PERFORMANE OF BUSH BEAN (BARI bush bean-1) AS AFFECTED BY INTEGRATED NUTRIENT MANAGEMENT

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CERTIFICATE

This is to certify that thesis entitled, **"PERFORMANE OF BUSH BEAN (BARI bush bean-1) AS AFFECTED BY INTEGRATED NUTREIENT MANAGEMENT"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in SOIL SCIENCE**, embodies the result of a piece of *bonafide* research work carried out by **Most. Musharrat Zahan Lina**, Registration No. **11-04684** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: June, 2013
Place: Dhaka, Bangladesh

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DEDICATED
TO
MY BELOVED PARENTS

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The Author

ABSTRACT

PERFORMANCE OF BUSH BEAN (BARI BUSH BEAN-1) AS AFFECTED BY INTEGRATED NUTRIENT MANAGEMENT

An experiment was conducted at the experimental field, Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka during mid-November, 2011 to mid-March, 2012 to evaluate the suitability of BARI bush bean-1 cultivation with inorganic N fertilizer and organic cow dung application. The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. The treatments of the experiment involved, T_1 (90 kg N from urea); T_2 (80 kg N from urea + 10 kg N supplemented by cowdung); T_3 (70 kg N from urea+ 20 kg N supplemented by cow dung); T_4 (60 kg N from urea+ 30 kg N from urea); T_5 (50 kg N from urea + 40 kg N supplemented by cowdung); T_6 (40 kg N from urea+ 50 kg N supplemented by cowdung); T_7 (30 kg N from urea+ 60 kg N supplemented by cowdung); T_8 (90kg N supplemented by cowdung) and T_9 (Control) treatment. And the variety which was involved in the experiment, V_1= BARI bush bean-1. A significant variation was observed among the treatment in respect of different parameters of BARI bush bean-1. The tallest plant (43.67 cm) was recorded from T_8, while the shortest plant (33.67 cm) from T_9 (control) treatment. The maximum number of branches per plant (7.667) was obtained from T_8 (90 kg N supplemented by cowdung). The maximum number of flowers/plant (27.67) was observed from T_5 (50 kg N from urea +40 kg N supplemented by cowdung), the minimum number of flowers/plant (12.33) was observed from T_9 (control) treatment. The maximum number of pods per plant (25.0) was obtained from T_5 treatment. And the minimum number of pods per plant (11.3) was obtained from T_9 (control) treatment. The highest length of pods in each harvest (12.89 cm) was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cowdung). While the lowest weight (10.11 cm) from T_9 (control) treatment. An optimum amount of nitrogen for the whole growth period is necessary to produce maximum yield of good quality bush bean. The highest weight of 100 pods (4.71kg) at each harvesting was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cowdung). While the lowest weight (3.99 kg) from T_9 (control) treatment. Maximum green pod yield of bush bean (13.44 t/ha) was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cow dung). Whole, the minimum green pod yield of bush bean was found (8.48 t/ha) from T_9 (Control) treatment. The highest pH (6.1), Organic carbon (0.7019 %), total N (0.068 %), available P (22.0 ppm) was found in the treatment T_1, T_3, T_5 & T_8 and the lowest pH (5.8), organic carbon (0.2164 %), total N (0.031%), available P (14.0 ppm) was found in the treatmenT_1, T_6 & T_9. Maximum content of sulphur content (15.0 ppm) was found in the treatment T_8. On the other hand, minimum sulphur content (12.01 ppm) content was found in the treatment T_9. Maximum content of potassium content (0.182 meq/100 g soil) was found in the treatment T_8. On the other hand, minimum potassium content (0.122 meq/100 g soil) content was found in the treatment T_9.

CONTENTS

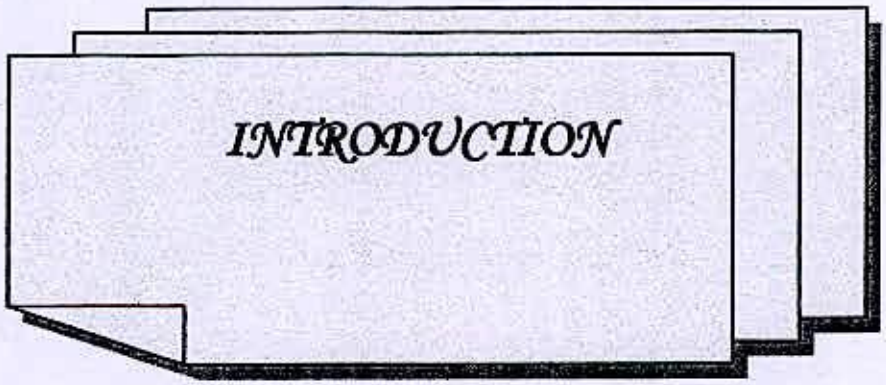
LIST OF TABLES

LIST OF ABBREVIATIONS

AEZ	: Agro Ecological zone
Agric.	: Agriculture
SAU	: Sher-e-Bangla Agricultural University
RCBD	: Randomized Complete Block Design

LIST OF APPENDICES

APPENDIX


INTRODUCTION

CHAPTER I

INTRODUCTION

Bush bean (*Phaseolus vulgaris* L.) is an important vegetable crop belonging to the family *Leguminosae* and sub-family *Papiolionaceae*, which was originated in the Central and South America (Swiader*et al*., 1992). It is also known as French bean, Kidney bean, Snap bean, Green bean, Raj bean, Navy bean, Pole bean, Wax bean, and Bonchi in different countries of the World (Duke, 1983; Salukhe*et al*. 1987; Tindall, 1988). In our country it is known as 'Farashi Seem' (Rashid, 1993). Bush bean is mainly used as green vegetable and its young pods and mature seeds are used as cooked vegetable.

Bush bean is widely cultivated in the temperate and subtropical regions, and also in many parts of the tropics (Purseglove, 1987). It is intensively grown in five major continental areas: Eastern Africa, North and Central America, South America, Eastern Asia and Western and South Eastern Europe. It is more suitable as a winter crop in the northeastern parts of India (AICPIP, 1987). According to FAO statistics, bush bean including other related species of the genus *Phaseolus* occupied 27.08 million hectares of the World's cropped area, and the production of dry pods was about 18.94 million tons with an average yield of 699 kg ha^{-1} (FAO, 2000). In Bangladesh there is no statistics about the area and production of this crop. It is not new crop in our country. It is cultivated in Sylhet, Cox's Bazar, Chittagong Hill Tracts and some other parts of the country in a limited scale. Immature pods are marketed fresh, frozen or canned. After harvest, plants

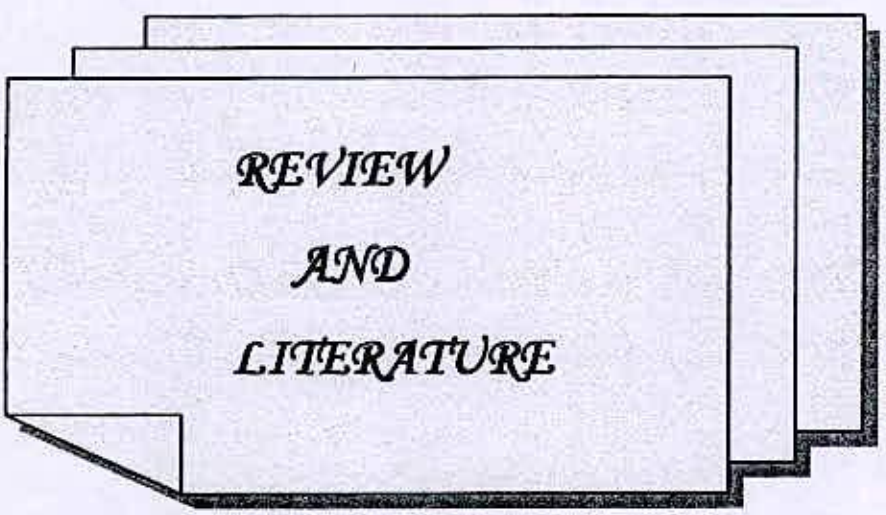
can be fed to cattle, sheep and horses. Its edible pods supply protein, carbohydrate, fat, fibre, thiamin, riboflavin, Ca and Fe (Shanmugavelu, 1989) and the seed contains significant amount of thiamin, niacin, folic acid (Rashid, 1993). Recently cultivation of bush bean is gaining popularity in Bangladesh mainly because of its demand as a commodity for export. But the productivity of bush bean at the farmers' field is very low (7-8 q ha^{-1}) and it does not mean the low yield potentiality of this crop. Lack of information about its management practices, poor fertility management, judicial level of fertilizer and exclusively growing local cultivars are the reasons for low potentiality of this crop (Saini and Negi, 1996).

Bush bean shows high yield potential, but unlike other leguminous crops it does not nodulate with the native rhizobia (Ali and Kushwaha, 1987). Therefore, requirement of nitrogenous fertilizers for the crop is of prime importance. Nutrient requirement for different cultivars usually is similar except on poor soils (Adams, 1984). Bush bean cultivation requires ample supply of nitrogen. Nitrogen is necessary for its vegetative growth and development. Fertilizer placement at 10-15 cm depth has promoted growth and development of root and shoot of bush bean (Chaib*et al.*, 1984). However, excessive or under dose of nitrogen can affect the growth and yield. An optimum amount of nitrogen is necessary to produce maximum yield of good quality bush bean. In case of application of the various fertilizer doses, there were significant differences in different yield contributing characters and yield of bush bean (Sa *et al.*, 1982; Tewari and Singh, (2000).

Nitrogen is one of the most essential elements for crop production. It encourages vegetative growth and increases leaf area of plants, which helps in photosynthetic activity. It stimulates root growth and development of the plant. Furthermore, it helps in uptake of other nutrients from the soil. Both excess and under doses of nitrogen hampered the yield. So for higher yield, judicious amount of nitrogen should be applied. Organic matter is the main source of nitrogen and Bangladesh soil is deficit in organic matter content. Soil organic matter is a key indicator of soil health because it plays a role in a number of key functions. There are often strong interactions between these different functions. For example, the biological function of providing energy that drives microbial activity also results in improved structural stability and creates organic materials that can contribute to nutritional capacity and resilience to change. Decomposition and mineralization of organic matter are required for functions such as provision of energy and nutrients. However, the maintenance or increases in organic matter help to maintain its positive effects on soil chemical and physical properties. So, when managing soil organic matter the never-ending turnover and the need to replace and rebuild is a constant demand of good agricultural practice. Nitrogen content of Bangladesh soil is very low. Nitrogen should be applied in such a way that minimum is leached or washed out and maximum its utilization for crop production. Nitrogen is necessary for germination to pod maturity of bush bean.

Under the above prospective, therefore, the present study has been planned and designed with the following objectives:

- To study the effect of integrated nutrient management on the yield and yield components of bush bean.
- To find out the appropriate combination of mineral N and organic source of N for better growth & yield of bush bean.


