

Original Research Article

Growth and Yield Response of Bush Bean (*Phaseolus vulgaris* L.) as Influenced by Different Levels of Nitrogen and Phosphorus Application

ABSTRACT

The experiment was conducted at Horticulture Farm at Sher-e-Bangla Agricultural University, Bangladesh during the period December, 2014 to March 2015 to evaluate the effect of different levels of nitrogen and phosphorous on the growth and yield of bush bean. The two factor experiment was laid out in Randomized Complete Block Design with three replications. The treatment was comprised of two factors- Factor A: levels of nitrogen i) 0 kg/ha, ii) 20 kg/ha, iii) 40 kg/ha and Factor B: levels of phosphorous – i) 0 kg/ha, ii) 50 kg/ha, iii) 75 kg/ha, iv) 100 kg/ha. The results revealed that most of the growth and yield contributing parameters were significantly influenced by the different levels of nitrogen and phosphorous application. The maximum promotive effect on growth and yield of bush bean was associated with 40 kg N/ha and 75 kg P₂O₅/ha. Again their combined application enhanced maximum vegetative growth and with higher pod yield and seed yield. Therefore, application of 40 kg N/ha with 75 kg P₂O₅/ha can be conducive for bush bean cultivation in Bangladesh with higher yield.

Keywords: growth, yield, bush bean, Nitrogen, Phosphorous

1. INTRODUCTION

Bush bean (*Phaseolus vulgaris* L.) is a versatile short duration legume crop with high grain yielding potential and can be used both as pulses and vegetable. Although the crop has originated in South America it has gained popularity all over the world for its high yielding potential and diversified use. Immature pods are marketed fresh, frozen and canned. Its dry seeds are used in preparations with fish, meat and other vegetables. Foliage of the plant may also provide hay, silage and green manures. After harvest, plants can be used as fodder to feed the cattle, sheep and horses. Its edible pods supply huge protein, carbohydrate, fat, fiber, thianin, riboflavin, Ca and Fe [1]. Due to its sublime nutritional quality and diversified use, it has gained huge popularity in Bangladesh over the recent years. Besides these, the crop has eminent export potential which has drawn the attention of Agriculture industry and exporters. So there is tremendous scope for the cultivation of this important vegetable crop in our country with the export potential. However, to ensure proper growth and yield, the crop needs optimum nutrient management. Nitrogen is one of the key elements for growth and development of a crop plants [2]. Meanwhile, it has been reported

35 that, unlike other leguminous crops, it does not nodulate with the native rhizobia [3].
36 Therefore, nitrogen input during production is very crucial for this crop. Nitrogen deficiency
37 constraints leaf area expansion, enhances leaf senescence, inhibits photosynthetic rate in
38 most of the crops and consequently reduces the crop productivity [4, 5]. In addition to this,
39 deficiency of phosphorous is now considered as one of the major constraints to successful
40 production of legumes and upland crops in Bangladesh [6]. The most obvious effect of
41 phosphorus is on the root development particularly of the lateral and fibrous rootlets that are
42 essential to fix the atmospheric nitrogen in legume crops. Phosphorous also make its
43 contribution through seed formation. In case of application of various fertilizer doses, there
44 were significant differences in pod number per plant in bush bean [7]. The plant height,
45 number of branches, length of pod per plant and seed yield per pod increase with
46 successive increase in the dose of nitrogen as well as phosphorous [8]. Therefore, optimum
47 combination of nitrogen and phosphorous may bring about considerable increase in the yield
48 of Bush bean due to their complementary effects. A detailed systematic study is needed to
49 find out the requirements and effect of nitrogen and phosphorous for maximizing the yield of
50 bush bean in Bangladesh. Considering the above, the present investigation was
51 undertaken to study the growth and yield response of bush bean under different levels of
52 nitrogen and phosphorous to find out the best combination of nitrogen and phosphorous for
53 maximizing the production of Bush bean.

54 **2. MATERIAL AND METHODS**

55 **2.1 Experimental site**

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59 The experiment was conducted at the Horticultural farm of Sher-e-Bangla Agricultural
60 University, Dhaka, Bangladesh from December 2014 to March 2015. The location of the
61 experimental site was 23°07'4"N latitude and 90°03'5"E longitude and at an elevation of 8.2 m
62 from sea level. The climate of experimental site was under the subtropical climate,
63 characterized by three distinct seasons, the winter season from November to February and
64 the pre-monsoon or hot season from March to April and the monsoon period from May to
65 October. The soil of the experimental area belongs to the Modhupur Tract (AEZ No 28). It
66 had shallow red brown terrace soil. The selected plot was medium high land and the soil
67 series was Tejgaon.

