



Effect of Nitrogen and Potassium on the Yield Components of BARI Bush Bean-2 and Post-harvest Nutrient Status of the Soil

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out at Sher-e-Bangla Agricultural University Farm during the *Rabi* season of 2008 to investigate the effect of nitrogen and potassium on the yield and yield components of BARI Bush Bean-2. The red brown terrace soil of Tejgaon was silty clay loam in texture having pH 5.6. The experiment was conducted in a Randomized Complete Block Design (RCBD) with three replications. The experiment comprises 4 levels of nitrogen in the form of urea (0, 40, 80 and 120 kg nitrogen/ha) and 4 levels of potassium from Muriate of Potash (0, 20, 40 and 60 kg potassium /ha). There was combination of sixteen treatments including control (no fertilizer). The results obtained revealed that different levels of nitrogen and potassium showed significant variations on the parameters studied. The treatment N₈₀K₄₀ (80 kg nitrogen + 40 kg potassium) gave the highest pod length (11.67 cm), pod diameter (3.13 cm), average single pod weight (5.99 g), total pod weight per plant (29.07 g), pod yield per plot (2033.33 g) and pod yield per hectare (4.96 tons). Thus the findings of the experiment suggested that combined use of 80 kg nitrogen + 40 kg potassium produced the maximum yield of BARI Bush Bean-2 in red brown terrace soil of the Tejgaon series.

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1. INTRODUCTION

Bush bean (*Phaseolus vulgaris* L.) belongs to the family leguminosae [1] and is one of the most important leguminous vegetables in the world [2]. Among major food legumes, bush bean is third in importance is grown and consumed in almost every part of the world [3,4]. The center of origin of this crop is in South America but is consumed in all parts of the globe for its edible seeds and pods [1]. Now it is cultivated in many parts of the tropics, sub-tropics and throughout the temperate region [5]. In Bangladesh, this crop is known as “Farashi Sheem” [6]. It is also known as the french bean, kidney bean, common bean, basic bean, snap bean, raj bean, navy bean, haricot bean, string bean, pole bean, wax bean and bonchi [7]. Bush beans are green, tender, rounded shaped pods, 4 to 6 inches (10 to 15 cm) long. The pods are eaten whole, including the immature seeds, when they are still young, juicy and tender. Its green pods are rich in protein, carbohydrate, fat, thiamin, riboflavin, Ca, Fe and niacin as well as fiber [8,9]. French bean can easily be grown in field as well as in homestead garden if the soil is managed properly [2]. The marketable parts of this fruit are immature green pods those are marketed either in fresh or in frozen or canned condition [10]. It also contains various immune system-boosting antioxidants e.g. flavonoids and carotenoids [11]. Due to their high levels of flavonoids, this power-packed legume has been shown to help manage and regulate diabetes symptoms in many patients and reduce the risk of heart diseases [12]. It has gained enormous demand in Bangladesh over recent years because of its glorious nutritional quality and versatile use. Additionally, the crop has a well-known export quality which has attracted the attention of the Agriculture industry and exporters [10]. This crop is also valuable in Bangladesh mostly for exporting tender beans to the European market [13]. In this context, the yield of Bush bean has become an important component of vegetable production and cash income. Many factors influenced the production of BARI Bush Bean-2. Among them, fertilizer especially nitrogen is the most effective and critical input for increasing crop yield [14]. In agro-ecological zones the requirement of fertilizer for any crop varies with the cultivars and soil types [15]. Nitrogen is one of the most limiting nutrients to plant growth [16]. [17] Found a maximum pod yield of Bush bean from 120 kg N ha⁻¹. By using 120 kg N ha⁻¹, [18]

found the maximum plant height, the number of branches per plant and green pod yield of Bush bean ha⁻¹. On other hand, for the successful production of legumes and upland crops in Bangladesh, the deficiency of Potassium is now considered as one of the major constraints [19]. Potassium also effects seed formation [20] and it also improves the fruit quality [21]. The most obvious effect of potassium is on root development, particularly of the lateral and fibrous rootlets that are essential to fix the atmospheric nitrogen in legume crops [14]. The sufficient application of K supports the increment of yield, fruit size, fruit color, shelf life and transport quality of many crops [22]. Research findings on response BARI Bush Bean-2 to nitrogen and potassium and their optimum requirement is limited. A judicious amount of nitrogen and potassium is essential to produce maximum and profitable yield of BARI Bush Bean-2. Considering the above facts, the present investigation was undertaken to find out the best combination of nitrogen and potassium for maximizing the production of BARI Bush Bean-2.

