EFFECT OF NITROGEN AND IRRIGATION MANAGEMENTS ON THE YIELD ATTRIBUTES AND YIELD OF MUNGBEAN

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Dedicated to
My
Parents & Teachers who laid the foundation of my success

CERTIFICATE

This is to certify that the thesis entitled, "**Effect of nitrogen and irrigation managements on the yield attributes and yield of mungbean (*Vigna radiata* L.) cv. BARI mung-5**" 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 result of a piece of bonafide research work carried out by **Md. Asaduzzaman,** Registration No. 26210/501 under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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Dated: 28/12/06

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The Author

EFFECT OF NITROGEN AND IRRIGATION MANAGEMENTS ON THE YIELD ATTRIBUTES AND YIELD OF MUNGBEAN

ABSTRACT

An experiment was conducted at the experiment field of the Department of Agronomy, Sher-e-Bangla Agricultural University; Dhaka to evaluate the effect of nitrogen and irrigation managements on the yield attributes and yields of mungbean (*Vigna radiata* L.) cv.BARI mung-5 during the period from March 2006 to May 2006. The trial comprised of ten treatments such as T_1= control, T_2=20 kg N ha^{-1} as basal, T_3=20 kg N ha^{-1} as basal with one irrigation at first flowering stage, T_4 =30 kg N ha^{-1} as basal, T_5=30 kg N ha^{-1} as basal with one irrigation at first flowering stage, T_6=40 kg N ha^{-1} as basal, T_7=40 kg N ha^{-1} as basal with one irrigation at first flowering stage, T_8=basal 10 kg N ha^{-1} and 10 kg N ha^{-1} as split with one irrigation at first flowering stage, T_9=basal 15 kg N ha^{-1} and 15 kg N ha^{-1} as split with one irrigation at first flowering stage and T_{10}=basal 20 kg N ha^{-1} and 20 kg N ha^{-1} as split with one irrigation at first flowering stage. Irrespective of treatment differences the mungbean plant as a pulse crop showed a lag phase in early growth stage (up to 40 DAS) while increase of growth parameters like number of leaves, leaf dry weight and steam dry weight per plant very slow. Thus, initiation of flowers (35 DAS) caused low dry matter production. Application of 30 kg N ha^{-1} as basal with one irrigation at first flowering stage (35 DAS) improved the growth parameters significantly. This greater dry matter eventually supported the plant to produce more number of branches and pods per plant, which resulted with maximum seed yield per plant (5.53 g) or per hectare (1.65 ton). A functional positive relationship was observed among number of branches per plant, pods per plant, seeds per pod and seed yield.

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LIST OF ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
FAO	=	Food and Agricultural Organization
AGM	=	Above ground dry matter
ppm	=	parts per million
N	=	Nitrogen
et al	=	And others
TSP	=	Triple super phosphate
MP	=	Muriate of Potash
RCBD	=	Randomized complete block design
DAS	=	Days after sowing
ha^{-1}	=	Per hectare
g	=	gram(s)
kg	=	Kilogram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Researces and Development Institute
Hi	=	Harvest Index
No.	=	Number
WUE	=	Water use efficiency
wt	=	Weight
LSD	=	Least Significant Difference
0c	=	Degree Celsius
NS	=	Not significant
mm	=	millimeter
Max	=	Maximu
Min	=	Minimum
%	=	Percent
cv.	=	Cultivar
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of coefficient of variance
Hr	=	Hour

CHAPTER 1

Introdution

CHAPTER 1

INTRODUCTION

Bangladesh grows various types of pulse crops. Among them grass pea, lentil, mungbean, blackgram, chickpea, field pea and cowpea are important. It is an important food crops because it provides a cheap source of easily digestible dietary protein. Pulse protein is rich in amino acids like isoleucine, leucine, lysine, valine etc. According to FAO (1999) a minimum intake of pulse by a human should be 80 g per head per day, whereas it is only 14.19 g in Bangladesh (BBS, 2005). This is because of the fact that national production of the pulses is not adequate to meet the national demand.

Among the pulse crops, mungbean (*Vigna radiata* L.) has special importance in intensive crop production of the country for its short growing period (Ahmed *et al*., 1978). In Bangladesh mungbean ranks third in acreage and production but ranks first in market price. Mungbean grain contains 51% carbohydrates, 26% protein, 10% moisture, 4% mineral and 3% vitamins (Khan, 1981; Kaul, 1982). The green plants can also be used as animal feed and its residues have manural value. The crop is potentially useful in improving cropping pattern as it can be grown as a catch crop due to its rapid growth and early maturing characteristics. It can also fix atmospheric nitrogen through the symbiotic relationship between the host mungbean roots and soil bacteria and thus improves soil fertility. It may play an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh, but the acreage and production of mungbean is steadily declining (BBS, 2005).

The dry period of Kharif-I is not favorable for mungbean germination. Kharif-II period is occupied by T- aman. Cultivation of high yielding varieties of wheat and winter rice has occupies considerable land suitable for mungbean cultivation. Beside these, low yield potentiality of these crops is responsible for declining the area and production. At present the area under pulse crops is 0.406 million hectares with a production of 0.322 million tones where mungbean is cultivated in the area of 0.108 million hectares with production of 0.03 million tones (BBS, 2005).

The average yield of mungbean is 0.69 t ha^{-1} (BBS, 2005) which is very poor in comparision to mungbean growing countries in the world. There are many reasons of lower yield of mungbean. The management of fertilizer is the important one that greatly affects the growth, development and yield of this crop. Pulses although fix nitrogen from the atmosphere, there is evident that application of nitrogenous fertilizers become helpful in increasing the yield (Patel *et al.,* 1984 and Ardeshana *et al.,* 1993). Nitrogen is most useful for pulse crops because it is the component of protein (BARC, 1997).

In Bangladesh, Kharif-I mungbean is a rainfed crop wich grows on residual soil moisture. Mungbean responses favorably to added water resulting in higher yields, especially when irrigation is given at the time of flowering. (Lawn, 1978 ; Miah and Carangal, 1981).

One or two irrigation is useful to obtain higher yields. In summer cultivation when temperature is high, relative humidity is low and evapo-transpiration is greater, then 3-4 irrigations may be needed to obtain higher yields of mungbean (Sing and Sing, 1979 and Lal and Yadav, 1981). Irrigation during flowering stage helps for retention of flowers and pod development.

Hence, the present study was down to maximize the seed yield of mungbean with optimum nitrogen dose and irrigation level.

Considering the above facts, the present work was conducted with following Objectives:

- To determine the optimum dose of nitrogen for maximum yield attributes and yield of mungbean.
- To evaluate the performance of mungbean under irrigation and non irrigation condition.
- To determine the time of application of nitrogen fertilizer and irrigation in mungbean for achieving maximum yield.

CHAPTER 2

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

In Bangladesh, pulse crops are generally grown without fertilizer and irrigation. However there are evidences that the yield of pulse can be increased substantially by using fertilizers and irrigation. There are also controversies regarding the rates of nitrogen and time of irrigation (Patel *et al.*, 1984; Ardeshana, *et al*,. 1993).

Information on fertilizer and irrigation managements of pulse related to the study are reviewed and presented in the following heads.

2.1 Effects of different fertilizers on plant characters of mungbean

2.1.1 Plant height

Yein *et al.* (1981) conducted a field experiment on nitrogen in combination with phosphorus fertilizer to mungbean. They revealed that application of 40 kg N ha^{-1} fertilizer increased plant height.

Trung and Yoshida (1983) conducted a field trial on mungbean in nutrient-rich soil, involving 0-100 ppm N as treatments. They observed that maximum plant height at all the stages of plant growth were obtained by the application of 25 ppm N.

Sardana and Verma (1987) carried out a study in New Delhi, India in 1983-84. They found that application of nitrogen, phosphorus and potassium fertilizers in combination resulted in significant increase in plant height of mungbean.

Hamid (1988) conducted a field experiment to investigate the effect of nitrogen and carbon on the growth and yield performance of mungbean (*Vigna radiate* L. wilczek). He found that the plant height of mungbean cv. Mubarik was found to be increased nitrogen at 40 kg ha^{-1}

Suhartatik (1991) in a study observed that increased application of NPK fertilizers significantly increased the plant height of mungbean.

Quah and Jaafar (1994) found that plant height of mungbean was significantly increased by the application of nitrogen fertilizer at 50 kg ha^{-1}.

2.1.2 Number of leaves

Srivastava and Verma (1982) showed that N application at the rate of 15kg ha^{-1} increased the number of green leaves, branches and dry matter accumulation in mungbean plants.

2.1.3 Total dry matter

The total dry matter production is the integration of daily dry matter production over the entire growth period. The accumulation and pattern of dry matter distribution is controlled by the rate of photosynthesis, respiration and environmental conditions

Yein (1982) carried out a field trial on mungbean in Assam India and reported that combined application of nitrogen and phosphorus significantly increased the dry weight of plants.