68 **2.2 Planting material**

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71 The variety of bush bean used in the experiment was BARI jharsheem. The seeds were
72 collected from Horticulture Research Centre, Bangladesh Agriculture Research Institute
73 (BARI), Gazipur, Bangladesh.

74 **2.3 Experimental design and treatments**

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77 The two factor experiment was laid out in Randomized Complete Block Design with three
78 replications. The experimental plot was first divided into three blocks. Each block consisted
79 of 12 unit plots. Thus the total number of plots was 36. The treatment was comprised of two
80 factors- Factor A: levels of nitrogen i) 0 kg/ha, ii) 20 kg/ha, iii) 40kg/ha and Factor B: levels of
81 phosphorous – i) 0 kg/ha, ii) 50 kg/ha, iii) 75 kg/ha, iv) 100 kg/ha. Different combinations of
82 nitrogen and phosphorous were assigned randomly to each block as per design of the
83 experiment. The size of the unit plot was 3m×4. A distance of 0.75m between the plots and
84 1m between the blocks were kept.

85 **2.4 Growth condition of Bush bean and measurement of parameters**

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88 Seedlings were grown following proper methods and all of the cultural practices were done
89 properly. Application of manure and fertilizers were applied as per treatment. Healthy and
90 uniform sized seedlings were transplanted in the main field. Intercultural practices were done
91 as per requirements. For controlling leaf caterpillars Nogos @ 1 ml/L water were applied two
92 times at an interval of 10 days starting soon after the appearance of infestation. Immature
93 green pods were harvested at tender stage, suitable for use as vegetable. First harvest was
94 done at 55 days after sowing (DAS) and was weighted to estimate the fresh pod yield. Again
95 the rest of the pods were harvested at mature stage when the pods become yellow and fully
96 dry. These seeds were collected from the pods and sun dried seeds were weighted to
97 estimate the seed yield.

98 **2.5 Data collection and statistical analysis**

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101 Different yield contributing data have been recorded from the mean of five harvested plants
102 which was selected at random of each unit plot of every harvesting stage. The plants in the
103 outer rows and the extreme end of the middle rows were excluded from the random
104 selection to avoid the border effect. The height of the plants was measured from the ground
105 level to the tip of the highest leaves. Green pods were harvested from each unit plot at 4
106 days interval and their total weight was recorded. Harvesting was done for four times and
107 their weight was recorded in each unit plot and expressed in kilogram (Kg). The green pod
108 yield per plant was finally converted to yield per hectare and expressed in ton (t). The data
109 obtained for different parameters were statistically analyzed to find out the significance
110 difference of variety and different fertilizer application on yield and yield contributing
111 characters of cabbage. The mean values of all the characters were calculated and analysis
112 of variance was performed by the 'F' (variance ratio) test. The significance of the difference
113 among the treatment combinations means was estimated by the Duncan's Multiple Range
114 Test (DMRT) at 5% level of probability.

115 **3. RESULTS AND DISCUSSION**

116 **3.1 Plant Height (cm)**

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120 Different levels of nitrogen and phosphorous exhibited significant variation in respect of plant
121 height of bush bean at different days after sowing (Table 1). In all the dates of observation
122 plant height gradually increased with the increasing nitrogen level. At final harvest the
123 maximum plant height (43.82cm) was obtained from the plant grown with 40kg N/ha and the
124 minimum (37.85cm) was recorded from control treatment. Nitrogen is the most essential
125 nutrient for plant growth which might have facilitated the highest plant height N₂. Similar
126 result was supported by [9] who reported that plant height increased with increasing rate of
127 N doses up to 120 kg/ha.

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129 Plant height was also significantly influenced by the application of different levels of
130 phosphorous at different growth stages (Table 2). Plant height was gradually increased with
131 the passage of time up to the final harvest. At harvest, the tallest plant (41.98 cm) was
132 produced from the plant growth with 100 kg P₂O₅/ha whereas the shortest plant was
133 recorded in the controlled treatment. Similar result was reported by [10,11].