2. MATERIALS AND METHODS

2.1 Experimental Site

The research work was conducted during the *Rabi* season of November 2008 to March 2009 at Sher-e-Bangla Agricultural University Farm, Sher-e-Bangla Nagar, and Dhaka. It is located at 90.335°E longitude and 23.774°latitudes. The soil of the experimental field belongs to the Tejgaon series of AEZ No. 28, Madhupur Tract and has been classified as Shallow Red Brown Terrace Soils in Bangladesh soil classification system. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the experiment. The collected soil was air-dried, ground and passed through 2 mm sieve and analyzed for some important physical and chemical properties. Some physical and chemical characteristics of the initial soil are presented in Table 1.

2.2 Planting Material

The variety of bush bean used in the experiment was BARI Bush Bean-2. The seeds were collected from Horticulture Research Centre, Bangladesh Agriculture Research Institute (BARI), Gazipur, Bangladesh.

2.3 Experimental Design and Treatments

The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The unit plot size was 2.4 m x 1.5 m (3.6 m²). The distance between the two plots was 50 cm and between blocks was 50 cm. The plots selected for the experiment was plowed on the 30th of November 2008 and cross-plowed several times to obtain a good tilth. The experiment consists of two factors viz. Nitrogen (N) and Potassium (K). Doses of nitrogen were 0, 40, 80, 120 kg/ha and doses of potassium were 0, 20, 40, and 60 kg/ha. Details of the treatments are as follows: T₀ = 0 kg N + 0 kg K ha⁻¹ (control), T₁ = 0 kg N + 20 kg K ha⁻¹, T₂ = 0 kg N + 40 kg K ha⁻¹, T₃ = 0 kg N + 60 kg K ha⁻¹, T₄ = 40 kg N + 0 kg K ha⁻¹, T₅ = 40 kg N + 20 kg K ha⁻¹, T₆ = 40 kg N + 40 kg K ha⁻¹, T₇ = 40 kg N + 60 kg K ha⁻¹, T₈ = 80 kg N + 0 kg K ha⁻¹, T₉ = 80 kg N + 20 kg K ha⁻¹, T₁₀ = 80 kg N + 40 kg K ha⁻¹, T₁₁ = 80 kg N + 60 kg K ha⁻¹, T₁₂ = 120 kg N + 0 kg K ha⁻¹, T₁₃ = 120 kg N + 20 kg K ha⁻¹, T₁₄ = 120 kg N + 40 kg K ha⁻¹ and T₁₅ = 120 kg N + 60 kg K ha⁻¹. Nitrogen was applied as Urea and Potassium was supplied as Muriate of Potash.

2.4 Growth Condition of Bush Bean and Measurement of Parameters

The manures and fertilizers like Cow dung (5000 kg/ha), TSP (200 kg/ha), Gypsum (60 kg/ha), and Boric acid (5 kg/ha) were applied according to [23]. The entire quantity of Cow dung, Gypsum, and Boric acid was applied during the final land preparation. The full doses of TSP and half of Urea and MoP were applied at seed sowing time and rest half MoP at 30 days after seed sowing. Seeds of BARI Bush Bean-2 were sown on 3 December 2008. The seeds were sown per hill at a depth of 5 cm and the seeds were covered with pulverized soil just after sowing and gently pressed with hands. Intercultural operations were done whenever required for getting better growth and development of the plants. Different yield contributing data have been recorded from the mean of five harvested plants which was selected at random of each unit plot of every harvesting stage. The plants in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid the border effect. First harvest was done at 55 days after sowing (DAS) and was weighted to estimate the fresh pod yield. Again the rest of the pods were harvested at mature stage when the pods become yellow and fully dry. These seeds were

collected from the pods and sun dried seeds were weighted to estimate the seed yield.

