EFFECT OF SOWING TIME AND NITROGEN ON THE GROWTH AND YIELD OF FRENCH BEAN (*Phaseolus vulgaris* L.)

BY

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CERTIFICATE

*This is to certify that the thesis entitled "Effect of Sowing Time and Nitrogen on the Growth and Yield of French Bean (Phaseolus vulgaris L.) submitted to the Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in HORTICULTURE**, embodies the result of a piece of bonafide research work carried out by **MD. AMINUL ISLAM**. **Registration No.00969** under my supervision and guidance. No part of the thesis has been submitted for my other degree or diploma.*

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

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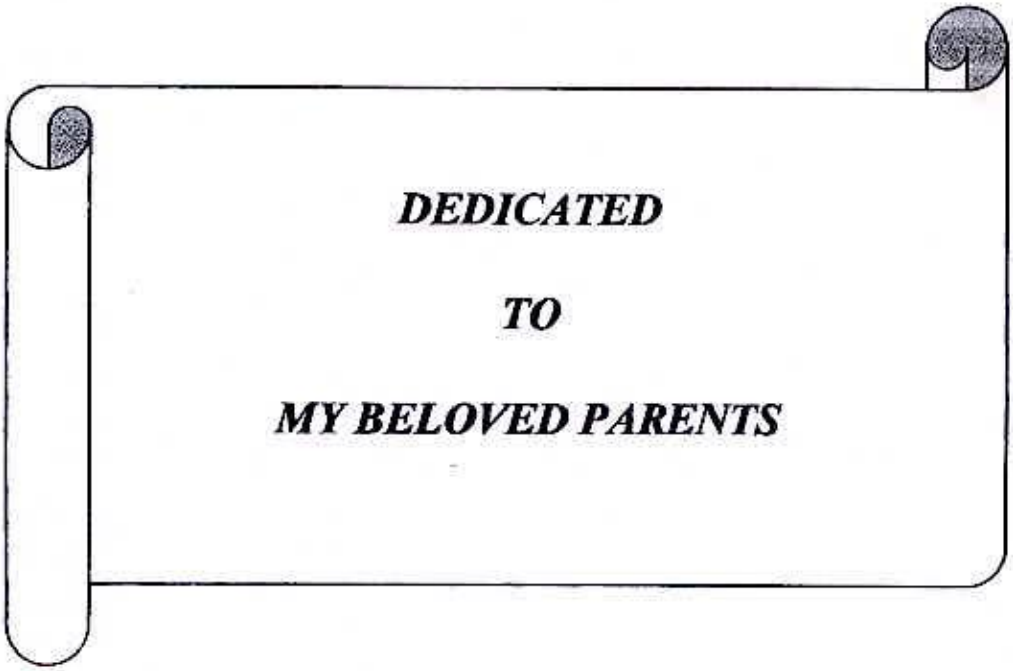
DEDICATED
TO
MY BELOVED PARENTS

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EFFECT OF SOWING TIME AND NITROGEN ON THE GROWTH AND YIELD OF FRENCH BEAN (*Phaseolus vulgaris* L.)

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ABSTRACT

The experiment was conducted to investigate the effect of sowing time and nitrogen on the growth and yield of french bean (BARI Zhar Sheem-1) at the farm of Sher-e-Bangla Agricultural University, Dhaka during the period of November, 2006 to March, 2007. The experiment included two factors; Factor A: Four sowing time (T_1=15 November, T_2=30 November, T_3=15 December and T_4=30 December) and Factor B: Four nitrogen level (N_0=0 Kg N/ha, N_1=45 kg N/ha, N_2=90 kg N/ha and N_3=135 kg N/ha). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. In case of sowing time, T_1 give highest yield of green pod (15.6 t/ha) and lowest (11.3 t/ha) was from T_4. Incase of nitrogen, N_2 produced the highest yield (15.7 t/ha) and lowest (9.8 t/ha) was from N_0. For combined effect T_1N_2 give the highest yield (17.9 t/ha) and lowest (8.4 t/ha) was from T_4N_0. On the basis of economic analysis the highest net return (TK. 1,70,023 /ha) and the highest benefit cost ratio (2.7) were obtained from the treatment combination of T_1N_2. It may be concluded that 15 November sowing with 90 kg N/ha is best for growth and yield of french bean.

LIST OF CONTENTS

LIST OFCONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro Ecological zone
BARC	=	Bangladesh Agricultural Research council
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
BCR	=	Benefit Cost Ratio
CV(%)	=	Coefficient of Variation
DAS	=	Days after Sowing
EC	=	Emulsifiable Concentration
FAO	=	Food and Agricultural Organization
g	=	Gram
kg/ha	=	Kilogram per hectare
LSD	=	Least Significant Difference
Max.	=	Maximum
Min.	=	Minimum
MOP	=	Muriate of Potash
N	=	Nitrogen
NS	=	Non significant
No.	=	Number
ppm	=	parts per million
RCBD	=	Randomized Complete Block Design
RH	=	Relative Humidity
SAU	=	Sher-e-Bangla Agricultural University
t/ha	=	Tone per hectare
TSP	=	Triple Super Phosphate

CHAPTER I

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) is an important vegetable crop belonging to the family Fabaceae, has been reported to be a native of central and south America (Swiader *et al.*,1992). In Bangladesh it is known as farashi sheem (Rashid, 1993). It is also known as basic bean, navy bean, pinto bean, raj bean, snap bean and string bean (Duke, 1983, Salunkhe *et al.*, 1987; Tindall, 1988). In our country, beans are mainly used as green vegetables. Seeds are also used as pulse in Sylhet, Moulvibazar, Sonamgoj, Hobigonj, Chittagong, etc.

It is widely cultivated in the temperate and sub tropical region and also in many parts of the tropics (Purseglove, 1987). French beans are grown intensively in five major continental areas: Eastern Africa, North and Central America, South America, Eastern Asia, Western and South Eastern Europe. Brazil is the largest french bean producing country in the world. In Bangladesh there is no statistics about the area and production of this crop. It is not new crop in our country and is cultivated in Sylhet, Cox's Bazar, Chittagong Hill Tracts and some other parts of the country in a rather limited scale in winter. According to FAO statistics, french bean including other related species of genus *Phaseolus* occupied 27.08 million hectares of the world cropped area and the production of dry green pods was about 1894 million tons with an average yield of 699 kg/ha (FAO, 2000). Recently cultivation of french bean is gaining popularity in Bangladesh mainly because of its demand as a commodity for export. Hortex Foundation and BRAC are trying to extent the production area, because french bean is now an exportable vegetable among other. Bangladesh presently earns about us $ 15 million per annum by exporting fresh horticultural produces, french bean share a big portion.

Production of french bean depends on many factors such as quality seed variety, sowing time, fertilizer and their proper management. Sowing time is an important factor for the yield of a crop. The optimum sowing time depends on the existing cropping pattern and prevailing environmental conditions. Growers tend to manipulate sowing time in order to obtain better growth and higher quality pod yield. The sowing time is also adjusted so as to synchronize the time of harvest with market demand. French bean can be grown well at 19-27^{0}C. Abdalla and Fischbeck (1978) stated that the pod set of french bean was poor at day/night temperature of 30/25^{0}c. The farmers sometimes sow the seeds of french bean early or late without knowing the optimum sowing time. In Bangladesh, french bean grows successfully in winter due to optimum temperature for their proper growth, development and fruit setting. It is sown in mid October to mid November. However, the temperature remains fairly high unto mid October, which gradually comes down in mid December. French bean is a short duration crop and thus yield per day is comparatively high planting time for bean is, therefore, very critical and sowing of seed should be done carefully so that the crop can take the best advantage of the entire cool period. So, it is important to study the effect of sowing time for achieving optimum yield attributes and yield of french bean.

French bean shows high yield potential, but unlike other leguminous crops it does not nodulated with native Rhizobia (Ali and Kuahwaha, 1987). Therefore the requirement of nitrogenous fertilizer for the crop is of prime importance. Nutrient requirement of different cultivars is usually similar except on poor soils (Adams, 1984). French bean cultivation requires ample supply of nitrogen. Excessive or under doses of nitrogen can affect the yield attributes and yield. So, optimum dose of nitrogen is necessary to produce maximum yield of good quality french bean.

Evidences reveal that sowing time and nitrogen fertilizer play an important role for french bean production. Considering the above facts, the present piece of study was undertaken with the following objectives:

i) To find out the optimum sowing time for maximizing yield attributes and yield of french bean.

ii) To assess the optimum level of nitrogen for maximizing the yield attributes and yield of french bean.

iii) To find out the suitable combination of sowing time and nitrogen dose for ensuring the higher yield of french bean and economic return.

CHAPTER II

REVIEW OF LITERATURE

French bean (*Phaseolus vulgaris* L.) is an important vegetable crop of the world. Research works on different aspects of its production have been carried out in different parts of the world. Many research works have been done in different parts of the world to study the effect of sowing time and different levels of nitrogen on the growth and yield of french bean. It has recently been introduced in Bangladesh. However a very few research work have been carried on french bean production under Bangladesh conditions. Some of the important findings related to the present study are reviewed in this chapter.

2.1 Effect of date of sowing on the growth and yield of french bean

An experiment was carried out by Lee *et al.* (2001) for the determination of seeding and harvesting time in snap bean cultivars of determinate types and indeterminate types in Korea. Seeds Weeds were sown times from 20 March to 18 June at 15-day intervals. The highest pod yield was produced by plants sown on 20 March for determinate types and on 4 April for indeterminate types.

A two season trial in Canterbury, New Zealand, Dapaah *et al.* (2000) studied the influence of sowing date and irrigation on the, growth and yield of pinto bean. The results showed that pinto bean can grow and yield well in Canterbury and that a yield advantage could be obtained when sown in mid to late November and with irrigation.

Sreelatha *et al.* (1997) conducted a field experiment in Andhara Pradesh on French bean cv. PDR 90-14, HUR 142, VL 63 Contender and Chintapalli local sown 1 or 16 November or 1 December. Dry Matter production, leaf area index and crop growth rate decreased with delay in sowing date and were generally highest in cv. PDR 90-14, Net assimilation rate was higher in the November sowing dates than the December sowing date and highest in cv. PDR 90-14.

Akdag (1997) carried out a field trial to study the suitable sowing dates for beans in Tokat. *Phaseolus vulgaris cv.* Tokat Yerli, Horoz and Dermasson were sown on 4 dates between early April and early June. Highest seed yields were obtained with sowing on 23-24 April. There were no significant differences in seed yield between cultivars.

Sharma *et al.* (1997) conducted an experiment in Himachal Pradesh, India to observe the influence of time of sowing on yield of French bean. *Phaseolus vulgaris cv.* KPC 8, HIM jawala and I were sown during the first or third week of May or first week of June. Delay in sowing after the third week in May significantly decreased seed yield.

Shivakumar *et al.* (1996) conducted a field trial to study the performance of winter. French bean as influenced by varieties, spacing and time of sowing. *Phaseolus vulgaris cv.* PDR-14 and HUR-37 were sowing on 15 or 25 October or 4 November in rows 30 or 43 cm. apart with intrarow spacing of 15 cm. Seed yield was similar in the 2 cultivars and was the highest with the 30 x 15 cm spacing and the 25 October sowing time.

Singer *et al.* (1996) investigated the effect of sowing date (9, 19 or 29 February) on the growth and yield of *Phaseolus vulgaris*. They reported that plant height and number of leaves were significantly influenced by sowing date and cultivar. The best plant and quality of pods were obtained from plants sown on 29 February.

Sahu *et al.* (1995) conducted a field trial to find out the performance of rajmash genotypes at different of planting. *Phaseolus vulgaris* cv. PDR 14, VL 63, HUR. 15 and NUR 137 were sown on 15 or 30 October or 15 or 30 November. October 30 was the optimum sowing date and cv. PDR 14 produced the highest yield (mean 1.7 t/ha). PDR 14 sown on 30 October gave significantly more yield that any other combination.

Bhadwaj *et al.* (1994) observed a sharp decrease in the yield of french bean with delayed sowing because of shift of time in fall decrease the number of pods per plants and 1000 grain weight. Beaver and Roman Hernandez (1994) have observed that the pod yield is positively correlated with green-shell yield at different sowing dates.

Azmi and Rathi (1992) conducted field experiment Nainital, India reported the effect of sowing date (15, 30 September; 15, 30 October; 15, 30 November) and cultivars (PDR-14 and UPF –635) on the development, spread and incidence of French bean crinkle stunt virus. The time taken for maximum disease development was less in early sown crops than in the later ones. Delayed sowing decreased disease incidence significantly but the difference in incidence between the cultivars was not significant yield was inversely proportional to disease incidence in sowing up to 30 October but decrease with further delay of the sowing date.

In a field trial at West Bengal, India Chatterjee and Som (1990) investigated the effect of sowing date on growth and seed production on french bean. It was observed that seeds sown in mid September; mid October or mid December gave average seed yields of 1.99, 0.94 and 0.49 t/ha, respectively. Seeds obtained from crops sown on these 3 dates gave 86.5%, 82.0% and 81.5% germination, respectively.

In a field trail at Maharashtra, India Vyas *et al.* (1990) studied the effect of sowing dates on french bean .They reported that 4 *Phaseolus vulgaris* Cultivars sown on 15 October and 30 October and 14 November gave average seed yields of 1.14, 1.23 and 0.95 t/ha, respectively.

Ali and Kushwaha (1987) observed that the seed yields were higher in *Phaseolus vulgaris* sown at the end of October in comparison to that sown on other dates . Seed yield varied with various sowing time (Chagas *et al.*,1982).

Gomez and Araya (1986) had sown eight cultivars of *Phaseolus vulgaris* (bushy type) on 23 May, 30 May, 6 June, and 13 June 1984. They obtained highest yields from earliest sowing (May, 23) and the lowest from the last two sowings in June.

Grafton and Schneiter (1985) reported that in *Phaseolus vulgaris* L., 250 seed weight varied significantly with sowing dates. No significant difference had been observed in seed in seed weight due to variation in sowing dates of chickpeas (Rajput *et al.*, 1986).

