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INFLUENCE OF NITROGEN AND PHOSPHORUS ON YIELD AND SEED QUALITY OF FRENCH BEAN

S.S.Kakon[1], Md. S.U. Bhuiyan[2] and S.M. A. Hossain[2]

[1]Agronomy Division, Bangladesh Agricultural Research Institute, Gazipur-1701
[2]Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2200
Corresponding author: *kakonbari@gmail.com*

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Abstract

The experiment was conducted at the research field of Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during *Rabi* (winter) season of 2010-11 to determine the optimum rate of nitrogen and phosphorus fertilizer on yield and seed quality of French bean. A randomized complete block design was followed with ten treatment combinations such as N_0P_0, N_0 P_{44}, N_{50} P_{44}, N_{100} P_{44}, N_{150} P_{44}, N_{200} P_{44}, $N_{150}P_0$, $N_{150}P_{22}$, $N_{150}P_{33}$ and $N_{150}P_{55}$. Number of pods and yield of French bean were significantly increased with the increase in N (150) and P (44) kg ha^{-1}. Averaged over the years, maximum number of pod (9.45 $plant^{-1}$) and seed yield (1563.33 kg ha^{-1}) were obtained when N and P were applied at the rate of 150 and 44 kg ha^{-1}, respectively while lowest yield to N_0P_0 treatment in both the years. The treatment ($N_{150}P_{44}$ kg ha^{-1}) gave the highest seed yield which was 51.4 and 54.30% higher than the control. Quality in terms of germination percentage and vigour index of harvested seed was also significantly influenced by higher doses of N and P while the lowest seed quality from plants that received no fertilizer in both the years.

Introduction

French bean (*Phaseolus vulgaris* L.) is a dual purpose crop grown as a pulse and vegetable crop. Its dry seeds are very nutritious containing about 24.9% protein, 60.1% carbohydrate, fat, thiamin, riboflavin, Ca, Fe and niacin as well as fibre (Pierce, 1987; Rashid, 1999 Including leguminous crop like French bean could improved cropping system as well as improve soil fertility. Recently cultivation of French bean is gaining popularity in Bangladesh because of its high nutritive value, good taste and wide range of use and also export purpose. But its yield is low compared to other French bean producing countries of the world due to lack of improved cultivars, balanced nutrition and cultural practices. Unlike other pulses, French bean is inefficient in symbiotic nitrogen fixation (Ali and Lal, 1992) as it lacks nodulation due to the absence of NOD gene regulator (Kushwaha, 1994). As nodulation is poor in french bean, it requires more N and P for root development, nodulation and better plant growth (Ssali and Keya, 1986). Phosphorus not only enhances the root growth but also promotes early plant maturity (Mullins *et al.,* 1996). Reddy *et al*. (2010) also reported that increased nitrogen levels from 75 to 150 kg ha^{-1} improved the yield attributes and seed yield (520 kg ha^{-1}) over 125, 100, 75 kg N ha^{-1}, respectively.

Padrit *et al.* (1996) found that phosphorus application to the seed crop of peas had improved seed vigour. Rao *et al*., (1983) observed that plants deficient in phosphorus produce seeds having slower germination than normal seed. French bean seed yield and quality can be enhanced by adopting improved agronomic practices, particularly by applying balanced nutrition to the crop. The present investigation was, therefore, carried out to determine the

optimum level of nitrogen and phosphorus fertilizer for exploiting the yield potential and seed quality of French bean.