REVIEW
AND
LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Bush bean is one of the most important legume vegetables in the world. Researches on various aspects of its production technology have been carried out worldwide. Many research works have been done in different parts of the world to study the effect of the nitrogen, effective sources of nitrogen on the growth and yield of bush bean. However, studies in this area appeared very limited in Bangladesh. For a better understanding and to know the research status on performance of nitrogen of bush bean, the relevant available literature have been reviewed and presented below:

A study was conducted by Deshmukh *et al.* (2007) in Maharashtra, India, during the rabi season of 2004-05 to determine the response of French bean cultivars (ArkaKomal, Varun, Contender and PDR 14) to different nitrogen rates (0, 50, 100 and 150 kg/ha). Dry pod weight per plant, seed weight per plant, number of seeds per pod and 100-seed weight were significantly influenced by the nitrogen treatment. Application of 150 and 100 kg N/ha had superior effect on all the yield attributes compared to treatments with 50 and 0 kg N/ha. The 100-seed weight and yield per plant were maximum in Varun followed by Contender, ArkaKomal and PDR 14. The number of seeds per pod was significantly higher in ArkaKomal and Contender due to their long pods. Less number of seeds per pod was observed in Varun and PDR 14 due to their short pods. Higher dry pod yields were recorded with applications of 150 and 100 kg N/ha. The beneficial effect of

nitrogen was observed on seed yield. There was incremental increase in biological yield and straw yield with the application of 150 and 100 kg N/ha.

Mahase *et al.* (2007) conducted an experiment in Nagpur, Maharashtra, India, during the rabi of 2005-06 to study the effects of nitrogen and irrigation levels on French bean (*P. vulgaris* cv. VL-63). In case of nitrogen levels, 105 kg N ha^{-1} proved significantly superior with respect to yield attributes, yield and water use efficiency than 75 kg N ha^{-1} and 45 kg N through urea + 45 kg N through FYM, while 90 kg N ha^{-1} was on a par in terms of yield attributes and yield with 105 kg N ha^{-1}.

The effect of N (0, 60, 90 and 120 kg/ha) and P (0, 45, 60 and 75 kg/ha) on the yield and quality of French bean on vertisols was evaluated by Umap*et et al.* (2006)in Maharashtra, India was evaluated N at 120 kg/ha produced the highest seed yield and stover yield of 14.45 and 17.74 q/ha, which was 50.83 and 53.06% higher than the control, respectively. Many plant species are characterized by pronounced sensitivity to sole ammonium supply and exhibit growth depression and particularly reduced leaf growth rates. Stress symptoms under sole ammonium supply may be related to perturbation of photosynthetic processes, e.g., low rates of net CO_2 assimilation, low quantum yield, reduced stomatal conductance, and carboxylation capacity. The results of three experiments with French bean plants supplied with an N concentration of 5 mM illustrate significantly lower dry mass and specific leaf area, reduced leaf expansion, and higher chlorophyll and N content of ammonium- compared to nitrate-supplied plants. Light-saturated rates of CO_2 assimilation per unit leaf area were higher under ammonium compared to nitrate supply

while no significant effects of N form on quantum yield. It is concluded that ammonium supply had no negative effects on the operation of photosynthetic protein-enzyme complexes.

Kikuti *et al.* (2005) studied the effects of different levels of N (0, 70, 140 and 210 kg ha^{-1}, urea source) and P_2O_5 (0, 100, 200 and 300 kg ha^{-1}) triple super phosphate source) on the bean. The initial and final stands of the plants, grain productivity and the utilization efficiency in response to N and of P_2O_5 treatments were evaluated. The N and K association resulted in small bean plant populations, and the P lessened that effect. The productivity was increased in response to N and P_2O_5 treatments, which varied according to the seasons. The maximum efficiency was obtained with N and P_2O_5 levels higher than those recommend for bean crop.

Bildirici *et al.* (2005) conducted an experiment during 2001 and 2002 to determine the effects of bacterial (*Rhizobium phaseoli*) inoculation, N fertilizers (0, 20, 40, 60 kg N ha^{-1}) and P fertilizer (0, 40, 60, 80 kg P_2O_5 ha^{-1}) on field bean. Nitrogen fertilizer exerted a significant and positive effect on pod number, grain yield and raw protein proportion, whereas no significant effect was observed on seed number pod^{-1} and 1000-seed weight.

The effects of N (0, 20, 40 and 60 kg ha^{-1}) and P (0, 30, 60 and 90 kg P_2O_5 ha^{-1}) on the seed yield of pea cv. Arkel and french bean [*Phaseolus vulgaris*] were investigated in Uttar Pradesh, India during 2002-03 (Lal, 2004). Nitrogen at 40 kg ha^{-1} was optimum for obtaining the maximum pea and bean seed yields.

Prajapati *et al.* (2004) conducted an experiment in SardarKrushinagar, Gujarat, India, to study nutrient uptake and yield of french bean as affected by weed control methods and nitrogen levels (0, 40, 80 and120 kg ha^{-1}). Among the N rates,120 kg ha^{-1} recorded the greatest N uptake (56.70 kg ha^{-1}), P uptake (18.47 kg ha^{-1}), K uptake (37.34 kg ha^{-1}), grain yield (1091.77 kg ha^{-1}), straw yield (1932.35 kg ha^{-1}), protein yield (228.39 kg ha^{-1}), net returns (10816 rupees ha^{-1}), and cost benefit ratio (1: 2.44).

Ram-Gopal *et al.*, (2003) investigatedthe effects of irrigation (0.5, 0.7 and 0.9 W/CPE) and nitrogen rates (50, 100 and 150 kg ha^{-1}), with or without 5 t farmyard manure (FYM)/ha, on the yield and water use of french bean (*Phaseolus vulgaris*) in a field experiment conducted in Faizabad, Uttar Pradesh, India. Plant height, number of branches $plant^{-1}$, dry matter $plant^{-1}$, grain yield, consumptive use of water and water use efficiency increased with increasing irrigation and N rates and with the addition of FYM.

Dhanjal *et al.* (2003) conducted a field experiment in Uttar Pradesh, India. The treatments consisted of 3 french bean (*P. vulgaris*) cultivars (HUR 87, PDR 14 and VL 63), 3 planting densities (250 × 103, 333 × 103 and 500 × 103 plants ha^{-1}) and 3 N levels (0, 60 and 120 kg ha^{-1}). Leaf area index and crop growth rate were highest at 500x103 plants ha^{-1}, whereas dry weight $plant^{-1}$, net assimilation rate and relative growth rate in general were the highest at 250 × 103 plants ha^{-1}. Increasing levels of N up to 120 kg ha^{-1} increased dry weight, leaf area index, crop growth rate and relative growth rate, but net assimilation rate increased up to 60 kg N ha^{-1} only.

A field experiment was conducted by Vishwakarma*et al.* (2002)to determine the response of two french bean (*Phaseolus vulgaris*) cultivars (Holland 84 and PDR 14) to different nitrogen application rates (0, 30, 60, 90 kg ha^{-1}) on sandy loam soil in Varanasi, Uttar Pradesh, India. Both cultivars showed differential performance for growth and yield attributes. Holland 84 was the tallest; whereas PDR 14 recorded the highest dry matter production $plant^{-1}$ as well as pods $plant^{-1}$, grains pod^{-1}, grains $plant^{-1}$, pod length and 100-grain weight. The growth, yield attributes and yield (grain and stover) increased with increasing rates of nitrogen up to 90 kg ha^{-1}.

A two-year experiment was conducted during 1995-97 with 5 nitrogen (0, 30, 60, 90 and 120 kg ha^{-1}) and 3 phosphorus levels (0, 30 and 60 kg P_2O_5 ha^{-1}) to study their impact on the growth, yield attributes, yield and economics of french bean (cv. PDR 14) under late-sown conditions of eastern Uttar Pradesh, India (Singh and Verma,2002). They showed that the highest rates of nitrogen (120 kg ha^{-1}) and phosphorus (60 kg ha^{-1}) resulted in the highest plant height, branches per plant, pods per plant, seeds per pod, 100-seed weight, grain yield (21.19 q ha^{-1} with 120 kg N ha^{-1}; and 18.68 q ha^{-1} with 60 kg P_2O_5 ha^{-1}) and straw yields (29.76 q ha^{-1} with 120 kg N ha^{-1} and 24.76 q ha^{-1} with 60 kg P_2O_5 ha^{-1}).

Chandel *et al.* (2002) conducted a field experiment to determine the effect of different nitrogen levels (0, 40, 80, 120 kg ha^{-1}) and *Rhizobium* inoculation (control, HURR-3, and Raj-2) on crop yield, nitrogen uptake and crop quality of french bean cv. HUR-137 in Varanasi, Uttar Pradesh, India. The yield components, crop and protein yield significantly increased with increasing nitrogen levels and the highest values were

registered with 120 kg N ha^{-1} during both years. *Rhizobium* inoculation increased crop yield over the control. Strain Raj-2 produced significantly higher grain and protein yield compared to HURR-3.

A field experiment was conducted by Farkadeet and Pawar (2002) in Maharashtra, India to determine the effect of N: P fertilizers at 60: 45, 90: 75 and 120: 75 kg/ha on *Phaseolus vulgaris* cultivars. The yield and growth characters increased with increasing N: P fertilizer level and the highest (15.93 q ha^{-1}) were observed at 120: 75 kg/ha.

Rahman (2001) conducted an experiment at Horticulture Farm, Bangladesh Agricultural University, Mymensingh to investigate the influence of nitrogen and plant spacing on French bean. He used four levels of nitrogen viz. 0, 30, 60 and 90 kg N/ha and found that plant height, number of branches per plant, green pod length, individual pod weight, pods per plant and green pod yield per hectare were significantly influenced by higher dose of nitrogen.

Chaudhuri *et al.* (2001) conducted an experiment in Nagpur, India to study the nutrient management of French bean. They reported that application of nitrogen significantly increased the plant height; pod number and grain yield $plant^{-1}$ in french bean. They recommended nitrogen fertilizer dose of 90 kg N ha^{-1}.

Rejeshand Singh (2001) carried out a field experiment in India to evaluate the effects of N (80, 160 and 240 kg ha^{-1}) and S (0, 20, 40 and 60 kg ha^{-1}) on the nutrient uptake and grain yield of french bean (*Phaseolus vulgaris* cv. HUR 137). The highest grain yield

(2,091 kg/ha) straw yields (3,331 kg ha^{-1}), total N uptake (90.70 kg ha^{-1}) and S uptake (6.58 kg ha^{-1}) was recorded at N level of 240 kg ha^{-1} and sulphur (S) at 40 kg ha^{-1} recorded the highest grain yield (1,811 kg ha^{-1}) total N uptake (77.45 kg ha^{-1}) and S uptake (6.06 kg ha^{-1}).

Dhanjal *et al.* (2001) conducted a field experiment in Uttar Pradesh, India to study the effects of crop density (500,000, 333,000, or 250,000 plants ha^{-1}) and N (0, 60, or 120 kg ha^{-1} applied at sowing) on the yield and yield components of *P. vulgaris* cultivars. The lowest crop density (250,000 plants ha^{-1}) gave the highest values of growth and yield components, except plant height which was the highest under 500,000 plants ha^{-1}. The highest seed and stover yields were recorded under medium crop density (333,000 plants ha^{-1}). The increase in N rate gave a corresponding improvement in yield and yield components.

