INFLUENCE OF COWDUNG AND NPK ON THE GROWTH AND YIELD OF SUMMER MUNGBEAN

BY

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This is to certify that the thesis entitled "INFLUENCE OF COWDUNG AND NPK ON THE GROWTH AND YIELD OF SUMMER MUNGBEAN" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in AGRONOMY**, embodies the results of a piece of bonafide research work carried out by **MD. ABU ROYHAN, Registration No. 00816**, under my supervision and guidance. No part of this thesis has been submitted for any other degree in any other institutions.

I further certify that any help or sources of information received during the course of this investigation have been duly acknowledged.

Dated : 26/6/08
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Dedicated TO
MY
Beloved Parents

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ABSTRACT

A field experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207 during the period of Kharif-1 season (March to May 2007) to study the effects of cowdung and NPK on growth and yield of summer mungbean (cv. BARI mung-6). Experimental treatment included three levels of cowdung (CD) viz. 0, 2.5, 5 t CD ha^{-1} and four levels of NPK viz. 0, 10 kg N + 8 kg P + 8 kg K, 20 kg N + 16 kg P + 16 kg K and 30 kg N + 24 kg P + 24 kg K ha^{-1}. The experiment was laid out in a Randomized Complete Block Design (RCBD) factorial with three replications. The results showed that different levels of CD and NPK had significant effects on plant height and dry weight plant^{-1} at all sampling dates. The highest number of branches plant^{-1} (2.67), number of pods plant^{-1} (12.80), number of seeds pod^{-1} (9.15), seed yield (1.29 t ha^{-1}), stover yield (2.81 t ha^{-1}), biological yield (4.09 t ha^{-1}) and harvest index (32.36 %) was obtained from the application of 2.5 t CD ha^{-1}. Application of 20 kg N, 16 kg P and 16 kg K ha^{-1} produced the highest number of branches plant^{-1} (3.00), number of pods plant^{-1} (14.45), number of seeds pod^{-1} (9.20), seed yield (1.53 t ha^{-1}), stover yield (2.89 t ha^{-1}), biological yield (4.42 t ha^{-1}) and harvest index (34.62 %). The combination of 2.5 t CD ha^{-1} X 20 kg N, 16 kg P and 16 kg K ha^{-1} gave the highest number of branches plant^{-1} (3.33), number of pods plant^{-1} (14.63), number of seeds pod^{-1} (9.21), seed yield (1.55 t ha^{-1}), stover yield (2.99 t ha^{1}), biological yield (4.54 t ha^{-1}) and harvest index (34.14 %).

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LIST OF ACRONYMS

AEZ	Agro- Ecological Zone
Anon.	Anonymous
Atm.	Atmospheric
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BRRI	Bangladesh Rice Research Institute
Cm	Centimeter
CV %	Percent Coefficient of Variance
cv.	Cultivar (s)
DAS	Days After Sowing
et al.	And others
FAO	Food and Agriculture Organization
G	Gram (s)
HI	Harvest Index
Hr	Hour(s)
K	Potassium
Kg	Kilogram (s)
LSD	Least Significant Difference
m^2	Meter squares
mm	Millimeter
MP	Muriate of Potash
N	Nitrogen
No.	Number
NS	Non significant
P	Phosphorus
P_2O_5	Phosphorus Penta Oxide
S	Sulphur
SAU	Sher-e- Bangla Agricultural University
SRDI	Soil Resources and Development Institute
TDM/ TDW	Total Dry Matter/ Total Dry Weight
TSP	Triple Super Phosphate
var.	Variety
Wt.	Weight
t ha^{-1}	Ton per hectare
CD	Cowdung
%	Percentage
^{0}C	Degree Celcius

CHAPTER I

INRODUCTION

Seed legumes occupy a unique position in the world agriculture by virtue of their protein content and capacity for fixing atmospheric nitrogen. It is the part and parcel particularly in Asian diet. In Bangladesh, pulses constitute the major source of dietary protein especially for the poor people. For the domestic animals of Bangladesh, pulse crops are also the best source of protein. In a developing country like Bangladesh, pulse can improve the over all nutritional value of cereal based diet.

Unfortunately, there is an acute shortage of seed legume production in the country. Daily per capita consumption of pulses in Bangladesh is only 13.29 g (BBS, 2001), while the World Health Organization suggested 45 g per capita per day for a balanced diet (BARI, 1998). Increase of pulse production is urgently needed to meet the demand and to increase pulse consumption as well as minimize the scarcity of fodder; the production is to be increased even more than three folds (BBS, 1999).

Mungbean (*Vigna radiata* L. Wilckzek) is one of the most important pulse crops of global economic importance. It belongs to the family Leguminosae, sub family Papilionaceae/ It is originated in South East Asia (India, Myanmar, and Thailand) and widely grown in India, Pakistan, Bangladesh, Myanmar, Thailand, Philippines, China and Indonesia. It's whole or split seeds are used as Dal (Soup) in our country. It has better taste flavor, digestibility and market price. On the nutrient point of view mungbean is perhaps the best of all other pulses crops It contains all most double amount of protein as compared to cereal. The whole seed of the crop is rich in 51% carbohydrate, 26% protein, 10% moisture, 3 % minerals and 3% vitamins (Khan, 1981 and Kaul, 1982).

Besides fixing atmospheric nitrogen in the soils mungbean also plays an important role in agriculture. Its stem and leaves are used in preparing a

Chapter 1
Introduction

concentrate feed called "Bhushi" which is rich in protein. The husks of the seeds are also used as feed for milk cow. Its roots break the plough pan of puddle rice field and go deep in search of water and nutrients. Some pulses like cowpea, black gram and mungbean is used as a green manuring crop.

Mungbean ranks fifth in acreage and production in Bangladesh. In spite of many advantages of mungbean, the acreage and production have been declining (BBS, 2001). This trend is mainly because the pulses in general can not compete with cereals under rice base cropping pattern. Thus they are being pushed away from fertile lands to marginal lands where nutritional limitations are severe. About 108 thousand acres of land was under its cultivation and its production was 30 thousand metric tons (BBS, 2005). The average production of mungbean in Bangladesh is lower than that in India and some other countries of the world. This is due to the facts that the farmers of Bangladesh generally grow mungbean by one ploughing and hardly use fertilizer. As a result, poor nodulation and pod setting is a general feature and no fertilizers supplied by farmers.

Mungbean is highly responsive to fertilizers and manures. It has a marked response to nitrogen, phosphorus and potassium. These nutrients play a key role in plant physiological process. For legume especially mungbean, nitrogen is more useful because it is the main component of amino acids as well as protein. Phosphorus deficiency causes yield reduction by limiting plant growth (Poehlman, 1991). It influences nutrient uptake by promoting root growth and nodulation (Singh *et al.*, 1999). Phosphorus enhances the uptake of nitrogen content in the crop which increases protein content of mungbean (Soni and Gupta, 1999). Phosphorus is an essential constituent of nucleoprotein, Phospholipids, many enzymes and other plant substances. Potassium also enhances the physiological growth of the mungbean. Say some thing about the function of CD. So, there is an ample scope of increasing the yield of mungbean per unit area with improved management practices and by using proper integrated use of fertilizers and manure (cowdung). Therefore, research on nutrient requirements of mungbean should be undertaken on an urgent basis. Considering the above facts the present work was conducted to evaluate the influence of different levels of cowdung and NPK on the growth and yield of mungbean with the following objectives-

i. to find out the optimum dose of cowdung for optimum growth and yield of mungbean.

ii. to find out the optimum doses of NPK fertilizers for achieving higher productivity in mungbean.

iii. to study the effect of interaction between cowdung and NPK fertilizers levels on the yield of mungbean.

Chapter 2

Review of literature

CHAPTER 2

REVIEW OF LITERATURE

Nutrient requirements of different pulse crops depend on initial fertility status of the soil as well as yield goals. A number of investigations have been done on the effect of nitrogen and phosphorus on growth and yield of summer mungbean in different parts of the world especially in the South East Asia. In Bangladesh, research in this line is very limited. Available information pertinent to present study are reviewed and presented in this chapter.

2.1 Effect of NPK on mungbean

2.1.1 Effect of Nitrogen on mungbean

Sultana (2006) observed that plant height of mungbean showed superiority at 30 kg N ha $^{-1}$ followed by 40 kg N ha^{-1}. Nitrogen fertilizer significantly influenced plant height at all growth stages of Mungbean. At 20, 35, 50, 65 DAS and harvest the maximum heights were observed in the plants treated with 30 kg N ha^{-1}.

Ghosh (2004) used different levels of nitrogen and indicated that number of branches $plant^{-1}$ of mungbean was gradually increased with increasing N level at 25 kg N ha^{-1}.

Masud (2003) observed the highest plant height of mungbean with the application of 30 kg N ha^{-1} while Ghosh (2004) at 25 kg N ha^{-1}.

Quah and Jafar (1994) noted that plant height of mungbean was significantly increased by the application of nitrogen fertilizer with 50 kg ha^{-1} and also noted that 1000 seed weight of mungbean increased significantly by the application of nitrogen at 50 kg ha^{-1}.

Rudreshappa and Halikatti (2002) studied the effect of nitrogen levels (0, 12.5 and 25 kg ha^{-1}) on growth, yield and nutrient uptake of greengram in paddy fallows. Application of 12.5 kg N ha^{-1} was recorded to produce significantly higher seed yield. Further increase in nitrogen dose (25 kg N ha^{-1}) did not significantly increase the yield.

Srinivas *et al.* (2002) examined the effects of N (0, 20, 40, and 60 kg ha^{-1}) and P (0, 20, 50 and 75 kg ha^{-1}) along with seed inoculation with *Rhizobium* culture on the growth, yield and yield components of greengram. They observed that number of pods $plant^{-1}$, pod length and seeds pod^{-1} were increased with increasing rates of P and with increasing rates of N up to 40 kg ha^{-1} and also observed that 1000 seeds weight in greengram.

Tank *et al.* (1992) found that mungbean fertilized with 20 kg N ha^{-1} along with 40 kg P_2O_5 ha^{-1} produced significantly higher number of pods $plant^{-1}$ over the unfertilized control.

Pathak *et al.* (2001) evaluated the effect of N levels (0, 10, 20 or 30 kg ha^{-1}) on growth and yield of greengram under rainfed conditions during the summer of 1999. Application of 20 kg N ha^{-1} yielded poor than that of 30 kg N ha^{-1}.

Mian *et al.* (2000) found out the effect of foliar spray with Bavistin 50 WP (0.05 %), Indofil M-45 80 WP (0.2 %) and urea (1.2 %) on the control of *Cercospora* leaf spot and it was reported that foliar application of urea showed no significant effect on *Cercospora* leaf spot (CLS) but increased seed yield.

Mandal and Sikder (1999) laid out a green house pot experiment where mungbean (*Vigna radiata*) cv. BARI Mung-5 grown on saline soil and given 0, 50, or 100 kg N ha^{-1} and 0, 75 or 150 kg P ha^{-1}. Growth and yield increased significantly with N application, while P significantly increased the setting of pods and seeds. Root growth was significantly improved by individual and combined application of fertilizer.

Sarma and Sarma (1999) grew mungbean using farmer's practices as using fertilizer of (10 Kg N + 335 Kg P_2O_5 ha^{-1}). The highest yield (0.77 t) was given by the fertilizer application.

Mozumder (1998) studied five nitrogen levels (0, 20, 40, 60 & 80 kg N ha^{-1}) and two varieties of summer mungbean viz., BINA mung 2 and Kanti and found that nitrogen exerted negative effect on the harvest index.

Abd-El-Lateef *et al.* (1998) studied the effect of foliar applications of nutrients on the growth and yield of mungbean cv. Kowmy-1. Experimental results revealed that application of urea increased the number of branches $plant^{-1}$.

Provorov *et al.* (1998) observed the effect of seed inoculation of mungbean with strain CIAMI 901 of Bradyrhizobium and found that the seed yield was increased by 39.2 % and 1000-seed weight 16 %. These results were equivalent to applying 120 kg ha^{-1}. Best results were obtained with inoculations +60 kg N.

In a field experiment Satyanarayanamma *et al.* (1996) observed that spraying of 2% urea at flowering and pod development stage produced the highest seed yield (1.59 t ha^{-1}) over the control.

Kaneria and Patel (1995) reported that the application of 20 kg N ha^{-1} to mungbean significantly increased the seed yield from 1.08 to 1.4 t ha^{-1}.