Materials and Methods

The experiment was conducted at Agronomy research field of Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh during November to April during 2010-11 and 2011-12. The experiment site was located Chhiata Series under Agro-Ecological Zone-28 (AEZ-28) of $23^0$59' N and $90^0$24' E. The rainfall during the experimental period was 42.0 mm in the first year and 189 mm in the second year. The soil of the experimental field was loamy in texture, low in organic matter (1.27%), acidic in nature with pH (6.1) and contained very low amount of total nitrogen (0.067%), phosphorus (9.6%), sulphur (12%), zinc (2 meq $100g^{-1}$) and medium amount of potassium (0.18 meq $100g^{-1}$). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 4.8 m × 3.0 m. There were ten treatment combinations such as N_0P_0, N_0 P_{44}, N_{50} P_{44}, N_{100} P_{44}, N_{150} P_{44}, N_{200} P_{44}, $N_{150}P_0$, $N_{150}P_{22}$, $N_{150}P_{33}$ and $N_{150}P_{55}$. The source of N was urea and that of P was triple super phosphate. Other fertilizers were muriate of potash, gypsum and zinc sulphate, respectively. The total amount of TSP, muriate of potash, gypsum, zinc sulphate and 50% of urea were mixed with the soil during final land preparation and the rest urea was top dressed at 35 days after sowing (DAS). The seeds of french bean var. BARI Jharsheem-1 were sown on 25 November, 2010 and 2011, respectively. Seeds were treated with vitavax and sown continuously in 30 cm apart with plant distance 15 cm. Weeding was done at 25 and 40 DAS. For uniform germination, a light irrigation was given by sprinkler method after sowing of seeds. Three irrigations were given at 25, 40 and 60 DAS. The yield component data were collected from 10 randomly selected plants prior to harvest from each plot. At harvest, the yield data was recorded plot wise and seeds were separated from the pods manually. The standard germination test was conducted following ISTA, 1996 rules. Seed vigour index was calculated by multiplying percent and seedling length. The protein content was calculated by multiplying the nitrogen content (%) in seeds by 6.25. Data on all the parameters were analyzed statistically with the help of a computer package programme MSTAT -C and means were separated using DMRT.

Results and Discussion

Yield and yield contributing characters

The effects of N and P fertilizer application on yield and yield contributing characters of French bean in both the years (Table 1). Plant receiving more nitrogen prolonged duration to complete vegetative growth, which resulted longer time of flowering, as similar to Kaisar *et al*. (2007). The number of flowers $plant^{-1}$ and pods $plant^{-1}$ significantly increased with the increasing levels of N. Plants treated with 200 kg N ha^{-1} produced maximum number of flowers $plant^{-1}$ followed by 150 kg N ha^{-1}. Plants grown in P treated plots recorded significantly higher number of flowers $plant^{-1}$ over control. Plants treated with 150 kg N ha^{-1} produced maximum number of pods $plant^{-1}$ which was statistically similar to 100 kg N. Number of pods $plant^{-1}$ increased due to sufficient supply of N for better growth of plant which might have led to higher photosynthesis and the development of higher number of pod bearing branches (Reddy *et al*., 2010; Prajapati *et al.,* 2003). Percentage of abscission was slightly reduced by the application of N and P but the variations were not consistent with the level of N and P application in both the years (Table 1). Saha (2003) reported that plants supplied with adequate mineral N had a greater flower number but less pod set.

The maximum seed size was observed in the plants grown with 150 kg N ha^{-1} which was statistically similar to 100 and 200 kg N ha^{-1}. Application of 44 kg P gave the highest 100-seed weight which was at par with that of 22 and 55 kg P ha^{-1} while smallest seeds from control plot. Averaged over the years significantly the highest seed yield was recorded in 150 kg N and 44 P kg ha^{-1} due to higher number of pods $plant^{-1}$ and 100-seed weight. The increase in yield might be due to increased availability of nitrogen and phosphorus, causing accelerated photosynthetic rate leading to more production of carbohydrates and improvement in growth and yield attributes. These results agree with the findings of Singh, 2000; and Reddy *et al.,* 2010. Further increase of N and P fertilizers tended to decrease the seed yield There was positive linear relationship between pods $plant^{-1}$ and seed yield (Fig.1 and 2) indicating that 97 and 96% of total variation in seed yield of french bean could be explained by the linear function in pods $plant^{-1}$ in both the years. Application of N fertilizer generally increased seed yield over N control but the yield response was not linear. Likewise increase in seed yield was observed up to 44 P kg ha^{-1} and further increment seed yield was not increased due to the over growth of the plants. From the regression analysis it is observed that seed yield was related with the N and P levels following a quadratic relationship (Fig. 3 and 4) averaged over years. From the quadratic regression, $Y= -0.026 N^2 + 9.33N + 684.7$, it is estimated that 178 kg N ha^{-1} is optimum dose for getting maximum seed yield of French bean. Srinivas and Naik (1990) reported optimum dose to be 125.6 kg ha^{-1} for French bean production while nitrogen was applied up to 160 kg ha^{-1} in their field trial. The response of seed yield to phosphorus was quadratic in nature and from the regression equation, $Y= -0.141P^2 + 13.81P + 1356$, the estimated optimum levels for getting maximum seed yield was 48.97 kg P ha^{-1}. Seed yield was positively correlated with growth parameters and yield contributing characters *viz*., total dry matter production $plant^{-1}$ at harvest (0.953), number of pods $plant^{-1}$ (0.986) and 100-seed weight (0. 981).