Fisher (1980) carried out an experiment at Nairobi, Kenya with four *Phaseolus vulgaris* genotypes compared there sowing dates during one season (April-June, 1976) and four sowing dates during a second season (November, 1976 – January, 1977). He reported a decline in yield with delay in sowing in both the seasons. He also identified the number of pods per plant and flower abscission to be the most important yield contributing characters. The number of pods per plant decreased and flowers abscission increased with the delay in sowing.

Carrasco *et al.* (1979) conducted an experiment in Puerto Rico and found that the September sown plants yielded 100g/m^2 while the November sown ones produced 175 g/m^2 .The optimal sowing season of snap bean as reported by Creso (1975) was found to extend from December to March.

Vieira (1977) observed that French bean sown in October and flowering commenced in mid December .In chickpea, late sowing enhanced early flowering (Haloi and Baldev, 1986).

Scasbrick *et al.* (1976) in a 3 years trial using several sowing dates found that mid May sowing is the best time for acceptable seed yields of *Phaseolus vulgaris* of England. They, however, related the optimum sowing time with optimum soil temperature at a depth of 10 cm (12-13^{0}c). The number of days required from sowing to pod formation varied from 51 to 84 days.

Mota and Shaw (1975) recommended that Australia as the best time for sowing of French bean it economic conditions permit practices, which would raise the soil temperature to the optimum high level.

Kuksal *et al.* (1973) conducted an experiment in India and studied the evaluation of optimum sowing time for dwarf French bean. They reported that maximum growth. Branching vegetative yield and seed yield followed by planting on 16 April and 1June, later sowings gave poorer yield sowing to growth phase limitation.

2.2 Effect of nitrogen on the growth and yield of french bean

Chandel *et al.* (2002) observed a field experiment was conducted to determine the effect of different nitrogen levels (0, 40, 120 kgN/ha) on crop yield nitrogen of uptake and crop quality of french bean cv. HUR-137 in Varanasi, Uttra Oradesh, India, The yield component, crop and protein yield significantly increased with increasing nitrogen level and the highest values registered with 120 kg N/ha. The nitrogen content and nutrient uptake increased with increasing nitrogen level and highest values were recorded with 120 kg N/ ha.

Chawdhuri *et al.* (2001) investigated the nutrient management in french bean in Nagpur, Maharashtra, India. They recommended fertilizer dose of 90 kg N/ha and 60 kg $P_2 0_5$/ha.

Rajesh *et al.* (2001) carried out a field experiment in India to evaluate the effect of N (80, 160 and 240 kg/ha) and S (0, 20, 40 and 60 kg/ ha) on the nutrient uptake and grain yield of french bean (*Phaseolus vulgaris* cv.) HUR 137) The highest grain yield was recorded at N level of 240 kg/ha (2091 kg/ha) and that of straw yields (3331 kg/ha) and the highest total N (90.70 kg/ha) and S (6.58 kg/ha) uptake. Sulphur (S) at 40 kg/ha recorded the highest grain yield (1811 kg/ha) and the highest total N (77.45 kg/ha) and S (6.06 kg/ha) uptake.

In India, Tewari and singh (2000) worked with an experiment on french bean to determine the optimum and economical does of nitrogen (0, 40, 40, 120 and 160 kg/ha) for better growth and seed yield. They reported that application of 120 kg N/ ha produced significantly higher number of pods per plant, weight of seeds per plant, number of seeds per pod and seed yield, whereas 160 kg N/ ha significantly reduced seed yield.

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

Singh and Singh (2000) carried out field trial in India with different nitrogen levels on yield and yield components of french bean. (0, 40, 80 or 120 kgN/ha). 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, 75 P_2O_5 kg/ha and 50 kg k_2O/ha was the best combination in terms of economics and seed yield.

Rana and Singh (1998) showed that seed and straw yield were increased significantly with increasing nitrogen rate in french bean. They used 0, 40, 80 or 120 kg N/ ha and 0, 50 or 100 kg P_2O_5/ ha. The mean increase in seed yield with 120 kg N/ ha compared with 0, 40 mid 80 kg N/ ha was 66.6, 21.7 and 7.0% respectively. Gajendra and Singh (1998) stated that application of 120 kg N, 90 kg P_2O_5 and 45 kg K_2O per hectare gave higher grain yield of french bean.

Devender *et al.* (1998) carried out an experiment to study the effect of nitrogen and phosphorus on yield of french bean and stated that application of nitrogen upto 15 kg and 60 kg P_2O_5/ha significantly increased seeds per pod and seed yield.

Sushant *et al.* (1998) conducted an experiment in Uttar Pradesh to investigate the effect of irrigation, nitrogen and phosphorus on the seed yield of french bean and stated that application of nitrogen upto 100kg/ha and unto 60 kg P_2O_5/ha significantly increased the yield attributes, yield and water use efficiency.

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 upto 90 kg N/ha. Application of 120 kg N/ha did not result in any further increase in yields compared to the 90 kg N/ha application.

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 (1.41 t/ha) and at the density of 3, 33,333 plant/ha (yield 1.14 t) and the row spacing of 30 cm (yield 1.13 t).

Singh *et al.* (1996) investigated from an experiment in Uttar Paradesh, India to the response of French to spacing and nitrogen levels. They reported that seed yield increased with up to 120 kg N and 30x10 cm spacing.

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

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) They stated that seed yield increased from 0.38 to0.92 t/ha with the increase in number of irrigation and it increased with up to 90 kg N/ha

Bhatnagar *et al.* (1992) conducted a field trial at Rajasthan, India to find out the effect of nitrogen on French bean during winter. Nitrogen was applied at 20,40.or 60 kg N/ha .They reported that seed yield and nitrogen uptake in seed increased and crude protein percentage decreased with increase in nitrogen application rate.

Parthiban and Thamburaj (1991) conducted an experiment in India and recorded increased grain yield with nitrogen fertilization up to 50 kg/ha in french bean. Number of pods and grain yield per plant increased significantly with nitrogen fertilization over the control.

Hedge and Srinivas (1990) worked in India on plant water relation and nutrient uptake in french bean and observed that nitrogen application increased green pod yield, nutrient uptake and water use efficiency.

A field experiment was carried out by Srinivas and Naik (1990) at Bangalore, India to investigate the growth, yield and nitrogen uptake in vegetable french bean as influenced by nitrogen. Nitrogen was applied at 0, 40, 80,120 and 160 kg t/ha. They observed that application at of nitrogen increased plant growth, nutrient uptake and yield of green pods.

In India, Hedge and Srinivas (1989) conducted an experiment in India to study the effect nitrogen on growth and yield of french bean .In their trial, the crop received 0, 40, 80 or 120 kg/ha of nitrogen. The green pod yield was the greatest (124.3-132.3 q/ha) at the highest N rate. Kuccy (1989) noted that addition of nitrogen at 30mg/kg soils had stimulatory effect on plant growth.

An experiment was carried out by Srinivas and Narik (1988) at Bangalore. India to study the response of vegetable french bean to nitrogen. Nitrogen was applied at 0, 40, 80,120 and 160 kg/ha. They reported that pod yields were increased with increasing fertilizer rate, from 3927 kg/ha at o kg N/ha to 13169 kg/ha at 160 kg N/ha.

Bhopal and Singh (1987) conducted a field experiment in Himachal Pradesh to find out the response of French bean to nitrogen and phosphorus fertilization with *Phaseolus vulgaris* beans grown for green pods. Nitrogen was applied at 0-90 kg/ha and P_2O_5 at 0-120 kg/ha, and a basal does of K_2o at 50 kg/ha. The optimum nitrogen: phosphorus dose was 67.3 : 79.7 kg/ha; it gave yield over 210 q/ha.

Chandra *et al.* (1987) reported from an experiment that plant growth was increased with increasing rate of nitrogen in French bean. Sa *et al.* (1982) observed that with the application of various N fertilizer doses, pod number per plant was significantly influenced. Srinivas and Naik (1988) reported that increasing N fertilizer increased the pod yield in french bean.

In field trial at varanasi, India Chandra *et al.* (1987) showed that plant growth and yield (46.19-71.59 q/ha) increased with seed inoculation with increased with increasing N (0-50 kg/ha) and with seed inoculation with *Rhizobium*.

Ali and Tripathi (1986) worked with an experiment in Uttar Pradesh, India to observe the influence of nitrogen levels (0-60 kgN/ha) on french bean and noticed that number of pods /plant, 100 seed weight, seed yield and seed protein content increased with increasing nitrogen rate.

Singh *et al.* (1981) showed that seed yields of *Phaseolus vulgaris* were increased significantly with increasing N rates (0-120 kgN/ha) and with upto 60 P_2O_5 Kg/ha. Another experiment was carried out by Sa *et al.* (1982) and observed that in case of application of various fertilizer doses there were significant differences in pod number per plant in french bean.

2.3 Interaction effect of the growth and yield of french bean

Griffin *et al.* (2001) conducted a two years to trial to investigate the effects of season, sowing date, population, additional N and inoculation with Rhizobia on yield of pinto bean in England. Pod yield was greater with the 2 May than 22 May sowing.

While carrying out an experiment on the production technology of french bean cultivation in India, Virender *et al.* (2000) found that the sowing time differs greatly in different agro climatic conditions. It is sown from March to October in different parts of the country. Its higher yield can be obtained with the application of nitrogen up to 120 kg/ha and phosphorus up to 60 kg/ha.

In India Vinod *et al.* (1999) investigated the effect of sowing time (5 and 20 October and 4 and 19 November) and graded rates of nitrogen (0, 50, 100 and 150 Kg/ha). They reported that number of pods per plant, green pod weight per palnt (g) and pod yield (g/ha) increased with sowing on 4 November and with 150 kg N/ha.

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 kgN/ ha. Seed yield and total P uptake increased with to up to 25 KgN/ha, whereas total N and K uptake increased with up to 37.5 kg N/ha.

Rennie and Kemp (1981) observed from a field trial in Canada with eleven french bean cultivars representing a wide range of types, inoculated with *Rhizobium Phaseoli* and grown in a nitrogen-free medium in a controlled environment at two low temperature regimes corresponding to mid May or early June plantings. There were differences between cultivars in their ability to fix nitrogen under the two

low temperature regimes. Tand early June plantings fixed more nitrogen than mid-day ones.

Hardwick (1972) carried out a field trial to study the emergence and early growth of French bean and runner bean sown on different time (from April onwards). He observed that very early sowing appeared to have a lasting depressive effect on the growth rates of seedlings of both species. The estimated weights of seedlings at emergence were lower in the early sowings than in later sowings.

From the above mentioned literatures, it can be concluded that both the date of sowing and nitrogen levels have significant effect on the yield contributing characters and yield of French bean It is also observed that higher doses of nitrogen performed better at early sowing that lower does of nitrogen and late sowing.

CHAPTER III

MATERIALS AND METHODS

In this chapter short descriptions of the location of the experimental plot climatic condition of the area experimental materials used for, design of the experiment, methods of cultivation and data collection, statistical analysis and economic analyses have been presented.

3.1 Experimental site

3.1.1 Location

The research work was conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka-1207 to study the effect of sowing time and nitrogen on the yield contributing characters and yield of French bean during the period from November 2006 to March 2007. Experimental field was located at $90^0$22 longitude and $23^0$41N latitude and altitude of 8.6 m above the sea level.

3.1.2 Characteristics of soil

Land was Agro ecological zone of modhupur tract (AEZ no. 28). It was deep red brown terrace soil and belongs to "Noadda" cultivated series. The selected Experimental site was well-drained medium high land. Soil was silt loam in texture having pH 6.18. The amount of organic carbon, total N, available P and K were 1.25%, 0.08%, 20ppm and 0.20 mg/100g soil, respectively. Physical and chemical characteristics of the soil have been presented in Appendix I.

3.1.3 Climate

Experimental area belongs to subtropical climatic zone which is characterized by heavy rainfall high temperature and relatively long day period during "Kharif-1"

season (April-September) and scarce rainfall low humidity low temperature and short day period during "Rabi" season (October-March). This climate is also characterized by distinct season viz., the monsoon extending from May to October , the winter or dry season from November to February and per-monsoon period or hot season from March to April (Edris *et al.* 1979). The meteorological data in respect of temperature, rainfall, relative humidity average sunshine and soil temperature for the entire experimental period have been shown in Appendix II.

3.2 **Planting materials**

Variety of french bean used in the experiment was "BARI Zhar Sheem-1". Seeds were collected Bangladesh Agricultural Research Institute (BARI) Joydebpur, Gazipur.

3.3 **Treatments of the experiment**

The experiment involved two factors, namely, (i) Factor A: Sowing time and (ii) Factor B: Nitrogen.