2.5 Data Collection, Chemical Analysis and Statistical Analysis

Data were collected on pod length, pod diameter, average single pod weight, total pod weight per plant, pod yield per plot and pod yield per hectare. The initial and post-harvest soil samples were analyzed for both physical and chemical properties. To determine the different physical and chemical properties various methods and procedures are used like, the particle size of soil by [24], soil textural class was ascertained using USDA textural triangle, soil pH by [25], organic carbon by [26], organic matter by [27], total nitrogen by [28], available phosphorous by [29], exchangeable potassium by [30], available sulphur by [31] and available Zinc by [32]. The data obtained from the experiment were analyzed statistically using the MSTAT computer package program to find out the significance of the difference among the treatments. The mean values of all the treatment were calculated and analysis of variances for all the characters was performed by the 'F' (variance ratio) test. The significance of the differences among the pairs of treatment means was estimated by the Duncan Multiple Range Test (DMRT) at 1% and 5% level of probability [33] for the interpretation of results.

3. RESULTS AND DISCUSSION

3.1 Interaction Effect of Nitrogen and Potassium on the Growth and Yield of BARI Bush Bean-2

The interaction effect of nitrogen and potassium treatments on different characters is discussed below.

3.1.1 Pod length

The interaction effect of nitrogen and potassium on the length of pod was found to be significant (Table 2). The highest length of pod was found (11.67 cm) under treatment interaction T₁₀ (80 kg N + 40 kg K ha⁻¹) which is statistically at par with treatments T₁ (0 kg N + 20 kg K ha⁻¹), T₂ (0 kg N + 40 kg K ha⁻¹), T₃ (0 kg N + 60 kg K ha⁻¹), T₄ (40 kg N + 80 kg K ha⁻¹), T₅ (40 kg N + 20 kg K ha⁻¹), T₆ (40 kg N + 40 kg K ha⁻¹), T₇ (40 kg N + 60 kg K ha⁻¹), T₈ (80 kg N + 0 kg K ha⁻¹), T₉ (80 kg N + 20 kg K ha⁻¹), T₁₁ (80 kg N + 60 kg K ha⁻¹), T₁₂ (120 kg N + 0 kg K ha⁻¹), T₁₃ (120 kg N + 20 kg K ha⁻¹), T₁₄ (120 kg N + 40 kg K ha⁻¹) and T₁₅ (120 kg N + 60 kg K ha⁻¹) and the lowest length of

pod was found (9.90 cm) under the treatment interaction T_0 (0 kg N + 0 kg K ha⁻¹). This result is similar with [34]. As a part of the chlorophyll molecule Nitrogen activates the normal metabolic process of leaves. The leaves contain the highest level of N become metabolically most active. So the adding of nitrogen boosts the vegetative growth viz. pod length of BARI Bush Bean-2. Potassium has a significant role in the translocation of assimilates to sinks by influence electron transport in the transport chain of crops which increase pod length [35]. The application of potassium fertilizer significantly increases in pod length of bean [36]. High photosynthesis activity and source strength that supported assimilates for pods may have partially contributed in lengthening the pods.

Table 1. Physical and chemical properties of the initial soil sample

Soil properties	Value
A. Physical properties	
1. Particle size analysis of soil.	
% Sand	28.2
% Silt	41.20
% Clay	30.6
2. Soil texture	Silty Clay
B. Chemical properties	
1. Soil pH	5.6
2. Organic matter (%)	1.17
3. Total N (%)	0.08
4. Available P (mg kg ⁻¹)	13.42
5. Available K (me100g ⁻¹)	0.13
6. Available S (mg kg ⁻¹)	23.74
7. Available Zn (mg kg ⁻¹)	3.20

3.1.2 Pod diameter

The interaction effect of nitrogen and potassium on the pod diameter was found to be significant. The highest diameter of pod was found (3.13 cm) treatment interaction T_{10} (80 kg N + 40 kg K ha⁻¹) which is statistically at par with treatment interaction T_1 (0 kg N + 20 kg K ha⁻¹), T_3 (0 kg N + 60 kg K ha⁻¹), T_5 (40 kg N + 20 kg K ha⁻¹), T_6 (40 kg N + 40 kg K ha⁻¹), T_8 (80 kg N + 0 kg K ha⁻¹), T_9 (80 kg N + 20 kg K ha⁻¹), T_{11} (80 kg N + 60 kg K ha⁻¹), T_{12} (120 kg N + 0 kg K ha⁻¹), T_{13} (120 kg N + 20 kg K ha⁻¹), T_{14} (120 kg N + 40 kg K ha⁻¹) and T_{15} (120 kg N + 60 kg K ha⁻¹). The lowest diameter of pod was found (2.10 cm) under control treatment interaction (Table 2). This may be due to BARI Bush Bean-2 responded well to the enhanced doses of potassium fertilizer [1]. A suitable supply of nitrogen favors the increase of carbohydrates as it is a part of the chlorophyll