Table 1. Seed yield and yield components of French bean as affected by levels of nitrogen and phosphorus fertilizer during 2010-11 and 2011-12

Treatments	Flowers $plant^{-1}$ (no.)		Pod $plant^{-1}$ (no.)		100-seed weight (g)		Seed yield (kg ha^{-1})	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
N_0P_0	24.67e	26.67f	4.59e	4.72e	18.74c	17.93d	682.16f	673.02e
N_0 P_{44}	27.67e	32.00d-f	5.17de	5.13e	19.17c	19.29cd	750.12ef	723.58e
N_{50} P_{44}	34.17d	35.33c-e	6.33c-e	5.82de	21.15b	20.51bc	956.79de	981.98d
N_{100} P_{44}	38.17 bc	41.00bc	8.08a-c	7.87a-c	23.06a	22.73ab	1375.12a-c	1413.15a-c
N_{150} P_{44}	41.33 ab	45.03ab	9.28a	9.62a	23.38a	23.14a	1543.33a	1583.33a
N_{200} P_{44}	44.33a	50.00a	9.07a	9.23ab	21.83ab	22.13ab	1451.67ab	1479.63ab
$N_{150}P_0$	25.67e	30.43ef	6.68b-d	7.06cd	21.12b	20.87a-c	1158.27cd	1206.36c
$N_{150}P_{22}$	35.67cd	38.40b-d	7.53a-c	7.62bc	22.41ab	22.07ab	1259.75bc	1314.38bc
$N_{150}P_{33}$	38.33bc	41.33bc	8.50ab	8.71a-c	22.76a	22.20ab	1495.00ab	1536.90ab
$N_{150}P_{55}$	41.00ab	43.87ab	8.35ab	8.62a-c	22.16ab	21.83ab	1420.00a-c	1460.00ab
CV (%)	4.65	6.83	10.13	9.31	2.89	4.51	8.88	7.25

NS = Not significant, CV = Co efficient of variation.

In a column, figures having common letter(s) do not differ significantly at 1% level by DMRT

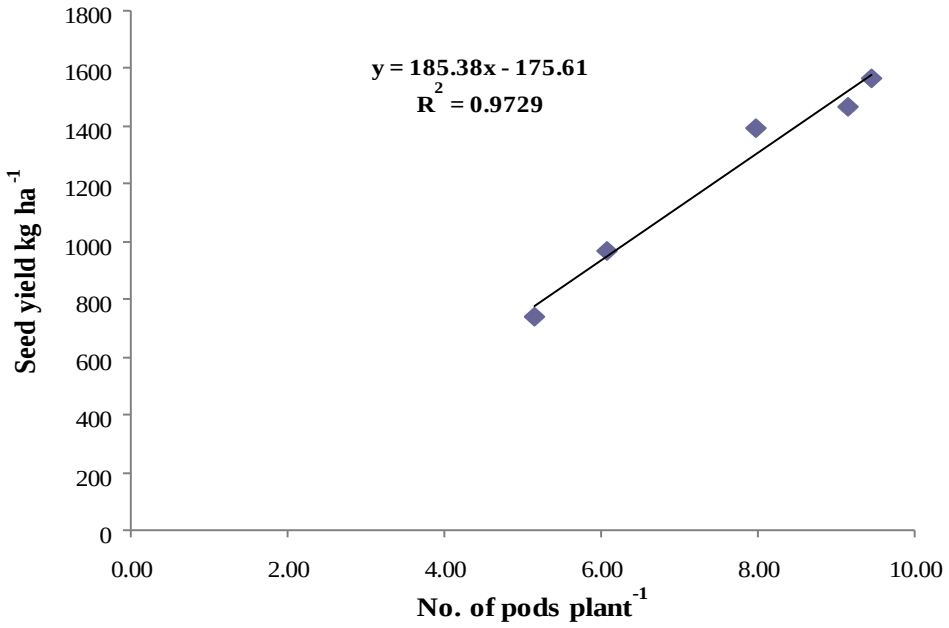

Fig.1 Relationship between pods plant^{-1} (no.) and seed yield as affected by nitrogen level averaged over years.