Sarkar and Banik (1991) revealed that application of 10 kg N ha^{1} to mungbean resulted in appreciable improvement in yield attributes.

Gopala *et al.* (1993) found out the response of mungbean cultivars (Pusa Baishakhi, LGG 407, LGG 410 and MS 267) to a uniform dose of 20 kg N ha^{-1}. It was concluded that plant height, net assimilation rate (NAR), crop growth rate (CGR), relative growth rate (RGR) increased at 20 kg N ha^{-1}.

Gopala *et al.* (1993) observed that number of seeds pod^{-1} significantly increased with increase in phosphorus level from 0-50 kg P_2O_5 ha^{-1} where uniform dose of 20 kg N $ha^{-1}$was applied as a basal for all treatments.

Tank *et al.* (1992) observed that mungbean fertilized with 40 kg N ha^{-1} produced the highest seed yield $plant^{-1}$ while the lowest was observed in control treatment (0 kg N ha^{-1}).

Sarkar and Banik (1991) observed that application of 10 kg N ha^{-1} to mungbean resulted in appreciable improvement in number of pods $plant^{-1}$ over no nitrogen.

Hamid (1991) evaluated the effects of foliar application of nitrogen on mungbean cv. Mubarik. In both pot and field trials he showed 10 kg N ha^{-1} increased the number of pods $plant^{-1}$.

Sarkar and Banik (1991) observed that stover yield of mungbean increased significantly due to the use of N up to 10 kg ha^{-1}. On an average, the stover yield increased by 24 % due to the application of 10 kg N ha^{-1} over no nitrogen.

Suhartatik (1991) also reported that NPK fertilizers significantly increased the plant height of mungbean.

Agbenin *et al.* (1991) revealed that application of N significantly increased plant height, seed yield, dry weight, crop growth rate and nutrient uptake of mungbean over control.

Leelavathi *et al.* (1991) reported that different levels of nitrogen showed significant difference in seed yield of mungbean up to a certain level .

Samiullah *et al.* (1987) observed that number of seeds pod^{-1} were the highest with 10 kg N + 75 kg P_2O_5 + 60 kg K_2O in summer mungbean.

Mahmoud and Gad (1988) observed that nitrogen application increased the stover production up to a certain level under different row spacing of mungbean.

Sardana and Verma (1987) reported that application of nitrogen, phosphorus and potassium fertilizers resulted in significant increase in plant height and pod length of mungbean.

Suhartatik (1991) noted that residue of lime with NPK fertilizers significantly increased the pod length of mungbean.

Patel and Parmar (1986) observed that increasing N application to rainfed *Vigna radiata* (cv. Gujrat-1) from 0-45 kg ha^{-1} increased average seed yield from 0.83 to 0.94 t ha^{-1} and also increased protein content, plant height number of branches $plant^{-1}$, pods $plant^{-1}$ seeds pod^{-1}, pod length and 1000 seed weight.

In trials, on clayey soils during the summer season of 1979-80, Patel *et al.* (1984) studied the effects of 0, 10, 20 and 30 kg N ha^{-1} along with up to 20 kg N ha^{-1} significantly increased the number of pods $plant^{-1}$ of mungbean. Further increase in phosphorus rate was not economical.

2.1.2 Effect of Phosphorus on mungbean

Sarkar *et al.* (2005) assessed the effect of plant spacing and phosphorus on seed yield of mungbean and observed that the highest number of branches $plant^{-1}$, pods $plant^{-1}$, seed yield, stover yield and harvest index was found in the 30 cm × 10 cm spacing with 40 kg P_2O_5 ha^{-1}.

Kumar *et al.* (2003) investigated the response of mungbean cultivars (Asha, MH 97-2, MH 85-111 and K 851) to different levels of P (0, 20, 40, and 60 kg P_2O_5 ha^{-1}). They found that P at 20, 40, and 60 kg ha^{-1} increased the seeds pod^{-1} over control.

Kumar *et al.* (2003) conducted an experiment to find out the response of mungbean cultivars (Asha, MH 97, MH 85- 111 and k 851) to different levels of phosphorus (0, 20, 40, and 60 kg P_2O_5 ha^{-1}) in Haryana, India. They found that the noumber of branches $plant^{-1}$ increased with increasing rates of P.

Khan *et al.* (2002) studied out the effect of phosphorus and *Rhizobium* inoculums on mungbean. They observed that seed yield of mungbean increased with increasing phosphorus significantly.

Khan *et al.* (2002) observed that the number of branches $plant^{-1}$ increased with increasing rate of P_2O_5 in both *Rhizobium* inoculated and uninoculated mungbean.

Sardar (2002) evaluated the effect of phosphorus fertilizer on the growth and yield of *Vigna radiata* and reported that application of P at the rate of 40 kg N ha^{-1} enhanced the harvest index.

Singh *et al.* (2001) observed that 30 kg P_2O_5 kg ha^{-1} soil gave the highest seed yield of greengram.

Yadav and Jakhar (2001) reported that seed and stover yield of mungbean increased with 60 kg P_2O_5 application ha^{-1}.

Ram and Dexit (2000) sowed mungbean cv. K- 851 on 20 or 30 March or 9 April and to which given 0, 20, or 60 kg P ha^{-1}. They reported that seed yield of mungbean increased with increasing phosphorus rate, which was best.

Masthan *et al.* (1999) found that number of seeds pod^{-1} of summer mungbean cv. LGG 127 increased with increasing the amount of in soil residual phosphorus rates.

Mitra *et al.* (1999) examined the rate of rock phosphate (50 kg P_2O_5 ha^{-1}) to summer mungbean grown in acid soils and reported that the P application maximized the number of seeds pod^{-1}.

Mitra *et al.* (1999) reported that 1000 - seed weight of summer mungbean might be maximized with application of rock phosphate (50 kg P_2O_5 ha^{-1}).

Mitra *et al.* (1999) reported that mungbean grown in acid soils gave the maximum number of pods $plant^{-1}$ with application of 50 kg P_2O_5 ha^{-1}.

Singh *et al.* (1999) grew mungbean cv. NDM-1 with 0-26.4 kg P ha^{-1}. Their study revealed that number of seeds pod^{-1} increased with up to 26.4 kg P ha^{-1}.

Singh *et al.* (1999) observed that seed yield of mungbean generally increased with up to 26.4 kg ha^{-1}. Raundal *et al.* (1999) reported that application 60 kg P_2O_5 ha^{-1} to mungbean significantly increased the seed yield (18.23 q ha^{-1}).

Singh and Ahlawat (1998) reported that application of phosphorus to mungbean cv. PS 16 increased the number of seeds pod^{-1} when grown in a sandy loam soil, low in organic carbon and N, medium in P and with a pH of 7.8 and increased the harvst index up to the rate of 12.9 kg P ha^{-1}.

Singh and Ahlawat (1998) stated that application of phosphorus to mungbean cv. PS 16 increased 1000 seeds weight with 12.9 kg P ha^{-1}.

Sharma and Singh (1997) studied the effects of various levels of phosphorus fertilizer (0, 25, 50 and 75 kg ha^{-1}) on the growth; yield attributes and yield of mungbean. They found that application of phosphorus at 50 kg ha^{-1} enhanced the seed yield significantly.

Bayan and Saharia (1996) reported that application of phosphorus to mnugbean (*Vigna radiata* L.) did not affect the number of pods $plant^{-1}$.

Saxena *et al.* (1996) reported that seed yield was the highest with 60 kg P_2O_5 ha^{-1} in 1988 which increased with up to 30 kg P_2O_5 ha^{-1} in 1989.

Shukla and Dixit (1996) conducted a field experiment with mungbean and reported that application of phosphorus significantly increased the number of seeds pod^{-1} when P was used up to the rate of 40 kg P_2O_5 ha^{-1}.

Shukla and Dixit (1996) studied the response of mungbean to *Rhizobium* the application inoculation at different levels of phosphorus. *Rhizobium* inoculation increased the plant height of mungbean. Their study showed that the plant height of mungbean increased with 40 kg P_2O_5 ha^{-1}.

Tomar *et al.* (1996) observed that harvest index of summer mungbean (*Vigna radiata*) was highest with 50 kg P_2O_5 ha^{-1}.

Kalita *et al.* (1995) reported that application of phosphorus significantly increased the seed yield of mungbean. Patel and Patel (1994) carried a field experiment during the summer season of 1990-1991 at Navasari, Gujarat, India. Mungbean cv. K 851 was given 20 kg N ha^{-1} + 40 kg P_2O_5 ha^{-1} (recommended rate) and this gave the highest seed yield (1.74 t ha^{-1}).

A field experiment was carried out by Gopala *et al*. (1993) to find out the response of mungbean to different levels of phosphorus (0, 25, 50, kg P_2O_5 ha^{-1}). Their study showed that number of seeds pod^{-1} significantly increased with the increase of phosphorus levels from 0 to 50 kg ha^{-1}.

Gopala *et al.* (1993) observed that the seed yield of mungbean increased significantly with increase in phosphorus levels from 0 to 50 kg P_2O_5 ha^{-1}. Phosphorus application increased the seed yield by 18 and 51.2% at 25 and 50 kg P_2O_5 ha^{-1} respectively over no phosphorus. Bayan and Saharia (1996) studied the effect of phosphorus on mungbean during the *Kharif* season of 1994-95. The result indicated that seed yield was not affected by phosphorus application.

Sharma *et al.* (1993) observed that stover of mungbean cv. Pusa Baishakhi was increased with increase of phosphorus up to or equivalent to 60 kg P_2O_5 ha^{-1}.

Tank *et al.* (1992) reported that mungbean fertilized with 20 kg N ha^{-1} could be assigned to show significantly longer pod length over the higher (40 kg N ha^{-1}) and lower (unfertilized control) levels of N. They also observed that pod length significantly increased with the increase of phosphorus up to the levels of 40 kg P_2O_5 ha^{-1} over control.

Bali *et al.* (1991) carried out a field trial during the *Kharif* season on silty clay loam soil and found that 1000 seeds weight of mungbean increased with phosphorus application up to 60 kg P_2O_5 ha^{-1}.

Patel and Patel (1991) observed that plant height of mungbean showed superiority at 60 kg P_2O_5 ha^{-1} followed by 40 kg P_2O_5 ha^{-1}. The crop was grown on the soil, which was sandy in texture, low in total nitrogen (0.04%), higher in available phosphorus (77.33 kg ha^{-1}) and rich in available K (388.15

kg ha^{-1}) with the p^H 7.5. In that experiment plant height was found to be increased with increasing level of phosphorus from 0 to 60 kg P_2O_5 ha^{-1}.

Sarkar and Banik (1991) observed that application of 10 kg N ha^{-1} to mungbean resulted in appreciable improvement in pod length over control.

Sarkar and Banik (1991) reported that increasing levels of P_2O_5 up to 60 kg ha^{-1} to mungbean resulted in correspondingly higher stover yield, which was attributed to synthesis of carbohydrates and protein.

Reddy *et al.* (1990) observed that application of phosphorus increased 1000-seed weight of mungbean. In another experiment, Patel *et al.* (1988) observed that application of 20 kg P_2O_5 ha^{-1} to mungbean increased 1000 seeds weight.

Kalita (1989) conducted a field trial during 1986-88, applying 30 kg P_2O_5 ha^{-1} to mungbean and noted that phosphorus application increased the number of seeds pod^{-1} over the control.

Samiullah *et al.* (1987) observed that number of seeds pod^{-1} were the highest with the fertilizer combination 10 kg N + 75 kg P_2O_5 + 60 kg K_2O ha^{-1} in summer mungbean.

Sardana and Verma (1987) stated that application of nitrogen; phosphorus and potassium fertilizers resulted in significant increases in 1000 seeds weight of mungbean.

Patel *et al.* (1984) found that application of 40 kg P_2O_5 ha^{-1} with 20 kg N ha^{-1} significantly increased the 1000 seeds weight of mungbean.

2.1.3 Effect of potassium on mungbean

Nita *et al.* (2002) carried out a field experiment in west Bengal, India during the summer of 1998-1999 to study the effect of K and S at 0, 20 and 40 kg ha^{-1} to mungbean applied singly or in combination. They reported that leaf area index, plant height, nodules plant^{-1}, nodule dry weight, pods plant^{-1}, seed yield, protein yield, harvest index and net production value of mungbean increased with increased with increasing rates of K and S.