Raju and Verma (1984) carried out a field experiment during summer season of 1979 and 1980 to study the response of mungbean var. Pusa Baishaki to varying levels of nitrogen (15, 30, 45 and 60 kg N ha^{-1}) in the presence and absence of seed inoculation with *Rhizobium*. They found that maximum dry matter weight per plant was obtained by the application of 60 kg N ha^{-1} inoculated with *Rhizobium*.

Agbenin *et al.* (1992) carried out a field experiment under glass house condition and found that nitrogen application significantly increased the dry matter yield of mungbean. In another study, Leelavathi *et al.* (1991) using different levels of nitrogen found a significant increase in dry matter production of mungbean with 60 kg N ha^{-1}.

Chowdhury and Rosario (1992) studied the effect of 0, 30, 60 or 90 kg N ha^{-1} levels on the rate of growth and yield performance of mungbean at los Banos, Philippines in 1988. They observed that N above the rate of 30 kg N ha^{-1} reduced the dry matter yield.

Santos *et al.* (1993) carried out an experiment on mungbean cv. Berken which was grown in pots in podzolic soil with 7 levels of N (0, 25, 50, 100, 200, 400 or 500 kg ha^{-1}). They noted that application of N op to 500 kg ha^{-1} increased the total dry matter.

Yakadri *et al.* (2002) studied the effect of nitrogen (40 and 60 kg ha^{-1}) on crop growth and yield of green gram (cv. ML-267). Application of nitrogen at 20 kg ha^{-1} resulted in the significant increase in leaf area ratios indicating better partitioning of leaf dry matter.

2.1.4 Number of flowers

Malik *et al.* (2003) conducted an experiment to determine the effect of varying levels of nitrogen (0, 25, and 50 kg ha^{-1}) and phosphorus (0, 50, 75 and 100 kg ha^{-1}) on the yield and quality of mungbean cv. NM-98 in 2001. They observed that number of flowers per plant was found to be significantly higher by 25kg N ha^{-1}

2.1.5 Number of Pods

In an experiment, Yien *et al.* (1981) applied nitrogen and phosphorus fertilizers to mungbean and reported that combined application of nitrogen and phosphorus fertilizers increased the number of pods per plant. The rate of nitrogen and phosphorus was 50 kg and 75 kg per hectare, respectively.

Salimullah *et al.* (1987) reported that the number of pods per plant was highest with the application of 50 kg N ha^{-1} along with 75 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} in summer mungbean.

Patel and Parmer (1986) conducted an experiment of the response of green gram to varying levels of nitrogen and phosphorus. They observed that increasing N application to rainfed mungbean (cv. Gujrat-1) from 0 to 50 kg N ha^{-1} increased the number of pods per plant.

Sarkar and Banik (1991) reported that application of 10 kg N ha^{-1} to mungbean resulted in appreciable improvement in the number of pods per plant while compared with no nitrogen.

Tank *et al.* (1992) reported that mungbean fertilized with 20 kg N ha^{-1} along with 75 kg P_2O_5 ha^{-1} significantly increased the number of pods per plant.

In trials, on clay soils during the summer season Patel *et al.* (1984) observed the effect of N levels (0, 10, 20 and 30 kg N ha^{-1}) and that of the P (0, 10, 20, 40, 60 and 80 kg P_2O_5 ha^{-1}) on the growth and seed yield of mungbean. In that experiment, it was found that application of 30 kg N ha^{-1} along with 40 kg P_2O_5 ha^{-1} significantly increased the number of pods per plant.

Srinivas *et al.* (2002) examined the effect of nitrogen (0, 20, 40 and 60 kg ha^{-1}) and P (0, 25, 50 and 75 kg ha^{-1}) on the growth and seed yield of mungbean. They observed that the number of pods per plant was increased with the increasing rates of N up to 40kg/ha followed by a decrease with further increase in N.

2.1.6 Number of seeds per pod

Malik *et al.* (2003) investigated the effect of varying levels of nitrogen (0, 25 and 50 kg ha^{-1}) and P (0, 50, 75 and 100 kg ha^{-1}) on the yield and quality of mungbean cv. NM-98 during 2001. It was found that number of seeds per pod was significantly affected by varying levels of nitrogen and phosphorus.

2.1.7 1000-seed weight

Patel *et al.* (1984) studied the effect of 0, 10, 20 and 30 kg N ha^{-1} and 0, 20, 40, 60 and 80 kg P_2O_5 ha^{-1} on the growth and seed yield of mungbean during summer season. They observed that application of 40 kg P_2O_5 ha^{-1} along with 20 kg N ha^{-1} significantly increased the 1000-seed weight of mungbean.

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

A field experiment was conducted by Sarkar and Banik (1991) to evaluate the effect of varying rates of N on mungbean. Results revealed that application of 10 kg N ha^{-1} resulted in the appreciable improvement in different yield attributes along with 1000 seed weight over control.

Trung and Yoshida (1983) carried out an experiment on mungbean, spraying 0-100 ppm N in the form of ammonium nitrate or 10 or 100 ppm N as urea, sodium nitrate, ammonium nitrate or ammonium sulphate. Results showed that 1000 seed weight was the highest with 100 ppm N than all the forms of N.

Bali *et al.* (1991) conducted a field trail one mungbean in kharif seasons on silty clay loam soil. They revealed that 1000- seed weight increased with 40 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1}.

Quah and Jaafar (1994) noted that 1000 seed weight of mungbean increased significantly by the application of nitrogen at 40 kg ha^{-1}.

Mahboob and Asghar (2002) studied the effect of seed inoculation at different nitrogen levels on the yield and yield components of mungbean at the agronomic research station, Farooqabad in Pakistan during the year of 2000 and 2001. They revealed that various yield components like 1000 grain weight were affected significantly with 50-50-0 NPK kg ha^{-1} application.

Srinivas *et al.* (2002) conducted an experiment on the performance of mungbean at different levels of nitrogen and phosphorus. Different rates of N (0, 25 and 60 kg ha^{-1}) and P (0, 25, 50 and 60 kg ha^{-1}) were tested. They observed that 1000- seed weight was increased with increasing rates of N up to 40 kg ha^{-1} along with increasing rates of P was than followed by a decrease with further increase in N.

2.1.8 Seed Yield

Werakonphanit *et al.* (1979) stated that mungbean showed no significant differences in response to different fertilizer levels. NPK levels of 0-0-0, 3-0-0 and 3-9-0 gave seed yield of 156, 168 and 175 kg ha^{-1} respectively. From the results of that study, it was concluded that the fertilizer application in mungbean was not necessary.

Yien (1982) conducted field trials on mungbean in Assasm, India and found that 10 kg N ha^{-1} in combination with 20 kg P ha^{-1} resulted in significant increase in the seed yield.

An experiment was conducted by Trung and Yoshida (1983) using 0-100 ppm N as treatment in the form of ammonium nitrate or 10 or 100 ppm N as urea, sodium nitrate, ammonium nitrate or ammonium sulphate. They found that seed yield of mungbean increased with the increase in N up to 50 ppm.

Raju and Verma (1984) reported that application of 15-60 kg N ha^{1} significantly increased seed yields of mungbean.

Results of an experiment, conducted by Sardana and Verma (1987) in Delhi, India, revealed that the application of nitrogen, phosphorus and potassium fertilizers in combination resulted in the significant increase in seed yield of mungbean.

Pongkao and Inthong (1988) applied N at the rate of 0-60 kg ha^{-1} on mungbean and reported that application of 15 kg N ha^{-1} was found to be superior giving 23% higher seed yield over the control. However 60 kg N ha^{-1} tended to produced seed yield which was at par of 15 kg N ha^{1}.

Arya and Kalra (1988) reported that application of N at the rate of 50 kg ha^{-1} along with 50 kg P ha^{-1} increased mungbean yield.

Results from field experiments conducted by Mahadkar and Saraf (1988) during summer season of mungbean showed that the application of N with P and K at 20:2:5 kg ha^{-1} gave higher seed yield.

A field experiments conducted by Sarkar and Banik (1991) to study the effect of N in combination with P on yield of mungbean. Results showed that application of N along with P significantly increased the seed yield of mungbean. The maximum seed yield was obtained with the combination of 20 kg N and 60 kg P_2O_5 ha^{-1}.

Leelavathi *et al.* (1991) showed significant increase in seed yield of mungbean by N 60 kg N ha^{-1}. While in another study Sarkar and Banik (1991) also reported that seed yield of mungbean increased significantly using 60kg N ha^{-1}.

Chowdhury and Rosario (1992) had undertaken a study to evaluate the effects of 0, 30, 60 or 90 kg N ha^{-1} on the growth and yield performance of mungbean at Las Banos, Philippines in 1988. They noted that applied N at the levels above 30 kg/ha reduced the seed yield.