Factor A: Sowing time

It consisted of four sowing time such as:

i. 15 November, 2006 (T_1)

ii. 30 November, 2006 (T_2)

iii. 15 December, 2006 (T_3)

iv. 30 December, 2006 (T_4)

Factor B: Nitrogen

Four levels of nitrogen (kg/ha) used were as follows:

i. 0 kg/ha (N_0)

ii.45 kg/ha (N_1)

iii.90 kg/ha (N_2)

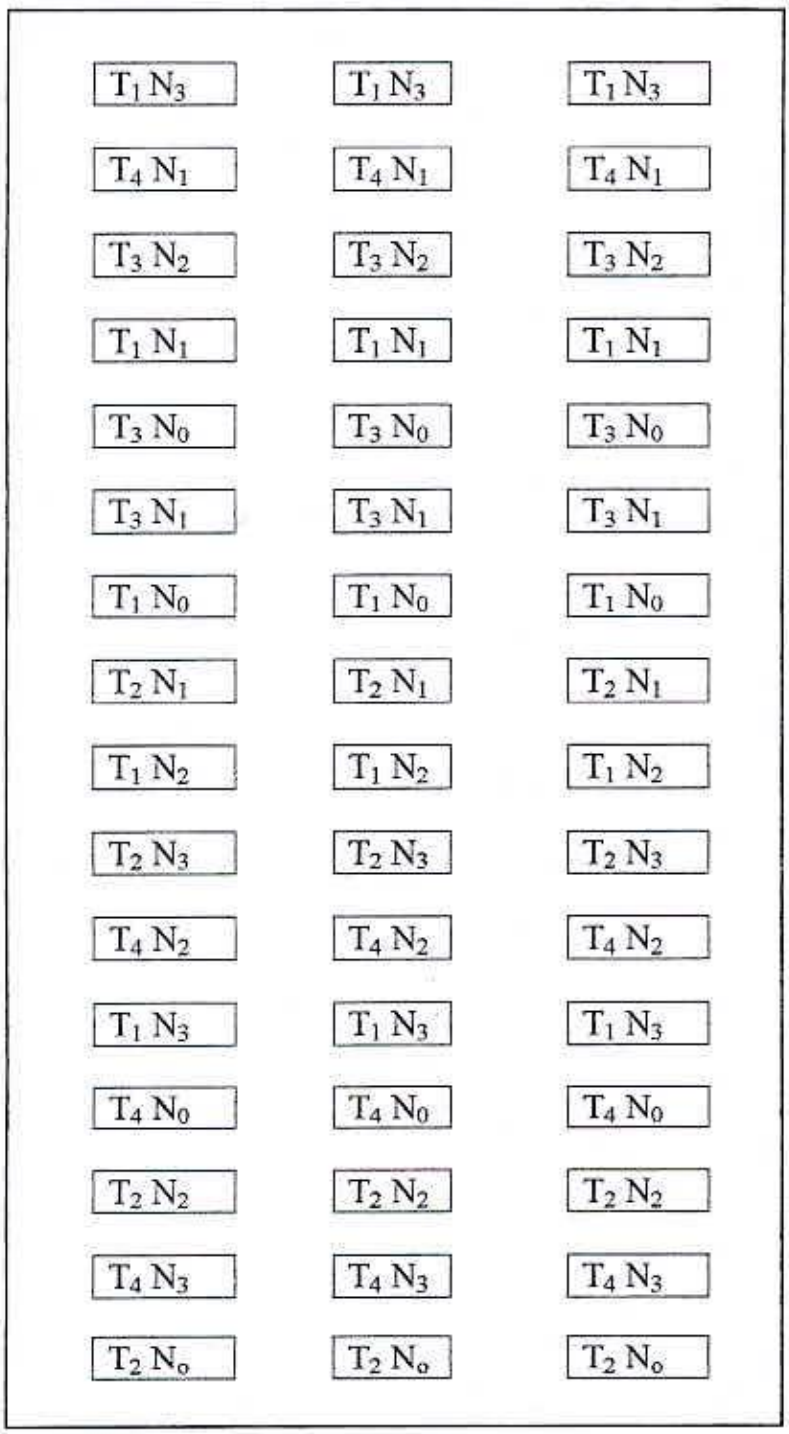
iv.135 kg/ha (N_3)

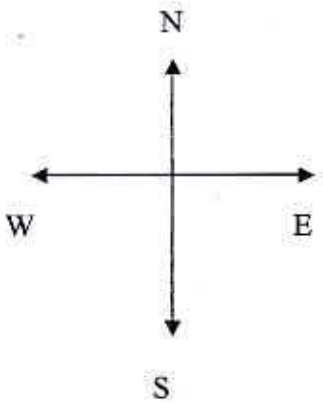
3.4 Design and layout of the experiment

The two factors was laid out in the Randomized Complete Block Design (RCBD) with there replication was divided into equal 3 blocks and each consists of 16 plots. Each unit plot was 2.1m×1.5 m in size .All together there were 48 unit plots in experiment and required 306.09 m^2 land. Distance between replication was 75 m and plot was 0.5 m. Treatments were randomly assigned to each of the block. Each unit plot had 5 rows with 30 cm distance and having 15 cm space in plant to plant.

3.5 Land preparation

At first the land was ploughed with a power tiller on 2 November 2006 and kept open to sunlight. Afterwards the experimental plot was prepared by five ploughings and cross ploughings followed by laddering to break the clods and to level the soil. The weeds and stubble of previous crops were collected and removed from the soil. These operations were done to bring the land under good tilth for sowing of seeds.





Plot size : 2.1 m × 1.5 m
Block spacing : 0.75 m
Plot spacing : 0.50 m
Spacing : 30 cm x 15 cm

Factor A : Sowing time
T_1= 15 November
T_2 = 30 November
T_3 = 15 December
T_4 = 30 December

Factor B : Nitrogen
N_o= No nitrogen
N_1 = 45 kg N/ha
N_2 = 90 kg N/ha
N_3 = 135 kg N/ha

Fig. Field layout of the experiment

3.6 Manure and fertilizer application

The following dose of manure and fertilizer were applied in the experimental plot.

Manure/fertilizer	Dose/ha	Dose/plot
Cowdung	10 ton	3 kg
TSP	150 kg	45 g
MOP	150 kg	45 g

The entire amount of well-decomposed cowdung, triple super phosphate (TSP) and muriate of potash (MOP) were applied and mixed with the soil during final land preparation. Nitrogen was applied as per treatment in the form of urea. The half amount of urea was applied during final land preparation and rest amount of urea in two installments at 15 and 30 days after sowing (DAS) seeds .Applied fertilizers were mixed properly with the soil of the plot.

3.7 Sowing of seeds

Seeds were sown at four different time viz. 15 November, 30 November, 15 December and 30 December 2006. In each plot seeds were sown in rows and there were five rows in each plot .In the row, plant to plant distance was 15cm and row-to-row distance was 30cm. Two seeds were sown in each hill at a depth of about 30 cm soil. The seeds were covered with pulverized soil just after sowing and gently pressed with hands surrounding of the experimental plot rows of french bean, plants were sown as border crops to reduce border effect.

3.8 Intercultural operations

3.8.1 Gap filling

During seed sowing, few seeds were sown in the border of the plots. Seedling was transferred to fill up the gap where seeds failed to germinate. Seedlings of about 15 cm in height were transplanted from border rows with roots plunged 5 cm below the soil in hills in the evening and when watering was done to protect the seedlings from wilting. All gaps were filled up within tow weeks after germination of seeds.

3.8.2 Thinning

When the plants well established, one healthy plant per hill was kept and remaining one was pull out.

3.8.3 Weeding

Experimental plots were kept weed free by hand. Weeding was done as necessary.

3.8.4 Irrigation

Irrigation was done whenever necessary. The young plants were irrigated by watering can. Beside this, irrigation was give four times at an interval of 10 days.

3.8.5 Plant protection

a. Insect pests

At the early stage of growth, some plants were attacked by insect pests (mainly aphids) and Malathion 57 EC was sprayed at the rate of 2ml/liter at an interval of 15 days.

b. Diseases

Seedlings were attacked by damping off and Dithane M-45 was sprayed at the rate of 2 ml/liter in water at an interval of 15 days. Some plants were attacked by bean common mosaic virus (BCMV), which was an important disease of French bean. These plants were removed from the plots and destroyed immediately.

3.9 Harvesting

As the seeds were sown in the field at four different times, the crops were harvested at different times when they reached harvestable maturity. Harvesting started from 3 January and continued up to 8 March. Botanical immature green pods were harvested at tender stage through hand picking and weighed to estimate the yield of fresh pod. At harvest, pods were nearly full size with the seeds still small with firm flesh (Swiader *et al.*1992). Pods were soft and smooth during harvesting.

3.10 Collection of data

Ten plants were selected at random in such a way that the border effect could be avoided. For this reason, the outer two lines and the outer plants of the middle lines in each unit plot were avoided. The details of data recording are given below.

3.10.1 Percentage of seedlings emergence

Cumulative emergences of seedling were recorded and were converted into percentage. It was observed after sowing upto attaining 80% emergence. The cotyledons coming out above the ground was considered to have been emerged.

3.10.2 Plant height (cm)

Plant height was recorded at 15, 25, 35 and 45 days after sowing (DAS). The plant height was taken from ground level to the tip of the largest leaf of the plants. Plant

heights was recorded from 10 randomly sampled plants and mean was calculated in centimeter (cm).

3.10.3 Number of leaves per plant

Number of leaves from 10 randomly selected plants from each unit plot at 10 days interval from 15 DAS to 45 DAS was calculated.

3.10.4 Leaf length (cm)

Leaf length (cm) was measured by using measuring scale from 10 randomly selected plants from each unit plot at 45 DAS and mean was recorded.

3.10.5 Leaf breadth (cm)

Leaf breadth (cm) was measured by using measuring scale from 10 randomly selected plants from each unit plot at 45 DAS and mean was recorded.

3.10.6 Number of branches per plant

Average number of branches per plant was found from 10 randomly selected plants from each unit plot at 45 DAS and mean was recorded.

3.10.7 Days to first flowering

The number of days from sowing to first flower opening was recorded from 10 randomly selected plants.

3.10.8 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.

3.10.9 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.

3.10.10 Length of green pod (cm)

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

3.10.11 Diameter of green pod (cm)

Diameter of green pod from 10 randomly selected plants from each unit plot was measured in cm with the help of slide calipers and their average was taken and was expressed in cm.

3.10.12 Number of seeds per green pod

Number of seeds per green pod was recorded from 10 randomly selected plants and the mean value was calculated.

3.10.13 Weight of fresh pods per plant (g)

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

3.10.14 Number of roots per plant

The number of roots was counted from 10 randomly selected plants at the time of harvesting.

3.10.15 Dry matter content of plant (%)

One hundred grams fresh weight of plant was taken from 10 randomly selected plants from each experimental plot. This 100 g plant was cut with a fine knife,

there after, dried under room condition and kept in an oven at 70°c for drying at 72 hours until the constant weight was reached. The percentage of plant dry matter was calculated by the following formula.

$$\text{Dry matter content of plant (\%)} = \frac{\text{Dry weight of plant}}{\text{Fresh weight of plant}} \times 100$$

3.10.16 Dry matter content of pod (%)

One hundred gram of fresh weight of pod was taken from 10 randomly selected pods of each experimental plot. This 100 g pod was cut with a fine knife, there after, dried under room condition and kept in an oven at 70°c for drying at 72 hours until the constant weight was reached. The percent pod dry matter content was calculated by the following formula.

$$\text{Dry matter content of pod (\%)} = \frac{\text{Dry weight of pod}}{\text{Fresh weight of pod}} \times 100$$

3.10.17 Pod yield

Green pod were harvested at regular from each unit plot and their weight was recorded. As harvesting was done at different interval and the total pod weights were recorded in each unit plot and expressed in kilogram (kg). The green pod yield per plot was finally converted to yield per hectare and expressed in ton (t).

3.11 Statistical analysis

Statistical analysis was done by using MSTATC statistical package program. The analyses of variance for the characters under study were performed by F variance test and ANOVA table has been presented in Appendix III. The mean differences were adjudged by using the Duncan's Multiple Range Test (Gomez and Gomez, 1984).

3.12 Economic analysis

Economic analysis was done in order to find out the find the most profitable treatment combinations. Calculation was done in details according to the procedure of Alam *et al.* (1989)

3.12.1 Total cost of production of French bean

All the non-material inputs cost, interest on fixed capital of land, total input cost and miscellaneous cost were considered for computing the total cost of production. The interest was calculated @12% for six months and miscellaneous cost was considered as 5% of the total input cost.

3.12.2 Gross return

Gross return was calculated on the sale price of marketing green pod of french bean. The price of green pod in the market was assumed to be Tk. 15,000/t.

3.12.3 Net return

Net return was by deducting the total production cost from the gross return for each treatment combination.

3.12.4 Benefit cost ratio

Economic indicator BCR was calculated using following formula for each treatment combination.

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Gross return}}{\text{Total cost of production}}$$

CHAPTER IV

RESULTS AND DISCUSSION

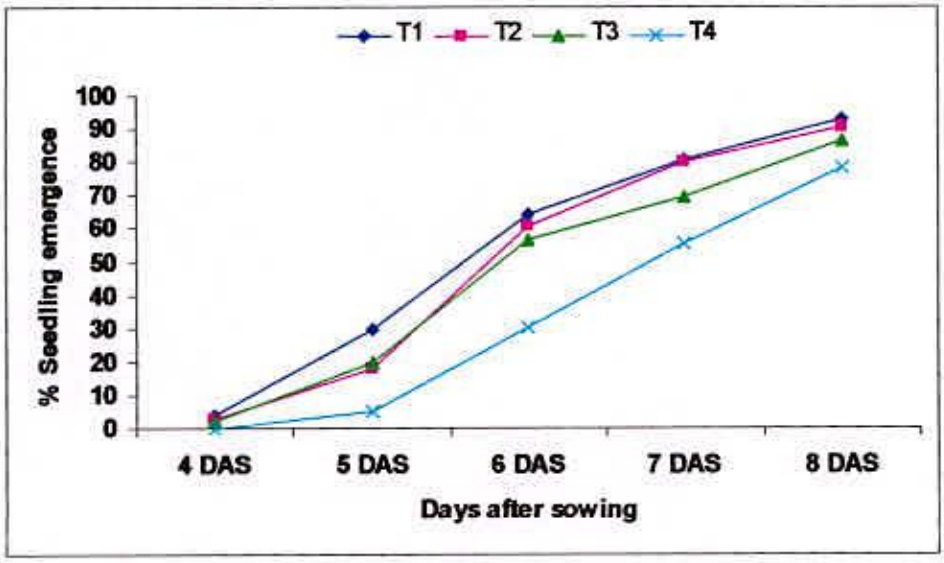
Experiment was conducted to investigate the effect of sowing time and different level of nitrogen on the growth and yield of french bean at the farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2006 to March, 2007. Analysis of variance of the data on different plant characteristics obtained from present study are shown in Appendix III. Results of the experiment as influenced by sowing time, different level of nitrogen and their different combinations have been present and discussed in this chapter under the following headings.

4.1 Percentage of seedlings emergence

Sowing time had significant on germination of french bean seed (Fig. 1). The highest germination (93.1%) at 8 DAS was found with 15 November sowing time, while it was the lowest (78.5%) at 8 DAS with that of 30 December sowing time. Germination percentage gradually decreased with the delay in sowing. In 15 November sowing emergence speed was the highest.