Prajapati *et al.* (2001) conducted an experiment in Gujarat, India, to determine the effects of weed control methods and N fertilizer application on the physiology of french bean. The highest values of fresh and dry weight per plant, net assimilation rate (NAR), crop growth rate (CGR), relative growth rate (RGR), and grain yield were recorded under weed free conditions. Similarly, most of the physiological parameters, namely fresh and dry matter production per plant, LAI, NAR, RGR, and CGR were significantly high with 120 kg N/ha.

Bassan (2001) studied that the application Mo application through leaves or in the rows, and side dressing with 4 N levels on a winter bean (*Phaseolus vulgaris*) crop. Inoculation increased plant dry matter weight, but decreased the number of pods plant^{-1}, grains plant^{-1} and 100-seed weight. N applied at 90 kg ha^{-1} resulted in high seed production, with or without inoculation. No effect of Mo was observed in any of the treatments. Inoculation did not affect seed germination and field seedling emergence, whereas the treatment without Mo and with 90 kg N ha^{-1} provided seeds with high germination index.

Tewariand Singh (2000) conducted a field trial in Uttar Pradesh, India to determine the optimum and economical dose of nitrogen (0, 40, 80, 120 or 160 kg N ha^{-1}) and phosphorus (0, 20, 40 or 60 kg P_2O_5 ha^{-1}) for better growth and seed yield of french bean. Plant height, number of branches and length of pod increased with successive increase in the doses of nitrogen as well as phosphorus. Application of 120 kg N ha^{-1} produced significantly higher number of pods plant^{-1}, weight of seeds plant^{-1}, number of seeds pod^{-1} and seed yield, whereas 160 kg N ha^{-1} significantly reduced seed yield. The highest values on the above yield attributes were recorded with 60 kg P_2O_5 ha^{-1}. The combination of 120 kg N + 60 kg P_2O_5 ha^{-1} along with 60 kg K_2O ha^{-1} gave the highest seed yield, net profit and net return per rupee investment.

Teixeira *et al.* (2000) conducted a field experiment to study the effect of sowing density (6, 10, 14 and 18 seeds m^{-2}) and N levels (0, 50, 100 and 150 kg N ha^{-1}) on *P. vulgaris*. Grain yield increased with increasing N rates, resulting in increased numbers of pods plant^{-1}, seeds pod^{-1} and 100-seed weight. This effect, however, was influenced by

seasons and sowing densities. An increase in sowing density reduced the number of pods plant^{-1}, and in the absence of N fertilizers increased the grain yield. An increase in sowing density also reduced weed infestation during harvest.

Ghosal *et al.* (2000) conducted a field trial in Bihar, India to study the effect of varying N rates (0, 40, 80, 120,160 kg N ha^{-1}) and times of application on the growth and yield of french bean. They observed that nitrogen at the rate of 160 kg N ha^{-1} resulted in significantly highest values for number of pods plant^{-1}, weight of pods plant^{-1}, grain yield and straw yield.

Daba and Haile (2000) reported that *Rhizobium* inoculation and N significantly increased grain yield, nodule number and dry matter yield of french bean. Singh and Singh (2000) carried out a field trial in India with different nitrogen levels (0, 40, 80 or 120 kg N ha^{-1}) on yield and yield components of french bean They observed that seed yield and 100-seed weight increased with increasing N rate.

Arya *et al.* (1999) conducted an experiment in India to investigate the effect of N, P and K on French bean. They used different doses of NPK combinations. It was concluded that N promoted growth and suggested that 25 kg N ha^{-1}, 75 P_2O_5 kg ha^{-1} and 50 kg K_2O ha^{-1} was the best combination in terms of economics and seed yield.

Sushant *et al.* (1998) conducted an experiment in India to investigate the effect of N (0, 50 or 100 kg N ha^{-1}) and P (0, 30 or 60 kg P ha^{-1}) on the yield and water used efficiency of french bean. Yield increased with increasing irrigation and N and P rates. The highest

yield was obtained at 100 kg N ha^{-1} and 60 P_2O_5 kg ha^{-1}. Water use efficiency increased with increasing N and P rates. Interaction of irrigation and N, and N and P was significant for pods $plant^{-1}$ and seed yield.

In a field experiment during the rainy seasons of 1993/94 and 1994/95 at Rahuri, Maharashtra, India, and *P.* vulgaris cv. Waghya was irrigated at flowering and/or branching and was given 0, 40, 80 or 120 kg N ha^{-1} (Wani *et al.*, 1998). Yield and yield component values increased with increasing N rate and were highest with irrigation at 75 mm CPE.

Nandan and Prasad (1998) conducted a field trial at Pusa, Bihar to study yield and water use efficiency of *P. vulgaris* cv. Uday and was given 6 irrigation treatment and 3 N treatments (40, 80 or 120 kg N ha^{-1}). Seed yield in the first year was the highest (1.31 t ha^{-1}) when given 3 irrigations at 25, 50 and 75 days after sowing, while in the second year the highest yield of 1.35 t ha^{-1} was obtained when irrigating at a 0.8 IW: CPE [irrigation water: cumulative pan evaporation] ratio. Yield and water use efficiency increased with increasing N rate in both years.

In a field trial conducted at India Lakhaoti, and Rana *et al.* (1998) found that *Phaseolus vulgaris* seed and straw yields increased significantly with each increment in N rate in both seasons. The mean increase in seed yields with 120 kg N ha^{-1} compared with 0, 40 and 80 kg N ha^{-1} was 66.6, 21.7 and 7.0% respectively. Growth and yield parameters

generally followed the same trend. Applied P also increased seed yield, and 100 kg P_2O_5 ha^{-1} gave 39.8 and 7.4% more yield than 0 and 50 kg P_2O_5 ha^{-1}, respectively.

An experiment was carried out in Uttar Pradesh, in India by Baboo *et al.* (1998) to study the response of french bean to applied nitrogen. Seed yield was increased with the increase of nitrogen and it was higher with 120 kg N ha^{-1}. Gajendra and Singh (1998) stated that application of 120kg N ha^{-1}, 90 kg P_2O_5 ha^{-1} and 45 kg K_2O ha^{-1} gave higher grain yield of french bean.

Calvache *et al.* (1997) found significant increase in seed yield, pod number $plant^{-1}$, number of seeds pod^{-1} and harvest index in french bean through increased nitrogen application. Durge *et al.* (1997) stated that the highest yield of french bean (957kg ha^{-1}) was obtained with 150 kg N ha^{-1}.

Furlani *et al.* (1996) conducted an experiment in green house and observed a highly significant correlation between leaf chlorophyll content and leaf N concentration with N application rate. It was concluded that the chlorophyll content gave accurate assessment of N status in bean plant. Sharma *et al.* (1996) studied the effect of N fertilizer (0, 40, 80 and 120 kg N ha^{-1}) and timing of application on growth and yield of french bean. They observed that increasing level of N significant increase in seed yield, number and weight of pods $plant^{-1}$ and number of seeds pod^{-1}upto 120 kg N ha^{-1}. However, in the case of seed yield, pod length and 100 seed weight, variation in 80 and 120 kg N ha^{-1} were not

significant. They also reported that application of N in three equal splits gave higher seed yield attributes in french bean.

Koli *et al.* (1996) conducted an experiment in Maharashtra, India to study the influence of row spacing, plant densities and nitrogen levels on yield of french bean. Results revealed that seed yield was the highest with 60 kg N ha^{-1} and at the density of 333,333 plants ha^{-1} (1.41 t) and the row spacing of 30 cm (1.13 t).

Singh *et al.* (1996) investigated the response of french bean to spacing and nitrogen levels. They reported that seed yield increased with up to 120 kg N and 30 × 10 cm spacing. An experiment was conducted by Dahatonde and Nalamwar (1996) at Maharashtra, India to study the effect of nitrogen and irrigation levels on yield and water use of french bean. Seed yields were increased significantly up to 90 kg N ha^{-1}.

A field experiment was conducted by Bagal and Jadhav (1995) to find out the effects of nitrogen and *Rhizobium* on yield and nutrient uptake by french bean. Seeds were inoculated with *Rhizobium phaseoli* or not inoculated and the crop was given 0, 12.5, 25 or 37.5 kg N ha^{-1}. Seed yield and total P uptake increased up to 25 kg N ha^{-1}, whereas total N and K uptake increased up to 37.5 kg ha^{-1}.

Vermaand Saxena (1995) reported that the growth and yield of *P. vulgaris*. in response of 0, 60 or 120 kg ha^{-1} each of N as urea, P_2O_5 as super phosphate and K_2O as muriate of potash. Seed yields were the highest with 120 kg N or 120 kg P_2O_5, but were not significantly affected by K_2O.

Dwivedi *et al.* (1994) conducted a field experiment during the winter seasons of 1990-92 at Agwanpur, Bihar, *Phaseolus vulgaris* cv. PDR 14 was sown at inter-row spacing of 30, 45 or 60 cm with an intra-row spacing of 8 cm to give densities of 400000, 286000 and 200000 plants ha^{-1}, respectively, and was given 40, 60, 80 or 100 kg N ha^{-1}. Seed yield was the highest at the density of 400000 plants ha^{-1} and increased with up to 80 kg N ha^{-1}.

Carranca *et al.* (1993) conducted an experiment on *Phaseolus vulgaris* cv. *Martingal* plants on a heavy alluvial soil supplied with 20, 80, 140 or 200 kg N ha^{-1}. Fertilizer treatment did not significantly affect pod yield, N uptake or crop quality. At the end of the growing cycle nitrate accumulation in the soil was observed at the highest N application rates. The lowest N rate (20 kg ha^{-1}) was sufficient to obtain yields >10 000 kg ha^{-1} without decreasing the pod quality for deep freezing. Seasonal variations affected yield, pod N content and most quality characteristics with high significance, except for N content in tops and pod alcohol-insoluble solids content.

Negi and Shekhar (1993) conducted a field trail in Himachal Pradesh, India to study the response of French bean genotypes to nitrogen. They used *Phaseolusvulgaries* cv. Katrain 1, Him 1, B_4 and B_6 and 0 –90 kg N/ha and observed that seed yield was the highest in B_6 (1.99 t ha^{-1}) and lowest in Katrain 1 (1.45 t ha^{-1}) and it increased with up to 60kg N ha^{-1}.

Dahatonde *et al.* (1992) carried out an experiment in Akola, India to observe the response of french bean to irrigation regimes and nitrogen levels (0-120 kg N ha^{-1}). They stated that

seed yield increased from 0.38 to .92 t ha^{-1} with the increase in number of irrigation and N application with up to 90 kg ha^{-1}.

Bhatnagar *et al.* (1992) conducted a field trial at Rajastan, India to find out the effect of nitrogen on french bean during winter. Nitrogen was applied at 20, 40 or 60 kg ha^{-1}. They reported that seed yield and nitrogen uptake in seed increased and crude protein percentage decreased with increasing nitrogen application rate.