Patel *et al.* (1992) conducted a field trial to evaluate the response of mungbean to sulphur fertilization under different levels of nitrogen and phosphorus. Greengram cv. Gujrarat 2 and K 851 were given 10 kg N + 20 kg P ha^{-1} , 20kg N + 40 kg P $ha^{1}$and 0, 10, 20 or 30 kg S ha^{-1} as gypsum. Seed yield was 1.2 and 1.24 t ha^{-1} in Gujrarat 2 K 851, respectively 20 kg N + 40 kg P ha^{-1}.

Phimsirkul (1992) conducted a field trial on mungbean variety, U- Thong I grown in different soils under varying N levels. Results revealed that there was no effect of N fertilizer when mungbean was grown in Mab Bon soil. However, seed yield of mungbean was increased when the crop received N at 30 kg ha^{-1}

Tank *et al.* (1992) found that mungbean fertilized with 20 kg N along with to level of 40 kg P_2O_5 ha^{-1} increased seed yield significantly over the unfertilized control.

Ardeshana *et al.* (1993) conducted a field experiment on clay soil during the rainy season of 1990 to study the response of mungbean to nitrogen. They observed that seed yield increased with application of nitrogen fertilizer up to 20 kg N ha^{-1} in combination with phosphorus fertilizer up to 40 kg P_2O_5 ha^{-1}

Sinhg *et al.* (1993) examined the effects of varying levels of N on mungbean cv. MH-85-61. They found that nitrogen application at the rate of 30 kg N resulted in the highest seed yield in mungbean.

Bachchhav *et al.* (1994) conducted a field experiment during the summer seasonwith green gram cv. Phule-M. They observed that among nitrogen fertilizers rates (0-45 kg N ha^{-1}) seed yield increased with 30 kg N ha^{-1}

Kaneria and Patel (1995) conducted a field experiment on a Vartisol in Gujarat, India with mungbean cv. K 581 using 0 or 20 kg N ha^{-1} levels. They found that application of 20 kg N ha^{-1} significantly increased the seed yield (1.14 ton ha^{-1}) when compared with that of control (1.08 ton ha^{-1}).

In a field experiment conducted by Satyanarayanamma *et al.* (1996), five mungbean cultivars were sprayed with 2% urea at pre-flowering, flowering, pod development or at all the combinations or at combination of two of three growth stages. They reported that spraying urea at flowering and pod development stages produced the highest seed yield.

Karle and Pawar (1998) examined the effect of varying levels of N and P fertilizers on summer mungbean. They reported that mungbean produced higher seed yield in in with the application of 15 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1}.

A field experiment was carried out by Sharma and Sharma (1999) during summer seasons at Golaghat, Assam, India. Mungbean was grown using farmers practices (no fertilizer) or using a combinations of fertilizer application (30 kg N+35 kg P_2O_5 ha^{-1}). Seed yield was 0.40-ton ha^{-1} with farmer's practices, while the highest yield was obtained by the fertilizer application (0.77 ton ha^{-1}).

Mandal and Sikder (1999) conducted a greenhouse pot experiment on mungbean cv. BARI Mung-5 under different N rates (0, 20 and 30 kg ha^{-1}). They noted that the seed yield increased (700, 800 and 900 kg ha^{-1}) significantly with increased N application.

Mahboob and Asghar (2002) studied the effect of seed inoculation at different nitrogen levels on mungbean at the agronomic research station, Farooqabad in Pakistan. They revealed that seed inoculation +50-50-0 NPK kg ha^{-1} exhibited superior performance in respect of seed yield (955 kg ha^{-1}).

Malik et *al.* (2003) conducted an experiment to determine the effect of varying levels of nitrogen (0, 25 and 50 kg ha^{-1}) and phosphorus (0, 50, 75, and 100 kg ha^{-1}) on the yield and quality of mungbean cv. NM-98. Growth and yield components were significantly affected by varying levels of nitrogen and phosphorus. A fertilizer combination of 25 kg N + 75 kg ha^{-1} resulted with maximum seed yield (1112.96 kg ha^{-1}).

Mozumder *et al.* (2003) conducted an experiment to study the effect of different nitrogen levels viz. 0, 20, 40, 60 and 80 kg N ha^{-1} on Binamoog-2 and they observed that increase of nitrogen fertilizer increased seed yield up to 40 kg N ha^{-1} and that was 1607 kg ha^{-1}.

Rajender *et al.* (2003) investigated the effects of N (0, 10, 20 and 30 kg ha-1) and P (0, 20, 40 and 60 kg ha^{-1}) fertilizer rates on mungbean genotypes MH 85-111 and T44. Grain yield increased with increasing N rates up to 20 kg ha^{-1}. Further increase in N did not affect yield.

Nadeem *et al.* (2004) studied the response of mungbean cv. NM-98 to seed inoculation and different levels of fertilizer (0-0, 15-30, 30-60 and 45-90 kg N-P_2O_5 ha^{-1}) under field conditions. Application of fertilizer significantly increased the yield and the maximum seed yield was obtained when 30 kg N ha^{-1} was applied along with 60 kg p_2o_5 ha^{-1}

2.1.9 Harvest Index

Harvest index is the ratio of economic yield to the biological yield reflected by the translocation of assimilates to the grain.

Mozumdar *et al.* (2003) conducted a field experiment at the Bangladesh Agricultural University, Mymensingh. They tested five levels of nitrogen (0, 20, 40, 60 and 80 kg ha^{-1}) and two varieties of summer mungbean viz., Binamoog-2 and Kanti. The results revealed that nitrogen application had negative affect on the harvest index in both the varieties.

2.2. Effect of irrigation on mungbean and other pulse crops

It is well established that the effects of water stress on growth and yield depend both on the degree of stress and on the stage of growth at which the stress occurs.

Siowit and Kramer (1977) observed that in soybean, the maximum reduction in yield due to moisture occured during bean filling stage. D rastic yield reduction was also reported in mungbean due to water stress (Sadasivam *et al., 1988;* Hamid *et al., (1990).* The yield loss was primarily caused by the reduction of canopy development, inhibition of photosynthetic rate and lower dry matter production

Eck and Musick (1979) discussed that yield reductions from stress initiated at early boot stage resulted from both reduced seed size and seed numbers of mungbean.

Pandey *et al.* (1984) reported that mungbean is more susceptible to water deficits than many grain legumes Water stress affects canopy development and overall growth process but there are varietal differences in stress tolerance.

Talukder (1987) reported that wheat seed yield and harvest index were the most susceptible parameters to water stress treatment imposed at flowering and pod development stages.

Sadasivam *et al.* (1988) reported that stress during vegetative phase reduces grain yield through reducing plant size, limiting root growth and number of pods and harvest index in mungbean. Decreased grain yield due to water stress was also reported in chickpea (Provakar and Suraf, 1991), soybean (Rajput *et* *al.*, 1991), green grain and black gram (Tripurari and Yadav, 1990), fababean (Khade *et al.*, 1990).

Pannu and Singh (1988) demonstrated the total dry matter as well as grain yields were affected by moisture stress in mungbean.

Hamid *et al.* (1990) reported a drastic yield reduction in mungbean due to water stress. The yield loss was primarily caused by the reduction of canopy development, inhibition of photosynthetic rate and lower dry matter production.

Majumdar and Roy (1992) reported that the higher grain yield and positive effect on yield components due to irrigation application in summer sesame. Similar result was found in soybean (Rajput *et al*1991), in edible pea (Rahman *et al.*, 2000), in greengram (Pal and Jana, 1991), in gram (Javia *et al.*, 1989) in chickpea

Denmead and Shaw (1960) in their studies with corn stated that plant growth, grain yield and dry matter production were reduced in all growth stress by water deficits. They further reported that when the deficit was removed the growth rate did not immediately return to normal but required several days to recover.

Salter and Goode (1967) stated that the extent of yield reduction from water deficits depends not only on the magnitude of the deficit but also on the stage of growth of bush bean. Yield and dry matter production were reduced in all growth stress by water deficits. They further reported that when the deficit was removed the growth rate did not immediately return to normal but required several days to recover.

Dubtez and Mahalle (1969) found that water stress reduced yield of bush bean by 53%, 71% and 35% when the stress occurred during preflowering, flowering and pod formation periods respectively.

Vitkov *et al.*, (1972) found that sprinkler irrigation wetting up to 60 cm depth of soil increased the seed yield up to 950 kg per hectare of French bean.

Field peas were most sensitive to water stress during flowering and early pod filling stage (Hsiao and Acevedo, 1974; Lewis *et al.*, 1974, Hiler *et al.*, 1972). Pod filling stage of soybean.