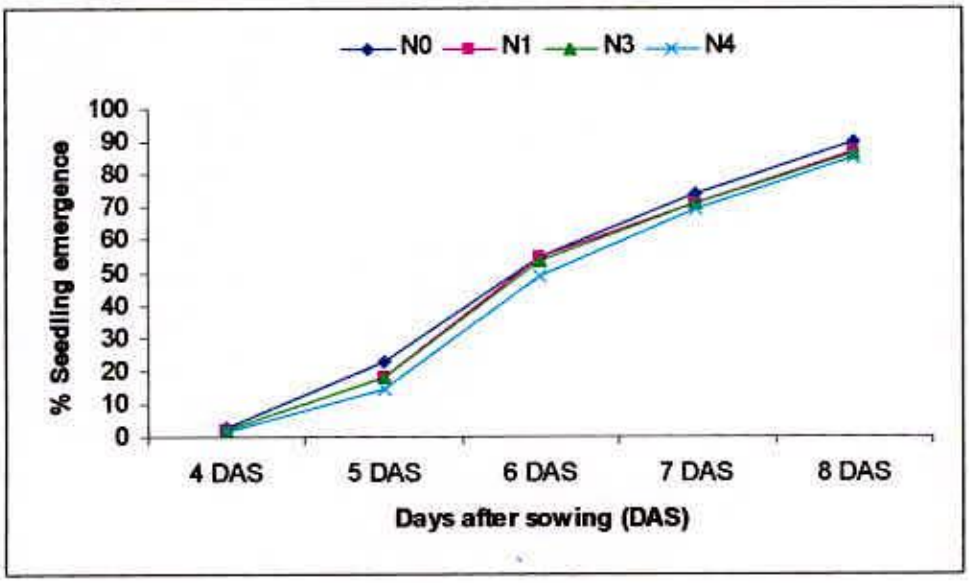
Germination percent varied significantly by different level of nitrogen (Fig. 2). The maximum germination (89.8%) at 8 DAS had been recorded with 0 kgN/ha and the minimum germination (85.5%) at 8 DAS with 135 kgN/ha germination percentage decreased with the increase in nitrogen rate.

Combined effect between sowing time and different levels of nitrogen in respect of percentage of seedlings emergence was found to be significant at 8 DAS (Appendix III). The results in this regard have been presented in Table 1. Treatment combination of 15 November sowing with 0 kg N/ha gave maximum germination (94.8%) at 8 DAS and minimum (77.4%) at 8 DAS was found in the treatment combination of 30 December sowing time with 135 kg N/ha.



T_1 : 15 November T_2 : 30 November
T_3 : 15 December T_4 : 30 December

Fig. 1 Effect of sowing time on percentage of seedling emergence of french bean



N_0 : 0 kg N/ha N_1 : 45 kg N/ha
N_2 : 90 kg N/ha N3 : 135 kg N/ha

Fig. 2 Effect of nitrogen on percentage of seedling emergence of french bean

4.2 Plant height

Result on the main effect of sowing time on the growth and yield of French bean at 15, 25, 35, and 45 DAS have been presented in Fig. 3. Plant height of French bean varied significantly at 15, 25, 35 and 45 days after sowing (DAS) due to date of sowing. At 15 DAS, the longest plant height (14.9 cm) was observed due to 15 November sowing and the shortest (12.2 cm) plant was observed due to 30 December sowing. Similar trend was followed at 25, 35 and 45 days after sowing. At 25 DAS, the longest (26.8 cm) plant height was recorded from 15 November sowing and the shortest (24.4 cm) from 30 December sowing. At 35 DAS, the longest plant height (49.01cm) was observed due to 15 November sowing and the shortest (36.3 cm) plant was observed due to 30 December sowing. At 45 DAS, the longest plant height (57.8cm) was observed due to 15 November sowing and the shortest (47.2 cm) plant was observed due to 30 December sowing. The plant height gradually decreased with the delay in sowing. This difference may be due to difference in climate. Andrews *et al.* (1983) reported that the low temperature in December suppressed the growth of lateral branches. The plant height might have varied due to the effect of low temperature prevailing during December. The reported by Singer *et al.* (1996) plant height was significantly influenced by sowing date.

Significant variation of plant height was observed due to application of different levels of nitrogen (Fig.4). At 15 DAS, the longest (15.4cm) plant was produced due to application of 135 kg N/ha which was identical (14.6cm) to 90 kg N/ha and the shortest (12.2 cm) plant was produced in control treatment. At 25 DAS, the longest (28.0 cm) plant was produced due to application of 135 kg N/ha which was identical (25.7 cm) to 90 kg N/ha and the shortest (22.9 cm) was found from 0 kg N/ha.At 35 and 45 days after sowing, similar patterns of results were observed due to nitrogen application. At 35 DAS, the longest (44.5 cm) plant was produced in 90 kg N/ha and the shortest (39.9 cm) was found from control treatment. At 45

DAS, the longest (55.8 cm) plant and the shortest (50.6 cm) plant were observed due to application of 135 kg N/ha and control condition, respectively. Vishwakarma *et al.* (2002) also observed that the plant height increased due to application of nitrogen in french bean. Arya *et al.* (1999) reported that application of nitrogen promotes the growth of french bean. It was due to the fact that plant received more nitrogen, which encouraged more vegetative growth. Similar were reported by Srinivas and Naik, (1988) and Chandra *et al.* (1987).

Significant variation of plant height was observed due to combined effect of sowing time and nitrogen level (Appendix III). At 15 DAS, the longest (17.4 cm) plant was produced due to 15 November sowing and 135 kg N/ha (T_1N_3). The shortest plant (11.0 cm) was produced due to 30 December sowing and 0 kg N/ha (T_4N_O). At 25 DAS, the longest (31.9cm) plant was produced due to 15 November sowing and 135 kg N/ha obtained from the treatment combination of (T_3N_O) and the shortest plant (25.5 cm) was 15 December sowing and 0 kg N/ha. At 35 DAS, the longest (53.3 cm) plant was obtained from 15 November sowing and 135 kg N/ha which was identical to 15 November sowing and 90 kg N/ha (51.6 cm). The shortest plant (35.1 cm) was produced due to 30 December sowing and 0 kg N/ha (T_4N_O). At 45 DAS, the longest (63.3 cm) plant was produced due to 15 November sowing and 135 kg N/ha which was Similar to 15 November sowing and 90 kg N/ha (62.6 cm). While the shortest plant (46.8 cm) was produced due to 30 December sowing and 0 kg N/ha (Table 1).

Tabl 1 Combined effect of sowing time and level of nitrogen on percentage of seedling emergence, plant height and number of leaves of french bean

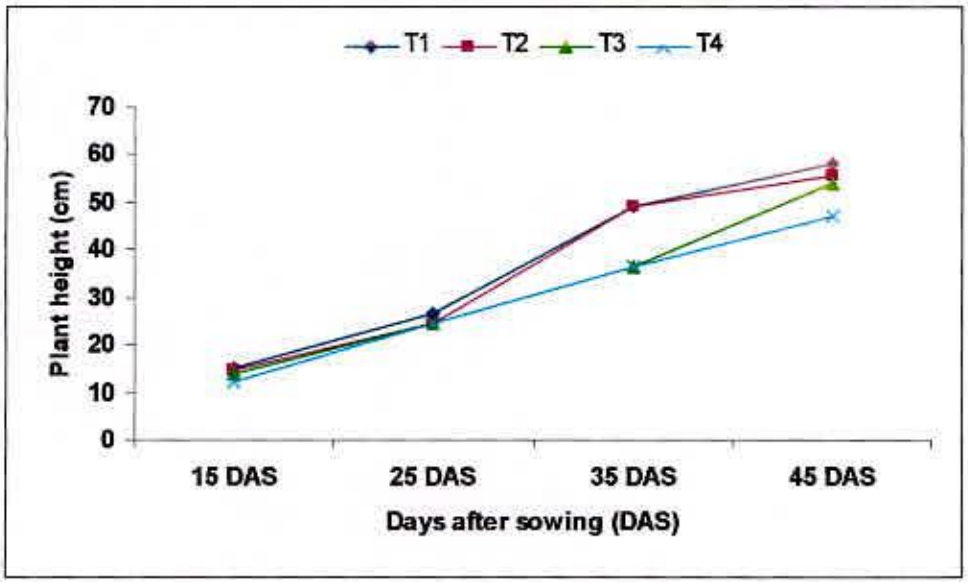
Factor A X Factor B	Percent of seedling emergence					Plant height (cm)				Number of leaves per plant			
	4 DAS	5 DAS	6 DAS	7 DAS	8 DAS	15 DAS	25 DAS	35 DAS	45 DAS	15 DAS	25 DAS	35 DAS	45 DAS
T_1N_0	4.6b	31.2b	65.1b	80.5bc	94.8a	12.3hi	22.9fgh	43.0f	51.4f	3.8a	4.6 gh	10.8	15.6
T_1N_1	3.5c	28.7c	62.5cd	77.4d	90.5bc	14.2d	25.0d	48.0d	59.1b	3.5abc	6.20e	10.7	17.0
T_1N_2	5.1b	33.8a	68.2a	86.1a	93.3a	15.8b	27.3c	51.6ab	62.6a	3.6ab	8.8ab	12.1	17.3
T_1N_3	2.5d	25.6d	61.5cde	78.4cd	91.8b	17.4a	31.9a	53.3a	63.3a	3.8a	8.9a	13.3	19.0
T_2N_0	6.1a	18.9f	63.5bc	80.5bc	92.3b	13.6de	22.8fgh	45.4e	51.6f	3.0bcd	5.9ef	11.8	16.1
T_2N_1	3.5c	21.5e	61.0de	81.0bc	90.2bc	13.9d	22.1h	49.3cd	54.1de	3.6ab	8.8a	11.9	16.1
T_2N_2	1.5e	17.9fg	58.9f	83.0b	91.8b	15.3bc	24.9de	50.1bc	57.2bc	3.5abc	7.6cd	12.4	17.1
T_2N_3	0.0f	14.3h	58.9f	76.4d	88.7c	15.9b	28.7b	51.0bc	59.2b	3.6ab	7.9bc	13.0	18.1
T_3N_0	2.0de	27.6cd	60.0ef	76.9d	91.2bc	11.9i	20.3i	36.3g	53.8e	3.0abc	6.3e	10.7	14.6
T_3N_1	2.0de	18.9f	63.0cd	71.8e	91.2bc	13.0fg	22.3gh	35.9g	56.2cd	2.9bcd	6.7de	10.8	14.2
T_3N_2	1.5e	17.9fg	54.3g	62.5g	81.0e	15.0c	27.2c	35.5g	56.6c	2.3de	5.7efg	11.4	15.4
T_3N_3	3.5c	15.8gh	50.2h	68.0f	83.5d	15.1c	28.0bc	37.2g	55.6cde	2.8cd	6.2e	12.9	16.0
T_4N_0	0.0f	14.3h	30.2j	58.4h	81.0e	11.0j	25.5d	35.1g	46.8g	2.3de	4.6gh	9.9	11.1
T_4N_1	0.0f	3.5i	33.8i	55.3i	77.9f	11.9i	24.7de	37.2g	47.0g	2.0e	4.5h	10.0	12.4
T_4N_2	0.0f	2.5i	32.8i	53.8i	77.6f	12.6gh	23.7ef	36.2g	49.9f	3.1abc	4.9fgh	11.7	13.0
T_4N_3	0.0f	1.5i	24.6k	54.8i	77.4f	13.3ef	23.5fg	36.6g	49.9f	2.07e	4.8gh	11.1	12.8
LSD(0.05)	0.54	2.30	1.90	2.65	2.49	0.56	1.20	1.89	2.0	0.68	1.01	3.05	3.54
Level of significance	**	**	**	**	**	**	**	**	**	**	**	NS	NS
CV (%)	14.33	7.49	2.14	2.22	1.71	2.44	2.87	2.66	2.29	13.30	9.31	6.86	4.58

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.

Sowing time
T_1 : 15 November
T_2 : 30 November
T_3 : 15 December
T_4 : 30 December

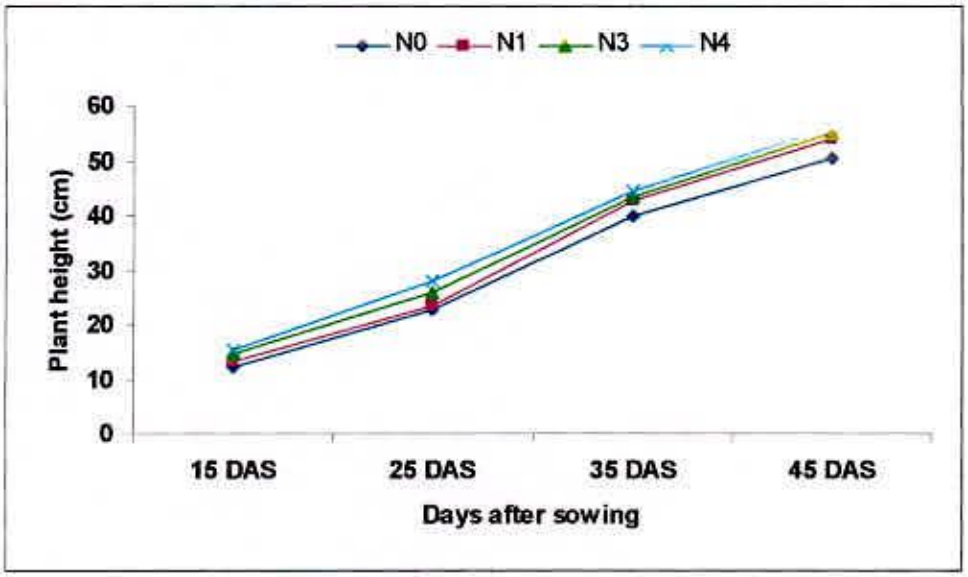
Nitrogen level
No = 0 kg N/ha
N_1 = 45 kg N/ha
N_2 = 90 Kg N/ha
N_3 = 135 kg N/ha

DAS = Days after sowing
CV = Co efficient of variance
*** = Significant at 5% level of probability**
**** = Significant at 1% level of probability**
NS = Non significant