Bengtsson (1991) conducted an experiment on with 0, 30 or 60 kg N ha^{-1}. N fertilizer generally increased seed yield, 1000-seed weight and seed protein content. The number of root nodules was significantly increased by inoculation.

Parthiban and Thamburaj (1991) recorded increased grain yield with nitrogen fertilization upto 50 kg N ha^{-1}. Number of pods and grain yield $plant^{-1}$ increased significantly with nitrogen fertilization over the control.

A field experiment was carried out by Srinivas and Naik (1990) at Bangalor, India to investigate the growth, yield and nitrogen uptake by vegetable french bean as influenced by nitrogen and phosphorus fertilizers. Nitrogen was applied at 0, 40, 80, 120 and 160 kg ha^{-1} and P_2O_5 at 0, 40 and 80 kg ha^{-1}. They observed that application of nitrogen and phosphorus increased plant growth, nutrient uptake and yield of green pods.

Hegde and Srinivas (1990) worked on the water relation and nutrient in french bean and observed that nitrogen application increased green pod yield, nutrient uptake and water use efficiency but had no marked effect on water relation and canopy temperature. Singh

et al. (1990) reported that N fertilization and irrigation french bean increased the number of pods plant^{-1} and 100 seed weight with increase in nitrogen level.

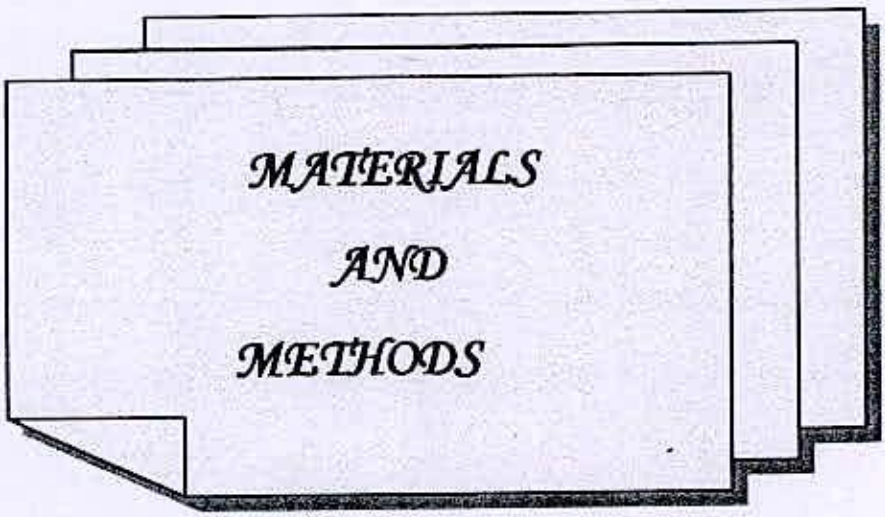
In a field at Bangalore, India Hegde and Srinivas (1989) worked on the effect of irrigation and nitrogen on growth, yield and water use of french bean. In their trial, the crop received 0, 40, 80 or 120 kg ha^{-1} of nitrogen. The green pod yield was the greatest (124.3 – 132.3 q ha^{-1}) at the highest N rate. Kuccy (1989) noted that addition of nitrogen at 30 mg kg^{-1} soil had stimulatory effect on plant growth.

Srinivas and Naik (1988) carried out an experiment at Bangaloe, India to study the response of vegetable French bean to nitrogen and phosphorus fertilization. Nitrogen was applied at 0, 40, 80, 120 or 160 kg N ha^{-1}. They reported that pod yields were increased with increasing fertilizer rate, from 3927 kg ha^{-1} at 0 kg ha^{-1} to 13167 kg ha^{-1} at 160 kg N ha^{-1}. Ali and Tripathi (1988) worked with an experiment in Uttar Pradesh, India to observe the influence of genotype, nitrogen levels (0 –60 kg ha^{-1}) and plant population of french bean and noticed that number of pods plant^{-1}, 100- seed weight, seed yield and seed protein content increased with increasing nitrogen rate.

Bhopal and Singh (1987) conducted a field trail in Himachal Pradesh, India to find out the response of French bean to nitrogen and phosphorus fertilizers with French bean grown for green pods. Nitrogen was applied at 0-90 kg ha^{-1} and P_2O_5 at 0-120 kg ha^{-1}, and a basal dose of K_2O at 50 kg ha^{-1}. The optimum nitrogen: phosphorus dose was 67.3: 79.7 kg ha^{-1}; it gave yields over 210 q ha^{-1}.

In a field trail at Varanasi India, Chandra *et al.* (1987) showed that plant growth and yield (46.19 - 71.59 q ha^{-1}) increased with increasing N (0 - 50 kg ha^{-1}) and with seed inoculation with *Rhizobium*. Kushwaha (1987) conducted an experiment in Uttar Pradash, India to study the response of french bean to different levels of nitrogen and phosphorus. He used 0, 30, 60, 90 and 120 kg N ha^{-1} and obtained seed yields of 1.32, 2.05, 2.33, 2.54 and 2.76 t ha^{-1}, respectively. It was reported that yield differences were associated with differences in pod number per plant.

Katoch *et al.* (1983) while working with nitrogen reported that 30 kg N ha^{-1} increased the maximum nodule number and nodule weight $plant^{-1}$ of french bean.


MATERIALS
AND
METHODS

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during the period from mid November, 2011 to mid March, 2012 to find out the performance of mineral N with (cow dung) on the growth and yield of BARI bush bean-1. This chapter presenting a brief description of the experimental site, soil, climate, experimental design, treatments, cultural operations, data collection and analysis of different parameters under the following headings-

3.1 Location

The experiment was carried out in the field of Sher-e-Bangla Agricultural University Farm, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is $23^0 74^/N$ latitude and $90^0 35^/E$ longitude and an elevation of 8.2 m from sea level (Anon., 1989).

3.2 Characteristics of soil

The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ- 28) and the General Soil Type is Deep Red Brown Terrace Soils. 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 parameters. The initial physical and chemical characteristics of soil are presented in Table 1.

Table: 1. Initial characteristics of the soil in experimental field

1. pH		6.0
2. Particle-size analysis of soil	Sand %	29.04
	Silt %	41.80
	Clay %	29.16
3. Textural Class		Silty Clay Loam
4. Organic matter (%)		0.840
5. Total N (%)		0.067
6. Phosphorous (ppm)		22
7. Potassium (me/100g soil)		0.12

3.3 Weather condition of the experimental site

The climate of experimental site was under the subtropical climate, characterized by three distinct seasons, the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.*, 1979).

3.4 Planting material

Seeds of BARI bush bean-1 used as a test crop for the study and the seeds of this variety were collected from Bangladesh Agricultural Research Institute, Gazipur. This variety was developed by BARI and exposed for cultivation in the year of 1996 (BARI, 2006). It is a dwarf and bushy type plant and can be easily grown in minimum or shading light.

3.5 Treatment of the Experiment

The experiment considered of the following treatments:

T_1: 90 kg N from urea

T_2: 80kg N from urea +10 kg N supplemented by cowdung

T_3: 70 kg N from urea +20 kg N supplemented by cowdung

T_4: 60 kg N from urea +30 kg N supplemented by cowdung

T_5: 50 kg N from urea +40 kg N supplemented by cowdung

T_6: 40kg N from urea +50 kg N supplemented by cowdung

T_7: 30 kg N from urea +60 kg N supplemented by cowdung

T_8: 90 kg N supplemented by cowdung

T_9: Control (00)

[Dry decomposed cowdung contains 1% N]

3.6 Layout of the Experiment

The experiment was laid out in single factors Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the treatments in each plot of each block. Each block was divided into 9 plots where 9 treatment combinations were allotted at random. There were 27 unit plots altogether in the experiment. The size of the plot was 2.5 m × 2.5 m. The distance between two blocks and two plots were kept 50 cm. The layout of the experiment is shown in Figure 1.

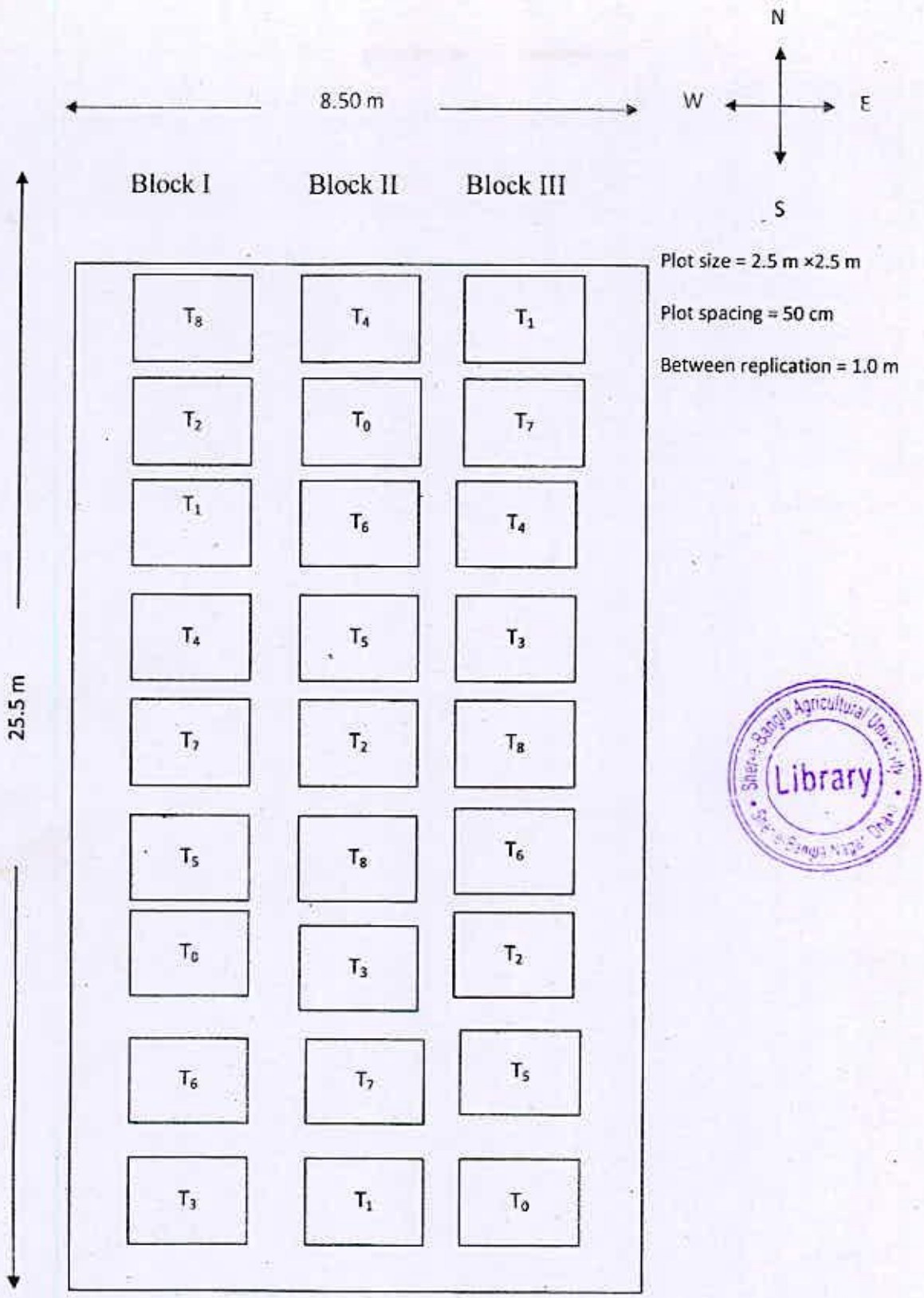


Figure 1. Layout of the experimental field

3.7 Land preparation

The experimental field was first opened on early November, 2011 with the help of a power tiller and prepared by three successive ploughings and cross-ploughings. Each ploughing was followed by laddering to have a desirable fine tilth. The visible larger clods were hammered to break into small pieces. All kinds of weeds and residues of previous crop were removed from the field. Individual plots were cleaned and finally leveled with the help of wooden plank.