Lewis *et al.* (1974) reported that sorghum grain yields were reduced to 17.34% and 10% from control when water deficit occurred at late vegetative to booting stage respectively.

Turk *et al.* (1980) demonstrated the response of cowpea to intensities of drought at different stages of growth and reported that yields were not reduced by drought imposed during the vegetative stage; while drought occurred during the flowering stage substantial yield reduction was obvious. Variation in yields resulted from difference in number of pods/m^2 and small seed size.

Cselotel (1980) reported that a regular water supply particularly during flowering and pod formation is necessary for high yield and good quality of snap beans. Higher number of dry pods per plant, increased seed weight and seed yield per hectare was found when irrigation was done weekly (Haque, 1988) and Sankar (1992) reported similar results in peas and green gram respectively

Lawlor *et al.* (1981) observed that yields, total dry matter production and harvest index of barley were decreased by water stress. The grain growth in un-irrigated crop was decreased. This was probably due to insufficient supply of current assimilating to fill the grain as because the plant had little photosynthates.

Hassan and Mashhady (1983) reported that interactions between soil salinity and available soil water induced significant effects on dry matter content, grain yield, grain number and 1000-grain weight of wheat. The stress conditions caused by high soil salinity and limited soil moisture progressively decreased the dry matter conent of the wheat plant and triticale.

Irrigation increased pigeonpea yield by 97% but drought during the reproductive phase was the major yield-limiting factor (ICISAT, 1986).
Frick and Pinolato (1987) found that the deleterious effects of drought stress imposed at flowering reduced numbers of filled spikelets per panicle and reduced photosynthetic leaf area that effect directly the grain of chickpea.
Petersen (1989) reported that water stress reduced pods per plant and mean seed weight in *Phaseolus vulgaris* and pods per plant and seeds per pod in *P. acutifolius*. Similar results were reported by Lopes *et a.*, (1988).

Khade *et al.* (1990) found highest number of pods (8.28) plant^{-1}, seeds (16.43) pod^{-1} and seed yield (1.03 t ha^{-1}) with 3 irrigations in *Vicia sp.*
Viera *et al.* (1991) reported a yield reduction of 35 to 40% when drought stress was imposed during seed filling but found no effect on germination or vigour in soybean.

Karim *et al.* (1993) state that soil and atmospheric water stress control plant growth directly of soybean.

Nandan and Prasad (1998) reported that grain yield and net returns were higher with 3 irtigations than with 1 and 2 irrigations in french bean (Provaker and Suraf, 1991) and blackgram (Tripurari and Yadav, 1990).

Biswas (2001) reported that irrigation frequency exerted a remarkable impact on yield of field bean. Application of 3 irrigations increased vegetable pod yield about 19% and 13% and seed yield about 53% and 30% over 1 and 2 irrigations respectively. He also reported higher number of pods/plant seeds/pod and pod length with higher frequency of irrigation.

CHAPTER 3

MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

In this chapter, the details of different materials used and methodology followed during the experimental period are described.

3.1 Experimental site

The research work was carried out at the experiment field of Sher-e-Bangla Agricultural University, Dhaka, during the period from March to May 2006. Field view of the experimental field is shown in Appendix I.

3.2 Soil

Initial soil samples from 0-15 cm depth were collected from experimental field. The collected samples were analyzed at Soil Resources Development Institute (SRDI), Dhaka, Bangladesh. The physio-chemical properties of the soil are presented in Appendix II. The soil of the experimental plots belonged to the agro ecological zone of Madhupur Tract (AEZ-28). As shown in Appendix III.

3.3 Climate

The experimental area is under the subtropical climate. Usually the rainfall was heavy during Kharif season and scanty in Rabi season. The atmospheric temperatures were higher in Kharif season. The weather conditions during experimentation such as monthly mean rainfall (mm), mean temperature (^{0}C), sunshine hours and humidity (%) are presented in Appendix IV.

3.4 Planting material

The variety of mungbean used for the present study was BARI mung-5. The seeds of this variety were collected from the Pulse division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. Before sowing, the seeds were tested for germination in the laboratory and the percentage of germination was found to be over 90%. The important characteristic of this variety is mentioned below:

3.4.1 BARI mung-5 (Taiwani)

Plants are of average 40-45 cm height. Leaves are darker green. The variety is resistant to *Cercospora* leaf spot and yellow mosaic virus. Maximum seed yield is 1.1-1.4 ton/ ha. Seeds contain 20.93% protein and 49.46% Carbohydrate.

3.5 Land preparation

The land was irrigated before ploughing. After having zoe condition the land was first opened with the tractor drawn disc plough. Ploughed soil was then brought into desirable fine tilth by 4 operations of ploughing, harrowing and laddering. The stubble and weeds were removed. The first ploughing and the final land preparation were done on 20 February and 28 February 2006, respectively. Experimental land was divided into unit plots following the design of experiment. The plots were spaded one day before planting and the basal dose of fertilizers was incorporated thoroughly.

3.6 Fertilizer application

Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) were used as a source of nitrogen, phosphorous, and potassium respectively. Nitrogen was applied in the experiment as per treatment. P_2O_5 and K_2O were applied as basal dose at the rate of 48 and 33 kg per hectare respectively following the BARI recommendation.

3.7 Treatments of the experiment

The treatments were tested as follows:

T_1 = No fertilizer and no irrigation (Control)

T_2 = 20 kg nitrogen/ha as basal

T_3 = 20 kg nitrogen/ha as basal with one irrigation at first flowering stage

T_4 = 30 kg nitrogen/ha as basal

T_5 = 30 kg nitrogen/ha as basal with one irrigation at first flowering stage

T_6 = 40 kg nitrogen/ha as basal

T_7 = 40 kg nitrogen/ha as basal with one irrigation at first flowering stage

T_8 = 10 kg nitrogen/ha as basal and split 10 kg nitrogen/ha with one irrigation at first flowering stage

T_9 = 15 kg nitrogen/ha as basal and split 15 kg nitrogen/ha with one irrigation at first flowering stage

T_{10} = **20** kg nitrogen/ha as basal and split 20 kg nitrogen/ha with one irrigation at first flowering stage

3.8 Experimental design and lay out

The experiment was laid out in a Randomized complete block design (RCBD). Each treatment was replicated for three times. The size of each plot was 2.4m×2m. The distance between two adjacent replications (block) was 1.5 meter and plot-to-plot distance was 1 meter. The intra block and plot spaces were used as irrigation and drainage channels. A layout of the experiment has been shown in Appendix V.

3.9 Germination test

Germination test was performed before seed sowing in the field. Three layers of filter papers were placed on petridishes. Each petridish contained 100 seeds. Germination percentage was calculated by using the following formula.

$$\% \text{ Germination} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds taken for germination}} \times 100$$

3.10 Sowing of seeds in the field

The seeds of mungbean were sown on March 1, 2006. Seeds were treated with Bavistin before sowing the seeds to control the seed borne disease. The seeds were sown in solid rows in the furrows having a depth of 2-3 cm. Row to row distance was 30 cm.

3.11 Intercultural operations

3.11.1 Thinning

Seeds were germinated four days after sowing (DAS). Thinning was done two times; first thinning was done at 8 days after sowing and second was done at 15 days after sowing to maintain proper plant population in each plot.ie, 333333 plants ha^{-1}

3.11.2 Irrigation and weeding

Irrigation was done as per treatments. The crop field was weeded twice; first weeding was done at 25 DAS and second weeding was done 45 DAS.

3.11.3 Protection against insect and pest

At early stage of growth few worms (*Agrotis ipsilon*) and virus vectors (jassid) attacked the young plants and at latter stage of growth pod borer (*Maruca testulalis*) attacked the plant. Dimacron 50EC was sprayed at the rate of 1litre/ha.

3.12 Crop sampling and data collection

Ten plants from each treatment were randomly sampled and marked with sample card. The data of plant height, number of branches, number of flowers, and leaves per plant were recorded from sampled plants at an interval of fifteen days which was started from 25 DAS.

3.13 Harvest and post harvest operations

Harvesting was done when 90% of the pods became brown to black in color. The matured pods were collected by hand picking from a pre demarcated area of three linear at the center of each plot.

3.14 Data collection

The following data were recorded

i. Plant height (cm)
ii. Number of leaves per plant
iii. Leaves dry weight (g)
iv. Stem dry weight (g)
v. Reproductive dry weight(g)
vi. Above ground dry matter production per plant (g)
vii. Number of flowers per plant
viii. Number of pods per plant
ix. Number of seeds per pod
x. 1000- seed weight (g)
xi. Seed yield (g/ plant)
xii. Seed yield (t/ha)
xiii. Harvest index (%)

3.15 Procedure of data collection

3.15.1 Plant height (cm)

The heights of ten plants were measured with a meter scale from the ground level to the top of the plants and the mean height was expressed in cm.

