

## PERFORMANCES OF FRENCH BEAN AS INFLUENCED BY PLANT DENSITY AND NITROGEN APPLICATION

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### Abstract

Field experiments with French bean comprising two varieties (BARI bush bean-1 and BARI bush bean-2), three plant densities (500 x 10<sup>3</sup>, 333 x 10<sup>3</sup>, and 250 x 10<sup>3</sup> plants/ha as maintained by 20 x 10, 30 x 10, and 40 x 10 cm spacings, respectively) and three levels of N (0, 60, and 120 kg/ha) were conducted at the Agricultural Research Station, Raikhali in the district of Rangamati during the winter (*rabi*) seasons of 2004-05 and 2005-06. BARI bush bean-1 outyielded BARI bush bean-2. The lowest plant density (250 x 10 plants/ha) recorded significantly higher values of growth and yield attributes, except plant height which was the maximum with the highest plant density of 500 x 10<sup>3</sup> plants/ha. The highest plant density of (500 x 10<sup>3</sup> plants/ha) resulted in the highest pod yield in comparison with the lower and medium plant densities. Application of 120 kg N/ha coupled with the highest plant density (500 x 10<sup>3</sup> plants/ha) gave the maximum pod yield of 34.3 t/ha and 30.2 t/ha in BARI bush bean-I and BARI bush bean-2, respectively.

Key Words: French bean, plant density, nitrogen.

### Introduction

French bean (*Phaseolus vulgaris* L.) is an important legume vegetable grown during *rabi* season for its tender green pods with high protein, calcium and iron contents. The Bangladesh Agricultural Research Institute (BARI) has developed two potential French bean varieties. Plant density and soil fertility are the two important factors of crop production. Several authors have reported that pod yield of French bean increases with the increase of plant density (Ali 1989; Dhanjal *et al.*, 2001; Mozumder *et al.*, 2003; Shivakumar *et al.*, 1996; Singh *et al.*, 1996). Mozumder *et al.* (2003) obtained the highest yield of French bean from the plants spaced at 25 cm x 10 cm, while Dhanjal *et al.* (2001) and Shivakumar *et al.* (1996) in their experiments observed the highest yield at the spacing of 30 cm x 10 cm and 30 x 15 cm, respectively. Contrary to the general recommendation of reduced nitrogen application to legume crops because of their ability to fix atmospheric nitrogen, French bean readily responds to large dose of nitrogen. French bean possesses high yield potential, but unlike other leguminous crops, it does not nodulate with the native rhizobia and its response to applied nitrogen is

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as high as 120 kg/ha (Srinivas and Naik, 1990 and Rana *et al.*, 1998). Practically, a suitable combination of plant spacing and nitrogen level is very important in producing higher yield of French bean. Thus, the present investigation was undertaken to determine proper spacing and optimum nitrogen dose for realizing the maximum yield potential of French bean in south-eastern hilly region.

### **Materials and Method**

The experiment was conducted at the Agricultural Research Station (ARS), Raikhali, Rangamati Hill district during the winter (*rabi*) seasons of 2004-05 and 2005-06. The soil was sandy clay loam with pH 5.6, and contained 0.53% organic carbon, 0.92% organic matter, 0.079% total N, 8.0 µg/g available phosphorus and 0.17 meq/100 g soil exchangeable potassium. The treatments comprising two varieties (BARI bush bean-1 and BARI bush bean-2), three plant densities ( $500 \times 10^3$ ,  $333 \times 10^3$ , and  $250 \times 10^3$  plants/ha) and three levels of nitrogen (0, 60, and 120 kg/ha) were replicated thrice in  $2 \times 3 \times 3$  RCBD factorial design. The size of each plot was 3.0 x 1.2 m. Plant densities of  $500 \times 10^3$ ,  $333 \times 10^3$  and  $250 \times 10^3$  plants/ha were maintained by adopting 20 x 10, 30 x 10, and 40 x 10 cm spacings, respectively. Seeds were sown on 11 November 2004 and 20 November 2005 at the rate of two seeds/hill. After 15 days of sowing (DAS) thinning was done keeping one healthy seedling/hill. A uniform dose of P (35 kg/ha), K (66 kg/ha), and cowdung (5 t/ha) was used in this experiment. The full dose of phosphorous, potassium, and cowdung, and half of nitrogen as per treatment was applied during planting and the rest half of nitrogen was applied 25 days after sowing. The source of N, P, and K were urea, TSP, and MOP. In addition to pre-sowing irrigation, four additional irrigations were given to the crop. Tender green pods were picked out at regular intervals for recording plot-wise yield and a total of five pickings was made.