Sangakkara *et al.* (2001) carried out a field experiment to determine the benefits of potassium in overcoming water stress in mungbean. They found that potassium increased shoot and root growth and was considered as a significant factor in overcoming soil moisture stress in tropical cropping systems.

Gobinder and Thirumurugan (2000) carried out an experiment and observed that 1.0% KCl + 1.0% KNO_3 spray gave the highest value for plant height at harvest (48.6 cm), leaf area index at 60 DAS (6.83), dry matter production at harvest (2783 kg ha^{-1}), number of pods plant^{-1} (20.6), pod length (8.12cm), number of seed pod^{-1} (10.77), 100-seed weight (4.0 g), seed yield (777 kg ha^{-1}) of mungbean and benefit :cost ratio (2.53).

Prasad *et al.* (2000) conducted a pot experiment to study the effects of potassium on yield, water use efficiency and K-uptake by summer mungbean. They observed that total biomass production, seed yield, the water use efficiency and potassium uptake significantly increased with 20 and 30 kg K as compared to other levels of potassium.

Chawdhury and Mahamood (1999) laid out a field experiment to study the effect of optimum levels of growth, yield and quality of mungbean and reported that 50 kg K_2O gave the highest seed yield (832 kg ha^{-1}).

Mitra and Bhattacharyya (1999) carried out a field experiment and found that 20:40:40 kg N, P and K ha^{-1} gave the lowest disease intensity and highest plant height, leaf area index, number of pods plant^{-1}, seed yield and harvest index of mungbean.

Abed-el-lateef *et al.* (1998) carried out a field experiment with 0, 15.5, 31 kg P_2O_5 and or 24 kg K_2O feddan^{-1} and observed that seed yield of mungbean was increased by the application of K and the lower rates of P (1 feddan =0.42 ha).

Sushil *et al.* (1997) conducted an experiment to study the effect of sulphur, potassium supply (0, 25, 50, and 100 mm) on seed protein of *Vigna radiata*. They reported that the amount of globulin and albumin were increased with increasing concentrations of K. Tryptophan in the entire protein fraction also increased with K levels.

Asghar *et al.* (1996) conducted a field experiment to study the influence of various doses of potassium on yield and quality of mungbean. They reported that the number of pods plant^{-1}, number of seeds pod^{-1}, seed yield ha^{-1} and seed protein contents were influenced significantly by potassium application and the highest seed yield (1.67t ha^{-1}) was obtained with application of 75 K_2O ha^{-1}.

Chattejee and Mondal (1996) carried out a field experiment on integrated fertilizer management with or without application of potassium and organic matter or manure . They observed that maximum crop productivity was achieved using 150% of the recommended doses of N, P and K in rice-potato-sesame, rice-potato-groundnut system and the available K status was improved in 0 - 15 cm soil depth.

Mishra and Ahmed (1994) conducted an experiment in which leaves were sprayed with superphosphate, potassium chloride or NPK (14:35:14) and reported that P and K at low concentration (0.1%) increased nodulation and root dry weight. They also reported that plant dry weight and nodulation were increased significantly with the application up to 0.5% NPK.

Singh *et al.* (1993) conducted a field experiment to study the response of greengram to nitrogen, phosphorus and potassium. They reported that application N, P and K improved plant productivity and enhanced the seed yield of greengram significantly. They also reported that response to K_2O was recorded up to 40 kg ha^{-1}.

Dinata *et al.* (1992) studied the effect of 0, 12.5, 25, 37.5, 50 and 75 kg K_2O ha^{-1} and reported that application of potassium significantly increased the entire yield attributing characters, seed yield and dry matter with each increasing levels of potassium in mungbean.

Sangakkara (1990) carried out a field experiment to study the effects of 0 - 120 kg K_2O ha^{-1} on growth, yield parameters and seed quality of mungbean and reported that K application increased plant growth rate, flowers $plant^{-1}$, percentage pod set, seeds pod^{-1}, 100 - seed weight and yield $plant^{-1}$.

Maiti *et al* (1988) reported that 60 or 100 kg ha^{-1} each of P_2O_5 and K_2O increased seed yield in *Vigna radiata* and lentil.

Sardana and Verma (1987) made a field trail in Delhi, India with combined application of aldicarb (for the control of various insect pests) with nitrogen, phosphorus and potassium fertilizers and reported that plant height, leaf surface area, number and length of pods, 1000-seed weight and yield of greengram were significantly increased.

2.2 Effect of cowdung on mungbean

Bodruzzaman *et al.* (2004) evaluated the the effect of integrated use of cowdung and fertilizers on crop productivity in a wheat-mungbean-rice cropping pattern at Wheat Research Centre, Dinajpur, Bangladesh for 2-years (1997-98 and 1998-99). The treatments were 100% NPKSZn, 50% NPKSZn+5 t CD/ha, 50% NPK+5 t CD/ha, 50% SZn+5 t CD/ha, 10 t CD/ha and control. Mungbean was grown in between wheat and rice with a blanket dose of 50 kg/ha N only. The varieties for wheat, rice and mungbean were Kanchan, BRRI dhan 32 and BARI mung 5, respectively. The added fertilizers and manure significantly influenced the seed yields of the crops. The highest yield in both wheat and rice was obtained with 100% NPKSZn in both the years. The higher yield in 100% NPKSZn was attributed to better yield contributing characters of the crops compared to those in other treatments. Fifty percent nutrients plus cowdung or sole cowdung was not sufficient to produce satisfactory yield in either wheat or rice.

A field experiment was conducted by Hisar and Haryana (2001) in India, during the kharif seasons of 1998 and 1999 to study the response of moongbean (V. radiata cv. MH 96-1) to P application (at 0, 20 and 40 kg/ha) in relation to farmyard manure (FYM; 0 and 5 t/ha) and Zn (0 and 15 kg/ha) levels. Application of FYM at 5 t/ha increased yield of moongbean by 9.6% compared to without FYM. ZnSO4 at 15 kg/ha significantly increased moongbean yield during both the years over no ZnSO4, while application of 20 and 40 kg P2O5/ha produced 9.9 and 18.6% more yield, respectively, over the control..

Sudha-Bansal *et al.*, (1999) observed that composting of farm wastes (cattle manure mixed with different crop residues) with and without earthworms. The effect of various composts on growth and N and P uptake of mung bean (Vigna radiata cv. K 851) was investigated in pot experiments. There was more total N in worm inoculated compost than in compost without worms. Maximum dry matter production of mung bean, and N and P uptake, were given by compost prepared from a 3:7 mixture of cattle manure and rice straw inoculated with earthworms, although the benefit of worms in this compost was not statistically significant.

2.3 Combined effect of N, P and K fertilizers and cowdung on mungbean

In a field experiment Satish *et al.*, (2003) observed that sandy loam soil of Haryana, India to investigate the effect of *Rhizobium* sp. seed inoculation, FYM (farmyard manure) at 5 t/ha, vermicompost at 2.5 and 5 t/ha, and 4 levels of fertilizers (control, no chemical fertilizer; 75% recommended dose of fertilizer, RDF; 100% RDF. N:P at 20:40 kg/ha; and 125% RDF) on the performance of mungbean cv. Asha. *Rhizobium* sp. inoculation significantly increased the seed yield. Increasing RDF levels up to 100% also increased seed yield. Vermicompost at 5 t/ha produced 16.5 and 9.5% higher seed yield compared to FYM at 5 t/ha and vermicompost at 2.5 t/ha, respectively, in 2002. However, The organic amendment did not affect the seed/pod in 2001, and the 1000-seed weight in both years. The interaction of the different treatments was significant in 2002. Vermicompost application at both levels resulted in higher yield compared to FYM. Yield increased with increasing fertilizer rate up to 125% RDF, when applied with FYM, but yield was higher under the treatment 100% RDF + vermicompost (both rates).

A field trial was conducted by Dhingra *et al.* (1998) in 1992 - 94 at Ludhiana, Punjab, India to examine the combined effects of NPK fertilizers on the productivity of mungbean. They found that mungbean gave positive response to combined application of NPK fertilizers.

Reddy *et al.* (1998) reported that application of cowdung (5 t ha^{-1}) along with recommended N; P and K fertilizers resulted in significant high yield of mungbean.

Singh and Ahlawat (1998) stated that application of phosphorus to mungbean cv. PS 60 increased the number of branches per plant up to 12.9 kg/ha when grown in a sandy loam soil, low in organic carbon and N, and medium in P and K and with a pH of 7.8.

Sharma and Singh (1997) noted that application of 50 kg P/ha to mungbean enhanced the number of branches per plant. Singh and Ahlawat (1998) stated that application of phosphorus to mungbean cv. PS 60 increased the number of branches per plant up to 12.9 kg/ha when grown in a sandy loam soil, low in organic carbon and N, and medium in P and K and with a pH of 7.8.

Patel *et al.* (1993) evaluated the effects of farmyard manure (FYM) and NPK fertilizers on soil bulk density in rice-wheat-green gram sequences after 6 years of cropping were studied at Navsari, India. Ten different treatments were evaluated. Nitrogen was applied through urea, phosphorus through single super phosphate and potash through muriate of potash. The crops differed significantly in their effect on bulk density and porosity. The maximum bulk density and minimum porosity were observed after rice harvest. Nitrogen fertilizer increased the bulk density from 1.41 to 1.44 g/cm and decreased porosity from 46 to 45%. Addition of P and K in conjunction with N counteracted the adverse effects of N on bulk density and porosity. The lowest bulk density (1.36 g/cm) and highest porosity (48%) was observed in the FYM treatments.

An experiment was conducted by Sardana and Verma (1987) in New Delhi, India, in 1983-84. They stated that application of nitrogen, phosphorus and potassium fertilizers resulted in significant increases in plant height of mungbean.

During field trial, carried out by Sardana and Verma (1987) in New Delhi, India in 1983-84, it was found that application of nitrogen, phosphorus and potassium fertilizers resulted in significant increases in pod length in mungbean. Suhartatik (1991) noted that residue of lime with NPK fertilizer significantly increased the pod length of mungbean.

Samiullah *et al.*, (1987) reported that number of pods per plant was highest with the application of 10 kg N + 75 kg P_2O_5 + 60 kg K_2O in summer mungbean. He also observed that NPK fertilizers significantly increased the number of pods per plant.

Sardana and Verma (1987) carried out an experiment in Delhi, India, in 1983-84 and stated that application of N, P, K fertilizers resulted in significant increases in 1000- seed weight of mungbean.

In a field experiment, Yein *et al.*, (1981) applied N, P and K fertilizers to mungbean which resulted in increased plant height. He also carried out 2-year field trials in Assam, India on mungbean and reported that application of various levels of N, P, K fertilizers significantly increased the plant height.

Chapter 3

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

A field experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207 during the period of Kharif-1 season (March to May 2007) to study the effects of NPK and cowdung on growth and yield of mungbean (cv. BARI mung-6). The materials used and methods followed in the investigation are presented in this chapter.

3.1 Description of the Experimental Site

3.1.1 Site and soil

The experimental area was situated at 23°41' N latitude and 90°22' E longitudes at an altitude of 8.6 meter above sea level. The soil belonged to "The Modhupur Tract", AEZ-28 (FAO, 1988) (Appendix I). Topsoils were clay loam in texture and olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH ranged from 5.5 - 5.6 and had organic carbon 0.82%. The experimental area was flat having available irrigation and drainage facilities situated above flood level. The physical and chemical properties of soil are presented in Appendix II.

3.1.2 Climate and weather

The site is under sub tropical climate. It was characterized by high temperature accompanied by moderately high rainfall during Kharif season (April-September) and low temperature in the Rabi (October-March) season. The maximum, minimum and mean air temperature (^{0}C), rainfall (mm), relative humidity (%) and sunshine (hours) during the experimental period are given in Appendix III.

3.2 Plant Material

Mungbean variety BARI mung-6 was used as plant material in the study. The salient characteristics of this variety are presented below:

BARI mung-6 is a variety developed by the Bangladesh Agricultural Research Institute and was released in 2003 by the National Seed Board. Plant height of this variety ranges from 45-50 cm. Seeds are green shiny and bigger than BARI moog-1. It is a late winter cum summer mungbean variety that matures between 80 - 90 days. All the pods are matured at a time. It is resistant to the *Cercospora* leaf spot and tolerant to yellow mosaic virus.