3.15.2 Number of leaves per plant

The leaves (trifoliate) were counted from ten plants. The average number of leaves per plant was determined.

3.15.3 Leaf dry weight

Ten plants were randomly selected from each treatment and leaves are separated from each plant then each treatments leaves were dried separately in oven for 72 hours and weight was taken carefully. This procedure was done from 25 DAS to 85 DAS at 15 days interval

3.15.4 Stem dry weight

Stems were separated from each treatments and each plant. These stems were dried separately in oven for 72 hours and dry was taken carefully. This procedure was done from 25 DAS to 85 DAS at 15 days interval

3.15.5 Reproductive dry weight

Reproductive (flowers and pods) dry weight of ten plants of the each treatment was measured from 40 DAS to 85 DAS.

3.15.6 Above ground dry weight

The sum of the plant parts (leaves dry weight, stem dry weight and reproductive dry weight) constituted the above ground dry weight

3.15.7 Number of flowers per plant

Number of total flowers of ten plants from each plot was counted and the mean number was expressed on per plant basis.

3.15.8 Number of pods per plant

Number of total pods of ten plants from each plot was counted and the mean number was expressed on per plant basis.

3.15.9 Number of seeds per pods

The number of seeds in each pod was also recorded from ten randomly selected pods at the harvest.

3.15.10 Weight of 1000-seed (g)

One thousand cleaned dried seeds were counted randomly from each harvest sample and weighed by using a digital electric balance and weight was expressed in gram (g).

3.15.11 Seed yield (t ha^{-1})

The seeds collected from 0.9 m^2 of each plot were sun dried properly. The weight of seeds was taken and converted the yield in t ha^{-1}.

3.15.12 Harvest index (%)

The harvest index was calculated by using the following formula

$$\text{Harvest Index (\%)} = \frac{\text{Grain Yield}}{\text{Biological Yield}} \times 100$$

3.15.13 Analysis of data

The data collected on different parameters were statistically analyzed to obtain the level of significance using the MSTAT-computer package program developed by Russel (1986). The means were separated following least significance deference (LSD) test at 0.05 level of significance

CHAPTER 4

RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

Present experiment was conducted with different doses of nitrogenous fertilizer and levels of irrigation to study their effects on mungbean. The results regarding the effect of nitrogen and irrigation on different yield and yield attributes of mungbean are presented in this chapter.

4.1 Plant height (cm)

Irrespective of treatments plant height rapidly increased from 25 days after sowing (DAS) to 40 DAS (Fig. 1), thereafter a slower rate of increase in height was recorded up to harvest. At early growth stage (25 DAS) no significant variation in plant height was observed due to treatment variation. Significant influence of treatment 30 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_5) on plant heights were recorded from 55 DAS to 85 DAS and by treatment 40 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_7), 20 kg Nha^{-1} as basal + one irrigation at first flowering stage (T_3), 20 kg N ha^{-1} as basal and split 20 kg N ha^{-1} + one irrigation at first flowering stage (T_{10}), 30 kg N ha^{-1} as basal (T_4) and 15 kg N ha^{-1} as basal and split 15 kg N ha^{-1} + one irrigation at first flowering stage (T_9) at 70 DAS; T_7, T_3, T_{10}, T_4, 10 kg N ha^{-1} as basal and split 10 kg N ha^{-1} + one irrigation at first flowering stage (T_8) and T_9 at 85 DAS. Plants of minimum height were found in each growth stage where they were grown without fertilizer & irrigation (control). Both nitrogen and irrigation probably increased cell division or cell elongation of mungbean plants, thus increased plant height.

Trung and Yoshida (1983) found similar results and Quah and Jafar (1994) found increased plant height of mungbean with nitrogen application. Haque (1988) also observed increased in plant height in bush bean due to application of irrigation at weekly intervals. An increased plant height due to application of irrigation was also reported in field pea (Yadav *et al.*, 1994)

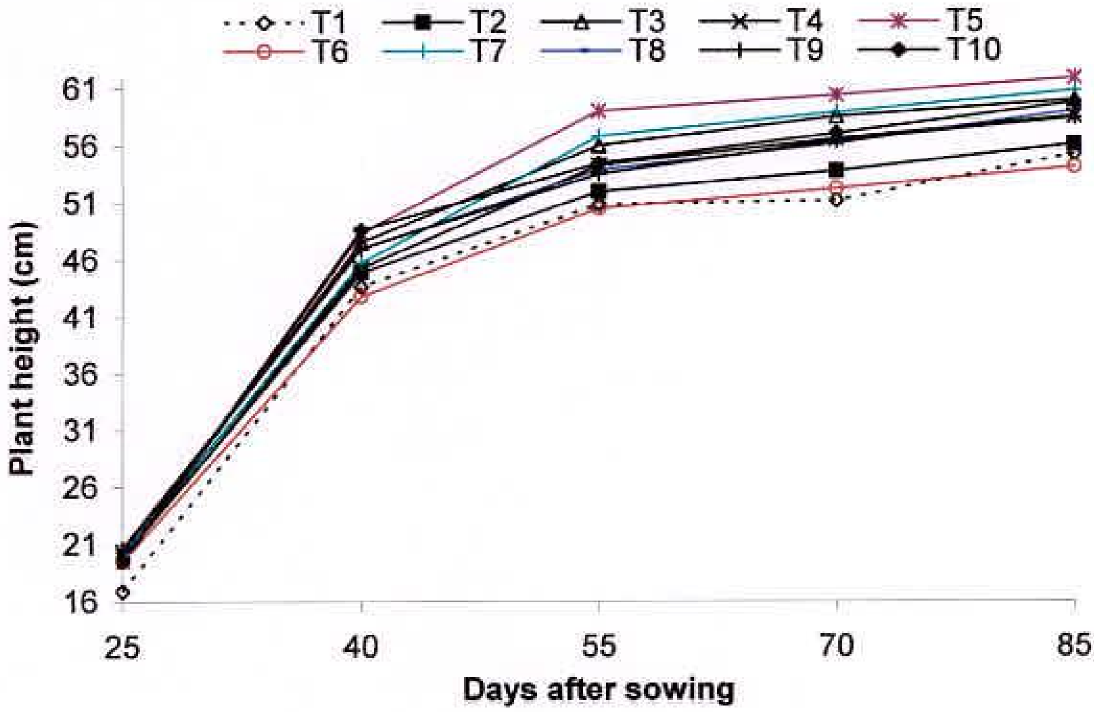

Fig. 1 Plant height of mungbean as influenced by nitrogen and irrigation

4.2 Number of branches per plant

Branches were increased from 40 DAS and reached the peak at 70 DAS and thereafter it leveled off. Significant increased number of branches was obtained in T_5. The treatment showed influence on plant to produce maximum branches per plant in each growth stage with some exception at 55 DAS (Fig. 2). The second highest number of branches per plant was observed from treatment 30 kg N ha^{-1} as basal (T_4) Plants in control plot showed lower number of branches from 40 to 85 days after sowing. The other treatments gave similar plant heights at different growth stages. Similar results were noticed in bush bean (Wani *et al.*, 1997) and in pea (Ferdous, 2001).

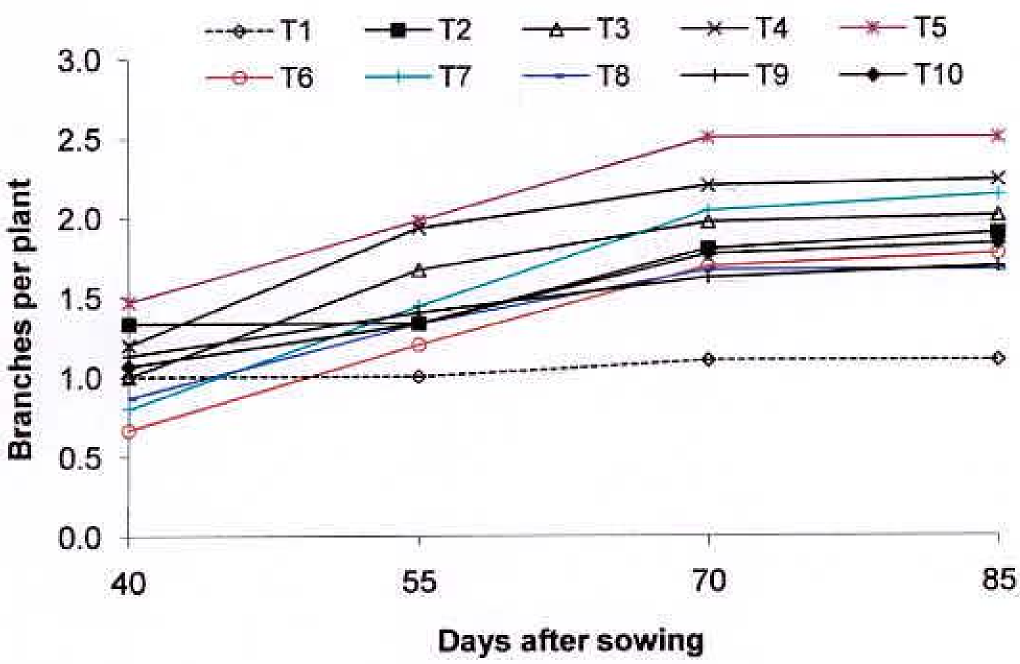

Fig. 2 Number of branches per plant of mungbean as influenced by nitrogen and irrigation.