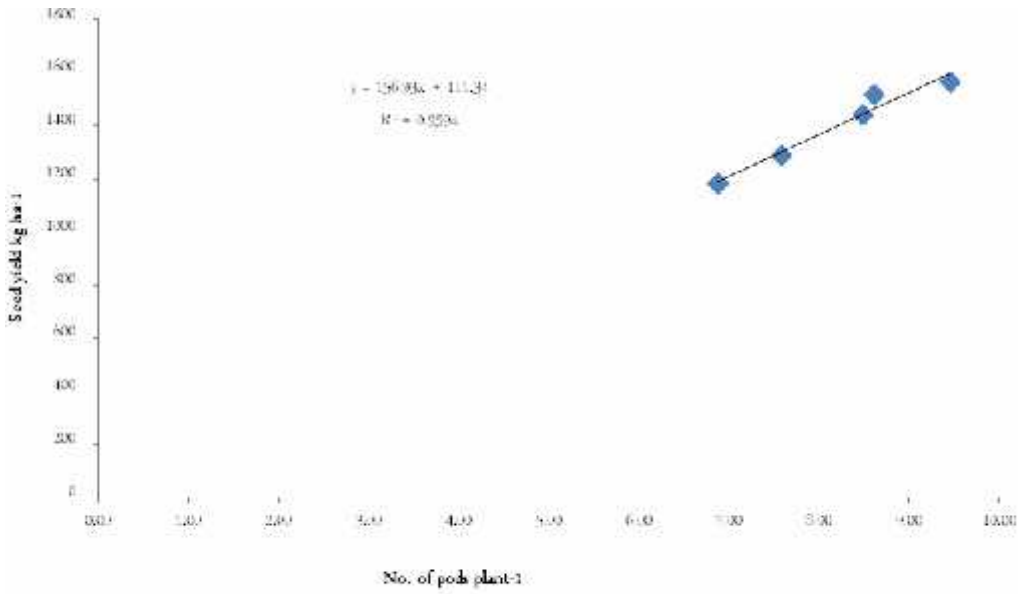

Fig. 2. Relationship between pods plant (no.) and seed yield as affected by phosphorus level (averaged over years)

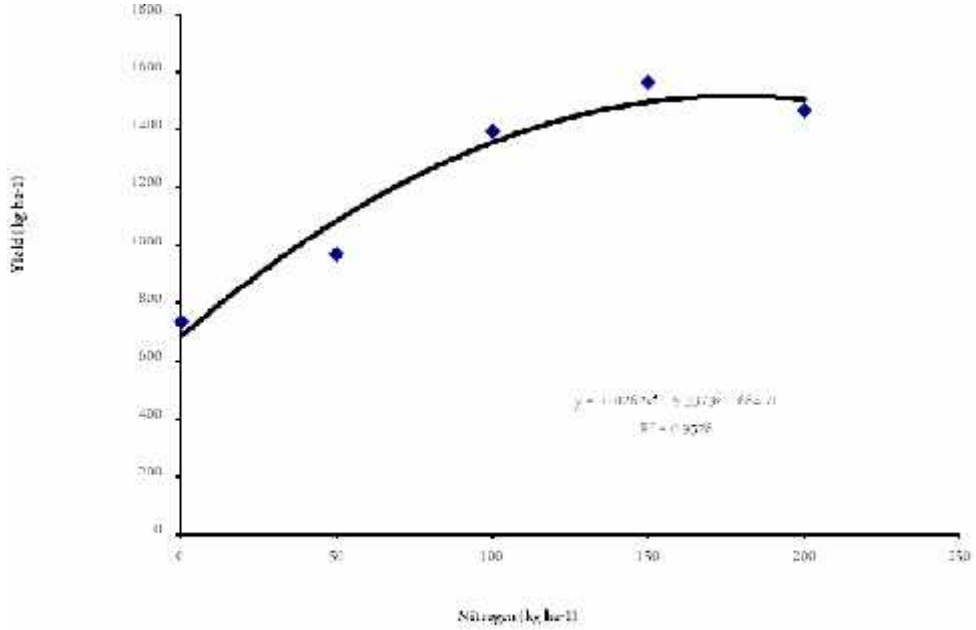

Fig. 3. Yield of French bean as affected by level of nitrogen fertilizers (averaged over years)