3.3 Experimental treatments

The experimental treatments were consisted of the combination of following inorganic and organic fertilizers

Organic fertilizer (Cowdung) -

C_0 = No cowdung (control)

C_1 = 2.5 tons cowdung ha^{-1}

C_2 = 5 tons cowdung ha^{-1}

Inorganic fertilizers (NPK) -

F_0= No Fertilizer (control)

F_1= 10 kg N + 8 kg P + 8 kg K ha^{-1}

F_2= 20 kg N + 16 kg P + 16 kg K ha^{-1}

F_3 = 30 kg N + 24 kg P + 24 kg K ha^{-1}

As such the experiment had the following 12 treatments combination:

C_0F_0	C_1F_0	C_2F_0
C_0F_1	C_1F_1	C_2F_1
C_0F_2	C_1F_2	C_2F_2
C_0F_3	C_1F_3	C_2F_3

3.4 Experimental Design and Layout

The experiment was laid out in a randomized complete block design (RCBD/ factional) with three replications. The unit plot size was 4 m × 2.5 m. Laying out of the experiment was done on 25 March 2007 and in that day, the land was ready for sowing seeds.

3.5 Land Preparation

The experimental land was opened on 1 March 2007 with a power tiller and subsequently ploughed twice with country plough followed by laddering. Sufficient moisture was present in the field. The land preparation was completed on 25 March 2007 and was ready for lying out.

3.6 Fertilizer Application

The amount of N @ 0, 10, 20 and 30 kg N ha^{-1} , P @ 0, 8, 16 and 24 kg P ha^{-1} and K @ 0, 8, 16 and 24 kg ha^{-1} were applied in the form of urea, triple supper phosphate and muriate of potash respectively as per treatment. Cowdung as an organic fertilizer was applied @ 0, 2.5 and 5 ton ha^{-1} as per the treatment requirements. All the fertilizers were applied at the final land preparation.

3.7 Sowing of Seeds

Seed sowing was done in rows on 28 March 2007 @ 25 kg ha^{-1}. Row to row and plant-to-plant distance were 30 cm and 10 cm, respectively. The sowing depth of about 3 cm was maintained from the soil surface.

3.8 Intercultural Operations

Gap filling was done 10 days after planting wherever necessary due to failure of germination of some seeds. Thinning was done at 20 days after planting to maintain optimum plant density. First weeding was done at the time of thinning and second weeding was done at 35 days after first weeding. One light irrigation was given to all the plots after first weeding. Insecticide Sumithion 57 EC @ 2 ml $litre^{-1}$ was sprayed at the time of pod formation to control pod borer.

3.9 General Observations

The crops were frequently monitored to note any change in plant characters. The crop looked promising since the initial stage and it maintained a satisfactory growth till harvest.

3.10 Harvesting and Sampling

The crops were harvested at a time due to synchronous maturity of pods. At first 50% of early matured pod was harvested by hand picking at 77 days after sowing. Finally 7 days after first harvesting all plants were harvested plot-wise by uprooting and were bundled separately, tagged and brought to the threshing floor of the Agronomy Field Laboratory. All of the harvested pods were kept separately in properly tagged gunny bags. Five plants were randomly selected prior to maturity from each plot for data recording.

3.11 Threshing

The crop bundles were sun dried for two days by placing them on threshing floor. Seeds were separated from the plants by beating the bundles with bamboo sticks.

3.12 Drying, Cleaning and Weighing

The collected seeds were dried in sun to keep the moisture content at about 12% level. The dried and cleaned seed and stover were weighted plot-wise.

3.13 Recording of Data

Following observations regarding growth, yield and yield contributing characters were made.

A. Growth parameters

i. Plant height (cm)
ii. Dry matter plant^{-1} (g)
iii. No. of nodule plant^{-1}
iv. Dry weight of nodule plant^{-1}

B. Yield parameter

i. No. of branches plant^{-1}
ii. No. of pods plant^{-1}
iii. No. of seeds pod^{-1}
iv. Pod length (cm)
v. 1000-seed weight (g)
vi. Seed yield (kg ha^{-1})
vii. Stover yield (kg ha^{-1})
viii. Biological yield (kg ha^{-1})
ix. Harvest index (%)

3.14 Outline of Data Recording

A brief outline on data recording is given below:

A. Growth parameters

i. Plant height: The plant height was measured from ground level to the tip of the plant.

ii. Dry matter plant^{-1}: Dry matter plant^{-1} was measured from 5 selected plants and the average total dry matter plant^{-1} was calculated.

iii. Number of nodule plant^{-1}: Number of nodule plant^{-1} was counted from 5 selected plants and the average total nodule number plant^{-1} was calculated.

iv. Dry weight of nodule plant^{-1}: Dry weight of nodule plant^{-1} was measured from 5 selected plants and the average total dry weight of nodule plant^{-1} was calculated.

B. Yield parameters

i. Number of branches plant^{-1}: From each plot the number of branches plant^{-1} of 5 randomly selected plants was counted and value are determined.

ii. Number of pods plant^{-1}: Number of pods plant^{-1} was counted in each selected plant sample.

iii. Number of seeds pod^{-1}: Number of seeds pods^{-1} was counted from twenty selected pods of each selected plant sample. Then the average seed number pod^{-1} was calculated.

iv. Pod length: Length of 5 randomly selected pods from each sample was measured with the help of scale and their average value was recorded.

v. Weight of 1000-seeds: One thousand seeds were counted from the seeds sample of each plot separately, and then their weight was recorded taken in an electrical valance.

vi. Seed yield: Seed yield was recorded plot-wise and was expressed in terms of yield hectare^{-1}. Seed yield was adjusted to 12 % moisture content.

vii. Stover yield: After pod separation, the plants were sun dried for several days to a constant weight. The stover yield was then recorded and expressed on per hectare basis.

viii. Biological yield: The sum of seed yield and stover yield were recorded and expressed on per hectare basis.

ix. Harvest index: Harvest index was calculated using the following formula (Garden *et al.*, 1985).

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100.$$

Where,

Biological yield = Seed yield + Stover yield.

3.15 Analysis of Data

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of Computer Package MSTAT-C and Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) adjudged mean differences.

Chapter 4
Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

The present experiment was carried out in order to evaluate the effect of cowdung and fertilizer on growth and yield of summer Mungbean. Data on different parameters as per experimental requirements were recorded and analyzed. The mean values of different growth parameters have been presented in Table 4.1, 4.2, 4.3 and Figures 4.1, 4.2, 4.3 and 4.4 respectively. Yield and yield components have been presented in Tables 4.4, 4.5, 4.6 and Figures 4.5, 4.6, 4.7, 4.8 and 4.9 respectively. The results of the experiment have been presented and discussed in this chapter under the following headings and sub-headings.

4.1 Growth Parameter

4. 1. 1 Plant height

Plant height was significantly influenced by cowdung at all growth stages of mungbean (Fig. 4.1). At 15, 30, 45 DAS and at harvest the maximum plant heights (10.52, 31.25, 41.25 and 45.96 cm) were observed in the plants treated with 2.5 ton cowdung ha^{-1} and the minimum plant height was observed with control .

NPK fertilizer rate had significant effect on plant height at all growth stages of mungbean (Fig. 4.2). The tallest plants heights (11.14, 32.08, 41.61 and 46.17 cm) were obtained from the application of F_2 treatment at 15, 30, 45 DAS and at harvest respectively and the shortest plants height was observed at control at all sampling dates. Quah and Jafar (1994) noted that plant height of mungbean was significantly increased with increased application of nitrogen.

The interaction effect of cowdung and NPK fertilizer were significant at all sampling dates. Table 4.3 shows that the highest plant heights (11.99, 33.82, 43.95 and 47.39 cm) were found from application of C_1F_2 treatment at 15, 30,

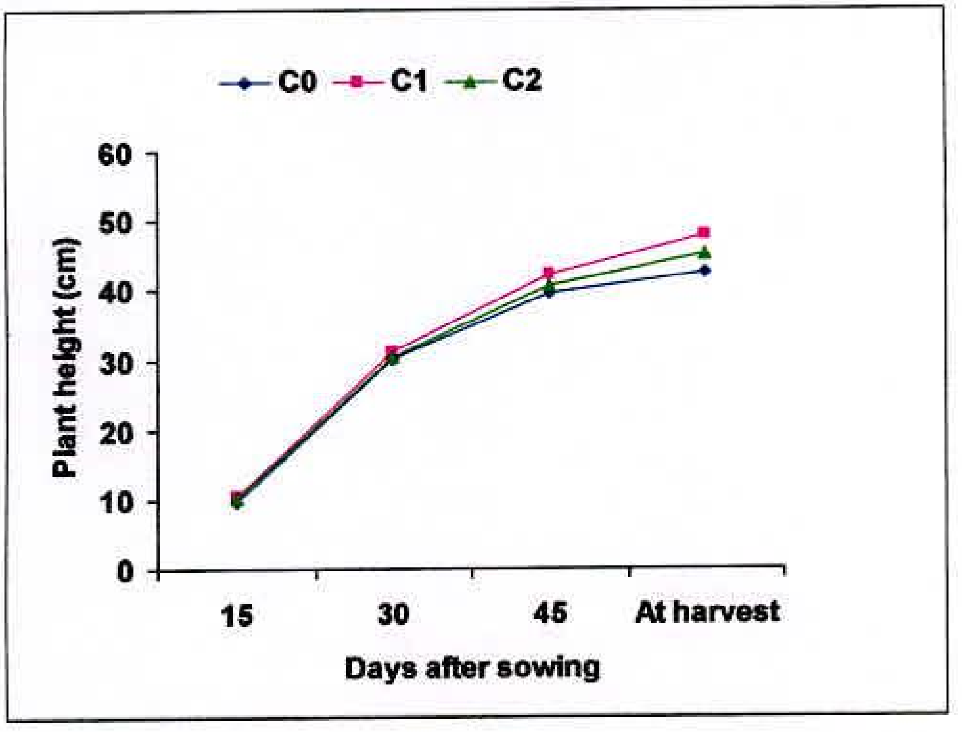


Fig. 4.1 Plant height of mungbean at different days after sowing as influenced by different rates of cowdung

C_0 = 0 t cowdung ha^{-1} (Control)

C_1 = 2.5 t cowdung ha^{-1}

C_2 = 5 t cowdung ha^{-1}

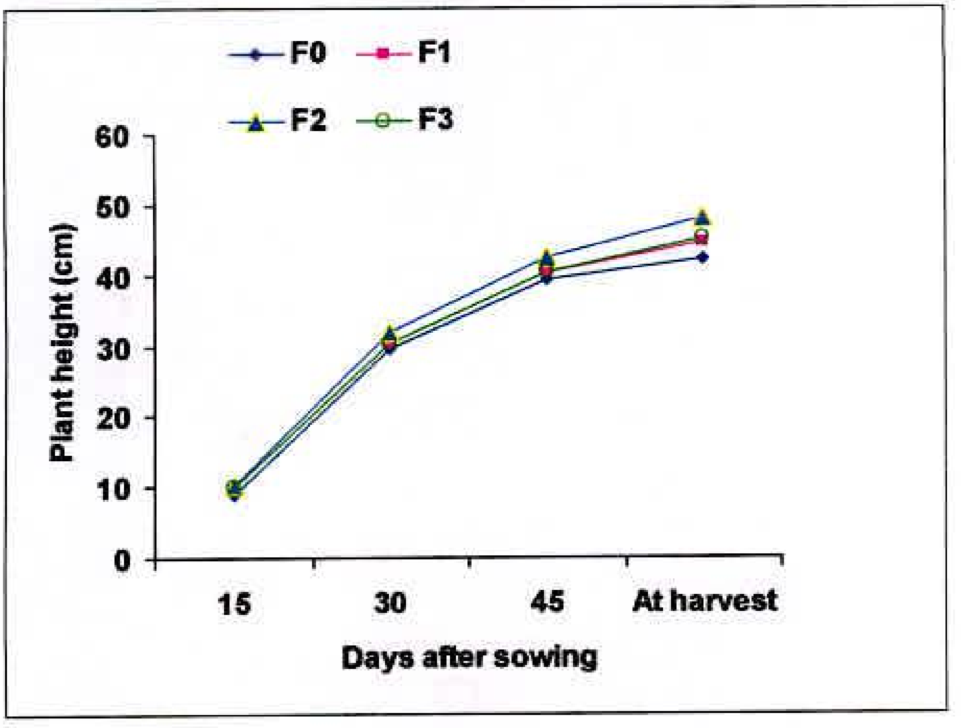


Fig. 4.2 Plant height of mungbean at different days after sowing as influenced by NPK

F_0 = 0 kg NPK ha^{-1} (Control)

F_1 = 10 kg N, 8 kg P and 8 kg K ha^{-1}

F_2 = 20 kg N, 16 kg P and 16 kg K ha^{-1}

F_3 = 30 kg N, 24 kg P and 24 kg K ha^{-1}

45 DAS and at harvest respectively and the lowest from control treatment. Bodruzzaman *et al.* (2004) showed the effect of integrated use of cowdung and fertilizers on crop productivity. The added fertilizers and manure significantly influenced the seed yields of the crops.