4.3 Number of leaves per plant

Numbers of leaves per plant were increased greatly from 25 DAS and continued up to 55 DAS and then the increment was not significant (Fig. 3). Treatment T_5 (30 kg N ha^{-1} as basal one irrigation at first flowering stage) resulted in maximum leaves per plant in each growth stage which were different form other treatments. Plants showed lower number of leaves per plant when grown without fertilizer and irrigation (control). Treatment 20 Kg N ha^{-1} as basal + one irrigation at first flowering stage (T_3) gave second highest number of leaves per plant at 55 and 70 days after sowing. But other treatments gave intermediate number of leaves per plant at each growth stage. Srivastava and Verma (1982) showed that N application at a rate of 15 kg ha^{-1} increased the number of green leave, in mungbean plants.

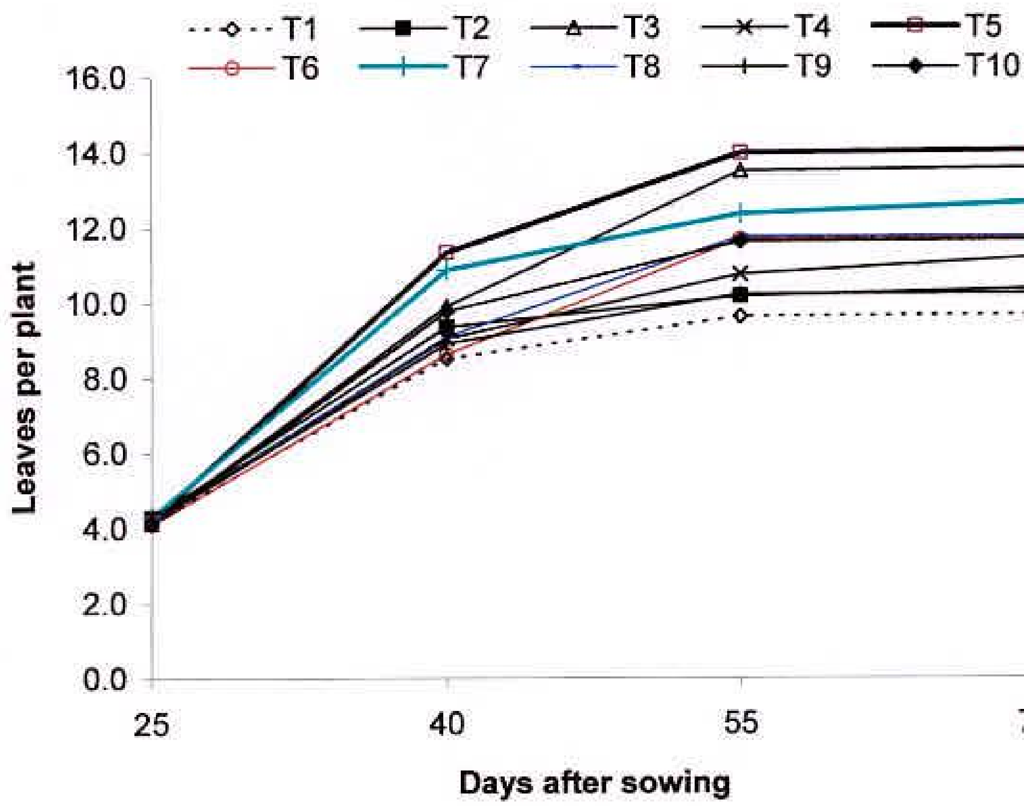

Fig. 3 Number of leaves per plant of mungbean as influenced by nitrogen and irrigation

4.4 Number of flowers per plant

Plants produced maximum flowers at 55 DAS and 70 DAS then it decreased significantly (Fig. 4). Treatment 20 kg N ha^{-1} as basal+one irrigation at first flowering stage (T_3) and 30 kg N ha^{-1} as basal+one irrigation at first flowering stage (T_5) gave higher number of flowers from 40 DAS to 70DAS. Plants of control plots gave significantly lower number of flowers at each growth stage. Similar result was found by Malik *et al.*, (2003). They observed that number of flowers per plant was significantly higher at 25 kg N ha^{-1}.

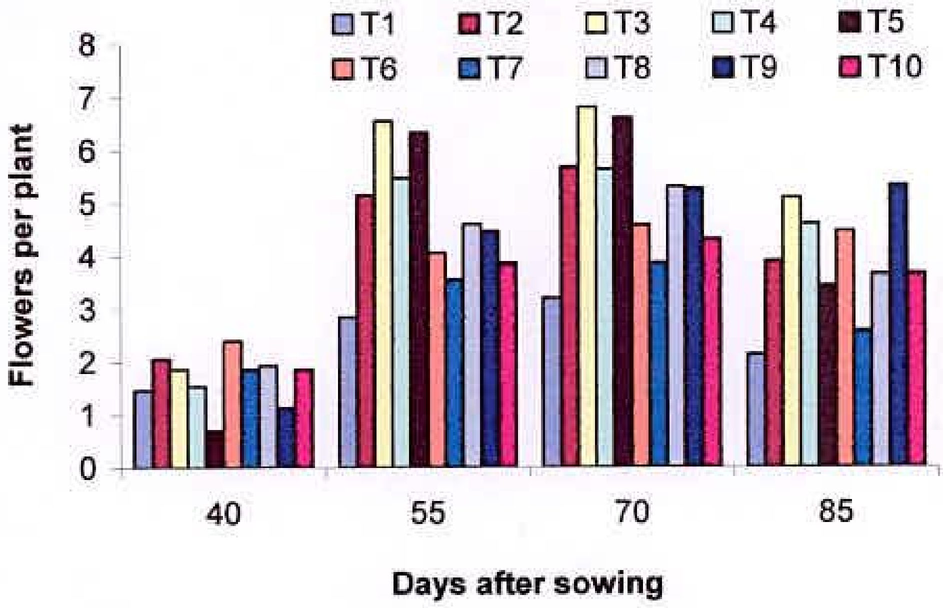

Fig. 4 Number of flowers per plant of mungbean as influenced by nitrogen and irrigation

4.5 Leaf dry weight (g/plant)

In general, the accumulations of leaf dry matter were very slow at early growth stage (25 to 40 DAS). Then it increased significantly between 55 to 70 DAS (Fig.5) and continued up to harvest, which indicated the inderminancy characteristics of mungbean. At early stages (25 to 40 DAS) no significant variation in leaf dry weight was measured due to treatment variables. Treatment 30 kg N ha^{-1} as basal+one irrigation at first flowering stage (T_5) was found superior to other treatments in accumulation of dry matter in leaf at each growth stage. Plants grown without fertilizer and irrigation had minimum leaf dry weight at each growth stage. Reduction in leaf dry matter due to water stress in different legumes was also reported earlier in mungbean (Sadasivam *et al,* 1988) and soybean (Siowit and Kramer, 1977) which might be attributed to reduced leaf size.