The data on plant height, number of branches per plant, number of plants/m<sup>2</sup>, pod length, pod width, number of green pods per plant and green pod weight per plant and green pod weight per plot were recorded from randomly selected 10 plants of the inner rows. The plot yield was converted to per hectare yield. The different parameters were analyzed statistically and the treatment means were separated by DMRT at 5% level of probability.

### **Results and Discussion**

#### **Varietal performances**

The data on the effect of varieties, plant density, and nitrogen levels on the yield attributers and pod yield have been presented in Table 1. There was no significant difference in two varieties (BARI bush bean-I and BARI bush bean-2) with respect to branches per plant, pod length, and number of green pods per

plant. However, the plant height, pod width, and green pod weight per plant were significantly higher in BARI bush bean-I as compared to BARI bush bean-2. BARI bush bean-I gave significantly higher yield than BARI bush bean-2.

**Table 1. Effect of variety, plant density, and nitrogen on the yield attributes and yield of French bean (average of 2 years).**

Treatments	Plant height (cm)	No. of branches /plant	Pod length (cm)	Pod width (cm)	No. of green fruits /plant	Green pod wt/plant	Green pod yield (t/ha)
<b>Variety</b>							
V <sub>1</sub>	45.3a	4.02	12.3	0.73a	20.5	80.5a	23.3a
V <sub>2</sub>	41.8b	4.37	12.2	0.66b	20.1	71.4b	21.4b
<b>Plant density</b>							
S <sub>1</sub>	44.5a	3.86b	11.6b	0.60b	17.8b	58.8c	24.5a
S <sub>2</sub>	43.1b	4.28a	12.3a	0.70a	19.8b	77.5b	22.6b
S <sub>3</sub>	43.0b	4.44a	12.7a	0.71a	26.3a	87.3a	20.0c
<b>Nitrogen rate</b>							
N <sub>0</sub>	39.8c	3.85c	11.9b	0.66b	15.6c	54.6c	15.9c
N <sub>1</sub>	44.0b	4.19b	12.4a	0.69b	21.5b	77.5b	23.3b
N <sub>2</sub>	46.7a	4.54a	12.4a	0.72a	23.8a	87.3a	27.8a
CV (%)	3.48	6.58	4.90	2.86	5.01	5.01	5.81

Figures having uncommon letters in a column are significantly different at 5% level of probability by

DMRT

S<sub>1</sub>=500 x 10<sup>3</sup>, S<sub>2</sub>= 333 x 10<sup>3</sup>, S<sub>3</sub> = 250 x 10<sup>3</sup> plants/ha

N<sub>0</sub> = 0, N<sub>1</sub> = 60, and N<sub>2</sub> = 120 kg N/ha; V<sub>1</sub> = BARI Bush bean-1, V<sub>2</sub> = BARI Bush bean-2

### Effects of plant density

Plant height increases with the increase of plant density because of competition of light (Dhanjal *et al.*, 2001). Maximum plant height (44.5cm) was obtained from the highest plant density (500 x 10<sup>3</sup> plants/ha) and the lowest from the lowest plant density (250 x 10<sup>3</sup> plants/ha). Yield components viz., branches per plant, pod length, pod width, number of green pods per plant and green pod weight per plant recorded the highest values at lower plant density. However, it was not reflected in pod yield per ha, because higher (500 x 10<sup>3</sup> plants/ha) and medium plant density (333 x 10<sup>3</sup> plants/ha) outyielded the lower plant density. The maximum pod yield was recorded with the highest plant density (24.5 t/ha) and the lowest pod yield with the lowest plant density (20.0 t/ha). These results are in agreement with the findings of Mozumder *et al.* (2003) and Singh *et al.* (1996).

### Effects of nitrogen

Plant height and branches per plant increased with increasing level of N (Table 1). Pod length, pod width, number of green pods per plant and green pod weight per plant were found highest at 120 kg N/ha. Higher values of plant height and number of branches per plant with 120 kg N/ha resulted in better growth and development of plants, thus leading to the maximum pod size (pod length x width), more number of green pods per plant and green pod weight per plant. The result is in consonance with the findings of Dahatonde and Nalamwar (1996) and Dhanjal *et al.* (2001). The maximum pod yield (27.8 t/ha) was obtained from the application of 120 kg N/ha and it was minimum (15.9 t/ha) in control (No) treatment. Higher yield for 120 kg N/ha fertilization was contributed by higher values for yield attributes compared to the lower dose (60 kg N/ha). These results are in agreement with the findings of Srinivas and Naik (1990) who recorded the maximum pod yield of French bean at 160 kg N/ha that was at par with 120 kg N/ha.