T_1 : 15 November T_2 : 30 November
T_3 : 15 December T_4 : 30 December

Fig. 3 Effect of sowing time on plant height of french bean



N_0 : 0 kg N/ha N_1 : 45 kg N/ha
N_2 : 90 kg N/ha N3 : 135 kg N/ha

Fig. 4 Effect of nitrogen on plant height of french bean

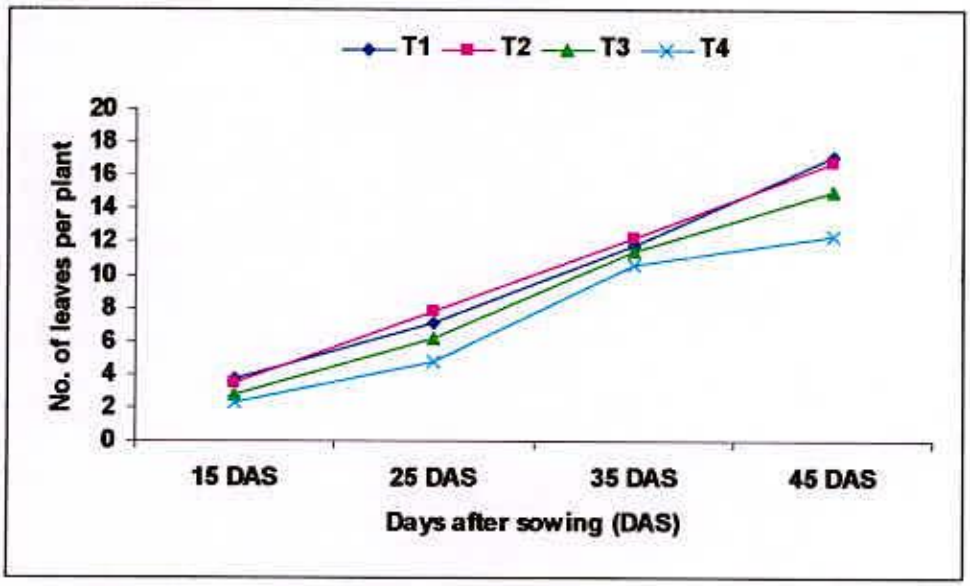
4.3 Number of leaves per plant

An increase in number of leaves indicates good growth and development of french bean and is directly related to the yield of pod. The more the leaf, the more the photosynthetic area and there by higher yield. Number of leaves per plant of French bean varied significantly at 15, 25, 35 and 45 days after sowing (DAS) due to application of sowing time (Fig. 5). At 15 DAS, the maximum (3.7) and the minimum (2.3) number of leaves per plant was recorded due to 15 November sowing and 30 December sowing, respectively. At 25 DAS, the maximum (7.1) number of leaves per plant was recorded due to 15 November sowing and the minimum (4.7) was found from 30 December. At 35 DAS, the maximum (12.3) number of leaves per plant was recorded due to 30 November sowing which was identical to 15 November sowing (11.7) and the minimum (10.7). At 45 DAS, the maximum (17.2) number of leaves per plant was recorded due to 15 November where as the minimum (12.3) was found from 30 December sowing. The difference in number of leaves caused by date of sowing might be due to the variation in the environmental conditions. Earlier sowings seemed to obtain favorable climate and longer time for growth than the late sowings. Sowing date had significant influenced on number of leaves per plant of french bean. The results are in conformity with that of Singer *et al.* (1996).

Number of leaves per plant of french bean varied significantly at 15, 25, 35 and 45 days after sowing (DAS) due to different nitrogen levels (Fig. 6). The maximum (3.2) number of leaves per plant was recorded due to application of 90 kg N/ha and the minimum (3.0) was recorded from control at 15 DAS. At 25 DAS, the maximum (6.9) number of leaves per plant was recorded due to application of 135 kg N/ ha and the minimum (5.3) was found from control condition. At 35 DAS, the maximum (12.6) number of leaves per plant was obtained due to

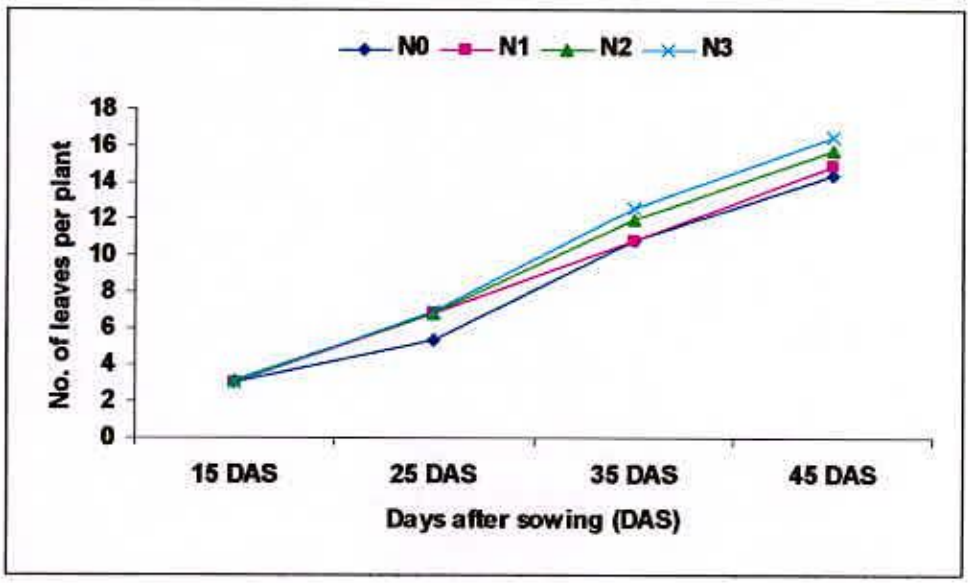
application of 135 kg N/ha and the minimum (10.8) was found from control treatment. The minimum (16.5) number of leaves per plant was recorded from 135 kg N/ha and the minimum (14.3) was obtained from control at 45 DAS.

The combined effect of sowing time and nitrogen was significant at 15 DAS and 25 DAS for number of leaves per plant and non-significant at 35 DAS and 45 DAS for number of plant of french bean (Table 1 and Appendix III). Number of leaves per plant of french bean was the lowest in control at all observation. At 15 DAS, the highest (3.8) number of leaves per plant of french bean was observed due to combined effect of 15 November sowing and 135 kg N/ha and the lowest (2.03) number of leaves per plant of French bean was found from the combined effect of 30 December sowing and 0 kg N/ha. At 25 DAS, the highest (8.9) number of leaves per plant of french bean was observed due to combined effect of 15 November sowing and 135 kg N/ha and the lowest (4.6) number of leaves per plant of french bean was observed due to interaction of 30 December sowing and 0 kg N/ha. At 35 DAS, the highest (13.3) number of leaves per plant of french bean was observed due to interaction of 15 November sowing and 135 kg N/ha and the lowest (9.9) number of leaves per plant recorded was due to 30 December sowing and 0 kg N/ha. At 45 DAS, the highest (19.0) number of leaves per plant of French bean was observed due to interaction of 15 November sowing and 135 kg N/ha (T_1N_3) and the lowest (11.1) number of leaves per plant was recorded from the treatment combination of 30 December sowing and 0 kg N/ha (T_4N_0).



T_1 : 15 November T_2 : 30 November
T_3 : 15 December T_4 : 30 December

Fig. 5 Effect of sowing time on number of leaves per plant of french bean



N_0 : 0 kg N/ha N_1 : 45 kg N/ha
N_2 : 90 kg N/ha N_3 : 135 kg N/ha

Fig. 6 Effect of nitrogen on number of leaves per plant of french bean

4.4. Leaf length

There was significant variation in the leaf length due to sowing time (Table 2). The highest leaf length (18.2 cm) was recorded from the 15 November sowing (T_1) and the lowest length (13.1 cm) was obtained from the 30 December sowing (T_4).

There was significant effect of nitrogen on the leaf length (table 3). The longest leaf length (19.9cm) was obtained from the 135 kg N/ha and the shortest (13.0 cm) was observed from the 0 kg/ N.

The combined effect of sowing time and nitrogen varied length significantly on leaf length (Appendix III). The longest leaf length (22.6 cm) was recorded from the treatment combination of 15 November sowing with 135 kg N/ha (T_1N_3) and the shortest (11.0 cm) was obtained from the combination of (T_4N_O) 30 December sowing with 0 kg N/ha (Table 3).

4.5 Leaf breadth

There was significant variation on leaf breadth due to date of sowing (Table 2). The higher leaf breadth (11.7 cm) was found from the 15 November sowing (T_1) and the lowest (9.7 cm) was obtained from the 30 December sowing (T_4).

There was significant variation of different level of nitrogen on the leaf breadth (Table 2). The highest (12.2 cm) leaf breadth was recorded from N_3 (135 kg N/ha) and the lowest leaf breadth (9.1 cm) was obtained from the 0 kg N/ha.

Combined effect of sowing time and nitrogen was also found significant on leaf breath (Appendix III). Highest leaf breadth (13.7 cm) was recorded from the treatment combination of 15 November sowing with 135 kg N/ha (T_1N_3) and the lowest (8.4 cm) was obtained from the treatment combination of (T_4N_O) 30 December sowing with 0 kg N/ ha (Table 3).

Table 2 Main effect of sowing time and nitrogen on different yield attributes of french bean

Treatments	Leaf length (cm)	Leaf breadth (cm)	No. of branches per plant	Days to 1st flowering	No. of flowers per plant	No. of pods per plant	Length of green pod(cm)	Diameter of green pod (cm)
Factor A (Date of sowing)								
T_1	18.2a	11.7a	11.0a	32.6d	43.4a	29.2a	14.9a	1.5a
T_2	17.6a	11.3ab	9.4b	35.3c	41.3b	27.2b	14.8a	1.4a
T_3	16.2b	10.1bc	9.1b	39.9b	36.3c	22.7c	13.4b	1.3b
T_4	13.1c	9.7c	7.6c	45.5a	33.0d	20.5d	12.6c	1.5a
LSD(0.05)	0.64	1.18	0.75	1.02	0.96	0.90	0.65	0.08
Level of significance	**	**	**	**	**	**	**	**
CV (%)	4.72	13.17	9.64	3.21	2.99	4.33	5.58	7.15
Factor B (Level of nitrogen)								
N_0	13.0d	9.1c	6.2c	34.1d	29.2d	17.8d	11.9c	1.2c
N_1	15.4c	10.1bc	8.9b	37.c	37.3c	23.4c	13.6b	1.3b
N_2	16.8b	11.3ab	11.1a	39.7b	44.5a	29.8a	15.3a	1.6a
N_3	19.9a	12.2a	10.8a	41.9a	43.2b	28.6b	15.1a	1.6a
LSD(0.05)	0.64	1.18	0.75	1.02	0.96	0.90	0.65	0.08
Level of significance	**	**	**	**	**	**	**	**
CV (%)	4.72	13.17	9.64	3.21	2.99	4.33	5.58	7.15

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.

Sowing time
T_1= 15 November
T_2 = 30 November
T_3 = 15 December
T_4 = 30 December

Nitrogen level
No= 0 kg N/ha
N_1 = 45 kg N/ha
N_2 = 90 Kg N/ha
N_3 = 135 kg N/ha

DAS =Days after sowing
CV =Co efficient of variance
* = Significant at 5% level of probability
** = Significant at 1% level of probability
NS : Non significant

Table 2. Contd.

Treatments	No. of seeds per green pod	No of roots per plant	Dry matter content of plant (%)	Pod weight per plant (g)	Dry matter content of pod (%)	Pod yield per plot (kg)
T_1	6.3a	11.1a	25.0a	79.7a	7.0a	4.7a
T_2	5.8b	10.8a	22.8b	75.4b	6.4b	4.4a
T_3	6.0ab	10.6a	22.2b	62.4c	6.5b	3.7b
T_4	5.5c	9.9b	20.5c	57.6d	6.3c	3.4c
LSD(0.05)	**0.34**	**1.49**	**0.80**	**0.82**	**0.37**	**0.30**
Level of significance	**	**NS**	**	**	**	**
CV (%)	**6.84**	**8.81**	**4.33**	**2.60**	**6.79**	**8.98**
N_0	5.2c	9.1b	20.2c	50.6c	5.9c	2.9c
N_1	6.0b	11.1a	22.2b	65.3b	6.3b	3.9b
N_2	6.4a	11.7a	23.8a	79.7a	6.8a	4.7a
N_3	6.2ab	11.5a	24.4a	79.4a	7.2a	4.7a
LSD(0.05)	**0.34**	**1.49**	**0.80**	**0.82**	**0.37**	**0.30**
Level of significance	**	**	**	**	**	**
CV (%)	**6.84**	**8.81**	**4.33**	**2.60**	**6.79**	**8.98**

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.

Sowing time
T_1 : 15 November
T_2 : 30 November
T_3 : 15 December
T_4 : 30 December

Nitrogen level
No = 0 kg N/ha
N_1 = 45 kg N/ha
N_2 = 90 Kg N/ha
N_3 = 135 kg N/ha

DAS = Days after sowing
CV = Co efficient of variance
*** = Significant at 5% level of probability**
**** = Significant at 1% level of probability**
NS = Non significant

4.5 Number of branches per plant

There was significant variation was found in respect of total number of branches per plant due to different sowing time (Table 2). The maximum number of branches (11.0) was observed from 15 November sowing date and the minimum (7.6) number of branches was observed from 30 December sowing date. It was possibly due to the fact that early sowing resulted in better vegetative growth which probably led to the higher number of branches per plant.

Application of different levels of nitrogen had highly significant effect on the total number of branches per plant (Table 2). The highest (11.1) and the lowest (6.2) number of branches per plant were found in the nitrogen level of 90 kg/ha and 0 kg/ha, respectively. Nitrogen enhanced vegetative growth and development of plant up to a limiting level and higher does of nitrogen (135 N/ha) application, the number of branches per plant was decreased.

Combined effect between sowing time and different level of nitrogen on the number of branches per plant showed significant variation (Appendix III). It was found that 15 November sowing with 90 kg N/ha produced the highest (14.5) number of branches per plant and the treatment combination of 30 December sowing with 0 kg N/ha gave the lowest (5.1) (Table 3).