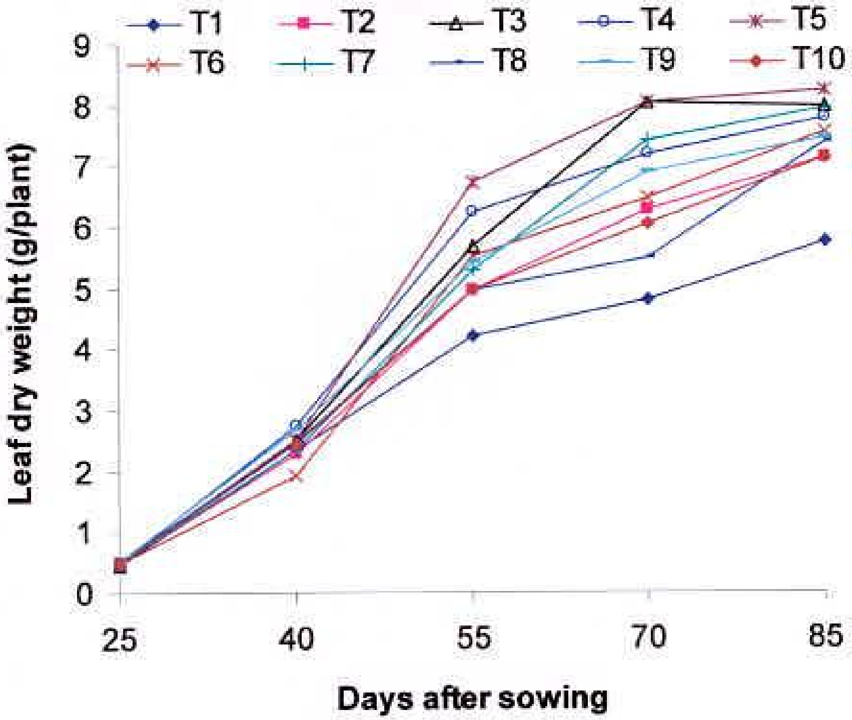

Fig. 5 Leaf dry weight of mungbean as influenced by nitrogen and irrigation

4.6 Stem dry weight

Accumulation of stem dry matter was very slow between 25 to 40 DAS. There after it increased sharply at 55 DAS and it continued up to harvest (85DAS) (Fig.6). Different treatment could not show any influence to increase stem dry weight at 25 DAS and 40 DAS. The highest dry weight of stem was observed in treatment 20 kg N ha^{-1}as basal + one irrigation at first flowering stage (T_3), 30 kg N ha^{-1} as basal (T_4), 30 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_5) and 40 kg N ha^{-1}as basal + one irrigation at first flowering stage (T_7) at each growth stage. Control treatments synthesized minimum stem dry matter in different crop growth stages. Reduction in stem dry matter in cowpea (Wein *et al.*, 1979) and shoot dry matter in soybean (Siowit and Kramer, 1977) due to water stress was also reported elsewhere.

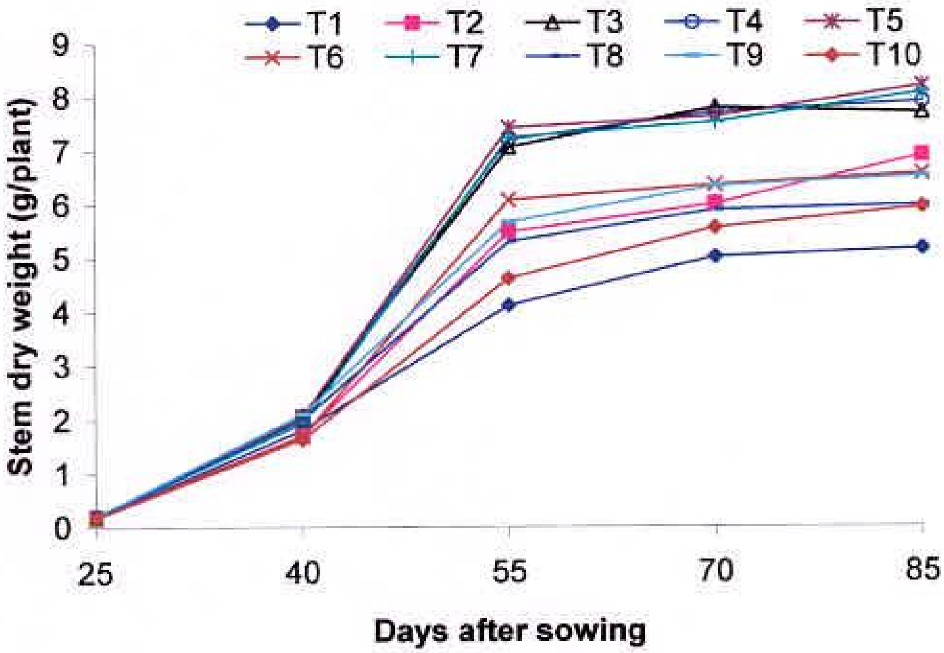

Fig. 6 Stem dry weight of mungbean as influenced by nitrogen and irrigation

4.7 Dry weight of reproductive organs

Dry weight of reproductive organ increased slowly at the beginning and then exponentially, which continued up to maturity (Fig.7). It was observed that the treatment variation could not show any difference in reproductive dry weights from 40 DAS to 55 DAS. Sharp increase in dry weight of reproductive organ might be the resultant of remobilization of reserves from vegetative parts as well as translocation of assimilates towards the grains. Nitrogen and irrigation application showed significant variation in reproductive organ of mungbean. The maximum dry weight of reproductive organ observed in the treatment 30 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_5) followed by 20 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_3) and 40 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_7).The lowest reproductive organ was found in control. The rest of treatments were statistically similar. Available reports indicated that legume plants produce less photosynthate under water stress condition, viz. mungbean (Hamid *et al.*, 1990), soybean (Siowit and Kramer, 1997) and Cowpea (Keneth and Hall, 1980).

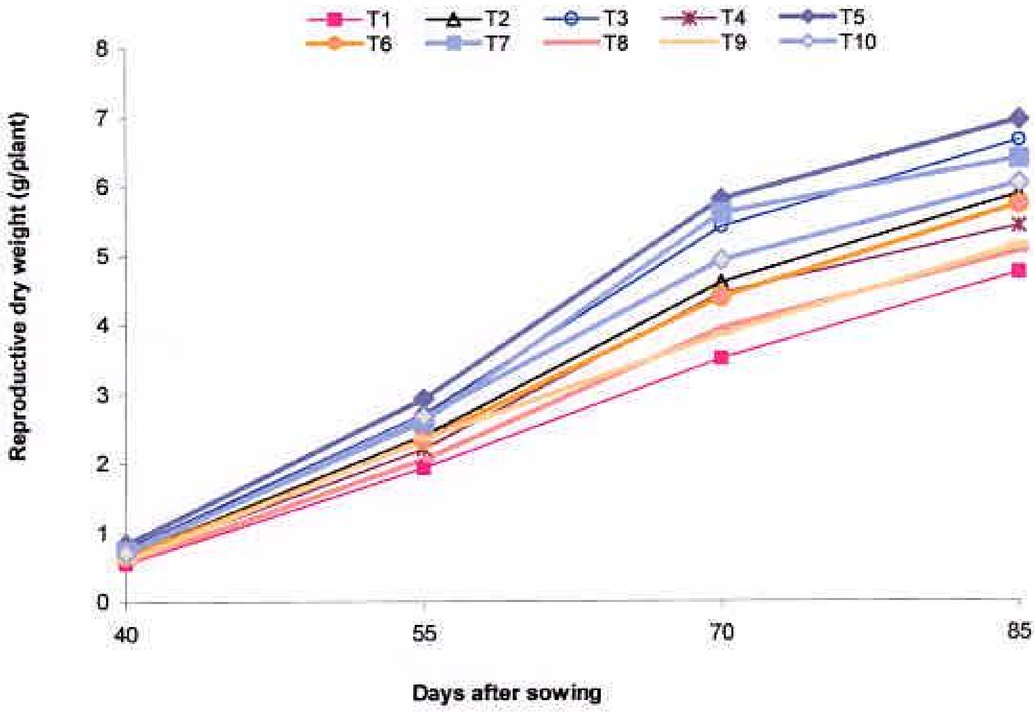

Fig. Reproductive dry weight of mungbean as influenced by nitrogen and irrigation

4.8 Above ground dry weight (g/plant)

Above ground dry weight of mungbean increased progressively over time and attained maximum at maturity (Fig. 8). Above ground dry weight was slower during initial growth stage up to 40 DAS and thereafter, sharply increased up to 85 DAS. Treatment 30 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_5) had greater influence on plant producing maximum above ground dry weight and that was noticed after 40 DAS till maturity. These variations in above ground dry matter production was greater compared to other treatments. The maximum above ground dry matter (23.00 g) was found at harvest (85 DAS). Control treatment produced minimum above ground dry matter in each growth stage. Agbenin *et al.*, (1992) reported that applied nitrogen significantly increased the dry matter yield of mungbean over control.

Lower dry weight in control plot might be due to internal nutrient and moisture stresses of plant, which caused reduction in both cell division and cell elongation and reduced carbohydrate synthesis and hence the growth was reduced (Kramer, 1988). The increase in dry matter due to higher number of irrigation was also recorded by Nandan and Prasad (1998).