molecule. A suitable level of N stimulates the metabolic process and produces additional food that reserved in fruits. That's why pod diameter increases with the application of an optimum dose of N. The potassium intake leads to positive effects on photosynthesis, leaf area index, growth, enhancement of ATP, NADPH synthesis, and increase of mobilization of nitrogenous materials to grain in cereals, regulation of stomata opening and closure and decrease of transpiration [37]. Either efficient species have certain morphological characteristics that increase uptake of utilization of nutrients or they are able to improve the availability of nutrients, hence increase the size of the fruit [38].

3.1.3 Average single pod weight

The interaction effect of nitrogen and potassium on the average single pod weight was found to be significant (Table 2). The highest average single pod weight was found (5.99 g) treatment interaction T_{10} (80 kg N + 40 kg K ha⁻¹) which is statistically at par with treatment interaction T_1 (0 kg N + 20 kg K ha⁻¹), T_2 (0 kg N + 40 kg K ha⁻¹), T_5 (40 kg N + 20 kg K ha⁻¹), T_6 (40 kg N + 40 kg K ha⁻¹), T_8 (80 kg N + 0 kg K ha⁻¹), T_9 (80 kg N + 20 kg K ha⁻¹), T_{13} (120 kg N + 20 kg K ha⁻¹) and T_{15} (120 kg N + 60 kg K ha⁻¹). The lowest average single pod weight was found (4.15 g) under control treatment interaction. It was clearly observed that there was a positive effect of nitrogen and potassium on the pod weight plant [34]. Also reported similar results. The increase in the yield component may be due to the suitable use of nitrogenous fertilizer which resulted in boosting in biosynthesis of the photosynthates and finally the yield [39]. Found K fertilizer improves sugar metabolism, enhances osmotic cell concentration, maintains stomatal guard cell turgor, helps regulate stomatal opening, participates in photosynthesis, and increases yield. Potassium is required for effective transformation of solar energy into chemical energy that could upsurge carbohydrate contain [40]. High nitrogen fertilizer uses may induce better a potassium requirement [41].

3.1.4 Total pod weight per plant

The interaction effect of nitrogen and potassium on the total pod weight per plant was found to be significant. The highest total pod weight per plant was found (29.07 g) treatment interaction T_{10} (80 kg N + 40 kg K ha⁻¹) which is statistically at par with treatment interaction T_6 (40 kg N + 40 kg K ha⁻¹), T_8 (80 kg N + 0 kg K ha⁻¹) and T_{14} (120 kg N + 40 kg K ha⁻¹). The lowest total pod weight

per plant was found (21.30 g) under control treatment interaction (Table 2). Alike results were also reported by [1]. Nitrogen is a fundamental part of proteins, phytochromes, compounds, coenzymes, chlorophyll and nucleic acids. By nitrogen and its associated compounds mainly governs all the biochemical processes occurring in plants which make it essential for the growth and development of BARI Bush Bean-2. The plant-available potassium (exchangeable K) status of a soil has a considerable influence on the uptake of nitrogen (N) by crops [42]. Reported that potassium has a crucial role in the translocation and storage of assimilates. This explanation agrees also with other findings [43, 44] where it was concluded that the amount of photosynthate available for biomass production.