4.1.2 Dry matter plant^{-1}

The effect of cowdung levels on dry matter plant^{-1} was significant at all sampling dates (Fig. 4.3). The highest dry matter matter plant^{-1} (0.70, 1.49, 7.18 and 9.46 g) was found in treatment C_1 and the lowest was found in control.

NPK fertilizer rate had significant influenced on dry matter plant^{-1} (Fig. 4.4). The highest dry matter plant^{-1} (0.70, 1.72, 7.32 and 10.09 g) was found in treatment F_2 and the lowest was found in control at all growth studies.

The interaction of cowdung and NPK had significant effect on dry matter plant^{-1}. Table 4.3 shows that the highest dry matter plant^{-1} (0.89, 1.98, 8.99 and 11.98 g) was obtained at 15, 30, 45 and at harvest, respectively from the interaction of C_1F_2 treatment and the lowest dry matter weight plant^{-1} (2.52g) was obtained in control treatment

4.1.3 Number of nodules plant^{-1}

Level of cowdung had significant influence on number of nodule plant^{-1} (Table 4.1). The highest number of nodule plant^{-1} (13.42) was obtained from the application of cowdung 5 t ha^{-1} and the lowest (12.08) was found from no cowdung application.

NPK fertilizer rate had significant influence on number of nodule plant^{-1} (Table 4.2). The highest number of nodule plant^{-1} (15.11) were obtained from both F_2 and F_3 treatment and the lowest number of nodule plant^{-1} (8.44) was observed with control treatment

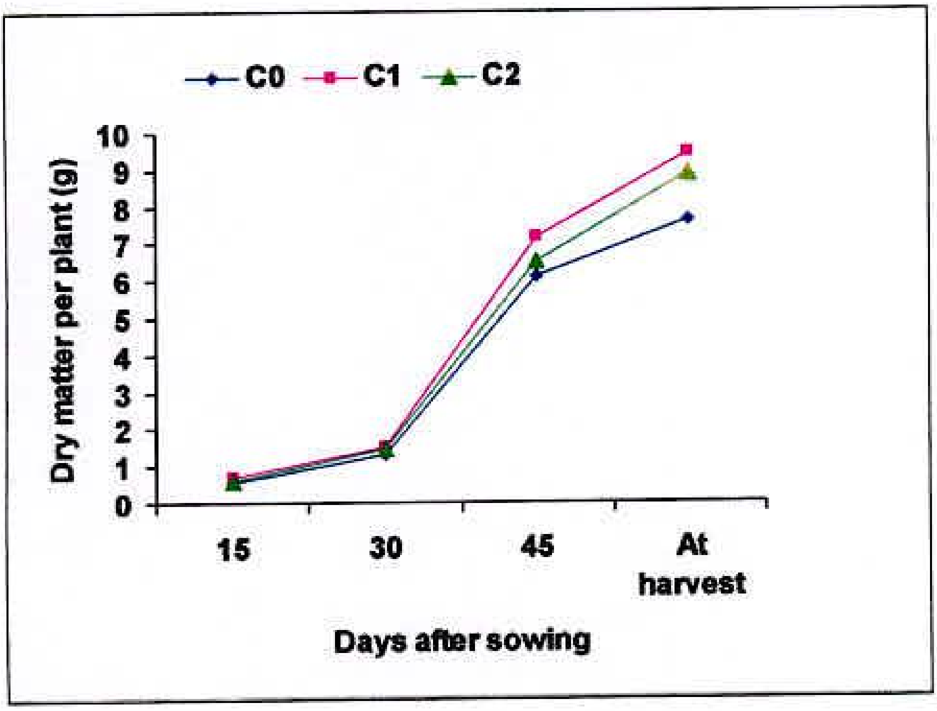


Fig. 4.3 Dry matter plant^{-1} of mungbean at different days after sowing as influenced by cowdung

C_0 = 0 t cowdung ha^{-1} (Control)

C_1 = 2.5 t cowdung ha^{-1}

C_2 = 5 t cowdung ha^{-1}

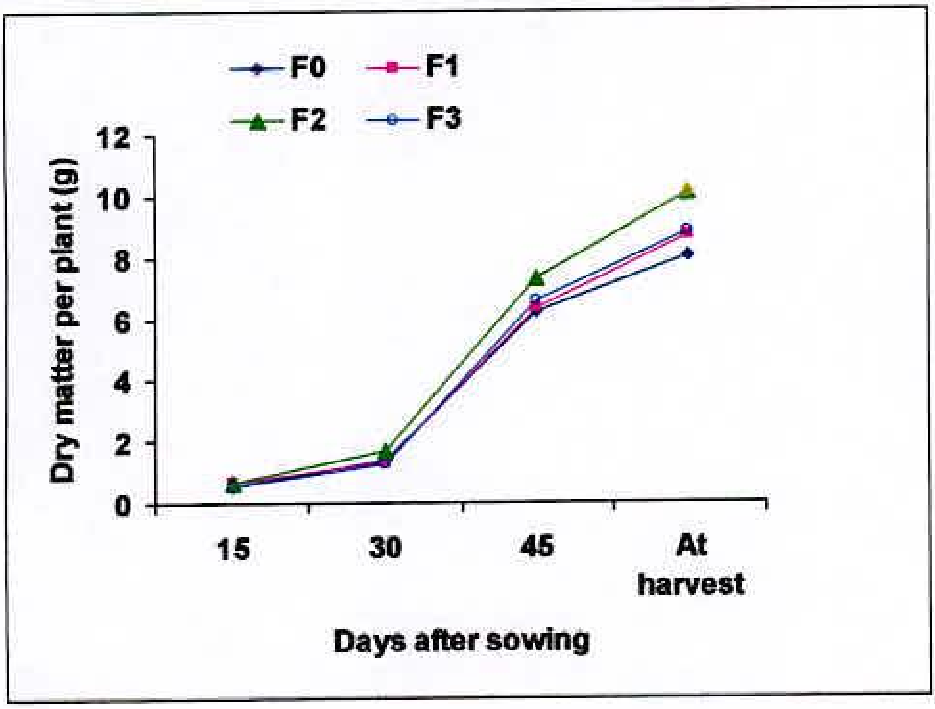


Fig. 4.4 Dry matter plant^{-1} of mungbean at different days after sowing as influenced by NPK

F_0 = 0 kg NPK ha^{-1} (Control)

F_1 = 10 kg N, 8 kg P and 8 kg K ha^{-1}

F_2 = 20 kg N, 16 kg P and 16 kg K ha^{-1}

F_3 = 30 kg N, 24 kg P and 24 kg K ha^{-1}

The interaction of cowdung and NPK fertilizer had significant effect on number of nodule plant^{-1}. Table 4.3 shows that the highest number of nodule plant^{-1} (15.00) was found from the interaction of C_1F_2 treatment and the lowest number of nodule plant^{-1} (7.67) was found from the control treatment.

4.1.4 Dry weight of nodules plant^{-1}

Level of cowdung had no significant influence on dry weitht of nodule plant^{-1} (Table 4.1). However, the highest dry weight of nodule plant^{-1} (0.140 g) was obtained from the application of C_1 and the lowest (0.133) was found from control treatment.

NPK fertilizer rate had significant influenced on dry weight of nodule plant^{-1} (Table 4.2). The highest dry weight of nodule plant^{-1} (0.157 g) was obtained F_2 and the lowest (0.012 g) with no NPK treatment.

The interaction of cowdung and NPK fertilizer had significant effect on dry weight of nodule plant^{-1}. Table 4.3 shows that the highest dry weight of nodule plant^{-1} (0.167 g) was found from the interaction of C_1F_2 treatment and the lowest (0.103 g) was found from C_0F_0 treatment.

Table 4.1 Effect of cowdung on different growth attributes of summer mungbean

Level of Cowdung	No. of nodule $plant^{-1}$	Dry weight of nodule $plant^{-1}$
C_0	12.08 b	0.139
C_1	12.17 b	0.133
C_2	13.42 a	0.140
Level of significance	*	NS
$S\bar{x}$	0.29	0.009
CV (%)	8.08	6.76

In a column, figures having similar letter(s) or without letters do not differ significantly where as figures having dissimilar letter(s) differ significantly at 5% level as per DMRT

NB.

* = Indicates significant at 5% level

NS = Indicates not significant

C_0 = 0 t cowdung ha^{-1} (Control)
C_1 = 2.5 t cowdung ha^{-1}
C_2 = 5 t cowdung ha^{-1}

Table 4.2 Effect of NPK on different growth attributes of summer mungbean

Level of NPK	No. of nodule plant^{-1}	Dry weight of nodule plant^{-1}
F_0	8.44 c	0.120 d
F_1	11.56 b	0.127 c
F_2	15.11 a	0.146 b
F3	15.11 a	0.157 a
Level of significance	*	*
S $\bar{x}$	033	0.001
CV (%)	8.08	6.76

In a column, figures having similar letter(s) or without letters do not differ significantly where as figures having dissimilar letter(s) differ significantly at 5% level as per DMRT.

NB.

* = Indicates significant at 5% level

NS = Indicates not significant

F_0 = 0 kg NPK ha^{-1} (Control)
F_1 = 10 kg N, 8 kg P and 8 kg K ha^{-1}
F_2 = 20 kg N, 16 kg P and 16 kg K ha^{-1}
F_3 = 30 kg N, 24 kg P and 24 kg K ha^{-1}

Table 4.3 Interaction effect of cowdung and NPK on different growth attributes of summer mungbean

Cowdung x NPK	Plant height (cm)				Dry matter plant^{-1} (g)				No. of nodule plant^{-1}	Dry weight of nodule plant^{-1}
	15 (DAS)	30 (DAS)	45 (DAS)	At harvest	15 (DAS)	30 (DAS)	45 (DAS)	At harvest		
C_0F_0	8.92 f	29.04 j	38.82 k	40.17 f	0.49 d	1.29 ef	5.33 e	7.34 j	7.67 e	0.133 d
C_0F_1	9.65 e	29.70 i	39.12 j	43.20 e	0.54 cd	1.23 g	6.73 bcd	8.43 h	11.33 bc	0.127 e
C_0F_2	10.36 cd	31.30 b	39.83 h	45.18 bcd	0.59 bcd	1.51 c	6.36 bcd	9.60 b	14.33 a	0.143 c
C_0F_3	9.97 de	30.98 d	40.75 d	44.98 bcd	0.55 cd	1.15 h	6.06 de	9.18 c	15.00 a	0.153 b
C_1F_0	9.15 f	29.95 g	39.58 i	44.29 de	0.61 bcd	1.27 fg	6.15 cde	9.08 d	8.00 de	0.103 g
C_1F_1	10.48 c	31.07 c	41.17 b	46.03 bc	0.68 bc	1.34 de	6.51 bcd	8.06 i	11.00 bc	0.120 f
C_1F_2	11.99 a	33.82 a	43.95 a	47.39 a	0.89 a	1.98 a	8.99 a	11.98 a	15.00 a	0.140 c
C_1F_3	10.45 c	30.15 e	40.32 e	46.12 b	0.63 bcd	1.38 d	7.10 bc	8.75 e	14.67 a	0.167 a
C_2F_0	9.25 f	29.84 h	39.95 g	45.05 bcd	0.59 bcd	1.62 b	7.12 b	8.61 g	9.67 cd	0.123 ef
C_2F_1	10.18 cd	30.16 e	41.10 bc	45.14 bcd	0.74 ab	1.37 d	5.78 de	9.64 b	13.33 b	0.133 d
C_2F_2	11.07 b	31.12 c	41.04 c	45.95 bc	0.62 bcd	1.67 b	6.62 bcd	8.70 ef	16.00a	0.153 b
C_2F_3	10.08 cd	30.08 f	40.19 f	44.75 cd	0.53 cd	1.27 g	6.51 bcd	8.67 f	15.67 a	0.150 b
Level of significance	*	*	*	*	*	*	*	*	*	*
$S\bar{X}$	0.13	0.01	0.025	0.39	0.05	0.01	0.28	0.08	0.58	0.001
CV (%)	2.22	0.13	0.12	1.53	15.20	1.17	7.57	0.18	8.04	6.76

In a column, figures having similar letter(s) or without letters do not differ significantly where as figures having dissimilar letter(s) differ significantly at 5% level as per DMRT.