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135 In case of combined effect of Nitrogen and Phosphorous, the maximum plant height (44.60
136 cm) was observed from the treatment combination N₂P₂ whereas the minimum plant height
137 was observed from the control treatment. The present result is in agreement with the
138 findings of [9].

139 **3.2 Number of pod/plant**

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142 The number of pod per plant differed significantly due to the application of different levels of
143 nitrogen (Table 1). The maximum number of pods per plant (13.26) was produced from the
144 40kg N/ha. On the contrary, minimum number of pod per plant was recorded from the control
145 treatment. It might be due to the adequate supply of nitrogen which facilitated the increased
146 number of pod bearing branches.

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148 The number of pod per plant was also showed significant effect on increasing the number of
149 pod per plant (Table 2). The maximum number of pods per plant (13.62) was recorded from
150 50 kg P_2O_5 /ha meanwhile the minimum number of pod per plant was recorded from the
151 control treatment. The result is in conformity with the [11,12, 13].

152
153 Combined effect of different levels of nitrogen and phosphorous on the number of pod per
154 plant showed significant variation (Table 3). The maximum number of pods per plant (13.90)
155 was recorded from the combined treatment of 40kg N/ha and 50 kg P_2O_5 /ha. On the contrary
156 minimum number of pods per plant was found from the N_2P_3 . It has been reported that P
157 uptake reduced above 60 kg P_2O_5 /ha.

158 159 **3.3 Pod length (cm)**

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161 Nitrogen had significant influence in respect to pod length (Table 1). Pod length gradually
162 increased with the increasing dose of nitrogen fertilizer. The highest length of green pod of
163 bush bean (17.51 cm) was found in the crop grown with the higher dose of nitrogen (40 kg
164 N/ha) and lowest was observed from the control treatment. Length of the green pod was also
165 influenced significantly by the different doses of phosphorous (Table 2). The maximum
166 length of green pod (16.99 cm) was obtained from 100 kg P_2O_5 /ha. On the other hand
167 minimum pod length was recorded from 50 kg P_2O_5 /ha. It was observed that the interaction
168 effect of different doses of nitrogen and phosphorous on green pod length was significant
169 (Table 3). The highest pod length (18.05 cm) was recorded from the treatment combination
170 40 kg N/ha and 75 kg P_2O_5 /ha and the lowest was recorded from the control treatment.

171 172 **3.4 Pod weight/plant**

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174 A significant variation was observed in respect of pod weight per plant ad different level of
175 nitrogen (Table 1). The highest pod weight per plant (85.26 g) was obtained from 40 kg N/ha
176 and the lowest pod weight (48.57 g) per plant was recorded from the control. The level of
177 phosphorous was also significantly influenced the pod weight per plant of bush bean in the
178 similar way. The highest pod weight (72.27 g) was obtained from the plant which was treated
179 with 75 kg P_2O_5 /ha and the lowest (62.10 g) from the control treatment. The combined effect
180 of different levels of nitrogen and phosphorous on pod weight per plant was found
181 statistically significant (Table 3). The maximum pod weight per plant (89.16 g) was obtained
182 from the treatment N_2P_1 whereas the minimum was obtained from the control treatment.

183 184 **3.5 Pod yield**

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186 The result indicated that nitrogen had significant effect on pod yield per hectare (Table
187 1).The maximum pod yield (16.56 t/ha) was obtained from 40 kg N/ha and the minimum pod
188 yield (10.04 t/ha) in control. Phosphorous also influenced significantly the pod yield per
189 hectare (Table 2).The combined effect of different level of nitrogen and phosphorous on pod
190 yield per hectare was found to be statistically significant (Table 3). The highest pod yield per
191 hectare (18.61 t/ha) was achieved from the treatment combination 40 kg nitrogen per
192 hectare with 75 kg P_2O_5 /ha whereas the lowest value per hectare (9.22 t/ha) was found from
193 the control combination. Similar kind of result was reported by [14,15].

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3.6 No of seeds/pod

The number of mature seeds per pod was significantly influenced by the application of nitrogen (Table 1). The highest seed per pod (5.85) was obtained from the plant receiving 40 kg N/ha. The lowest number of mature seed per pod (5.31) was recorded from control treatment. This result might be due to the better growth and development and larger pod formation with higher rate of N application. Similar kind of result was reported by []. Different doses of phosphorous also significantly influenced the number of seed per pod (Table 2). Number of seed per pod increased with increasing rates of phosphorous fertilizer. It was maximum (5.63) at 100 kg P₂O₅/ha which was statistically similar to 75 kg P₂O₅/ha whereas the minimum number of seed (5.13) was obtained with zero phosphorous. There was also significant interaction between nitrogen and phosphorous in respect of seed per pod (Table 3). The maximum number of seeds per pods (6.16) was recorded from the treatment combination 40 kg N/ha with 50 kg P₂O₅/ha whereas the minimum number of seed per pod was recorded in the control treatment.