3.8 Fertilizer application

Manures and fertilizers that were applied to the experimental plot presented in Table: 2. the total amount of cowdung, TSP, MOP, zinc and sulphur was applied as basal dose at the time of land preparation. Total amount of urea (as per treatment) was applied in two installments at 15 and 30 day after seed sowing.All fertilizers are calculated as per The Fertilizer Recommendation Guide, 2006.

Table: 2. Dose and method of application of fertilizers in bush bean field

Fertilizers and Manures	Dose/ha	Application (%)		
		Basal	15 DAS	30 DAS
Cowdung	As per treatment	100	--	--
Urea	As per treatment	--	50	50
TSP	150 kg	100	--	--
MOP	80 kg	100	--	--
Gypsum	44 kg	100	--	--
Zinc sulphat (monohydrate)	5.5 kg	100	--	--

Source: BARI, 2006

3.9 Sowing of seeds

The seeds of BARI bush bean-1 were sown on 17 November 2011 in rows with maintaining the spacing of 30 cm × 15 cm.

3.10.1 Irrigation

Light over-head irrigation was provided with a watering can to the plots immediately after germination of seedlings. Irrigation also provided at 10 and 25 days after seed sowing.

3.10.2 Gap Filling

Dead, injured and week seedlings were replaced by healthy one from the stock kept on the border line of the experimental plot. Seedlings were re-transplanted with a big mass of soil with roots to minimize transplanting shock. The transplanted seedlings give out with shading and watering for 3 days continued for the establishment of seedlings.

3.10.3 Weeding

Weeding was done two times at 10 and, 25 days after seed sowing followed by irrigation in the plots considering the optimum time for removal weed.

3.10.4 Plant Protection

The crop was protected from the attack of insect-pest by spraying Malathion. The insecticide application were made fortnightly as a matter of routine work from seedling emergence to the end of harvest.

3.11 Harvesting

The pod was harvested depending upon the attaining good sized and the harvesting was done manually at Feb-Mar 2012. Enough care was taken during harvesting.

3.12 Data collection

The data were collected from the inner rows of plants of each treatment to avoid the border effect. In each unit plot, 10 plants were selected at random for data collection. Data were collected in respect of the plant growth characters and yield of bush bean. Data on plant height, number of branches per plant, number of leaves per plant were counted at final harvesting stage. Data were recorded on the following parameters-

3.12.1 Plant height

The height of plant was recorded in centimeter (cm) by using a meter scale. The height was measured from the ground level to the tip of the leaf of an individual plant. Mean value of ten selected plants was calculated for each unit plot and expressed in centimeter (cm).

3.12.2 Number of branches per plant

Number of branches per plant was counted and the data were recorded from randomly selected 10 plants and mean value was counted.

3.12.3 Number of flowers per plant

From 10 randomly selected plants from each unit plot numbers of flowers were counted and their mean values were recorded

3.12.4 Number of pods per plant

From 10 randomly selected plants from each unit plot numbers of pods were counted and their mean values were recorded.

3.12.5 Length of green pod (cm)

The pods from each randomly selected plant were measured using centimeter scale and the mean value was calculated and expressed in centimeter.

3.12.6 Weight of fresh pods per plot (kg)

Pods from 10 randomly selected plants were weighed and their average was taken in gram (g).

3.12.7 Pod yield per plant

Green pod were harvested at regular from each plant and their weight was recorded. Harvesting was done at different interval and the total pod weights were recorded from each plant and average for each plant was finally converted to yield per hectare and expressed in ton (t).

3.13 Soil analysis

Soil samples were analyzed for both physical and chemical characteristics viz. organic matter, pH, total N and available P contents. The soil samples were analyzed by the following standard methods as follows:

3.13.1 Soil pH

Soil pH was measured with the help of a glass electrode pH meter, the soil water ratio being maintained at 1: 2.5 (Jackson, 1962).

3.13.2 Organic matter

Organic carbon in soil sample was determined by wet oxidation method of Walkley and Black (1935). The underlying principle was used to oxidize the organic matter with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and conc. H_3PO_4 and to titrate the excess $K_2Cr_2O_7$ solution with 1N $FeSO_4$. The content of organic matter was calculated by multiplying the percent organic carbon by 1.73 (Van Bemmelen factor) and the results were expressed in percentage (Page *et al.*, 1982).

3.13.3 Total nitrogen

Total N content of soil were determined followed by the Micro Kjeldahl method. One gram of oven dry ground soil sample was taken into micro kjeldahl flask to which 1.1 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 6 ml H_2SO_4 were added. The flasks were swirled and heated to 200^0C and added 3 ml H_2O_2 and then heating at 360^0C was continued until the digest was clear and colorless. After cooling, the content was taken into 100 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared in a similar manner. These digests were used for nitrogen determination (Page *et al.*, 1982).

Then 20 ml digest solution was transferred into the distillation flask. Then 10 ml of H_3BO_3 indicator solution was taken into a 250 ml conical flask which was placed under the condenser outlet of the distillation apparatus so that the delivery end dipped in the acid. Add sufficient amount of 10 N-NaOH solutions in the container connecting with distillation apparatus. Water runs through the condenser of distillation apparatus was checked. Operating switch of the distillation apparatus collected the distillate. The conical flask was removed by washing the delivery outlet of the distillation apparatus with distilled water. Finally the distillates were titrated with standard 0.01 N H_2SO_4 until the color changes from green to pink. The amount of N was calculated using the following formula:

$$\% N = (T-B) \times N \times 0.014 \times 100 / S$$

Where,

T = Sample titration (ml) value of standard H_2SO_4

B = Blank titration (ml) value of standard H_2SO_4

N = Strength of H_2SO_4

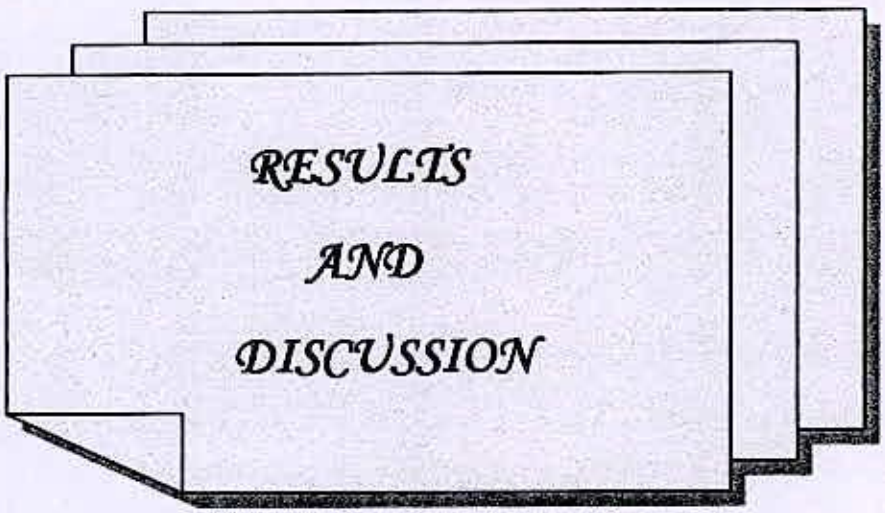
S = Sample weight in gram

3.13.4 Available phosphorus

Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH8.5 (Olsen *et al.*, 1954). Phosphorus in the extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated by the standard P curve (Page *et al.*, 1982).

3.13.5 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference among the treatments. The mean values of all the characters were evaluated and analysis of variance was done by the 'F' (variance ratio) test. The mean differences were evaluated by Duncan's Multiple Range Test (DMRT) at 0.05 level of probability (Gomez and Gomez, 1984).


RESULTS
AND
DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to find out the performance of mineral N and organic cowdung on the growth and yield of BARI Bush bean-1. Data on yield contributing characters, yield, nutrient concentration in plant and pods, uptake by plant and pod, nutrients status of post harvest soil was recorded. The results have been discussed and possible interpretations given under the following headings.

4.1 Yield contributing characters and yield of bush bean-1

4.1.1 Plant height (cm)

There were no significant variations recorded for plant height due to mineral N with organic source cowdung (Table: 3). The tallest plant (43.67 cm) was recorded from T_8 and T_7, while the shortest plant (33.67 cm) recorded from T_9 treatment (control) treatment. The increase in plant height due to the application of different level of N from inorganic and organic sources might be associated with stimulating effect of nitrogen on various physiological process including cell division and cell elongation of the plant. Mahase *et al.* (2007), Vishwakarma *et al.* (2002), Farkadeet and Pawar (2002) also reported similar results from their earlier experiment using nitrogen.

4.1.2 Number of branches per plant

Significant variations were recorded for number of branches per plant of bush bean due to mineral N and organic source N from cowdung (Table: 3). The maximum number of branches per plant (7.667) was obtained from T_8 (90 kg N supplemented by cowdung) and T_5 (50 kg N from urea+ 40 kg N supplemented by cowdung) and test is statistically identical with the treatments T_1, T_2, T_3, T_4, T_6 and T_7, respectively . Data was found that all the treatments produced significantly highest number of branches per plant compared to the control condition. Rahman (2001) also found that number of branches per plant was significantly influenced by higher dose of nitrogen.