NB.
* = Indicates significant at 5% level
NS = Indicates not significant

C_0 = 0 t cowdung ha^{-1} (Control)
C_1 = 2.5 t cowdung ha^{-1}
C_2 = 5 t cowdung ha^{-1}

F_0 = 0 kg NPK ha^{-1} (Control)
F_1 = 10 kg N, 8 kg P and 8 kg K ha^{-1}
F_2 = 20 kg N, 16 kg P and 16 kg K ha^{-1}
F_3 = 30 kg N, 24 kg P and 24 kg K ha^{-1}

4.2 Yield Parameter

4.2.1 Number of branches plant^{-1}

Level of cowdung had significant influence on number of branches plant^{-1} (Table 4.4). The highest number of branches plant^{-1} (2.67) was obtained from the application of C_1 and lowest (2.06) was obtained from control treatment.

NPK fertilizer rate had significant influenced on number of branches plant^{-1} (Table 4.5). The highest number of branches plant^{-1} (3.00) was obtained from application of F_2 which was statistically similar with that of F_3 and the lowest (2.00) were obtained from no NPK application.

The interaction of cowdung and NPK fertilizer had significant influence on number of branches plant^{-1} (Table 4.5). The highest number of branches plant^{-1} (3.33) was obtained from application of C_1F_2 and the lowest (2.00) were obtained from control treatment which was statistically similar with that of C_1F_0 and C_2F_0 treatment.

4.2.2 Number of pods plant^{-1}

Number of pods plant^{-1} was significantly affected by the rate of cowdung (Fig. 4.5). The highest number of pods plant^{-1} (12.80) was obtained from the application of C_1 and the lowest (11.37) was obtained from no cowdung application.

Rate of NPK was significantly influenced by the number of pods plant^{-1} (Fig. 4.6). The highest number of pods plant^{-1} (14.45) was obtained from application of F_2 and the lowest (11.28) was obtained from control treatment.

The interaction of cowdung and NPK fertilizer had significant influence on number of pods plant^{-1} (Table 4.6). The highest number of pods plant^{-1} (14.63) was obtained from application of C_1F_2 and the lowest (10.15) were obtained from control treatment

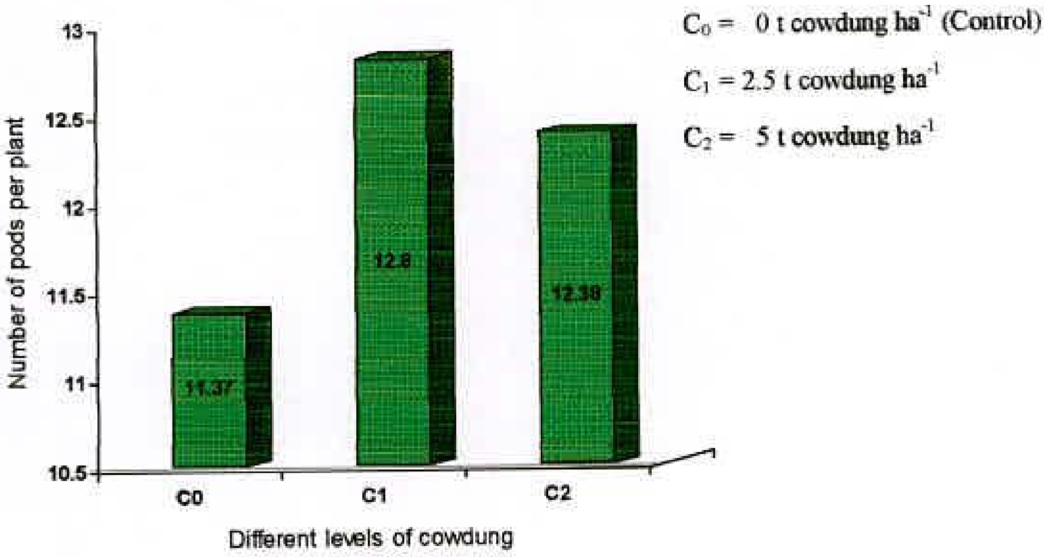


Fig. 4.5 Effect of different levels of cowdung on number of pods $plant^{-1}$

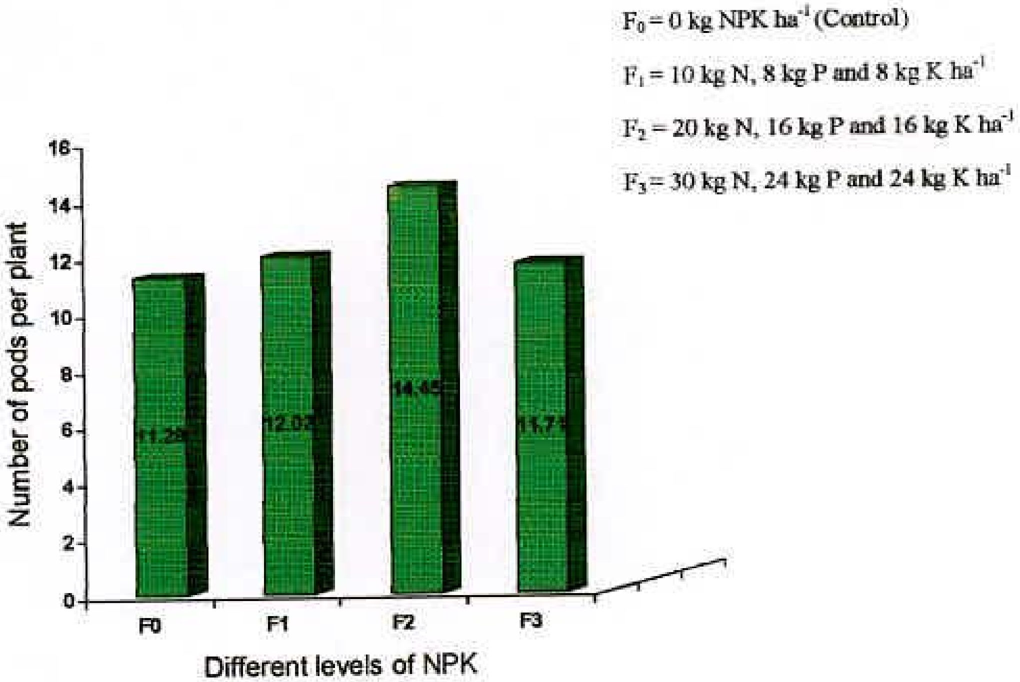


Fig. 4.6 Effect of different levels of NPK on number of pods $plant^{-1}$

4.2.3 Number of seeds pod^{-1}

Level of cowdung had significant influence on number seeds pod^{-1} (Table 4.4). However, the highest number of seeds pod^{-1} (9.15) was found from C_1 and the lowest (8.70) from no cowdung application..

Number of seeds pod^{-1} was significantly affected by the rate of NPK fertilizer (Table 4.5). However, the highest number of seeds pod^{-1} (9.20) was found with F_2 and the lowest (8.56) from control treatment. Gopala *et al.* (1993) observed that number of seeds pod^{-1} significantly increased with increase in phosphorus level.

The interaction of cowdung and NPK fertilizer had significant influence on number of seed pod^{-1} (Table 4.6). However, the highest number of seeds pod^{-1} (9.21) was obtained from C_1F_2 and lowest (8.13) from control treatment.

4.2.4 Pod length

Level of cowdung had no significant influence on pod length. However the highest pod length (9.70 cm) was observed from the application of C_2 and the shortest (9.63 cm) from no cowdung application (Table 4.4).

Level of NPK fertilizer had no significant influence on pod length. However the highest pod length (9.94 cm) observed from F_2 and the shortest (9.89 cm) from no NPK fertilizer application (Table 4.5).

There was no significant effect due to interaction between different level cowdung and NPK fertilizer on pod length. However the highest pod length (10.01cm) was found from the combination of C_1, F_2 treatment and the lowest (79.71 cm) from control treatment (Table 4.6).

4.2.5 1000-seed weight

1000-seed weight was not influenced by different level of cowdung. Numericaly the highest weight of 1000 seeds (49.82 g) was observed from the application of C_1 and the lowest (49.70 g) from C_2 and control treatment (Table 4.4).

Level of NPK fertilizer had no significant influence on 1000 seeds weight. Apparently the highest 1000-seed weight (50.21 g) and pod length (9.94 cm) observed from F_2 and the lowest (49.09 g) was found with control treatment (Table 4.5).

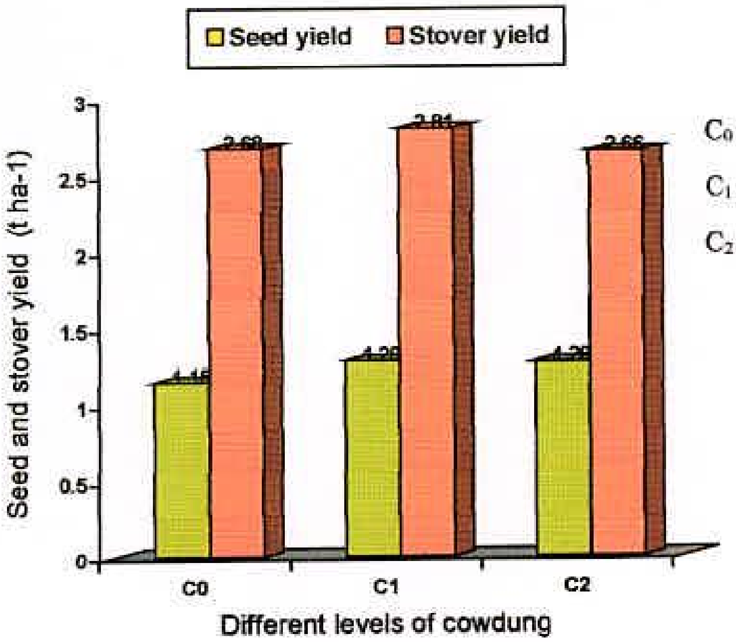
There was no significant influence of interaction between different level cowdung and NPK fertilizer on 1000-seed weight Visualy the highest 1000-seed weight (50.18 g) was found from the combination of C_1, F_2 treatment and the lowest 1000-seed weight (48.85 g) was obtained from control treatment (Table 4.6).

4.2.6 Seed yield

Cowdung had significant influence on seed yield (Fig. 4.7). The highest seed yield (1.29 t ha^{-1}) was found when the crop was fertilized with C_1. Probably higher number of branches $plant^{-1}$, higher number of pods $plant^{-1}$, higher number of seeds pod^{-1} due to the application of cowdung at 2.5 t ha^{-1} contributed to the higher seed yield. The lowest seed yield (1.15 t ha^{-1}) was obtained from no cowdung application.

Rate of NPK fertilizer had also remarkable influence on seed yield (Fig. 4.8). It was found that the highest seed yield (1.53 t ha^{-1}) was obtained from F_2 and the lowest (1.09 t ha^{-1}) from no NPK fertilizer application.

The effect of interaction of cowdung and NPK rate had significant influence on seed yield (Fig. 4.9). Application of C_1 and F_2 produced the highest seed yield (1.1.55 t ha^{-1}). The lowest seed yield (0.92 t ha^{-1}) was obtained from control treatment. Quah and Jafar (1994) noted that the added fertilizers and manure significantly influenced the seed yields of the crops.