Table 3. Combined effect of sowing time and level of nitrogen on different yield attributes and yield of french bean

Factor A X Factor B	Leaf length (cm)	Leaf breadth (cm)	No. of branches per plant	Days to 1st flowering	No. of flowers per plant	No. of pods per plant	Length of green pod(cm)
T_1N_0	14.7g	10.1	6.9h	29.2i	32.4g	20.7h	12.7ef
T_1N_1	16.4ef	10.6	9.8def	31.8h	41.6d	29.2cd	13.2de
T_1N_2	19.1c	12.4	14.5a	34.1fg	52.1a	35.2a	16.8a
T_1N_3	22.6a	13.7	12.8b	35.4f	47.7b	31.7b	16.8a
T_2N_0	14.4g	9.8	6.7h	32.6gh	30.0h	19.0h	12.3efg
T_2N_1	17.1de	11.2	8.9efg	34.4fg	41.8d	28.0de	15.0bc
T_2N_2	17.8d	11.7	10.3cde	34.7fg	48.1b	31.5b	15.9ab
T_2N_3	21.1b	12.5	11.6bc	39.4e	45.4c	30.1bc	15.9ab
T_3N_0	12.0hi	8.3	6.3hi	34.2fg	27.5i	16.5i	11.3g
T_3N_1	15.3fg	9.4	9.4d-g	39.3e	35.2f	19.7h	13.2de
T_3N_2	16.4ef	11.1	10.8cd	42.2cd	41.1d	27.1ef	14.2cd
T_3N_3	21.0b	11.6	10.1c-f	43.9bc	41.6d	27.7de	14.9bc
T_4N_0	11.0i	8.4	5.1i	40.4de	26.8i	15.1i	11.4fg
T_4N_1	12.6h	9.4	7.8gh	43.0b	30.5h	16.6i	12.8ef
T_4N_2	14.1g	10.1	8.9efg	45.9a	36.7ef	25.6fg	13.0de
T_4N_3	14.8g	10.9	8.5fg	46.7a	38.1e	24.9g	13.4de
LSD(0.05)	**1.28**	**3.25**	**1.50**	**2.05**	**1.92**	**1.80**	**1.30**
Level of significance	**	NS	**	*	**	**	*
CV (%)	**4.72**	**13.17**	**9.64**	**3.21**	**2.99**	**4.33**	**5.58**

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.

Sowing time
T_1 = 15 November
T_2 = 30 November
T_3 = 15 December
T_4 = 30 December

Nitrogen level
No = 0 kg N/ha
N_1 = 45 kg N/ha
N_2 = 90 Kg N/ha
N_3 = 135 kg N/ha

DAS = Days after sowing
CV = Co efficient of variance
*** = Significant at 5% level of probability**
**** = Significant at 1% level of probability**
NS =Non significant

Table 3. Contd.

Factor A X Factor B	Diameter of green pod (cm)	No. of seeds per green pod	No of roots per plant	Dry matter content of plant (%)	Pod weight per plant (g)	Dry matter content of pod (%)	Pod yield per plot (kg)
T_1N_0	1.3gh	5.2	9.6	22.1	58.1h	6.2d	3.4
T_1N_1	1.3efgh	6.5	10.2	24.8	81.9c	6.3d	4.7
T_1N_2	1.8a	6.8	12.8	26.5	90.0a	7.6ab	5.3
T_1N_3	1.5bc	6.9	11.8	26.8	88.7a	7.8a	5.2
T_2N_0	1.2h	5.0	9.0	20.1	53.3i	6.1d	3.1
T_2N_1	1.3gh	6.2	10.9	22.7	78.6d	6.2d	4.7
T_2N_2	1.5bcd	6.5	11.3	24.8	85.1b	6.1d	5.0
T_2N_3	1.8a	5.7	11.9	23.6	84.4bc	7.3abc	5.0
T_3N_0	1.2gh	5.5	8.8	20.1	46.2j	6.0d	2.7
T_3N_1	1.3fgh	6.1	11.1	21.1	55.2hi	6.1d	3.3
T_3N_2	1.3dh	6.5	11.9	23.8	73.3ef	7.2abc	4.2
T_3N_3	1.4cg	6.1	10.8	23.9	74.9e	6.8bcd	4.4
T_4N_0	1.3gh	5.1	9.1	18.7	44.8j	5.2e	2.5
T_4N_1	1.5bf	5.2	12.1	20.1	45.6j	6.6cd	2.8
T_4N_2	1.6ab	5.8	10.8	22.2	70.4fg	6.5cd	4.2
T_4N_3	1.5be	5.9	11.6	21.1	69.6g	6.8bcd	4.0
LSD(0.05)	**0.17**	**2.86**	**2.99**	**4.22**	**6.78**	**0.74**	**3.09**
Level of significance	**	**NS**	**NS**	**NS**	**	*	**NS**
CV (%)	**7.15**	**6.84**	**8.81**	**4.33**	**2.60**	**6.79**	**8.98**

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.

Sowing time
T_1 = 15 November
T_2 = 30 November
T_3 = 15 December
T_4 = 30 December

Nitrogen level
No = 0 kg N/ha
N_1 = 45 kg N/ha
N_2 = 90 Kg N/ha
N_3 = 135 kg N/ha

DAS = Days after sowing
CV = Co efficient of variance
*** = Significant at 5% level of probability**
**** = Significant at 1% level of probability**
NS= Non significant

4.7 Days to first flowering

Sowing time had significant effects on number of days required for first flowering (Table 2). The 15 November sowing (T_1) gave first flowering at the shortest time (32.6 days). On the other hand 30 December sowing took the maximum time (45 days). The variation of days to first flowering might be due to variation in temperature due to different sowing time. But due to high temperature no flower was anthesised. The present observation was in full agreement with that of Graham (1979).

Days required to first flowering was significantly influenced by the application of different levels of nitrogen (Table 2). The maximum time (41.9 days) required for first flowering was observed in case of 135 kg N/ha used and the shortest time (34.1 days was required by control treatment. It was due to the fact that plant received more nitrogen got long duration to complete vegetative growth, which encouraged in longer time of flowering. But the control plants where no nitrogen applied had shorter vegetative period.

The combined effect of sowing time and nitrogen level was found to be significant (Table 3 and Appendix III). The maximum time (48.7 days) required for first flowering was found in the treatment combination of 30 December and 135 kg N/ha and the minimum time (29.2 days) required for first flowering was found in the treatment combination of 15 November and 0 kg N/ha (T_1N_O).

4.8 Number of flowers per plant

There was significant variation in number of flowers per plant due to different sowing time (Table 2). The maximum number of flowers (43.4) was found from 15 November sowing date and the minimum number of flowers (33.0) was observed in 30 December sowing date. It could be noted that temperature was an important factor for flowering. It was possible that earlier sowing completed

vegetative growth prior to flowering and was also influenced by low night temperature during December, which favored early flowering. The number of flowers was decreased with delay in sowing. Similar result was reported by Sesay (1983) in bean plants.

The number of flowers was also significantly influenced by the application of different levels of nitrogen (Table 2). The maximum (44.5) number of flowers (29.2) per plant was recorded when 90 kg N/ha was applied and the minimum number of flowers was found when no nitrogen was applied.

The combined effect of sowing time and nitrogen on number of flowers per plant were also found to be significant (Table 3 and Appendix III). The highest number of flowers (48.1) per plant was found in the treatment combination of 30 November and 90 kg N/ha (T_2N_2). The lowest number of flowers (26.8) per plant was found in the treatment combination of 30 December and 0 kg N/ha (T_4N_O).

4.9 Number of pods per plant

Sowing time showed significant influence on number of pods per plant (Table 2). The highest (29.2) number of pods per plant was obtained from 15 November sowing and the lowest (20.5) number of pods per plant was found from 30 December sowing. Abdalla and Fischbeak (1978) stated that the pod set of French bean was poor at day/night temperature of $30/25^0$ C. From the above observation it was obvious that the variation of pod set might be due to variation in temperature due to different sowing time. The number of pods per plant was significantly reduced with delay in sowing. Similar result was reported by Fisher (1980).

Nitrogen showed significant effect on the number of pods per plant (Table 2). The number of pod increased significantly with the increase in nitrogen rate. The highest (29.8) number of pods per plant was obtained when the plants were supplied with 90 kg N/ha while the lowest number of pods per plant (17.8) was obtained when no nitrogen was applied. But the application of 135 kg N/ha did not

result in any further increase in number of pods per plant compared with 90 kg N/ha. The present investigation was agreement with that of Edje *et al.* (1975) and Sa *et al.* (1982) and Calvache *et al.* (1997) who reported significant difference in pod number per plant with different nitrogen levels.

Combined effect was also found significant effect on number of pods per plant due to sowing time and different level of nitrogen (Appendix III). The highest (35.2) number of pods per plant was found in the treatment combination of 15 November with 90 kg N/ha (T_1N_2) and the lowest (15.1) number of pods per plant was obtained from the treatment combination of 30 December when no nitrogen was applied (Table 3). It appears from the result that earlier sowing (15 November) produced maximum number of pods per plant and this was happened possibly due to the fact that plants from early sowing received favorable temperature for pod setting in December but the number of pods per plant decreased gradually as the temperature increased or less favorable photoperiodic condition later than December.

4.10 Length of green pod

There was significant variation on length of pod at harvest due to different sowing time (Table 2). The longest (14.9 cm) length of green pod was found from 15 November sowing and the shortest (12.6cm) length of green pod was found in 30 December sowing.

The effect of nitrogen on length of green pod at harvest was found to be statistically significant (Table 2). Longest (15.3 cm) green pod was obtained from 135 kg N/ha (N_3) and the shortest (11.9 cm) green pod was found in control treatment.

The combined effect between sowing time and different level of nitrogen showed significant variation on pod length (Appendix III). The longest length of green pod (16.8cm) was found from the treatment combination of 15 November and 135 kg

N/ha.(T_1N_3) and the shortest length of green pod (11.3 cm) was obtained from the treatment combination of 30 December and Okg N/ha (Table 3).

4.11 Diameter of green pod

Diameter of green pod varied significantly due to sowing time. The longest (1.5cm) diameter of green pods was observed due to 15 November sowing and the shortest (1.3cm) was obtained from 30 December sowing (Table 2).

Nitrogen showed significant effect on diameter of green pod (Table 2). The longest diameter of green pod (1.6 cm) was recorded when 135 kg N/ha was applied and the shortest (1.2 cm) diameter of green pod was found in control.

Combined effect of sowing time and nitrogen on diameter of green pod was found to be significantly (Table 3 and Appendix III). The longest diameter of green pod (1.8 cm) was found in the treatment combination of (T_2N_3) 30 November sowing date and 135 kg N/ha which was followed by (T_2N_2) 15 November sowing date and 90 kg N/ha (1.8 cm). On the other hand, the shortest diameter of green pod (1.2 cm) was found in 30 November sowing and no nitrogen was applied (Table 3).

4.12 Number of seeds per green pod

Due to effect of sowing time on number of seeds per green pod showed significant differences (Table 2). Early sowing (15 November) produced the maximum number of seeds per green pod (6.3), while the minimum number of seeds per green pod (5.5) was recorded in (late sowing) 30 December sowing. It appears that earlier sowing produced maximum number of seeds per pod due to the prevailing favorable climatic conditions for pollination and fertilization. The number of seeds per green pods decreased gradually with delay in sowing time.

Different level of nitrogen significantly influenced number of seeds per green pod (Table 2). The maximum number of seeds per green pods (6.4) was found from the level of 90 kg N/ha and the lowest (5.2) was found from the control treatment. The application of nitrogen produced significantly the higher number of seeds per pod of french bean, as reported by Tewari and Singh (2000).

Combined effect of sowing time and nitrogen on the number of seeds per green pod was found to be significantly different (Table 3 and Appendix III). The highest number of seeds per green pod (6.9) was found from the treatment combination of 15 November sowing time with 135 kg N/ha and the lowest (5.1) was found from the treatment combination of 30 December sowing with 0 kg N/ha (Table 3).

4.13 Number of roots per plant

Number of roots per plant varied significantly due to different sowing time (Table 2). 15 November sowing gave the highest number of roots per plant (11.1) and the lowest (9. 7) number was found from the 30 December sowing.

Number of roots per plant was significantly influenced by different level of nitrogen (Table 2). The number of roots per plant was the highest (11.7) at 90 kg N/ha treatments while the lowest (9.1) was noted from control treatment. It was possibly due to fact that nitrogen at higher rate upto 90 kg N/ha promoted more vegetative growth, which resulted in higher number of roots per plant.

The combined effect of sowing time and different level of nitrogen on the number of roots per plant was found to be non-significant (Appendix III and Table 3). From the results it was found that 15 November sowing time combined with 90 kg N/ha produced the highest number of roots per plant (12.8) and 30 December sowing with 0 kg N/ha gave the lowest (9.1).

4.14 Dry matter content of plant (%)

The variation in dry matter content (%) of plant of french bean was statistically significant due to different sowing time (Table 2). The highest (25.0%) dry matter content of plants was obtained from 15 November sowing time. The lowest (20.5%) dry matter content of plants was found from 30 December sowing date.

There was a significant effect of different level of nitrogen on percentage of dry matter content of plant (Table 2). The plants receiving 135 kg N/ha produced maximum (24.4%) dry matter content and the lowest (20.2%) in this regard was obtained from the 0 kg. N/ha.

There was no significant variation due to combined effect of sowing time and nitrogen level on dry matter content of french bean plants (Appendix III and Table 3). The maximum (26.8%) dry matter content of plant was obtained from the treatment combination of 15 November sowing time with 135 kg N/ha, while the minimum (18.2%) dry matter content of plants was recorded from the treatment combination of 30 December sowing time with 0 kg N/ha.

4.15 Pod weight per plant

There was significant variation among different sowing time for weight of pod per plant of French bean (Table 2). The highest (79.7 g/plant) pod weight was obtained from 15 November sowing time and the lowest (57.6 g/plant) pod weight was found from 30 December sowing time. The pod weight decreased with delay in sowing.

The pod weight per plant was significantly influenced due to different level of nitrogen (Table 2). The pod weight per plant increased with the increasing level of nitrogen and being the highest (79.7 g/plant) at 90 kg N/ha, while the lowest (50.6 g/plant) was found from control treatment where no nitrogen was applied.

Combined effect between sowing time and nitrogen was highly significant on the pod weight per plant of french bean (Appendix III). Their combined effect was also found to be significant. The highest (90.0 g/plant) pod weight was found from the treatment combination of 15 November sowing with 90 kg N/ha and the lowest (44.8 g/plant) weight of pod was obtained from the treatment combination of 30 December sowing with 0 kg N/ha (Table 3).

4.16 Dry matter content of pod (%)

A significant variation was found due to different sowing timeon the dry matter content of pod of french bean (Table 2). The maximum (7.0%) dry matter content of pod was found in early sowing (15 November) and the minimum (6.3%) dry matter content of pod from late sowing (30 December). The maximum dry matter content of pod from earlier sowing might be due to the effect of maximum development of pods. Dry matter production of french bean decreased with delay in sowing date as reported by Sreelatha *et al.* (1997).