Table: 3. Performance of mineral N and organic source on plant height and number of branches of bush bean

Treatments	Plant height (cm)	Number of branches/plant
T_1	40.33	6.667 ab
T_2	36.67	7.333 a
T_3	42.00	7.000 a
T_4	38.00	7.000 a
T_5	41.33	7.667 a
T_6	41.67	6.333 ab
T_7	40.33	6.333 ab
T_8	43.67	7.667 a
T_9	33.67	5.333 c
LSD (0.05)	NS	1.277

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1: 90 kg N from urea

T_2: 80kg N from urea+10 kg N supplemented by cowdung

T_3: 70 kg N from urea+20 kg N supplemented by cowdung

T_4: 60 kg N from urea+30 kg N supplemented by cowdung

T_5: 50kg N from urea+40 kg N supplemented by cowdung

T_6: 40 kg N from urea+50 kg N supplemented by cowdung

T_7: 30kg N from urea+60 kg N supplemented by cowdung

T_8: 90 kg N supplemented by cowdung

T_9: Control (00)

4.1.3 Number of pods per plant

Number of pods per plant of bush bean showed significant variation due to mineral N and the organic source as cowdung (Table: 4). The maximum number of pods per plant (25.0) was obtained from T_5 (90 50 kg N from urea +40 kg N supplemented by (cow dung) which were statistically identical with the treatment T_6 and T_7 treatments. And the minimum number of pods per plant (11.3) was obtained from T_9 (control) treatment which was statistically different from other treatments except T_8 treatment. Nitrogen should be applied in such a way that minimum is leached or washed out and maximum its utilization for crop production. Rahman (2001) found that pods per plant were significantly influenced by higher dose of nitrogen.

4.1.4 Length of bush bean

Length of bush bean pods showed statistically significant differences due to mineral N with cow dung (Table: 4). The highest length of 5 pods in each harvest (12.89 cm) was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cowdung), which was statistically similar with the treatment T_1, T_2 T_3 T_4, T_6, T_7 and T_8, respectively. While the lowest length (10.11 cm) was obtained from T9 (control) treatment. An optimum amount of nitrogen for the whole growth period is necessary to produce maximum yield of good quality bush bean.

4.1.5 Weight of 100 pods

Mineral N with the application of cowdung varied significantly in terms of weight of total pods (Table: 4). The highest weight of 100 pods (4.71kg) at each harvesting was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cowdung), which was closely related with the treatment , T_2 T_3, T_4, T_6, T_7 and T_8, respectively. While the lowest weight (3.99 kg) was obtained from T_9 (control) treatment. Rahman (2001) found that individual pod weights were significantly influenced by higher dose of nitrogen

4.1.6 Green pod yield (t/ha)

Green pod yield (t/ha) showed statistically significant differences due to mineral N with cowdung (Table: 4). Maximum green pod yield of bush bean (13.44 t/ha) was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cowdung), which was statistically similar with the treatments T_6 and T_7. Which, the minimum green pod yield of bush bean was found (8.48 t/ha) from T_9 (Control) treatment, which was statistically different with the other treatments. Rahman (2001) found that individual pod weight was significantly influenced by higher dose of nitrogen.

Table: 4. Performance of mineral N and organic cowdung on yield attributing characters and yield of bush bean

Treatments	Number of pods/plants	Length of pod(cm)	Wt. of 100 pods (kg)	Green pod yield (t/ha)
T_1	20.0 b	12.11a	4. 11a	10.08 b
T_2	18.7 b	12.61a	4.36a	9.64 bc
T_3	19.0 b	12.221a	4.66a	10.10b
T_4	16.3 bc	12.11a	4.28a	9.68bc
T_5	25.0 a	12.89a	4.71a	13.44 a
T_6	24.3 a	12.112a	4.20a	11.57ab
T_7	23.0 ab	12.22a	4.70 a	11.78ab
T_8	12.0 c	12.612a	4.53a	10.72 b
T_9	11.3 c	10.11b	3.99b	8.48c
LSD (0.05)	79.83	1.0689	1.3160	2.02

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1: 90 kg N from urea

T_2: 80kg N from urea+10 kg N supplemented by cowdung

T_3: 70 kg N from urea+20 kg N supplemented by cowdung

T_4: 60 kg N from urea+30 kg N supplemented by cowdung

T_5: 50kg N from urea+40 kg N supplemented by cowdung

T_6: 40 kg N from urea+50 kg N supplemented by cowdung

T_7: 30kg N from urea+60 kg N supplemented by cowdung

T_8: 90 kg N supplemented by cowdung

T_9: Control (00)

4.2 Post harvest soil

4.2.1 Soil pH

There were no significant variations recorded for pH due to the application of mineral N and organic cowdung (Table 5). The highest pH (6.1) was found in the treatment T_3, T_4 and T_6. And the lowest pH (5.8) was found in the treatment T_1, T_5 and T_8, which were statistically similar with other treatments.

4.2.2 Organic carbon (%) content in soil sample

There were no significant variations recorded for organic carbon due to mineral N with cowdung (Table 5). Maximum content of organic carbon (0.7019 %) was found in the treatment T_8. On the other hand, minimum organic carbon (0.2164 %) content was found in the treatment T_9, which was statistically different from other treatments.

4.2.3 Total N (%) in soil sample

There were no significant variations recorded for total N due to mineral N with cowdung (Table 5). Nitrogen content of the studied soil shows statistical variations due to effect of the different doses of organic and inorganic based nitrogen application. However, maximum content of nitrogen 0.07 (%) was found in the treatment T_1 Whereas, minimum nitrogen (0.031%) content was found in the treatment T_9 treatment, which was statistically different from other treatments.

4.2.4 Available Phosphorus (ppm) content in soil sample

Phosphorus content in soil sample (ppm) showed statistically significant differences due to mineral N with cow dung (Table 5). Phosphorus content of the studied soil shows statistical variations due to effect of the different doses of organic and inorganic based nitrogen application. However, maximum content of phosphorus 22.0 (ppm) was found in the treatment T_5, which was statistically similar with the treatments T_1, T_2, T_7, T_8, and T_9, respectively. Whereas, minimum phosphorus (14.0 ppm) content was found in the treatment T_6, which was statistically similar with the treatments T_3 and T4, respectively.

4.2.5 Available Sulphur (ppm) content in soil sample

There were no significant variations recorded for available sulphur due to mineral N with cow dung (Table 5). Sulphur content of the studied soil shows statistical variations due to effect of the different doses of organic and inorganic based nitrogen application. Maximum content of sulphur content (15.0 ppm) was found in the treatment T_8 .On the otherhand, minimum sulphur content (12.01 ppm) content was found in the treatment T_9, which was statistically different from other treatments.

4.2.6 Exchangeable Potassium content (meq/100 g soil) in soil sample

Potassium content in soil sample (%) showed statistically significant differences due to mineral N with cow dung (Table 5). Potassium content of the studied soil shows statistical variations due to effect of the different doses of organic and inorganic based nitrogen application. Maximum content of potassium content (0.182 meq/100 g soil) was found in the treatment T_8, which was statistically similar with the treatments T_3, T_5, T_6 and T_7, respectively. On the Otherhand, minimum potassium content (0.122 meq/100 g soil) content was found in the treatment T_9, which was statistically different from other treatments.

Table: 5. Chemical properties of post- harvest soil influenced by mineral N and cowdung

Treatments	pH	Organic carbon (%)	Total N (%)	Available phosphorus (ppm)	Available sulphur (ppm)	Exchangeable potassium (meq/100 g soil)
T_1	5.8	0.52	0.07	15.0 abc	13.35	0.144 b
T_2	6.0	0.44	0.064	19.0 ab	13.41	0.143 b
T_3	6.1	0.65	0.068	14.8 bc	14.7	0.161 ab
T_4	6.1	0.66	0.065	14.1 c	13.86	0.140 b
T_5	5.8	0.63	0.05	22.0 a	14.9	0.164ab
T_6	6.1	0.68	0.062	14.0 c	14.95	0.173 a
T_7	6.0	0.69	0.055	15.2 abc	13.085	0.170 a
T_8	5.9	0.70	0.063	18.0 ab	15.0	0.182 a
T_9	5.8	0.21	0.031	15.05 abc	12.01	0.122 c
LSD (0.05)	NS	NS	NS	0.054	NS	1.9754

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1: 90 kg N from urea

T_2: 80kg N from urea+10 kg N supplemented by cowdung

T_3: 70 kg N from urea+20 kg N supplemented by cowdung

T_4: 60 kg N from urea+30 kg N supplemented by cowdung

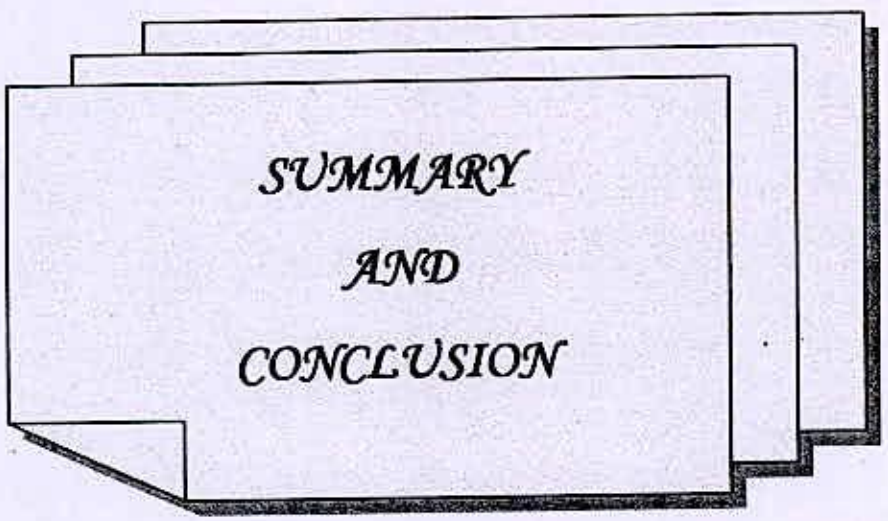
T_5: 50kg N from urea+40 kg N supplemented by cowdung

T_6: 40 kg N from urea+50 kg N supplemented by cowdung

T_7: 30kg N from urea+60 kg N supplemented by cowdung

T_8: 90 kg N supplemented by cowdung

T_9: Control (00)