**Tables 2. Yield attributes and yield of French bean as influenced by variety x plant density and variety x nitrogen levels (average of two years).**

Treatments	Plant height (cm)	Number of branches/plant	Plants/m <sup>2</sup> (no.)	Pod length (cm)	Pod width (cm)	Number of green fruits/plant	Green pod wt / plant (g)	Green pod yield (t/ha)
<b>Variety x plant density</b>								
V <sub>1</sub> S <sub>1</sub>	45.1ab	3.65	44.0a	11.8	0.70	18.1bc	62.0e	26.1a
V <sub>1</sub> S <sub>2</sub>	44.9ab	4.11	29.6c	12.3	0.72	19.8b	80.3c	22.8b
V <sub>1</sub> S <sub>3</sub>	46.0a	4.29	22.6d	12.8	0.72	23.6a	99.0a	21.1c
V <sub>2</sub> S <sub>1</sub>	43.9b	4.06	44.9a	11.6	0.64	17.4e	55.6f	3.4b
V <sub>2</sub> S <sub>2</sub>	41.3c	4.46	30.0c	12.3	0.68	19.9b	74.7d	22.5b
V <sub>2</sub> S <sub>3</sub>	40.0c	4.58	22.5d	12.5	0.69	23.1a	84.1b	18.8d
<b>Variety x nitrogen</b>								
V <sub>1</sub> N <sub>0</sub>	40.8d	3.76	31.8	12.0	0.70	16.0c	57.0d	15.86f
V <sub>1</sub> N <sub>1</sub>	46.4b	4.02	31.8	12.5	0.71	20.9b	86.9b	24.3c
V <sub>1</sub> N <sub>2</sub>	48.5a	4.27	32.1	12.5	0.74	21.5b	96.5a	30.0a
V <sub>2</sub> N <sub>0</sub>	38.8e	3.95	32.7	11.9	0.64	15.1c	51.2e	16.1e
V <sub>2</sub> N <sub>1</sub>	41.8d	4.36	31.9	12.3	0.67	21.4b	77.4c	22.3d
V <sub>2</sub> N <sub>2</sub>	44.6c	4.79	32.0	12.4	0.70	23.8a	85.8b	25.7b
CV(%)	3.48	6.58	3.85	4.90	2.86	5.01	6.15	5.81

Figures having uncommon letters in a column are significantly different at 5% level of probability by DMRT

S<sub>1</sub> = 500x 10<sup>3</sup>, S<sub>2</sub> = 333x10<sup>3</sup>, S<sub>3</sub> = 250x 10<sup>3</sup> plants/ha

N<sub>0</sub> = 0, N<sub>1</sub> = 60 and N<sub>2</sub> = 120 kg N/ha; V<sub>1</sub> = BARI bush bean-I, V<sub>2</sub> = BARI bush bean-2

### **Combined effect of variety and plant density**

Plant height, number of green pods, green pod weight per plant as well as green pod yield per hectare was significantly influenced by variety x plant density (Table 2). The maximum plant height was obtained with  $V_1S_3$ , which is statistically at par with  $V_1S_1$  and  $V_1S_2$ . The treatment  $V_1S_3$  gave the maximum number of green pods per plant that was statistically similar to  $V_2S_3$  treatment. The highest green pod weight per plant was obtained from  $V_1S_3$  treatment (99.0 g) followed by  $V_2S_3$  treatment (84.2 g). However, the treatment combination of  $V_1S_1$  gave the highest pod yield (26.1 t/ha). This is in perfect agreement with the results of Anon. (2000 a) that BARI bush bean-I gave the maximum pod yield at 20 cm x 10 cm spacing.

### **Combined effect of variety and nitrogen**

Plant height, number of green pods per plant, green pod weight per plant and green pod yield per hectare were significantly influenced by variety x nitrogen (Table 2). The maximum plant height (48.8 cm) was obtained from  $V_1N_2$  treatment combination whereas, the highest number of green pods per plant was found from  $V_2N_2$  treatment. The treatment  $V_1N_2$  produced the highest green pod weight per plant (96.5 g) and green pod yield (30.0 t/ha). The results are in close conformity with the findings of Anon. (2000b) that the pod yield of BARI bush bean-I increased with the increase of urea-N. Anon (2000c) reported that the highest pod yield of BARI bush bean -2 was obtained at 75 kg N/ha.