Dry matter content of pod was significantly affected by the application of different level of nitrogen. Dry matter content increased with the increasing level of nitrogen (Table 2). The maximum (7.2%) dry mater content of pods was obtained from the plants supplied with 135 kg N/ha and minimum (5.9%) from the control plants i.e. no nitrogen was applied. Dry matter production in French bean increased with increasing levels of nitrogen. Similar results were reported by Leelavathi *et al.* (1991).

Combined effect of sowing time and nitrogen level on dry matter content of pods of French bean was found significant (Appendix III and Table 3). The percent dry matter of pods ranged from 5.2% to 7.8%. The maximum (7.8%) dry matter content of pods was found in the treatment combination of early sowing (15 November) with 135 kg N/ha and the minimum (5.2%) dry matter content of pod

was found from the treatment combination of 30 December sowing with 0 kg N/ha i.e. when no nitrogen was applied.

4.17 Pod yield per plot (kg)

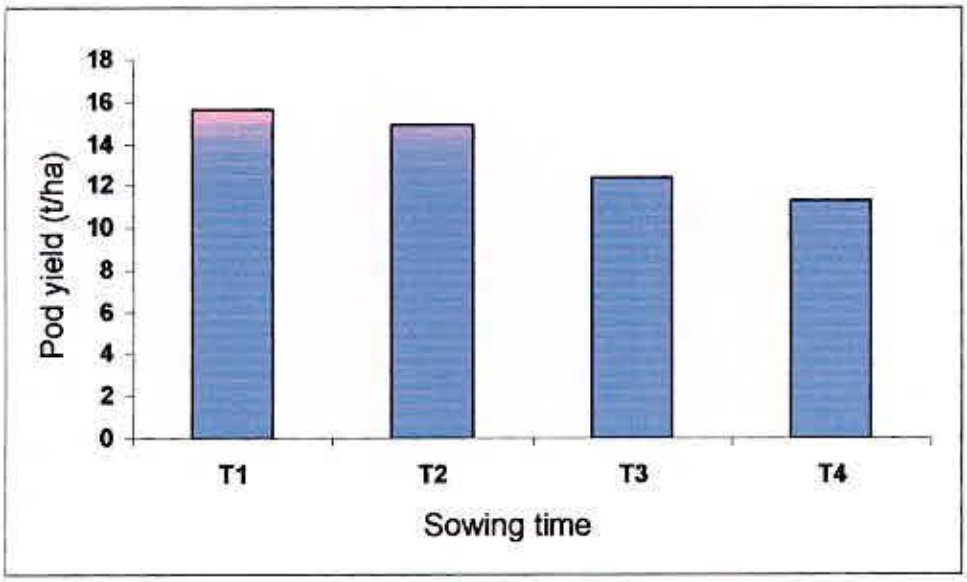
The pod yield per plot was significantly influenced by different sowing time (Table 2). Early sowing (15 November) produced maximum (4.7 kg) yield per plot and the lowest yield (3.4 kg) per plot was given by 30 December sowing. The plants of 15 November sowing had better growth due to favorable climatic conditions. The better growth of french bean in case of early sowing has contributed a lot to increase the pod weight which ultimately gave the higher yield of french bean. Yield decreased in case of later sowing.

There was significant effect of nitrogen on the pod yield per plot (Table 2). The highest (4.7 kg) pod yield per plot was recorded from the application of 90 kg N/ha, where as the lowest (2.9 kg) pod yield per plot was obtained from the control treatment.

There was in significant effect between the sowing time and level of nitrogen due to combined effect (Appendix III). Their combined effect was also found to be in significant (Table). The maximum (5.3) pod yield per plot was produced in the treatment combination of 15 November sowing with 90 kg N/ha. The minimum (2.5) pod yield per plot was recorded from the treatment combination of 30 December with 0 kg N/ha (Table 3). Results revealed that, earlier sowing of French bean and 90 kg N/ha could exert favorable influenced on the production of the maximum yield of pod per plot. The unfavorable influence of increased temperature might have resulted in decreased in yield of pod per plot in the later sowing.

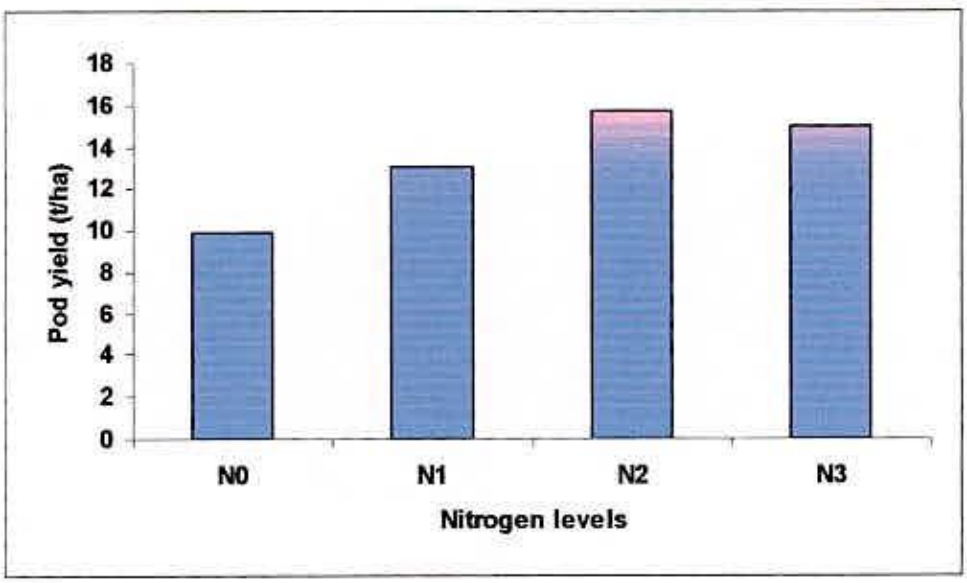
4.18 Pod yield (t/ha)

The yield of french bean per hectare has been converted from per plot yield. Sowing time as evident from significantly influenced the yield per hectare (Fig. 7). The highest (15.6 t) yield per hectare was obtained from 15 November sowing which was followed by 30 November (14.8 t). The lowest yield (11.3 t) per hectare was obtained from 30 December sowing. The date of sowing had profound influence on the yield of french bean. The highest yield obtained from early sowing was probably due to the better vegetative growth of the plants which ultimately led to the better flowering, fruit setting and ultimately increased yield per plant and per hectare. The decrease in the yield of french bean with delayed sowing because of shift of time in fall decreased the number of pods per plant. The present observation is in agreement with that of Bhadwaj *et al.* (1994). Pod yield was positively correlated with green-shell yield at different sowing time (Beaver and Roman-Hermandez, 1994).



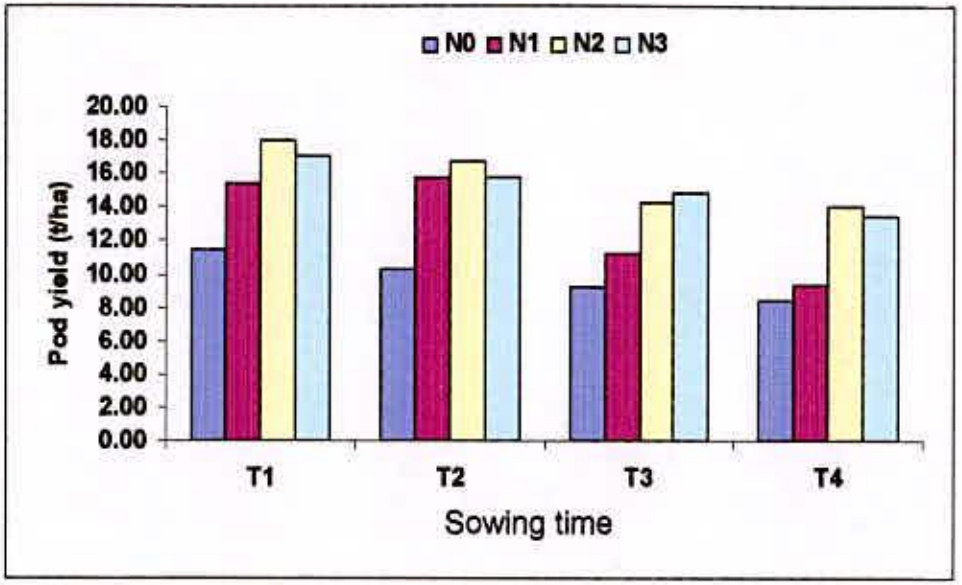
T_1 : 15 November T_2 : 30 November
T_3 : 15 December T_4 : 30 December

Fig. 5 Effect of sowing time on pod yield (t/ha) of french bean



N_0 : 0 kg N/ha N_1 : 45 kg N/ha
N_2 : 90 kg N/ha N3 : 135 kg N/ha

Fig. 2 Effect of nitrogen on pod yield (t/ha) of french bean



Sowing time	Nitrogen level
T_1 : 15 November	No : 0 kg N/ha
T_2 : 30 November	N_1 : 45 kg N/ha
T_3 : 15 December	N_2 : 90 Kg N/ha
T_4 : 30 December	N_3 : 135 kg N/ha

Fig. 9 Combined effect of sowing time and level of nitrogen on pod yield (t/ha) of french bean

The yield of french bean per hectare was significantly influenced by different level of nitrogen (Fig. 8). The maximum (15.7 t) yield of French bean was recorded with the application of 90 kg N/ha and the minimum (9.8 t) yield of French bean was found from the control treatment. Chowdhuri *et al.* (2001) recommended fertilizer dose of 90 kg N/ha. The pod yield increased significantly upto 90 kg N/ha as reported by Dahatonde and Nalamwar (1996).

The comined effect between sowing time and different level of nitrogen was significant on the yield of french bean (Appendix III and Fig. 9). The highest (17.9 t/ha) yield of french bean was obtained from the treatment combination of 15 November sowing with 90 kg N/ha. On the other hand the lowest (8.4 t/ha) yield was obtained from the treatment combination of 30 December sowing with 0 kg N/ha. It is apparent from above result that earlier sowing i.e. 15 November showed better performance particularly in relation to yield of french bean. That was may be attributed to the attainment of proper vegetative growth which ultimately influenced the yield.

4.19 Economic analysis of french bean production

Economic analysis was done on total cost of production, gross return, net return and benefit cost ratio (BCR) as per values of inputs and outputs during experiment.

4.19.1 Cost of production

The details cost of production has been shown in Appendix IV. The total cost of production per hectare varied from TK. 96,035 to TK. 99,143 among the treatment combination (Table 4). It was due to variable cost of production. Highest (99,143 Tk/ha) cost production was obtained from T_1N_3 where the lowest (96,035Tk/ha) was found from the treatment combination of T_4N_0.

4.19.2 Gross return

The gross return was recorded from Tk. 1,26,000 to 2,68,500 for the various treatment combinations (Table 4). Gross income was calculated on the basis of pod yield (t/ha) of French bean at TK. 15000/- per ton. However, the highest (2,68,500Tk) gross return was found from the treatment combination of T_1N_2 and the lowest (1,26,000 Tk) was found from the treatment combination of T_4N_0.

4.19.3 Net return

Net return or net profit was calculated through excluding the production cost from gross return. It also varied from Tk. 29,965/-to 1,70,023/- (Table 4). The highest net return was obtained from the treatment combination of 15 November sowing with 90 kg N/ha. The result also revealed that the highest net return (Tk. 1, 70,023/-) was obtained from the highest pod yield (17.9 t/ha), which was followed by the treatment. But the lowest net return (Tk. 29,965/-) was obtained from the lowest yield of French bean (8.4 t/ha) received from the treatment combination of 30 December sowing with 0 kg N/ha. So, it clearly indicated that 90 kg N/ha with 15 November sowing with 90 kg N/ha contributed to higher net return.

4.19.4 Benefit cost ratio (BCR)

The benefit cost ratio was found to be the highest 2.7 in the treatment combination of 15 November with 90 kg N/ha (Table 4). Here the highest net return (Tk. 1,70,023/-) showed the highest BCR (2.7). The lowest BCR was observed (1.3) from the treatment combination of 30 December sowing with 0 kg N/ha (Table 4) due to the lowest pod yield (8.4t). From economic point of view, the 15 November sowing with 90 kg N/ha was found to be the most suitable treatment combination for french bean production.

Table 4. Economic analysis of french bean considering sowing time and different level of Nitrogen

Treatments	Pod yield (t/ha)	Gross return (Tk/ha)	Total cost of production (Tk/ha)	Net return (Tk/ha)	Benefit cost ratio (BCR)
T_1N_0	11.4	171000	96590	74410	1.8
T_1N_1	15.4	231000	97811	133189	2.3
T_1N_2	17.9	268500	98477	170023	2.7
T_1N_3	17.0	255900	99143	156757	2.6
T_2N_0	10.3	154500	96368	58132	1.6
T_2N_1	14.7	220500	97590	122910	2.2
T_2N_2	16.8	252050	98255	153795	2.6
T_2N_3	16.6	249000	98921	150079	2.5
T_3N_0	9.2	138000	96146	41854	1.4
T_3N_1	11.2	168000	97367	70633	1.7
T_3N_2	14.8	222000	98033	123967	2.3
T_3N_3	14.2	213000	98699	114301	2.1
T_4N_0	8.4	126000	96035	29965	1.3
T_4N_1	9.4	141000	97256	43744	1.4
T_4N_2	14.0	210000	97922	112078	2.1
T_4N_3	13.4	201000	98588	102412	2.0

Sowing time
T_1 : 15 November
T_2 : 30 November
T_3 : 15 December
T_4 : 30 December

Nitrogen level
No : 0 kg N/ha
N_1 : 45 kg N/ha
N_2 : 90 Kg N/ha
N_3 : 135 kg N/ha

Note : Price of harvested green pod @ Tk 15000/-
Benefit cost ratio = Gross return ÷ Total cost of production

CHAPTER V

SUMMARY AND CONCLUSION

Experiment was conducted at the Farm of Shre-e-Bangla Agricultural University, Dhaka-1207 to study the effect of date of sowing and nitrogen on the yield contributing characters and yield of French bean during the period from November, 2006 to March, 2007. The land was belongs to Agro ecological zone of Modhupur tract (AEZ no. 28). The selected experimental site was well-drained high land. The soil was silt loam in texture pH 6.18.