3.1.5 Pod yield per plot

The interaction effect of nitrogen and potassium on the pod yield per plot was found to be significant (Table 2). The highest pod yield per plot was found (2033.33 g) treatment interaction T_{10} (80 kg N + 40 kg K ha⁻¹) which is statistically at par with treatment interaction T_0 (0 kg N + 0 kg K ha⁻¹), T_3 (0 kg N + 60 kg K ha⁻¹), T_6 (40 kg N + 40 kg K ha⁻¹), T_7 (40 kg N + 60 kg K ha⁻¹), T_8 (80 kg N + 0 kg K ha⁻¹), T_{11} (80 kg N + 60 kg K ha⁻¹), T_{12} (120 kg N + 0 kg K ha⁻¹) and T_{13} (120 kg N + 20 kg K ha⁻¹) and which is statistically followed T_2 (0 kg N + 40 kg K ha⁻¹), T_4 (40 kg N + 0 kg K ha⁻¹), T_5 (40 kg N + 20 kg K ha⁻¹), T_9 (80 kg N + 20 kg K ha⁻¹), T_{14} (120 kg N + 40 kg K ha⁻¹), T_{15} (120 kg N + 60 kg K ha⁻¹). The lowest pod yield per plot was found (883.33 g) under treatment interaction T_1 (0 kg N + 20 kg K ha⁻¹). About 50% at upper doses of applied N remains unreachable to a crop due to N loss through leaching. So, optimum dose of N gave the best result. Potassium is the most chief cation for plant growth and its development. It has multifunction at levels of physiology and biochemistry particularly those linked to enzymes activity that takes part in photosynthetic reactions and metabolism of carbohydrates. Potassium constitutes up to 10% of plant dry matter by weight [45]. Improved up to certain rates of N-K₂O but greater rates did not increase those parameters.

3.1.6 Pod yield per hectare

The interaction effect of nitrogen and potassium on the pod yield per hectare was found to be significant. The highest length of pod was found (4.96 tons) treatment interaction T_{10} (80 kg N + 40 kg K ha⁻¹) which is statistically at par with

treatment interaction T_1 (0 kg N + 20 kg K ha⁻¹), T_3 (0 kg N + 60 kg K ha⁻¹), T_6 (40 kg N + 40 kg K ha⁻¹), T_7 (40 kg N + 60 kg K ha⁻¹), T_8 (80 kg N + 0 kg K ha⁻¹), T_{11} (80 kg N + 60 kg K ha⁻¹), T_{12} (120 kg N + 0 kg K ha⁻¹) and T_{13} (120 kg N + 20 kg K ha⁻¹) and which is statistically followed T_2 (0 kg N + 40 kg K ha⁻¹), T_4 (40 kg N + 0 kg K ha⁻¹), T_5 (40 kg N + 20 kg K ha⁻¹), T_9 (80 kg N + 20 kg K ha⁻¹), T_{14} (120 kg N + 40 kg K ha⁻¹), T_{15} (120 kg N + 60 kg K ha⁻¹). The lowest length of pod was found (2.16 ton) under control treatment interaction (Table 2). Among all the vital nutrients applied to the plants nitrogen is the key one which has a crucial role in the process of photosynthesis. Higher rate of photosynthesis by the suitable dose of nitrogen offered more yield because enormous amount of dry matter, more assimilates were produced and transported to fill the seeds as a result of more applied nitrogen. The addition in the yield may be due to the better usage of applied K that resulted in enhancement in biosynthesis of the photosynthates and lastly the yield. There are various physiological processes in plant such as osmotic regulation, transporting carbohydrates and anion-cation balance respond to potassium concentration in plant tissues. The greater water use efficiency (production of unit dry matter per unit water transpired) at finest K+ nutrition outcomes from closely controlled opening and closure of stomata. Potassium not only helps the translocation of afresh synthesized photosynthates but also has valuable effect on the mobilization of stored material [45]. The yield responses to raise levels of nitrogen were lesser than when adequate amounts of P and K were applied [46,47].

3.2 Nutrient Status of Soil after Harvest of BARI Bush Bean-2 as Affected by Nitrogen and Potassium

3.2.1 Soil pH

The pH value of initial soil sample was 5.6 (Table 1). The lowest pH value (4.87) was observed in T_{13} treatment combination and the highest pH value (6.05) was observed in T_{14} treatment combination (Table 3). Application of N and K increase the soil pH reported by [48]. Use of mineral or organic fertilizers increases inputs of nutrients to soils, and the form in which the nutrients are applied and their fate in the soil-plant system determine the overall effects on soil pH. Macronutrients like N and K have the major effects on pH as they are added in much larger quantities to soil than micronutrients.