3.7 Thousand Seed weight

A significant variation was observed in respect of 1000 seed weight due to different nitrogen levels (Table 1). Maximum weight of 1000 seed (230.75 g) was recorded from application of 40 kg N/ha. Meanwhile minimum was obtained from the control treatment. The level of phosphorous were also significantly influenced the 1000 seed weight (Table 2). The highest 1000 seed weight (236.00 g) was recorded at 75 kg P₂O₅/ha while the lowest was obtained from the control treatment. The combined effect of nitrogen and phosphorous was found to be significant (Table 3). The highest weight of 1000 seed (255.00 g) was obtained from the treatment combination of 40 kg N/ha with 75 kg P₂O₅/ha. The lowest 1000 seed weight (211.00 g) was recorded from the control treatment.

3.8 Seed yield/plot

The result indicated that nitrogen had significant effect on seed yields per plot (Table 1). Seed yields per plot were varied from 2.65 kg to 3.3 kg. The maximum seed yield per plot was produced from the 40 kg N/ha and minimum seed yield per plot was obtained from the control. Phosphorous also influenced significantly the seed yield per plot (Table 2). Maximum seed yield per plot (3.08 kg) was obtained with the 75 kg P₂O₅/ha while the minimum was recorded in the control treatment. The combined effect of different levels of nitrogen and phosphorous on seed yield per plot was found to be statistically significant (Table 3). The highest yield per plot (3.53 kg) was obtained from the treatment combination of 40 kg N/ha with 50 kg P₂O₅/ha whereas the lowest value was found from the control treatment.

3.9 Seed Yield (t/ha)

The result indicated that nitrogen had significant effect on seed yield per hectare (Table 1). The maximum seed yield (2.71 t/ha) was obtained from 40 kg N/ha and the minimum (2.23 t/ha) in control treatment.

241 Phosphorous also influenced significantly the seed yield per hectare (Table 2). The maximum seed yield per hectare (2.58) was obtained
 242 with the 75 kg P₂O₅/ha whereas the minimum was obtained from the control treatment. The combined effect of different levels of nitrogen
 243 and phosphorous on seed yield per hectare was found to be statistically significant (Table 3). The highest yield per hectare (2.96 t) was
 244 obtained from the treatment combination of 40 kg N/ha with 50 kg P₂O₅/ha whereas the lowest value was found from the control treatment.
 245 The result is in agreement with [16, 17].
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247 **Table 1:** Effect of Nitrogen on the growth and yield contributing attributes of bush bean.

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Nitrogen Level	Plant height (cm)	Number of pod plant ⁻¹	Pod length (cm)	Pod weight plant ⁻¹	Pod yield (t ha ⁻¹)	No of seeds pod ⁻¹	1000 seed weight (g)	Seed yield plot ⁻¹ (kg)	Seed yield (tha ⁻¹)
N ₀	37.85 c	13.22 b	14.85 b	48.57 c	10.04 c	5.13 c	225.00 b	2.65 c	2.23 c
N ₁	41.34 ab	13.24 ab	16.58 ab	66.93 b	13.62 ab	5.35 b	228.50 ab	2.94 ab	2.42 b
N ₂	43.83 a	13.26 a	17.51 a	85.26 a	16.56 a	5.85 a	230.75 a	3.23 a	2.71 a
LSD (0.05)	0.988	0.065	0.488	0.065	0.100	0.088	1.955	0.037	0.046
CV	4.25	3.20	4.16	6.40	2.21	1.63	7.56	3.54	4.12

248 Means in a same column followed by different letter (s) are significantly different at P<0.05.

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251 **Table 2:** Effect of Phosphorous on the growth and yield contributing attributes of bush bean.

