¹ and the lowest (5.40) from BARI Jhar Sheem-1 combined with control. BARI Jhar Sheem-1 combined with 60 kg phosphorus ha⁻¹ produced longest (16.93 cm) pods while smallest (14.23 cm) in BARI Jhar Sheem-2 combined with control. Similarly BARI Jhar Sheem-1 combined with 60 kg phosphorus ha⁻¹ produced widest (0.81 cm) pods but Nick combined with control produced narrowest (0.77 cm) pods.

However highest number of tender pods plant⁻¹ (39.67), pod weight plant⁻¹ (146.33 g) and pod yield (24.40 t ha⁻¹) were obtained from BARI Jhar Sheem-2 combined with 60 kg phosphorus ha⁻¹ and the lowest number of pods (22.63) plant⁻¹, pod weight (91.43 g) plant⁻¹ and pod yield (15.23 t ha⁻¹) were found from

BARI Jhar Sheem-1 combined with control. Pod yield increased from combined effect of varieties with increasing levels of phosphorus. These results support with the findings of Mourice and Tryphone (2012) who claimed that bean genotypes with phosphorus increased the productivity of French bean.

Table 4. Correlation matrix for different physio-morphological parameters of growth and yield of French bean.

	NB/P	PL	PB	NS/P	NP/P	PW/P	PY/H
PH	.125	.639**	.726**	.654**	-.361*	-.360*	-.360*
NB/P		.318	.124	.007	.526**	.567**	.567**
PL			.524**	.576**	-.275	-.258	-.258
PB				.605**	-.230	-.266	-.266
NS/P					-.446**	-.543**	-.543**
NP/P						.887**	.887**
PW/P							1.000**

* PH - Plant height, NB/P – Number of branches per plant, PL – Pod length, PB – Pod breadth, NS/P – Number of seeds per pod, NP/P – Number of tender pods per plant, PW/P – Pods weight per plant, PY/H – Pod yield per hectare.

Correlation studies

Data of correlation studies on growth and yield parameters has been presented in Table 4. It was observed that there was highly significant positive correlation among plant height with yield factors viz. pod length, pod breadth and number of tender seeds per pod whereas plant height had significant negative correlation with number of pods per plant, pods weight per plant and pod yield per ha.

This result is partially similar with the observations of Haluk & Vahdettin (2013). Number of branches per plant exhibited significant positive correlation with number of pods per plant, pods weight per plant and pod yield per hectare. Similar result obtained from Haluk & Vahdettin (2013).

Similarly number of branches per plant exhibited insignificant but positively correlated with other factors viz. pod length, pod breadth, number of tender seeds per pod. Pod length had highly significant positive correlation with the pod breadth, number of tender seeds per pod but negative insignificant relation with the number of pods per plant, pod weight per plant and pod yield per ha.

Pod breadth had also negative insignificant association with the number of pods per plant, pod weight per plant and pod yield per hectare. Number of pods per plant expressed highly significant positive correlation with pod weight per plant and pod yield.

This result is in full agreement with of Rafat and Sharifi (2015). Yield of pod showed highly significant positive correlation with the number of branches per plant, number of pods per plant and pod weight per plant. So, it is clear that number branches per plant and number of pods per plant correlated notably to enhance the pod yield of French bean.

Conclusion

From the results and discussions it can be concluded that 60 kg ha⁻¹ phosphorus showed significant impacts on the growth, yield attributes and yield of French bean. BARI Jhar Sheem-2 gave better production than those of BARI Jhar Sheem-1 and Nick varieties. Whereas 60 kg ha⁻¹ phosphorus combined with BARI Jhar Sheem-2 gave higher yield in the active Tista flood plain of Bangladesh.

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