SUMMARY
AND
CONCLUSION

CHAPTER V

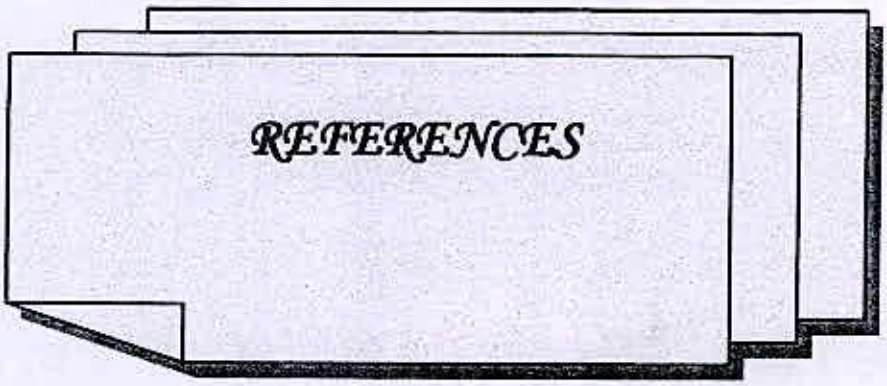
SUMMARY AND CONCLUSION

An experiment was conducted at the experimental field, Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka during mid-November, 2011 to mid-March, 2012 to evaluate the suitability of BARI bush bean-1 cultivation with inorganic N fertilizer and organic cow dung application. The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. The treatments of the experiment involved, T_1 (90 kg N from urea); T_2 (80 kg N from urea + 10 kg N supplemented by cowdung); T_3 (70 kg N from urea + 20 kg N supplemented by cow dung); T_4 (60 kg N from urea + 30 kg N supplemented by cowdung); T_5 (50 kg N from urea+ 40 kg N supplemented by cowdung); T_6 (40 kg N + 50 kg cowdung); T_7 (30 kg N from urea + 60 kg N supplemented by cowdung); T_8 (90kg N supplemented by cowdung) and T_9 (Control) treatment. And the variety which was involved in the experiment, V_1= BARI bush bean-1. A significant variation was observed among the treatment in respect of different parameters of BARI bush bean-1. Data on yield contributing characters, yield, nutrient concentration in plant and pods, uptake by plant and pod, nutrients status of post harvest soil was recorded. The tallest plant (43.67 cm) was recorded from T_8 (90 kg N supplemented by cowdung). While at the shortest plant (33.67 cm) from T_9 (control) treatment. The increase in plant height due to the application of different level of N from inorganic and urea organic sources might be associated with stimulating effect of nitrogen on various physiological process including cell division and cell elongation of the plant. The maximum number

of branches per plant (7.667) was obtained from T_8 (90 kg N supplemented by cowdung) and T_5 (50 kg N from urea + 40 kg N supplemented by cowdung) and test is statistically identical with T_1, T_2, T_3, T_4, T_6 and T_7. Data was found that all the treatments produced significantly highest number of branches per plant compared to the control condition. Optimum level of nitrogen ensured reproductive growth plant through optimum vegetative growth. Bush bean cultivation requires ample supply of nitrogen. The maximum number of pods per plant (25.0) was obtained from T_5 (50 kg N from urea +40 kg N supplemented by cowdung) which was statistically identical with the treatment T_6 and T_7 and the minimum number of pods per plant (11.3) was obtained from T_9 (control) treatment, which was statistically different from other treatment except T_8. Nitrogen should be applied in such a way that minimum is leached or washed out and maximum its utilization for crop production. The highest length of pods in each harvest (12.89 cm) was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cowdung), which was statistically similar with the treatment T_1, T_2, T_3, T_4, T_6, T_7 and T_8. While the lowest weight (10.11 cm) from T_9 (control) treatment. The highest weight of 100 pods (4.71kg) at each harvesting was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cowdung), which was closely related with the treatment T_2 ,T_3, T_4, T_6, T_7 and T_8 respectively. While the lowest weight (3.99 kg) from T_9 treatment (control). Maximum green pod yield of bush bean (13.44 t/ha) was recorded from T_5 (50 kg N from urea +40 kg N supplemented by cowdung), which was statistically similar with the treatments T_6 and T_7. While the minimum green pod yield of bush bean was found (8.48 t/ha) from T_9 (Control) treatment, which was statistically different with the other treatments. The highest pH

(6.1) was found in T_3, T_4 and T_6 treatments. And the lowest pH (5.8), was found in the treatment T_1, T_5 and T_7. Maximum content of organic carbon (0.7019 %) was found in the treatment T_8. On the other hand, minimum organic carbon (0.2164 %) content was found in the treatment T_9, which was statistically different from other treatments. Maximum content of nitrogen 0.07 (%) was found in the treatment T_1 which was statistically similar with the treatments T_2, T_3, T_4, T_6, T_7 and T_8, respectively. Whereas, minimum nitrogen (0.031%) content was found in the treatment T_9 treatment, which was statistically different from other treatments. However, maximum content of available phosphorus 22.0 (ppm) was found in the treatment T_5. Whereas, minimum phosphorus (14.0 ppm) content was found in the treatment T_6, which was statistically identical with the treatment T_3 and T_4, respectively. Maximum content of sulphur content (15.0 ppm) was found in the treatment T_8, which was statistically similar with the treatments T_3, T_4, T_5, T_6 and T_7, respectively. On the other hand, minimum Sulphur content (12.01 ppm) content was found in the treatment T_9, which was statistically different from other treatments. Maximum content of potassium content (0.182 meq/100 g soil) was found in the treatment T_8, which was statistically similar with the treatments T_3, T_5, T_6 and T_7, respectively. On the other hand, minimum Potassium content (0.12 meq/100 g soil) content was found in the treatment T_9, which was statistically different from other treatments.

From the present study finally it can be concluded that application of 50 kg N from urea and 40 kg N supplemented by cowdung for bush bean cultivation increased the number of pods/plant, length of pods/plant and green pods yield of BARI Bush bean-1.


REFERENCES

REFERENCES

Adams, M. W. (1984). Beans-Cowpea: Production constraints and national programs'- Cowpea Collaborative Research Support Program, Michigan State University, East Lansing, Michigan. 23-28.

AICPIP. (1987). Consolidated Report on Rabi Pulses. Directorate of Pulse Research, Kanpur. 62-67.

Ali, M. and Kushwaha B. I. (1987). Cultivation of Rabi rajmash in plants. *Indian Farm*, 37 (2): 20-23.

Ali, M. and Tripathi, A. (1988). Dry matter accumulation and yield of winter French bean as influenced by genotype, nitrogen level and plant population. *Indian J. Agric. Sci.*, 58 (4): 263-267.

Anonymous. (1989). Annual Report 1987-88. Bangladesh Agricultural Research Institute. Joydebpur, Gazipur. p. 133.

Arya, P. S., Sagar, V. and Singh, S. R. (1999). Effect of N, P and K on seed yield of french bean (*Phaseolus vulgaris* L.) var Contender. Haryana *J.Hort. Sci.*, 16 (8): 146-147.

Baboo, R., N. S. Rana, T. and Pantola, P. (1998). Response of French bean to nitrogen and phosphorus. Ann. Agri. Res., 19(1): 81-82.

Bagal, P. K. and Jadhav, A. S. (1995). Effect of nitrogen and *Rhizobium* on composition of french bean. *J. Maharashtra Argil. Univ.*, 20: 1, 53-55.

BARI. (2006). Krishi Projukti Hathboi. Bangladesh Agricultural Research Institute. Joydebpur, Gazipur.

Bassan, D. A. Z, S Buzetti, M. A. C Carvalho and Santos N.C.B. (2001). Seed inoculation and nitrogen and molybdenum application on a winter bean crop: production and physiological seed quality. *Revista Brasileira de Sementes*. 23 (1):76-83.

Bengtsson, A. (1991). Field experiments with inoculation and nitrogen fertilization of kidney beans (*Phaseolus vulgaris* L.). *Swedish Journal of Agricultural Research*. 21(2): 63-66.

Bhatnagar, G. S., Prowal, M. K. and Nanawati, G.C. (1992). Effect of nitrogen and mixtalol on French bean during winter. Indian *J. Agril. Sci.*, 62(4): 280-281.

Bhopal, S and Singh, B. (1987). Response of french bean to nitrogen and phoshorus fertilization. *Indian J. Agron.*, 32(3): 223-225.

Bildirici, N. and N. Yilmaz, N. (2005). The effects of different nitrogen and phosphorus doses and bacteria inoculation (*Rhizobium phaseoli*) on the yield and yield components of field bean (*Phaseolus vulgaris* L.). Journal-of-Agronomy. 4(3): 207-215.

Calvache, A. M., K. Reicheardt, E. Malavotta and Bacchi, O. O. S. (1997). Effect of water stress and nitrogen efficiency in bean. Scientia Agricola, 54 (3): 232-240 [Cited from Hort. Abst., 86 (1): 53, 1998].

Carranca, C. F, A. Ferreira, L. Andrada, M. L. Fernandes, M. E. Ferreira and M. A. C. Fragoso . (1993). Nitrogen fertilization of Phaseolus vulgaris for freezing. National Agronomy Research Station, INIA, Quinta do Marques, 2780 Oeiras, Portugal. Plant Nutrition, 31 August – 8 September. 429-433.

Chaib, S. L., E. A. Bulisami and Castro ,L.H.S.M. (1984). Growth and yield of bush beans as affected by depth of phosphate fertilizer application. *Pesquisa Agropecudria Brasileira*, 19(7): 817-822.

Chandel, R. S., Singh, R., Singh, O. N. and Singh, Singh R.(2002). Influence of nitrogen levels and *Rhizobium* inoculation on yield, quality and nitrogen uptake of French bean (*Phaseolus vulgaris* L.) . *Research Crops*. 3(3): 524-528.

Chandra, R., Rajpur, C. B. S. Singh, K. P. and Singh, S. J. P. (1987). A role on the effect of nitrogen, phosphorus and *Rhizobium* culture on the growth and yield of French bean of (*Phaseolus vulgaris* L.) cv. Contents. Haryana *J. Hort. Sci.*, 16(8): 146-147.

Chaudhuri, C. S., Mendhe, N. S., Pawer, S. W., Ingole, S. A. and Nikan, R. R.(2001). Nutrient management in french bean. *J. Soils crops*, 11(1): 137-139.

Daba, S and M. Haile. (2000). Effect of Rhizobial inoculation and nitrogen fertilizer on yield and nodulation of common bean. *J. Plant Nutrition*, 23 (5): 581-591.

Dahatonde, B. N. and Nalamwar, R. V. (1996). Effect of nitrogen and irrigation levels on yield and water use of French bean. *Indian J. Agron*., 41 (2): 265-268.

Dahatonde, B. N., Turkhede, A. B. and Kale, M. R(.1992). Purpose of french bean (*Phaseolus vulgaris* L.) to irrigation regimes and nitrogen levels. *Indian J.Agron*., 37 (4): 835-837.

Deshmukh, S. G., Karanjikar, P. N. and Arthamwar, D. N. (2007). Yield response of French bean varieties to nitrogen levels. *Journal of Food Legumes*. 20(2): 216-217.

Dhanjal, R., O. M. Prakash and Ahlawat, I.P.S . (2001). Response of french bean (*Phaseolus vulgaris*) varieties to plant density and nitrogen application. *Indian J. Agron*. 46(2): 277-281.

Dhanjal, R., O. M. Prakash and Ahlawat, I.P.S (2003). Physiological variations in French bean (*Phaseolus vulgaris*) cultivars as affected by plant density and nitrogen. *Indian J. Plant Physio*. 8(1): 34-37

Duke, J. A. (1983). Hand Book of Legumes of World Economic Importance (Second Ed.), Plenum Press, New York. P. 341.

Durge, V. W., I. A. Khan, B. N. Dahatonde and Vayas, J.S.(1997). Response of french bean to irrigation and nitrogen fertilization. *Ann. Plant Physiol.*, 11(2): 223-225.

Dwivedi, D. K., H. Singh, K. M. Singh, B. Shahi and Rai, J.N.(1994). Response of french bean (*Phaseolus vulgaris*) to population densities and nitrogen levels under mid-upland situation in north-east alluvial plains of Bihar. *Indian J. Agro.* 39(4): 581-583.

Edris, K. M., Islam, A. T. M. T., Chowdhury, M. S. and Haq, A. K. M. M. (1979). Detailed soil survey. BAU, Mymensingh. Dept. Soil survey. Govt of the people's Republic of Bangladesh. 118.