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Phosphorus Level	Plant height (cm)	Number of pod plant ⁻¹	Pod length (cm)	Pod weight plant ⁻¹	Pod yield (tonha ⁻¹)	No of seeds pod ⁻¹	1000 seed weight (g)	Seed yield plot ⁻¹ (kg)	Seed yield (tonha ⁻¹)
P ₀	39.83 c	13.20 b	16.29 b	62.10 c	10.76 c	5.13 b	223.33 c	2.65b	2.17 b
P ₁	40.66 b	13.62 a	15.93 c	68.25 b	13.51 b	5.44 b	227.00 bc	2.94 b	2.48 b
P ₂	41.55 ab	13.12 b	16.03 bc	72.27 a	15.35 a	5.56 ab	236.00 b	3.08 a	2.58 a
P ₃	41.98 a	12.99 c	16.99 a	65.08 bc	14.55 ab	5.63 a	226.00 bc	3.06 a	2.58 a
LSD (0.05)	1.142	0.075	0.564	0.415	0.115	0.10	2.258a	0.043	0.053
CV	4.55	1.19	4.65	5.87	4.12	3.07	8.67	2.43	4.11

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253 **Table 3:** Combined effect of Nitrogen and Phosphorous on the growth and yield contributing attributes of bush bean.

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Nitrogen Level	Plant height (cm)	Number of pod plant ⁻¹	Pod length (cm)	Pod weight plant ⁻¹	Pod yield (tonha ⁻¹)	No of seeds pod ⁻¹	1000 seed weight (g)	Seed yield plot ⁻¹ (kg)	Seed yield (tonha ⁻¹)
N ₀ P ₀	35.27d	13.20 b	15.04 c	40.66 e	9.22 d	4.73 d	211.00 d	2.21 d	1.89 d
N ₀ P ₁	36.33 cd	13.46 b	13.56 d	42.66 de	9.80 cd	4.97 cd	235.00 b	2.50 cd	2.13 _c
N ₀ P ₂	39.82 c	12.83 bc	15.16 c	57.71 _c	11.81 c	5.31 c	225.00 bc	2.87 c	2.41 bc
N ₀ P ₃	39.97 c	13.33 b	15.65 c	53.23 cd	10.93 c	5.54 ab	231.00 bc	2.91 bc	2.49 bc
N ₁ P ₀	40.46 bc	12.96 bc	16.09 bc	63.72 bc	10.15 c	5.22 c	219.00 cd	2.77 c	2.19 c
N ₁ P ₁	41.03 bc	13.51 b	16.17 bc	72.95 b	13.58 bc	5.22 c	218.00 cd	2.80 c	2.35 bc
N ₁ P ₂	41.30 b	13.53 b	16.22 bc	71.44 b	15.63 b	5.36 ab	227.00 bc	3.16 b	2.62 bc
N ₁ P ₃	42.57 b	13.45 b	17.82 ab	59.60 c	15.15 b	5.58 ab	236.00 b	3.07 bc	2.52 bc
N ₂ P ₀	43.77 b	13.50 b	17.76 ab	81.93 ab	12.91 bc	5.46 ab	228.00 c	2.95 c	2.42 bc
N ₂ P ₁	43.53 b	13.90 a	18.05 a	89.16 a	17.14 ab	6.16 a	229.00 c	3.53 a	2.96 a
N ₂ P ₂	44.60 a	13.00 b	16.71 bc	87.67 ab	18.61 a	6.01 a	255.00 a	3.22 b	2.73 b
N ₂ P ₃	43.40 b	12.20 c	17.51 ab	82.82 ab	17.57 ab	5.75 ab	223.00 bc	3.19 b	2.73 b
LSD(0.05)	1.978	0.131	0.977	0.720	0.200	0.177	3.910	0.075	0.09
CV (%)	2.85	2.59	3.54	3.44	4.87	1.91	3.01	1.52	2.19

254 Means in a same column followed by different letter (s) are significantly different at P<0.05; Factor A: levels of nitrogen i) 0 kg/ha, ii) 20
 255 kg/ha, iii) 40 kg/ha and Factor B: levels of phosphorous – i) 0 kg/ha, ii) 50 kg/ha, iii) 75 kg/ha, iv) 100 kg/ha.

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4. CONCLUSION

The result of the present study revealed that both nitrogen and phosphorous significantly influenced on the green pod and seed yield of bush bean. Application of 40 kg N/ha with 75 kg P₂O₅/ha has emerged as the best treatment for increasing growth and yield contributing attributes of bush bean and therefore can be conductive for bush bean cultivation in Bangladesh with higher yield.

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