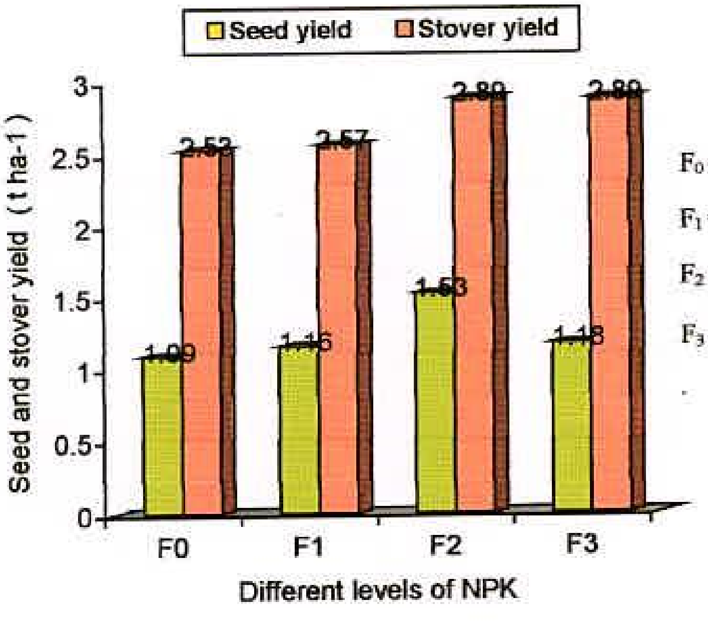


C_0 = 0 t cowdung ha^{-1} (Control)

C_1 = 2.5 t cowdung ha^{-1}

C_2 = 5 t cowdung ha^{-1}

Fig. 4.7 Effect of different levels of cowdung on seed and stover yield of summer mungbean



F_0 = 0 kg NPK ha^{-1} (Control)

F_1 = 10 kg N, 8 kg P and 8 kg K ha^{-1}

F_2 = 20 kg N, 16 kg P and 16 kg K ha^{-1}

F_3 = 30 kg N, 24 kg P and 24 kg K ha^{-1}

Fig. 4.8 Effect of different levels of NPK on seed and stover yield of summer mungbean

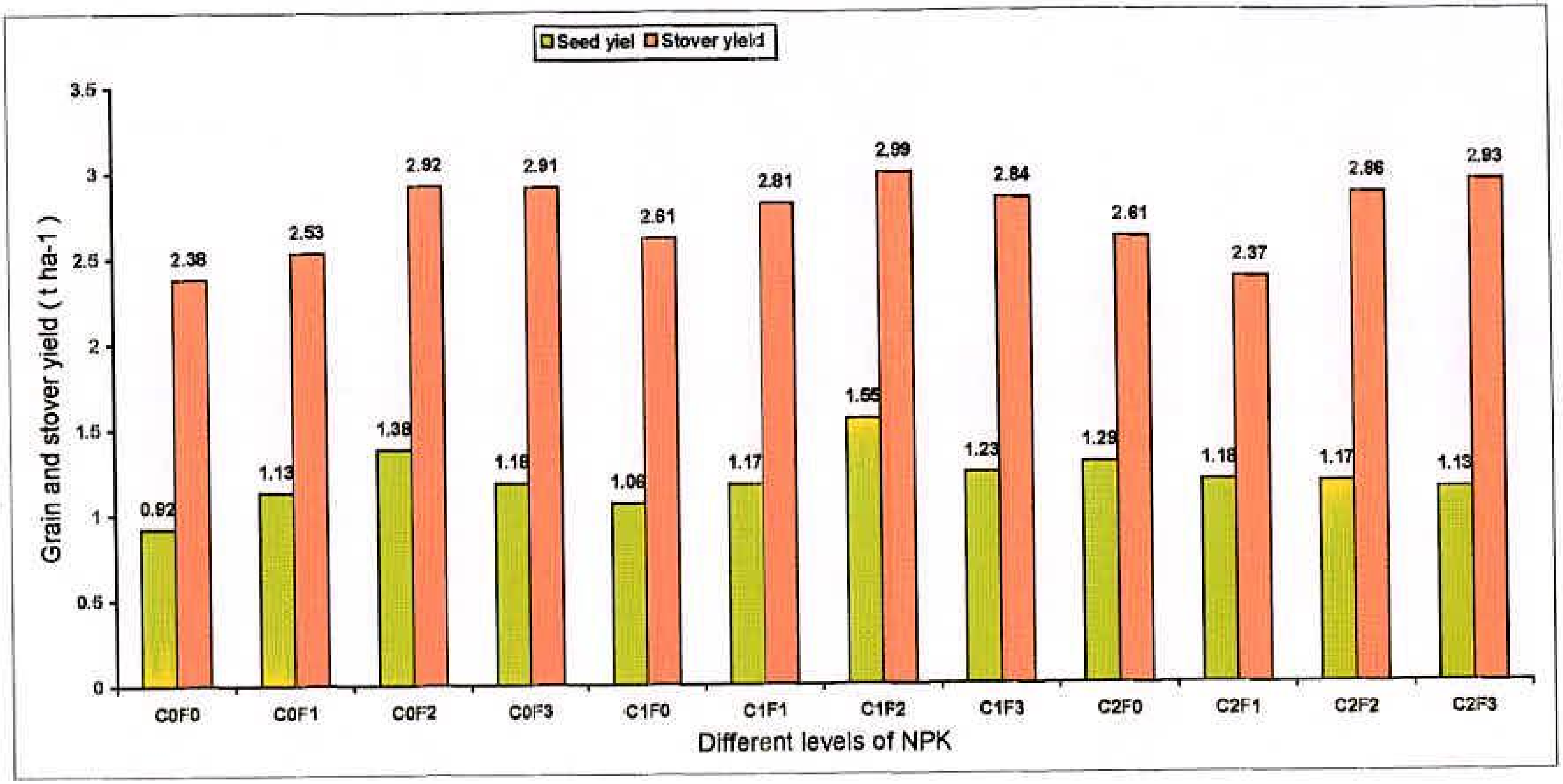


Fig. 4.9 Interaction effect of cowdung and NPK on seed and stover yield of summer mungbean

4. 2. 7 Stover yield

Stover yield was significantly affected by different levels of cowdung (Fig. 4.7). Figure 9 showed that the highest stover yield (2.81 t ha^{-1}) was produced by the application of C_1. The lowest stover yield (2.66 t ha^{-1}) was produced from C_2 application.

Rate of NPK fertilizer had also significant influence on stover yield (Fig. 4.8). From the figure 10, it was found that the highest stover yield (2.89 t ha^{-1}) was produced from the application of F_2 which was statistically similar with the application of F_3. The lowest stover yield (2.53 t ha^{-1}) was obtained from no NPK fertilizer application.

It was observed from Fig. 4.9 that interaction effect of cowdung and NPK rate on stover yield was significant. Figure 4.9 shows that the highest stover yield (2.99 t ha^{-1}) was produced from the combination of C_1, F_2 and control treatment produced the lowest stover yield (2.38 t ha^{-1}).

4. 2. 8 Biological yields

Biological yield was significantly affected by different levels of cowdung (Table 4.4). Table 4.4 showed that the highest biological yield (4.09 t ha^{-1}) was produced by the application of cowdung 2.5 t ha^{-1}. The lowest stover yield (3.83 t ha^{-1}) was produced from no cowdung application.

Rate of NPK fertilizer had significant influence on biological yield (Table 4.5). From table 4.5, it was found that the highest biological yield (4.42 t ha^{-1}) was produced from the application of F_2 and lowest (3.61 t ha^{-1}) from no NPK fertilizer.

It was observed from table 4.6 that interaction effect of cowdung and NPK rate on biological yield was significant. Table 4.6 shows that the highest biological yield (4.54 t ha^{-1}) was produced from the combination of C_1, F_2 and control treatment produced the lowest stover yield (3.28 t ha^{-1}).

4.2.9 Harvest index

Different level of cowdung had significant effect on harvest index. Table 4.4 showed that the highest harvest index (32.36%) was found from the application of C_1 and lowest (29.96%) from no cowdung application.

There was a significant effect of NPK fertilizer on harvest index (Table 4.5). The highest harvest index (34.62%) was obtained from F_2 and lowest (29.08%) from control treatment.

Interaction of cowdung and NPK fertilizer had significant effect on harvest index. The highest harvest index (34.14%) was obtained from the application of C_1F_2. On the other hand, the lowest harvest index (28.04%) was found from control treatment (Table 4.6).

Table 4.4 Effect of cowdung on the yield and yield contributing characters of summer mungbean

Cowdung	Number branches plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	1000-seed weight (g)	Seed yield Plant^{-1} (g)	Biological yield (t ha^{-1})	Harvest index (%)
C_0	2.06 c	8.70 b	9.63	49.70	5.22 b	3.83 b	29.96 c
C_1	2.67 a	9.15 a	9.70	49.82	5.63 a	4.09 a	32.36 a
C_2	2.50 b	8.77 b	9.68	49.70	5.58 a	3.96 ab	31.08 b
Level of significance	*	*	NS	NS	*	*	*
S $\bar{x}$	0.05	0.07	0.08	0.35	0.10	0.04	0.27
CV (%)	6.78	2.93	3.09	2.45	6.91	5.15	3.01

In a column, figures having similar letter(s) or without letters do not differ significantly where as figures having dissimilar letter(s) differ significantly at 5% level as per DMRT.

NB.
*Indicates significant at 5% level
NS Indicates not significant

C_0 = 0 t cowdung ha^{-1} (Control)
C_1 = 2.5 t cowdung ha^{-1}
C_2 = 5 t cowdung ha^{-1}

Table 4.5 Effect of NPK on the yield and yield contributing characters of summer mungbean

NPK	Number branches plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	1000-seed weight (g)	Seed yield Plant^{-1} (g)	Biological yield (t ha^{-1})	Harvest index (%)
F_0	2.00 c	8.56 c	9.89	49.09	4.76 c	3.61 c	29.99 bc
F_1	2.44 b	8.88 b	9.91	49.82	5.31 b	3.73 c	30.83 b
F_2	3.00 a	9.20 a	9.94	50.21	6.68 a	4.42 a	34.62 a
F_3	3.00 a	8.86 b	9.93	49.85	5.16 b	4.08 b	29.08 c
Level of significance	*	*	NS	NS	*	*	*
$S\bar{x}$	0.05	0.08	0.09	0.40	0.12	0.05	0.31
CV (%)	6.78	2.93	3.09	2.45	6.91	4.28	3.01

In a column, figures having similar letter(s) or without letters do not differ significantly where as figures having dissimilar letter(s) differ significantly at 5% level as per DMRT.

NB.
*Indicates significant at 5% level
NS Indicates not significant

F_0 = 0 kg NPK ha^{-1} (Control)
F_1 = 10 kg N, 8 kg P and 8 kg K ha^{-1}
F_2 = 20 kg N, 16 kg P and 16 kg K ha^{-1}
F_3 = 30 kg N, 24 kg P and 24 kg K ha^{-1}

Table 4.6 Interaction effect of cowdung and NPK on the yield and yield contributing characters summer mungbean

Cowdung × NPK	Number branches plant^{-1}	No. of pods plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	1000-seed weight (g)	Seed yield Plant^{-1} (g)	Biological yield (t ha^{-1})	Harvest index (%)
C_0F_0	2.00 e	10.15 e	8.13 e	9.71	48.85	4.03 e	3.28 f	28.04 f
C_0F_1	2.33 d	12.56 bc	9.08 abc	9.72	50.07	5.71 bc	3.66 de	30.87 cd
C_0F_2	3.00 b	13.11 b	9.17 ab	9.91	50.08	6.02 b	4.30 b	32.09 bc
C_0F_3	2.33 d	11.52 cde	9.06 abc	9.89	49.37	5.15 cd	3.55 ef	32.23 bc
C_1F_0	2.00 e	1115 cde	8.47 de	9.83	48.98	4.62 de	3.67 de	28.88 ef
C_1F_1	2.67 c	11.98 bcd	8.51 de	9.96	50.02	5.09 cd	3.98 c	29.39 def
C_1F_2	3.33 a	14.63 a	9.21 a	10.01	50.18	6.76 a	4.54 a	34.14 a
C_1F_3	3.00 b	12.47 bc	8.62 cd	9.88	49.92	5.36 bc	4.07 bc	30.22 de
C_2F_0	2.00 e	12.56 bc	9.08 abc	9.82	49.44	5.63 bc	3.90 cd	33.07 b
C_2F_1	3.00 b	11.87 bcd	8.71 bcd	9.88	49.83	5.15 b	4.09 bc	28.85 ef
C_2F_2	2.67 c	11.13 cde	9.11 a	9.95	50.08	5.08 cd	4.03 bc	29.03 def
C_2F_3	3.00 b	10.81 e	9.17 ab	9.97	49.81	4.93 de	4.06 bc	27.83 fg
Level of significance	*	*	*	NS	NS	*	*	*
$S\bar{x}$	0.01	0.43	0.15	0.16	0.70	0.21	0.09	0.54
CV (%)	6.78	6.15	2.93	3.16	2.45	6.91	4.28	3.01

In a column, figures having similar letter(s) or without letters do not differ significantly where as figures having dissimilar letter(s) differ significantly at 5% level as per DMRT.