FAO. (2000). Production Year Book. Food and Agricultural Organization of the United Nations. Rome, Italy. 54: 108.

Farkadeet, B. K., and W. S. Pawar.(2002). Growth performance and yield of french bean varieties as influenced by different fertilizer levels. *Indian J. Agric. Sci.* 12 (1): 142 –144.

Furlani, E., J. Nakagawa, L. J. Bulhoes, J. A. Amoreira and H. Grassi Flho. (1996). Correlation between chlorophyll content and rate of nitrogen applied to beans. *Bragantia*. 55(1): 171-175.

Gajendra, S. and Singh, T. P. (1998). Effect of moisture regimes and fertility levels on growth, yield and water use of french bean. (*Phaseolus vulgaris*). *Indian J. Agron.*, 44(2): 389-391.

Ghosal,S., Singh, O. N. and Singh, R. P. (2000). Effect of rate and time of application of nitrogen on growth and productivity of French bean. *Legume Res.*, 23(2): 110-113.

Gomez, K. A. and Gomez, A. A (1984). Statistical Procedure for Agricultural Research. (2nd Ed.). Jhon Willey and Sons, New York. 28-192.

Hegde, D. M. and Srinivas, K. (1989). Effect of irrigation and nitrogen on growth, yield and water use of french bean. *Indian J. Agron.*, 34(2): 180-184.

Hegde, D. M. and srinivas, K. (1990). Plant water relations and nutrient uptake in french bean. *Irrigation Sci.*, 11(1): 51-56.

Hunter, A. H. (1984). Soil Fertility Analytical Service in Bangladesh. Consultancy Report BARC, Dhaka.

Jackson, M. L. (1973). Soil Chemical Analysis. Prentice Hall. Inc. N. J., USA. p. 46.

Katoch, K. K, G. C. Aggarwas and F. C. Gary. (1983). Effect of nitrogen, soil compaction and moisture stress on nodulation and yield of soyabean. J. *Indian Soc. Soil Sci.*, 31: 215-219.

Kikuti, H., M. J. B. Andrade, J. G. Carvalho, and A. R. Morais. (2005). Nitrogen and phosphorus in the cultivated variety bean BRS MG Talisma (*Phaseolus vulgaris* L.). *J. Indian Soc. Soil Sci.*, 21: 115-119.

Koli, B. D., Akasheand.V.B. and Shaikh, A. A.(1996). Effect of row spacing, plant density and N – level on the yield and quality of french bean. *PKV Res. J.* 20(2): 174-175.

Kuccy, R. M. N. (1989). The influence of rate and time of mineral N application on yield and N_2 fixation by field bean. *Canadian J. plant Sci.* 69(2): 427-436.

Kushwaha, B. L. (1987). Response of winter french bean at varying levels of nitrogen and phosphorus in north India plains. *Indian J. Pulses Res.* 4(2): 217-218.

Lal.(2004). Effect of nitrogen and phosphorus on seed yield of pea (*Pisum sativum* L.) and french bean (*Phaseolus vulgaris* L.). *Progres. Horti.* 36(1): 150-151.

Mahase, N. N., Pattiwar, V. V., Deshpande, R. M., Raut, P. B., Adagale, M. W. and Borkar, L. S. (2007). Effect of nitrogen and irrigation levels on yield and water use of French bean (*Phaseolus vulgaris*). *Journal of Soils and Crops*. 17(2): 379-382

Nandan, N. N. and Prasad, P. K. (1998). Study of yield and water use efficiency of P. *vulgaris* cv. Uday. *Ann. Plant Physiol.*, 12(1): 112-115.

Negi, S. C. and Shekhar, J. (1993). Response of french bean genotypes to nitrogen. *Indian J. Agron.*, 38(2): 321-322.

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate, U.S. Dept. Agric. Circ., p. 929.

Page, A. L., Miller, R. H. and Keeney, D. R. (1982). Methods of analysis part 2, Chemical and Microbiological Properties, Second Edition American Society of Agronomy, Inc., Soil Science Society of American Inc. Madson, Wisconsin, USA. pp. 403-430.

Parthiban, S.and Thamburaj, S. (1991). Influence of Rhizobium culture and nitrogen fertilization on French bean. *South Indian Hort.*, 39(3): 137-138.

Prajapati, M P., Patel, H. A. Prajapati, B.H. and L.R. Patel, L.R. (2004). Studies on nutrient uptake and yield of french bean (*Phaseolus vulgaris* L.) as affected by weed control methods and nitrogen levels. *Legume Res.* 27(2): 99-102.

Prajapati, M. P., and Patel, L. R. (2001). Studies on physiological variations in frenchbean (*Phaseolus vulgaris* L.) as influenced by weed control methods and nitrogen levels under North Gujarat conditions. Gujarat *Agri. Univ. Res. J.* 26(2): 12-16

Purseglove, J. W. (1987). Tropical Crops: Dicotyledons. Longman, New York. 52.

Rahman, M. (2001). Influence of nitrogen and plant spacing on French bean. *Vegetable Sci.* 28(1): 45-49.

Ram-Gopal, Ghanshyam, S. and Singh, G. R. (2003). Effect of irrigation and nitrogen levels with and without FYM on the yield and water use of French bean (*Phaseolus vulgaris* L.). *Farm Sci. J.* 12(2): 182-183.

Rana, S. N. and Singh, R. (1998). Effect of nitrogen and phosphorus on growth and yield of french bean. (*Phaseolus vulgaris*). *Indian J. Agron.*, 43(2): 367-370.

Rashid, M. M. (1993). Sabji Biggan (in Bengali). 1st edition, Bangla Academy, Bangladesh . 387-390.

Rejesh, S. and Singh, R. S. (2001). Effect of nitrogen and sulphur application on its uptake and grain yield in french bean. *Indian J. Pulses Res.* 14(2): 154-155.

Sa, M. E. D., Bjuzetti, S. Morello, S. and Deziderio, N. D. (1982). Effects of plant density and phosphate fertilizer on bean production. Centro Nacional de Pesquisa Arroz Feijao, 101-103 [Cited from *Field Crop Abst.*, 28(2): 44-53, 1983].

Saini, J.P and Negi. S.C. (1996). Effect of cultivation and date of sowing on growth and yield of french bean (*Phaseolus vulgaris* L.) under dry temperature condition. *Indian J. Agron.* 43(1): 110-113.

Salukhe, D. K., Desai, B. B. and Bhat, N. R. (1987). Leguminous Vegetables (Peas and Beans). In Vegetabes and Flower Seed Production, Agricole Publishing Academy, New Delhi. pp. 265-302.

Shanmugavelu, K. G. (1989). Production technology of vegetable crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. pp. 446-461.

Sharma, V. K., Soroch, K. and Singh, C. M. (1996). Influence of time of sowing on yield of french bean (*Phaseolus vulgaris*) under dry temperate zone of Himachal Pradesh. *Indian J. Agron.*, 42(2): 320-322.

Singh, A. K. and Singh, S. R. (2000). Effect of different dates of sowing and nitrogen levels on yield and yield attributing traits of french bean (*Phaseolus vulgaris* L.). *Crop Res.* Hissar, 20(2): 257-260.

Singh, D. P., Rajput, A. L. and Singh, S. K .(1996). Response of french bean to spacing and nitrogen levels. *Indian J. Agron.*, 41(4): 608-610.

Singh, D.N., Mehar, R.C. and Singhans, M. (1990). Response of french bean to irrigation and nitrogen application. *Haryana J. Agron.* 6(1): 94-95.

Singh, N. B and Verma, K. K.(2002). Nitrogen and phosphorus nutrition of french bean (*Phaseolus vulgaris* L.) grown in eastern Uttar Pradesh under late-sown condition. *Indian J. Agro.*, 47(1): 89-93.

Srinivas, K. and Naik, L.B. (1988). Response of vegetable french bean (*Phaseolus vulgaris* L.) to nitrogen and phosphorus fertilization. *Indian J. Agril. Sci.* 58(9): 707-708.

Srinivas, K. and Naik, L. B. (1990). Growth, yield and nitrogen uptake in vegetable French bean (*Phaseolus vulgaris* L.) as influenced by nitrogen and phosphorus fertilization. *Haryana J. Hort Sci.* 19(1-2): 160-167.

Sushant, R. S., Dixit, S. P. and Singh, G. R. (1998). Effect of irrigation, nitrogen and phosphorus on seed yield and water use of rajmash (*Phaseolus vulgaris*) *Indian J. Agron.*, 44 (2): 382-388.

Swiader, J. M., Ware, G. W. and McCollum, J. P. (1992). Producing Vegetable Crops. 4th ed. Interstate Publishers, Inc. Danville, Illions, USA. PP. 223-249.

Teixeira, I. R., Andrade, M. J. B., Carvalho, J. G. Morais, A. R. and Correa, J. B. D.. 2000. Response of bean (*Phaseolus vulgaris* L. cv. Perola) crop to different sowing densities and nitrogen levels. *Ciencia grotecnologia.* 24(2): 399-408.

Tewari, J. . and Singh, S. (2000). Effect of nitrogen and phosphorus on growth and seed yield of French bean (*phaseolus vulgaris* L.). *Vegetable Sci.* 27(2): 172-175.

Tewari, J. K. and Singh, S. S. (2000). Effect of nitrogen and phosphorus on growth and seed yield of french bean. *Veg. Sci.* 27(2): 172-175.

Tindall, H. D. (1988). Vegetables in the tropics. McMillah education Ltd., 527.

Umap, P. A., Jadhao, S. D., Mali, D. V. and Rathod, P. K. (2006). Effect of nitrogen and phosphorus on yield and quality of French bean in vertisols. *Annals of Plant Physiology*. 20(2): 240-242

Verma,V. S, and Saxena, K. K. (1995). Response of French bean (*Phaseolus vulgaris*) to graded doses of nitrogen, phosphorus and potassium in silty-loam soil of central Uttar Pradesh. *Indian J. Agro*. 40(1): 67-71.

Vishwakarma, B., Singh, C. S., Rajesh, S. and Singh, R. (2002). Response of french bean (*Phaseolus vulgaris* L) varieties to nitrogen application. *Res. Crops*., 3(3): 529-532.

Walkley, A. and Black, D. R. (1935). An examination of the digestion method for determining soil organic matter and proposed modification of the chronic acid titration method. *Soil Sci*., 37: 29-38.

Wani, A. G., Tumbare A. D. and Dhonde, M. B. (1998). Response of rainy-season French bean (*Phaseolus vulgaris*) to irrigation regimes and nitrogen. *Indian J. Agro*. 43(4): 694-699.

APPENDICES

Appendix I. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period from October 2008 to March 2009

Month	*Air temperature (°C)		*Relative humidity (%)	*Rainfall (mm) (total)
	Maximum	Minimum		
October, 2008	26.03	18.22	81	34
November, 2008	25.82	16.04	78	00
December, 2008	22.4	13.5	74	00
January, 2009	24.5	12.4	68	00
February, 2009	27.1	16.7	67	30
March, 2009	31.4	19.6	54	11

* Monthly average,

* Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka - 1212