### **Combined effect of plant density and nitrogen**

The data in Table 3 indicate that there was significant differences in plant height, number of green pods and green pod weight per plant and green pod yield due to plant density x nitrogen rate interaction. The maximum plant height in BARI bush bean-I ( $V_1$ ) was recorded with the highest plant density ( $S_1$ ) at 120 kg N/ha ( $N_2$ ), whereas BARI bush bean-2 ( $V_2$ ) had similar response to  $S_3N_2$ ,  $S_1N_1$ ,  $S_1N_2$  and  $S_2N_2$ , while the minimum plant height was recorded at  $S_3N_0$  for both varieties. Average data of two varieties indicate that  $S_1N_2$  treatment gave the maximum plant height closely followed by  $S_3N_2$ . Anon. (2000b) reported that the close spacing of 20 cm x 10 cm coupled with the highest N produced maximum plant height. The maximum number of green pods per plant and green pod weight per plant was recorded with the lower plant density at the highest nitrogen level ( $S_3N_2$ ) in both the varieties whereas, the highest plant density with 0 kg N/ha ( $S_1N_0$ ) gave the lowest values. The maximum pod yield per ha was recorded with the highest plant density at the highest dose of N (120 kg/ha) in both the varieties, while minimum pod yield per hectare was noticed in control N with the highest plant density ( $S_1N_0$ ). Average performance of two varieties indicate that

the highest plant density accompanied by the highest N levels ( $S_1N_2$ ) gave the highest pod yield per ha.

**Table 3. Yield attributes and yield of French bean as influenced by plant density x nitrogen levels (average of 2 years).**

Spacing x Nitrogen	Plant height (cm)			Pod length (cm)			Pod width (cm)		
	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean
$S_1N_0$	36.8e	33.7d	36.3f	11.7	11.3	11.5	0.70	0.61	0.65
$S_1N_1$	46.4c	44.7a	45.5b	12.1	11.9	12.0	0.70	0.64	0.67
$S_1N_2$	53.3a	44.3a	48.8a	12.1	12.2	12.1	0.72	0.66	0.69
$S_2N_0$	42.3d	38.9c	40.1d	11.9	12.4	12.1	0.70	0.64	0.67
$S_2N_1$	45.8c	40.8b	43.3c	12.7	12.7	12.7	0.73	0.67	0.70
$S_2N_2$	46.6e	44.2a	5.4b	12.5	12.3	12.4	0.73	0.71	0.72
$S_1N_0$	41.5d	34.8d	38.1e	12.1	12.3	12.2	0.72	0.63	0.67
$S_3N_1$	48.2b	40.0b	44.1c	12.6	12.8	12.6	0.72	0.69	0.70
$S_3N_2$	49.1b	45.4a	47.3a	13.4	13.4	13.40	0.73	0.71	0.72
CV (%)	3.48			4.90			2.86		

Table 3. Cont'd.

Spacing x Nitrogen	No. of green pods/plant			Green pod weight/ plant (g)			Green pod yield (t/ha)		
	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean
$S_1N_0$	13.5f	13.7e	13.6f	46.3h	40.9g	43.6g	15.6e	14.3f	14.9f
$S_1N_1$	19.9cd	17.9c1	18.6e	64.2f	57.6e	60.9e	25.9cd	23.9e	24.9c
$S_1N_2$	20.6c	20.5c	20.5d	75.4e	68.4d	71.9d	34.3a	30.2a	32.2a
$S_2N_0$	15.7e	13.9e	14.8f	55.7g	52.8f	54.3f	16.6e	19.2e	17.9e
$S_2N_1$	20.6c	22.5c	21.6cd	89.2d	84.5d	86.8c	24.3d	23.4cd	23.4cd
$S_2N_2$	22.8b	23.2b	23.0bc	95.1c	86.8c	91.4c	28.8b	26.9b	27.6b
$S_3N_0$	18.9d	17.8d	18.3e	71.7e	60.1e	65.8de	15.7e	14.7f	15.2f
$S_3N_1$	24.0b	24.1b	24.0b	107.7b	90.1b	98.9b	25.8cd	19.5e	22.6d
$S_3N_2$	27.8a	27.8a	27.8a	117.7a	102.3a	110.0a	26.7c	22.1d	24.4c
CV (%)	3.48			6.15			5.81		

Figures having uncommon letters in a column are significantly different at 5% level of probability by DMRT

$S_1 = 500 \times 10^3$ ,  $S_2 = 333 \times 10^3$ ,  $S_3 = 250 \times 10^3$  plants/ha

$N_0 = 0$ ,  $N_1 = 60$  and  $N_2 = 120$  kg N/ha;  $V_1 =$  BARI Bush bean-1,  $V_2 =$  BARI Bush bean-2

From the above discussion, it could be concluded that French bean (BARI bush bean-I and BARI bush bean-2) should be cultivated at the plant density of  $500 \times 10^3$  plants per ha (20 x 10 cm) with application of 120 kg N/ha for obtaining higher yield in Rangamati area.

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