C_0 = 0 t cowdung ha^{-1} (Control)
C_1 = 2.5 t cowdung ha^{-1}
C_2 = 5 t cowdung ha^{-1}

F_0 = 0 kg NPK ha^{-1} (Control)
F_1 = 10 kg N, 8 kg P and 8 kg K ha^{-1}
F_2 = 20 kg N, 16 kg P and 16 kg K ha^{-1}
F_3 = 30 kg N, 24 kg P and 24 kg K ha^{-1}

NB.
*Indicates significant at 5% level
NS Indicates not significan

Chapter 5
Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

A field experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207 during the period of Kharif-I season (March to May 2007) to study the effects of cowdung and NPK on growth and yield of summer mungbean (cv. BARI mung-6). The experimental treatment consisted of (a) three levels of cowdung (CD), namely- i) no cowdung (control), ii) 2.5 t ha^{-1} CD, iii) 5.0 t ha^{-1} CD and (b) four levels of NPK, namely- i) no NPK fertilizer (control), ii) 10 kg N + 8 kg P + 8 kg K ha^{-1}, iii) 20 kg N + 16 kg P + 16 kg K ha^{-1} and iv) 30 kg N + 24 kg P + 24 kg K ha^{-1}. The experiment was laid out in a RCBD (factional) design with three replications having 36 plots. The size of each plot was 4m x 2.5 m. Intercultural operations were done as and when necessary. Data on growth parameters and yield attributes were recorded. The collected data were analyzed statistically and the means were adjudged by DMRT.

Level of cowdung and NPK had significant influence on plant height and dry matter $plant^{-1}$. The tallest plant height 11.99 cm, 33.82 cm, 43.95 cm and 47.39 cm was obtained (at 15, 30, 45 DAS and at harvest) from 20 kg N, 16 kg P ha^{-1}, 16 kg K and 2.5 t ha^{-1} CD and the shortest from control treatment.

Level of cowdung had significant influence on number of nodule $plant^{-1}$ and NPK had also significant influence on number of nodule $plant^{-1}$ and dry weight of nodule $plant^{-1}$. The highest number of nodule $plant^{-1}$ (15.11) were obtained from both 20 kg N, 16 kg P,16 kg K ha^{-1} and 30 kg N, 24 kg P, 24 kg K ha^{-1} and the lowest (8.44) was observed from the control treatment.

The highest number of nodule $plant^{-1}$ (15.00) was found from the interaction of 2.5 t ha^{-1} CD and 20 kg, 16 kg and 16 kg K ha^{-1}, whereas the lowest (7.67) was from combination of no cowdung x no NPK (control) treatment.

Level of cowdung had significant influence on number of branches plant^{-1}and NPK had also significant influence on number of branches plant^{-1}. The highest number of branches plant^{-1} (3.30) was obtained from application of 20 kg N, 16 kg P and 16 kg K ha^{-1} which was statistically similar to that of 30 kg N, 24 kg P and 24 kg K ha^{-1}. The lowest number of branches plant^{-1} (2.00) was obtained from control treatment. The interaction of cowdung and NPK fertilizer had also significant influence on number of branches plant^{-1}.

The highest number of pods plant^{-1} (12.80) was obtained from the application of 2.5 t cowdung ha^{-1} and the lowest (11.37) was obtained from no cowdung application.

Rate of NPK fertilizer significantly influenced the number of pods plant^{-1}. The highest number of pods plant^{-1} (14.45) was obtained from the application of 20 kg N, 16 kg P and 16 kg K ha^{-1} and the lowest (11.28) was obtained from no NPK fertilizer.

The interaction of cowdung and NPK fertilizer had significant influence on number of pods plant^{-1}. The highest number of pods plant^{-1} (14.63) was obtained from the combination of 2.5 t CD ha^{-1} and 20 kg N, 16 kg P and 16 kg K ha^{-1} where as lowest (10.15) was obtained from no CD along with no NPK.

The highest number of seeds pod^{-1} (9.15) was obtained from the application of 2.5 t CD ha^{-1} and the lowest number of seeds pod^{-1} (8.70) was obtained from no CD application.

Rate of NPK fertilizer significantly influenced the number of seeds pod^{-1}. The highest number of seeds pod^{-1} (9.20) was obtained from application of 20 kg N, 16 kg P and 16 kg K ha^{-1}and the lowest (8.56) was obtained from no NPK.

The interaction of cowdung and NPK fertilizer had significant influence on number of seeds pod^{-1}. The highest number of seeds pod^{-1} (9.21) was obtained from the combination of 2.5 t CD ha^{-1} and 20 kg N, 16 kg P and 16 kg K ha^{-1} and the lowest (8.13) was obtained from no CD with no NPK fertilizer.

The highest pod length (10.01 cm) was found from the combination of 2.5 t CD ha^{-1} and 20 kg N, 16 kg P and 16 kg K ha^{-1} where as the lowest (9.71 cm) was obtained from control treatment.

The highest seed yield (1.29 t ha^{-1}) was found when the crop was fertilized with 2.5 t ha^{-1} CD. Higher number of branches $plant^{-1}$, higher number of pods $plant^{-1}$, higher number of seeds pod^{-1} might have contributed to the higher seed yield of that treatment. The lowest seed yield (1.15 t ha^{-1}) was obtained from no cowdung application.

It was found that the highest seed yield (1.53 t ha^{-1}) was obtained from 20 kg N, 16 kg P and 16 kg K ha^{-1}. Application of 2.5 t ha^{-1} CD and 20 kg N, 16 kg P and 16 kg K ha^{-1} produced the highest seed yield (1.55 t ha^{-1}).

The highest stover yield (2.89 t ha^{-1}) was produced from the application of 20 kg N, 16 kg P and 16 kg K ha^{-1}. The highest stover yield (2.99 t ha^{-1}) was produced from 2.5 t ha^{-1} CD and 20 kg N, 16 kg P and 16 kg K ha^{-1}, and no CD and no NPK fertilizer produced the lowest (3.38 t ha^{-1}).

The highest biological yield (4.54 t ha^{-1}) was produced from 2.5 t ha^{-1} CD and 20 kg N, 16 kg P, 16 kg K ha^{-1} and no CD and no NPK fertilizer produced the lowest stover yield (3.28 t ha^{-1}).

The lowest harvest index (29.96 %) was obtained from no CD and highest (32.36%) from 2.5 t ha^{-1} CD application. The highest harvest index (34.62%) was obtained from 20 kg N, 16 kg P and 16 kg K ha^{-1} and lowest (29.08%) from 30 kg N, 24 kg P and 24 kg K ha^{-1} application. The highest harvest index (34.14%) was obtained from the application of 2.5 t ha^{-1} CD with 20 kg N, 16 kg P and 16 kg K ha^{-1}.

The overall results indicate that application of 2.5 t ha^{-1} cowdung with 20 kg N, 16 kg P and 16 kg K kg ha^{-1} produced greater yield and yield component compared to other treatments. So this treatment might be important for mungbean production. However, further investigation is necessary to make concrete recommendation.

Chapter 6

References

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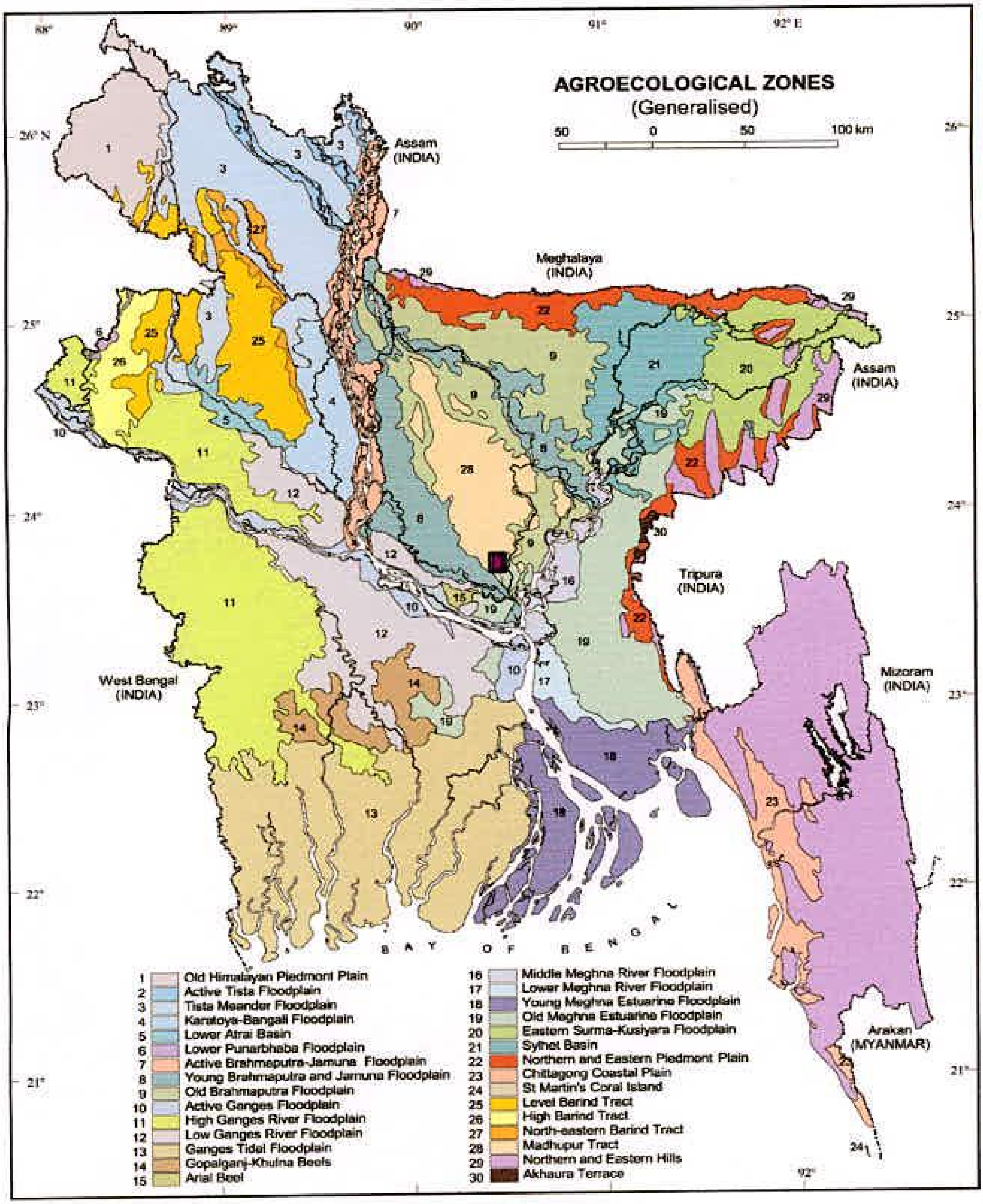
Appendix I. Map showing the experimental site under study



■ **The experimental site under study**

Appendix II. The physical and chemical characteristics of soil of the experimental site as observed prior to experimentation (0-15 cm depth).

Physical composition:

Particle size constitution

Sand	:	27%
Silt	:	45%
Clay	:	28%
Texture	:	Silty-clay
p^H	:	5.5-5.6

Chemical composition:

Soil characters	Value
Organic carbon (%)	0.82
Organic matter (%)	0.78
Total nitrogen (%)	0.07
Phosphorus	22.08 µg/g soil
Sulphur	25.98 µg/g soil
Magnesium	1.00 meq/100 g soil
Boron	0.48 µg/g soil
Copper	3.54 µg/g soil
Zinc	3.32 µg/g soil

Source: Soil Rrsources Development Institute (SRDI), Khamarbari, Dhaka.

Apendix III. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from March 2007 to June 2007.

Year	Month	Air temperature (^{0}C)			Relative humidity (%)	Total rainfall (mm)	Sunshine (h)
		Maximum	Minimum	Mean			
2007	March	31.40	19.60	25.50	54	11	254
	April	33.60	23.60	28.60	63	163	192
	May	34.70	25.90	30.30	70	185	242
	June	32.40	25.50	28.95	81	628	171

Source: Bangladesh Meteorological Department (Climate Division), Agargaon, Dhaka.

Appendix IV. Field view of the experimental plot