The content of organic carbon, total N, available P and K were 1.25%, 0.08%, 20 ppm and 0.20 mg 100g soil, respectively. The experiment included two factors, namely, Factor A: date of sowing (T_1=15 November, T_2=30 November, T_3= 15 December and T_4= 30 December) and Factor B: levels of nitrogen (N_0=0 kg/ha, N_1= 45 kg/ha,N_2= 90 kg/ha and N_3= 135 kg/ha). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each unit plot was 2m x 1.5 m in size. The variety of French bean used in the experiment was BARI Zhar Sheem 1. The seed was collected from the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

At first the land was ploughed with a power-tiller on 2 November, 2006 and open to sunlight. Afterwards experimental plot was prepared by five ploughings and followed by laddering to break the clods and to level the soil. The weeds and stubble of previous crop were collected and removed from the soil. These operations were done to bring the land under good tilth for sowing of seeds. The experimental plots were laid out in accordance with the experimental design.

Cow dung, triple super phosphate and muriate of potash were applied at the rates of 10 t/ha, 150 kg/ha and 150 kg/ha, respectively a dose. Nitrogen was applied according to the treatment allotted for each plot in from of urea. The ½ amount of urea was applied during

final land preparation and rest amount of urea in two installments at 15 and 30 days after sowing (DAS) the seeds.

Two seeds were sown each hill at a depth of 3.0 cm. The seeds were covered with pulverized soil just after sowing and gently pressed with hands. Seeds were sown at four different dates viz. 15 November 2006, 30 November 2006, 15 December 2006 and 30 December 2006 in rows with spacing of 30 cm x 15 cm. Intercultural operations were done as and when necessary.

Immature green pods were harvested at tender stage through hand picking and weighed to estimate the yield of fresh pod. Ten plants were selected at random in such a way that the border effect could be avoided. Data were taken on seedling emergence, plant height, number of levels per plant, leaf length, leaf breadth, number of branches per plant, days to first flowering, number of flowers per plant, number of green pods per plant, length of green pod, diameter of green pod and number of seeds per plant. Economic analysis was done for cost of production, gross return; net return and benefit cost ratio (BCR) calculation .The analyses of variance for the characters under study were performed by F variance test and mean differences were adjudged by using the Duncan's Multiple Range Test.

From results of the experiment it was found that the main effect of sowing time had significant effect on the percentage of seedlings emergence, plant height number of leaves leaf length, leaf breadth, days to first flowering, number of flowers per plant, number of pods per plant, length of green pod, diameter of green pod, number of seeds per pod, pod weight per plant, dry matter content of plant and of green pod, green pod yield per plot and per hectare. But there was

significant effect of sowing time on number of roots per plant french bean. The highest number of pod (29.2) per plant and the maximum pod yield (15.6t) per hectare were found in 15 November sowing.

Statistical analysis showed that nitrogen level had significant effect on the percentage of seedlings emergence, plant height, numbers of leaves, leaf length, leaf breadth, number of branches per plant, days to first flowering, number of flowers per plant, number of green pods per plant, length of green pod, diameter of green pod, pod weight per plant, number of seeds per pod, green pod yield per plot and per hectare. The maximum green pod yield (15.7 t) per hectare of French bean was found from 90 kg N/ha.

There was significant interaction effect between sowing time and nitrogen level in respect of yield of green pod per hectare. The treatment combination of 15 November and 90 kg N/ha produced the highest yield (17.9t/ha) while the lowest (8.4t/ha) was found from the treatment combination of 30 December with 0 kg N/ha.

The total cost production, estimated for the different combinations of sowing time and nitrogen level, indicated that 15 November sowing date with 135 kgN/ha was more expensive (Tk.99,143) Economic analyses revealed that early sowing (15 November) with 90 kgN/ha gave maximum net return (Tk.1,70,023 /ha) with a benefit cost ratio of (2.7). The results of the experiment indicated that 15 November sowing with the application of 90 kgN/ha might be recommended for french bean production under Sher-e-Bangla Agricultural University Farm conditions.

The following conclusion could be drawn from the results of the experiment:

1. Yield attributes and yield decreased gradually with crop in proper time due to existing cropping pattern, climatic conditions and for many other reasons. Early sowing would be beneficial if the existing cropping pattern were changed for sowing time french bean.

2. In respect of all the attributes and yield, nitrogen showed better performance at the level of 90 kg N/ha.

3. The experiment needs to be conducted in different regions of the country considering only the promising combinations of sowing time and nitrogen level under trial for a wider acceptability of the findings.

4. Further investigation needs to be done using sowing time earlier than 15 November to optimize sowing time.

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APPENDICES

Appendix I Results of the mechanical and chemical analysis of soil of the experimental plot Mechanical analysis

Mechanical analysis

Constituent	Percent
Sand%	33.65
Silt %	60.15
Clay %	6.20
Textural class	Silt loam

Chemical analysis

Soil properties	Analytical data
Soil P^H	6.18
Organic Carbon (%)	1.25
Total Nitrogen (%)	0.08
Available P (ppm)	20
Exchangeable K mg	0.2

Source: Soil Testing Laboratory, SRDI, Dhaka

Appendix II Monthly records of average temperature, rainfall and relative humidity during the period from November, 2006 to February, 2007.

Year	Month	Date	Average Temperature (^{0}C)			Total rainfall (mm)	Average relative humidity (%)	Soil temperature at different depth (^{0}C)		
			Max.	Min.	Average			5cm	10 cm	20 cm
2006	November	1-10	30.1	22.9	26.5	2	72.7	36.3	27.9	27.8
		11-20	30.2	19.5	24.8	1	69.0	24.8	26.3	26.8
		21-30	28.6	17.3	22.9	2	63.0	22.4	23.8	24.8
2006	December	1-10	27.3	15.5	21.4	0	69.6	20.4	22.0	22.8
		11-20	27.1	16.4	21.7	0	70.5	20.6	22.0	22.6
		21-31	26.2	15.5	20.8	0	67.9	20.0	21.3	22.1
2007	January	1-10	21.9	11.5	16.7	0	78.8	17.5	18.4	19.9
		11-20	24.6	11.3	17.9	0	58.4	17.1	19.1	19.4
		21-31	26.9	14.3	20.6	0	67.1	18.7	20.2	20.5
2007	February	1-10	26.4	17.7	22.0	17	79.7	21.7	22.8	22.7
		11-20	25.9	15.6	20.8	13	67.3	20.2	21.6	22.2
		21-28	29.3	16.9	23.1	0	57.5	21.6	23.4	23.9

Source: Bangladesh Meteorological Department, Agargaon, Sher-e-Bangla Nagar, Dhaka-1207

Appendix III Analysis of variance of the data on the growth and yield of french bean as influenced by of sowing time and nitrogen

Sources of variation	Degrees of freedom	Percent of seedling emergence				Plant height (cm)				
		4 DAS	5 DAS	6 DAS	7 DAS	8 DAS	15 DAS	25 DAS	35 DAS	45 DAS
Replication	2	0.55	0.72	11.05	22.27	8.44	20.79	20.25	7.70	6.63
Factor A(Date of sowing)	3	33.37**	1203.84**	2856.34**	1657.91**	489.26**	18.27**	15.83**	646.43**	242.43**
FactorB(Nitrogen)	3	5.83**	153.17**	100.56**	43.29**	41.36**	24.50**	65.35**	44.83**	97.49**
AXB(Interaction)	9	7.21**	32.68**	29.96**	48.99**	24.92**	1.09**	16.91**	13.18**	11.82**
Error	30	0.10	1.90	1.29	2.5	2.22	0.11	0.51	1.28	1.56

DAS : Days after sowing
CV : Co efficient of variance
*** : Significant at 5% level of probability**
**** : Significant at 1% level of probability**
NS : Non significant

Appendix III Contd.

Sources of variation	Degrees of freedom	No. of leaves/plant				Leaf length (cm)	Leaf breadth (cm)	No. of branchy plant	Days to 1st flowering	No. of flower/ plant
		15 DAS	25 DAS	35 DAS	45 DAS					
Replication	2	1.73	2.48	12.60	6.23	18.04	4	4.10	8.12	5.76
Factor A (Date of sowing)	3	4.56**	21.61**	5.41**	60.20**	61.36**	10.71**	23.70**	383.28**	268.05**
Factor B(Nitrogen)	3	0.05NS	6.55**	9.02**	10.27**	98.83**	21.00**	60.00**	130.34**	586.39**
AXB(Interaction)	9	0.50**	4.93**	0.64^{NS}	0.79^{NS}	3.16**	0.46^{NS}	2.70**	4.31*	12.58**
Error	30	0.16	0.36	0.63	0.49	0.59	2	0.80	1.51	1.32

DAS : Days after sowing
CV : Co efficient of variance
*** : Significant at 5% level of probability**
**** : Significant at 1% level of probability**
NS : Non significant

Appendix III Contd.

Sources of variation	Degrees of freedom	No. of pods/plant	Length of green pod(cm)	Diameter of green pod (cm)	No. of seeds/green pod	Pod wt/plant (g)	No of roots/plant	Dry matter content of plant(%)	Dry matter content of pod(%)	Pod yield per plot (kg)	Pod yield (t/ha)
Replication	2	7.34	16.22	0.04	1.14	24.06	0.33	12.21	4.67	1.6	10.38
Factor A(Date of sowing)	3	189.05**	14.58**	0.05**	1.58**	1309.74**	0.49NS	42.07**	1.10**	4.62**	51.6**
Factor B(Nitrogen)	3	362.61**	27.91**	0.31**	3.44**	2299.69**	16.46**	41.52**	4.03**	8.23**	91.53**
AXB(Interaction)	9	9.55**	1.76*	0.04**	0.30^{NS}	79.53**	1.59^{NS}	0.80^{NS}	0.59*	0.23^{NS}	2.58**
Error	30	1.17	0.60	0.01	0.16	3.21	0.92	0.96	0.20	0.13	0.38

DAS : Days after sowing
CV : Co efficient of variance
*** : Significant at 5% level of probability**
**** : Significant at 1% level of probability**
NS : Non significant

Appendix IV Cost of Production of green pod of french bean per hectare

A. Input cost (Tk/ha)

Treatments	Labour cost (Tk)	Ploughing cost (Tk)	Seed Cost (Tk)	Trrigation cost (Tk)	Pesticidal cost (Tk)	Cowdung cost (Tk)	Urea cost (Tk)	TSP cost (Tk)	MOP cost (Tk)	Total input cost (Tk)
T_1N_o	30500	4000	15,000	2000	2000	5000	-	6000	4500	69000
$T_1 N_1$	31000	4000	15,000	2000	2000	5000	600	6000	4500	70100
$T_1 N_2$	31000	4000	15,000	2000	2000	5000	1200	6000	4500	70700
$T_1 N_3$	31000	4000	15,000	2000	2000	5000	1800	6000	4500	71300
$T_2 N_0$	30300	4000	15,000	2000	2000	5000	-	6000	4500	68800
$T_2 N_1$	30800	4000	15,000	2000	2000	5000	600	6000	4500	69900
$T_2 N_2$	30800	4000	15,000	2000	2000	5000	1200	6000	4500	70500
$T_2 N_3$	30800	4000	15,000	2000	2000	5000	1800	6000	4500	71100
T_3N_0	30100	4000	15,000	2000	2000	5000	-	6000	4500	68600
$T_3 N_1$	30600	4000	15,000	2000	2000	5000	600	6000	4500	69700
$T_3 N_2$	30600	4000	15,000	2000	2000	5000	1200	6000	4500	70300
$T_3 N_3$	30600	4000	15,000	2000	2000	5000	1800	6000	4500	70900
$T_4 N_0$	30000	4000	15,000	2000	2000	5000	-	6000	4500	68500
$T_4 N_1$	30500	4000	15,000	2000	2000	5000	600	6000	4500	69600
$T_4 N_2$	30500	4000	15,000	2000	2000	5000	1200	6000	4500	70200
$T_4 N_3$	30500	4000	15,000	2000	2000	5000	1800	6000	4500	70800

Sowing time
T_1 : 15 November
T_2 : 30 November
T_3 : 15 December
T_4 : 30 December

Nitrogen level
No : 0 kg N/ha
N_1 : 45 kg N/ha
N_2 : 90 Kg N/ha
N_3 : 135 kg N/ha

Labour cost @ 100 Tk/Man
Ploughing (4 times) @ 1000Tk
Seed cost @ 300Tk/kg

Cowdung @ 500Tk/tone
Urea @ 6 Tk/kg
TSP @ 40Tk/kg
MOP@ 30Tk/kg

B. Overhead cost (Tk/ha)

Treatments	Cost for rent of land (6 month)	Miscellaneous cost (5% of the input cost)	Interest on running capital for 6 month (12%)	Total overhead cost (Tk/ha)	Total input cost (TK/ha)	Total cost of production (Tk/ha)
T_1N_0	20000	3450	4140	27590	69000	96590
T_1N_1	20000	3505	4206	27711	70100	97811
T_1N_2	20000	3535	4242	27777	70700	98477
T_1N_3	20000	3565	4278	27843	71300	99143
T_2N_0	20000	3440	4128	27568	68800	96368
T_2N_1	20000	3495	4194	27690	69900	97590
T_2N_2	20000	3525	4230	27755	70500	98255
T_2N_3	20000	3555	4266	27821	71100	98921
T_3N_0	20000	3430	4116	27546	68600	96146
T_3N_1	20000	3485	4182	27667	69700	97367
T_3N_2	20000	3515	4218	27733	70300	98033
T_3N_3	20000	3545	4254	27799	70900	98699
T_4N_0	20000	3425	4110	27535	68500	96035
T_4N_1	20000	3480	4176	27656	69600	97256
T_4N_2	20000	3510	4212	27722	70200	97922
T_4N_3	20000	3540	4248	27788	70800	98588

Sowing time
T_1 : 15 November
T_2 : 30 November
T_3 : 15 December
T_4 : 30 December

Nitrogen level
No : 0 kg N/ha
N_1 : 45 kg N/ha
N_2 : 90 Kg N/ha
N_3 : 135 kg N/ha