Table 2. Interaction effect of nitrogen and potassium on the growth and yield of BARI bush bean-2

Treatment combinations(A×B)	Pod length (cm)	Pod diameter (cm)	Average single pod weight(g)	Total pod weight per plant (g)	Pod yield per plot (g)	Pod yield per hectare (ton)
T ₀	9.90 c	2.10 e	4.15 d	21.30 f	1616.67 a-e	2.16 f
T ₁	10.43 ab	2.83 abc	4.97 a-d	21.80 ef	883.33 f	4.31 a-d
T ₂	10.27 ab	2.67 bcd	5.18 a-d	23.73 c-f	1550.00 b-e	3.78 b-e
T ₃	10.57 ab	2.90 abc	4.83 bcd	22.03 ef	1766.67 a-d	3.93 a-e
T ₄	10.57 ab	2.63 cd	4.92 bcd	25.40 b-d	1433.33 cde	3.50 cde
T ₅	10.73 ab	3.00 abc	5.46 abc	24.33 b-f	1533.33 b-e	3.74 b-e
T ₆	10.94 ab	2.93 abc	5.83 ab	26.63 abc	1800.00 a-d	4.39 a-d
T ₇	9.97 b	2.33 de	4.48 cd	23.83 c-f	1633.33 a-e	3.98 a-e
T ₈	10.71 ab	2.97 abc	5.28 abc	27.40 ab	1950.00 ab	4.75 ab
T ₉	11.17 ab	3.07 ab	5.77 ab	23.77 c-f	1350.00 de	3.29 de
T ₁₀	11.67 a	3.13 a	5.99 a	29.07 a	2033.33 a	4.96 a
T ₁₁	11.00 ab	2.90 abc	4.64 cd	22.30 def	1825.00 a-d	4.45 a-d
T ₁₂	11.03 ab	2.93 abc	4.66 cd	24.53 b-f	1600.00 a-e	3.90 a-e
T ₁₃	11.20 ab	2.90 abc	5.40 abc	26.27 abc	1850.00 abc	4.51 abc
T ₁₄	10.73 ab	2.93 abc	4.95 bcd	25.33 b-e	1166.67 ef	2.85 ef
T ₁₅	10.70 ab	2.93 abc	5.01 a-d	23.83 c-f	1533.33 b-e	3.74 b-e
CV (%)	7.28	7.47	10.48	7.01	15.43	15.40
Level of significance	*	NS	NS	*	*	*

* = Significant at 5% level

Values in a column with same letter(s) are statistically similar at 0.05 level of significance by DMRT.

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

Table 3. Interaction effect of nitrogen and potassium on the soil pH, organic matter, total N, available P, K, S and Zn in the soil after harvest of BARI bush bean-2

Treatment combination (A×B)	Soil pH	Organic Matter (%)	Total N (%)	Available P (mg kg ⁻¹)	Exchangeable K (m.eq / 100 g)	Available S (m.eq / 100 g)	Available Zn (mg kg ⁻¹)
T ₀	5.30 bc	0.96 bcd	0.04 c	16.34 cd	0.12 d	15.73 d	2.48 f
T ₁	5.09 bcd	1.11 ab	0.08 b	16.51 bcd	0.16 a-d	18.19 abc	2.95 de
T ₂	4.93 cd	1.05 bc	0.08 b	17.72 a-c	0.17 abc	21.43 bc	3.88 cd
T ₃	5.01 cd	0.93 b-d	0.05 bc	16.26 cd	0.25 ab	19.59 a-c	2.95 de
T ₄	5 cd	1.10 ab	0.10 ab	16.64 bcd	0.13 cd	17.27 bcd	2.61 gh
T ₅	5.02 cd	1.04 bc	0.07 bc	15.73 cd	0.17 a-c	19.87 a-c	3.00 de
T ₆	5.21 bc	0.98 bcd	0.06 bc	16.35 cd	0.13 bcd	26.47 a	4.42 a
T ₇	5.15 b-d	.98 bcd	0.07 bc	16.98 bc	0.24 ab	25.33 ab	3.27 e
T ₈	5.21 bc	1.06 bc	0.07 bc	15.83 cd	0.13 a-c	18.35 abc	2.54 def
T ₉	5.49 ab	0.90 bcd	0.08 b	19.03 ab	0.14 a-c	20.77 a-c	3.68 d
T ₁₀	5.50 ab	1.01 bc	0.12 a	19.41 a	0.23 ab	23.27 ab	4.30 ab
T ₁₁	5.21 bc	0.86 d	0.06 bc	16.20 cd	0.23 ab	18.37 abc	3.73 d
T ₁₂	5.51 ab	0.98 bcd	0.07 bc	14.95 d	0.16 a-d	17.27 bcd	2.86 de
T ₁₃	4.87 d	0.91 bcd	0.07 bc	17.71 abc	0.17 abc	19.53 bc	3.70 cd
T ₁₄	6.05 a	1.05 bc	0.07 bc	16.89 bcd	0.22 ab	21.47 bc	3.68 cd
T ₁₅	5.69 ab	1.16 a	0.07 bc	18.05 b	0.26 a	24.25 ab	4.10 bc
Level of significance	**	*	NS	*	*	**	**
CV (%)	9.47	9.43	20.39	7.07	14.90	5.41	4.47