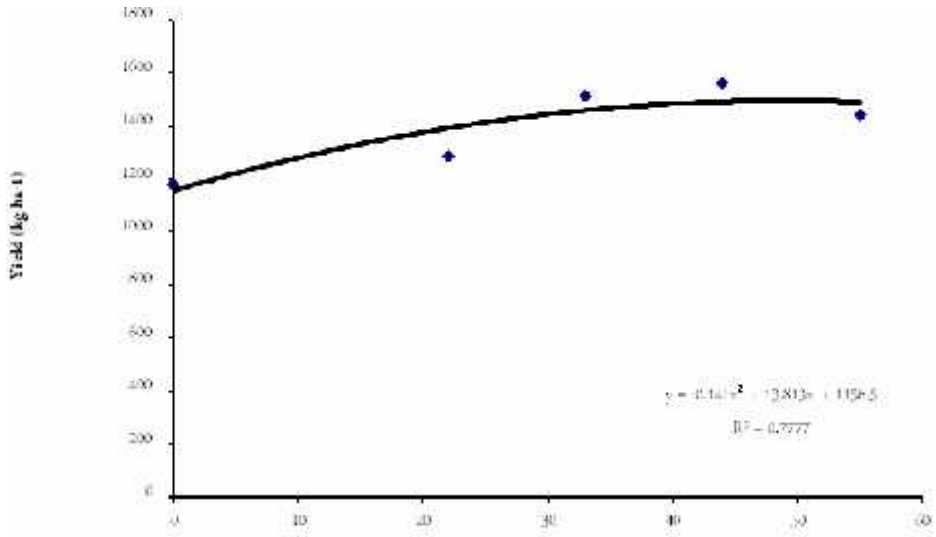

Fig. 4. Yield of French bean as affected by levels of phosphorus fertilizers (averaged over years)

Seed quality

The highest germination was obtained in plants which received $N_{150}P_{44}$ kg ha^{-1} while the lowest seed germination from plants that received no fertilizer. Application of N rates exerted a continuous significant increase in the percent germination up to 150 kg N ha^{-1} over 50 and 100 kg N ha^{-1}. Beyond this decreased germination (%) received 200 N kg ha^{-1}. Phosphorus exerted a significant influence on seed germination up to 22 kg ha^{-1} over control (Table 2). Significant increase in seed quality parameters was due to increase in 100- seed weight which in turn might have supplied adequate food reserves during germination and resulting in exhibiting of higher seedling vigour.

Vigour index

The best quality in respect of seedling vigour index was recorded with t 200 N but at par to 150 kg N ha^{-1} while control plot produced the lowest seedling vigour index. Similar results were reported by Saha (2003). The maximum seedling vigour indexes were recorded from 55 kg P ha^{-1} and it was at par with that of 22 kg and 33 kg P ha^{-1}.

Table 2. Effects of different levels of nitrogen and phosphorus fertilizers on seed quality of French bean during 2010-11 and 2011-12

N and P levels	Germination (%)		Vigour Index		Protein (%)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
N_0P_0	88.0b	81.00e	2192.63e	1872.00d	20.77e	21.02d
N_0 P_{44}	90.5ab	84.33de	2364.52c-e	2003.80cd	21.25de	21.54cd
N_{50} P_{44}	92.5ab	89.67b-d	2572.85b-d	2192.13bc	22.08cd	22.40b-d
N_{100} P_{44}	95.17a	92.33a-c	2785.92b	2310.23b	22.94a-c	23.17a-c
N_{150} P_{44}	95.5a	96.58a	3120.02a	2678.27a	23.65a	23.85ab
N_{200} P_{44}	93.2ab	95.33ab	3150.53a	2860.27a	23.96a	24.04a
$N_{150}P_0$	88.83b	86.67c-e	2256.73de	2061.77b-d	22.71bc	22.75a-c
$N_{150}P_{22}$	90.33ab	90.00b-d	2527.55b-d	2168.10bc	22.83a-c	23.23a-c
$N_{150}P_{33}$	92.5ab	90.67a-c	2636.58bc	2321.27b	23.19ab	23.38ab
$N_{150}P_{55}$	91.27ab	94.8ab	3125.57a	2739.25a	22.96ab	23.56a-c
CV (%)	2.21	2.73	5.12	5.28	1.59	2.92

CV = Co efficient of variation.

In a column, figures having common letter (s) do not differ significantly at 1% level by DMRT

Protein content of seed

Significantly higher protein content of seed was gained by applying 200 kg N which was statistical similar to 150 kg ha^{-1} N. These results are in agreement with (Singh *et al*., 2001) in soybean. However, when the plants grown without added N and P fertilizer produced the lowest protein content in seeds. Protein content significantly increased with increasing P fertilization 6.90 and 3.74 % higher protein content was recorded with 44 kg P compared to 22 and 33 kg Pha^{-1}, respectively. This might also be due to enhanced rate of bacterial nodulation (Ssali and Keya, 1986) and nitrogen fixation.

Conclusion

Two years result revealed that the application of N and P fertilizer up to150 and 44 kg ha^{1} exerted significantly positive effects on French bean in terms of seed yield and quality in Joydebpur area.

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