* = Significant at 5% level, ** = Significant at 1% level

Values in a column with same letter(s) are statistically similar at 0.01 and 0.05 level of significance by DMRT.

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

3.2.2 Organic matter (%)

In the studied soil, the initial organic matter was 1.17% (Table 1). Organic matter content varied due to application of different levels of fertilizers treatments. The minimum (0.86%) organic matter content of soil was observed in T₁₁ treatment combination while the maximum (1.16%) organic matter content was in T₁₅ treatment combination (Table 3) [49]. Stated that soil organic matter affected by the application of inorganic fertilizer like N and K.

3.2.3 Total nitrogen content (%)

The 0.08% total nitrogen content was found in the initial soil sample (Table 1). The lowest total nitrogen content of soil (0.05%) was observed in N₈₀K₀ treatment combination and the highest (0.08 %) total nitrogen content of soil was observed N₄₀K₄₀ treatments (Table 3) [48]. Found use of N and K slightly improves the total nitrogen content.

3.2.4 Available phosphorous content of soil (mg kg⁻¹)

The total phosphorous content of initial soil was 13.42 mg kg⁻¹ (Table 1). The combined effect of nitrogen and potassium showed a significant effect in respect of phosphorous content in the post-harvest soil sample. The highest (19.41 mg kg⁻¹) phosphorous content was observed in T₁₀ treatment and the lowest (14.95 mg kg⁻¹) phosphorous content was observed in T₁₂ treatment (Table 3). Application of N and K increase the soil available phosphorous content reported by [48].

3.2.5 Exchangeable potassium content of soil (m.eq 100⁻¹ mg)

In the studied soil, the initial potassium content was 0.13 mg kg⁻¹ (Table 1). A significant effect in respect of potassium content in the post-harvest soil sample was recorded due to the combined effect of nitrogen and potassium. The minimum 0.12 mg kg⁻¹ potassium content was observed in T₀ treatment and whereas the maximum in 0.26 mg kg⁻¹ in T₁₅ treatment (Table 3) [48]. Reported that the use of N and K improve the exchangeable potassium content of soil.

3.2.6 Sulphur content of soil (mg kg⁻¹)

The 23.7 mg kg⁻¹ sulphur content was found in the initial soil sample (Table 1). The combined effect of nitrogen and potassium showed a significant

effect in respect of sulphur content in the post-harvest soil sample. The lowest sulphur (15.73 mg kg⁻¹) content was found in control treatment and the highest sulphur content (26.47 mg kg⁻¹) was found in T₆ treatment (Table 3).

3.2.7 Zinc content of soil (mg kg⁻¹)

The initial potassium content of the studied soil was 3.20 mg kg⁻¹ (Table 1). The combined effect of nitrogen and potassium recorded a significant effect in respect of zinc content in the post-harvest soil sample. The smallest value zinc (2.48 mg kg⁻¹) content of soil was observed in T₀ treatment and the largest value zinc (4.42 mg kg⁻¹) content was observed in T₆ treatment (Table 3).

4. CONCLUSION

The ultimate findings of this experiment revealed that 80 kg N and 40 kg K showed better performance among all the treatments studied. So, the combined use of 80 kg nitrogen + 40 kg potassium can be recommended for increasing the yield of BARI Bush Bean-2 in red brown terrace soil of the Tejgaon series.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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