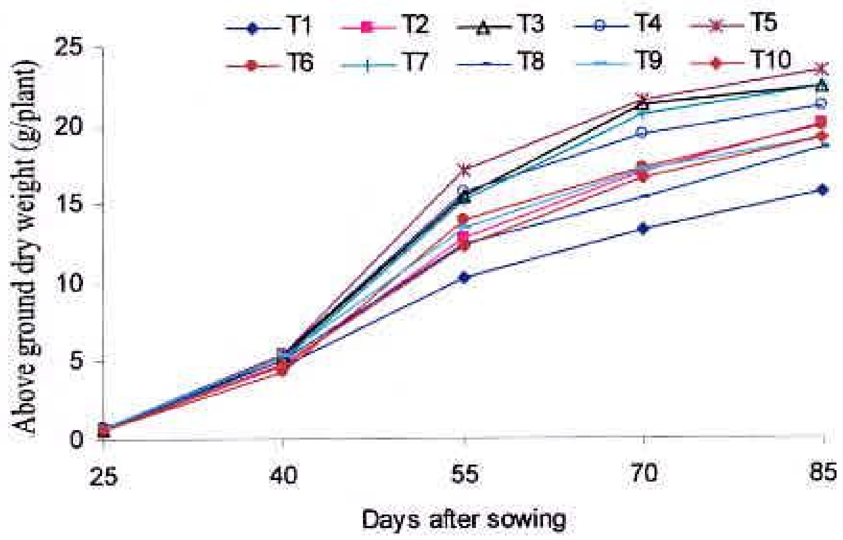

Fig. 8 Above ground dry weight of mungbean as influenced by nitrogen and irrigation

4.9 Yield contributing characters

Results of yield contributing characters have been presented in Table 1.

4.9.1 Number of pods per plant

Number of pods per plant is one of the most important yield contributing characters in mungbean. Both nitrogen and irrigation level significantly influenced the number pods per plant. Treatment of 30 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_5), 20 kg N^{-1} ha as basal + one irrigation at first flowering stage (T_3) and 40 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_7) gave significantly highest number of pods per plant. Nitrogen application at the rate of 20 kg ha^{-1} with no irrigation produced lower number of pods per plant. The other treatments were similar in producing intermediate number of pods per plant. Probably optimum soil moisture restricted flower and pod dropping, which might have contributed to more pods per plant under irrigated condition. Biswas (2001) found similar results in field bean. The reduced number of pods per plant (12.41) due to water stress was also reported earlier in field bean (Petersen, 1989 and Lopes *et al*, 1988). Number of pods per plant depended on the number of flowering nodes/plant, branches/plant and number of flowers/plant and their retention. Greater photosynthesis enhanced by more nutrient uptake with irrigation helps initiating more flowering buds, which ultimately helps to develop more pods.

4.9.2 Number of seeds per pod

The number of seeds per pod was not significantly affected by nitrogen and irrigation application. Number of seeds per pod of mungbean ranged from 6.46 to 10.46 due to the treatment variation. However, the maximum seed per pod was recorded from treatment T_5 (30 kg N ha^{-1} as basal + one irrigation at first flowering stage) and the lowest with T_1 (control). This finding was partly supported by Malik *et al.* (2003) who stated that application of nitrogen increased the number of seeds per pod.

4.9.3 1000-seed weight

Nitrogen and irrigation variation could not improve the 1000-seed weight. It may be assumed that genetical influence was greater than the treatment effects. The 1000-seed weight varied from 44.43g to 46.36 g. However, treatment of 20 kg N ha^{-1} as basal and split 20 kg N ha^{-1} + one irrigation at first flowering stage (T_{10}) produced heavier seed and lighter in T_1 (control).

Table 1 Effect of nitrogen and irrigation on yield contributing characters of mungbean

Treatments	Number of Pods/plant	Number of Seeds/pod	1000-seed weight (g)
T_1	12.41	6.46	44.43
T_2	25.10	8.37	45.61
T_3	38.30	9.17	45.27
T_4	25.42	8.32	46.08
T_5	43.30	10.46	46.23
T_6	23.83	8.39	45.99
T_7	36.97	8.32	45.67
T_8	25.90	8.16	44.93
T_9	27.26	8.02	46.24
T_{10}	29.09	8.15	46.36
LSD $_{(0.05)}$	**4.50**	**NS**	**NS**
CV%	7.88	10.20	2.10

4.10 Yield

4.10.1 Seed yield (g/plant)

Seed yield per plant is the combined effect of all the yield contributing parameters of a plant. In this experiment, highest seed yield per plant (5.53g) was observed in T_5 (30 kg N ha^{-1} as basal + One irrigation at first flowering stage) and followed by T_3 (20 kg N ha^{-1} as basal + one irrigation at first flowering stage) and 40 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_7) (Table 2). T_3 produced 5.11g seed per plant and the treatment 40 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_7) produced 4.91g seed per plant. The next maximum seed yield was obtained from T_{10} (20 kg N ha^{-1} as basal and split 20 N ha^{-1} + one irrigation at first flowering stage). The lowest yield per plant was recorded from control and that was 3.64 g/plant. The seed yield obtained from T_5 produced 51.92% more seed yield over control. T_5 produced highest yield due to maximum production of crop characters like plant height, branches per plant, leaves per plant, leaf dry weight, stem dry weight, total dry matter and pods per plant and seeds per pod. With the treatment T_1 (control) which was due to lack of resources those contribute on yield parameters. Similar results were observed in snap bean by Haque, (1988), in Frenchbean by Sing, 1990 and Verma *et al*., 1998.

4.10.2 Seed yield (t/ha)

The highest seed yield per hectare was also significantly affected by nitrogen and irrigation (Table 2). The maximum seed yield per hectare (1.658 ton) was observed in T_5 (30 kg N ha^{-1} as basal+one irrigation at first flowering stage), which was statistically similar to T_3 (20 kg N ha^{-1} as basal +one irrigation at first flowering stage) and T_7 (40 kg N ha^{-1} as basal + one irrigation at first flowering stage). The lowest yield per hectare (1.091 t/ha) was observed from the control treatment. The second maximum seed yield (1.39 t/ha) was recorded from plant treated with 40 kg N ha^{-1}+one irrigation at first flowering stage. Treatment of 30 kg N ha^{-1} as basal+one irrigation at first flowering stage probably influenced plant to have good production of dry matter in early stage and that eventually raised and partitioned to the reproductive units. The irrigation also helped optimum seed development. These findings agreed well with Bachchhav *et al.* (1994) who found that application of 30 kg N ha^{-1} resulted with highest seed yield of mungbean. Mozumder *et al.* (2003) also stated that application of 40 kg N ha^{-1} gave the highest seed yield. Similar result was also found in bushbean (Ahlawat and Sharma, 1998) and in pea (Ferdous 2001).

Table 2 Effect of nitrogen and irrigation on the yield of mungbean

Treatments	Yield (g/plant)	Yield (t/ha)
T_1	3.64	1.09
T_2	4.52	1.35
T_3	5.11	1.53
T_4	4.16	1.24
T_5	5.53	1.65
T_6	4.40	1.32
T_7	4.91	1.47
T_8	3.87	1.16
T_9	3.94	1.18
T_{10}	4.64	1.39
LSD $_{(0.05)}$	**0.604**	**0.242**
CV%	7.87	10.51

4.11 Harvest Index

Harvest index (HI) indicates the partitioning of dry matter between reproductive and vegetative part. The ratio of economic yield to biological yield is termed as harvest index. Higher HI might be beneficial in obtaining higher economic yield. A significant increase in HI was found in mungbean due to application of nitrogen and irrigation. The highest HI 35.75% and 34.7% was observed in treatment 20 kg N/ha as basal and split 20 Kg N h^{-1} + one irrigation at first flowering stage (T_{10}) and 30 kg N ha^{-1} as basal + one irrigation at first flowering stage (T_5) respectively. It was due to the increased dry matter accumulation, better root development resulting from higher partitioning of dry matter towards the production of economic yield. The lowest HI was observed at 30 kg N ha^{-1} as basal (T_4) and that was 29.0. Similar results were recorded in bush bean (Islam, 2001), in mungbean (Akhtaruzzaman, 1998) and in seasame (Roy *et al,* 1995).

Table 3 Effect of nitrogen and irrigation on harvest index of mungbean

Treatments	**Harvest Index (HI) %**
T_1	34.21
T_2	33.40
T_3	33.66
T_4	29.03
T_5	34.77
T_6	32.65
T_7	32.23
T_8	30.95
T_9	30.36
T_{10}	35.74
LSD $_{(0.05)}$	**3.245**
CV%	5.78

4.12 Correlation and Regression Analysis

Table 4 Correlation among the yield contributing characters and yield of mungbean

Parameters	Branches/plant	Pods/plant	Seeds/pod	1000-seed weight (g)	Seed yield
Branches/plant	1.000	0.781**	-0.418	0.508*	0.193
Pods/plant		1.000	-0.206	0.218	0.533*
Seeds/pod			1.000	-0.552*	0.443*
1000 seeds weight				1.000	0.398
Seed yield					1.000

** Significant at the 0.01 level.

* Significant at the 0.05 level.

From correlation study, it was observed that seed yield was significantly correlated with pods/plant and seeds/pod (Table 4). Branches/plant had correlation with pods/plant and 1000-seed weight.

The relation between number of branches per plant, pods per plant, seeds per pod, harvest index and yield were positive (R^2=0.19, R^2=0.53, R^2=0.157, R^2=0.042, respectively) (Figs. 9, 10, 11 and 12).

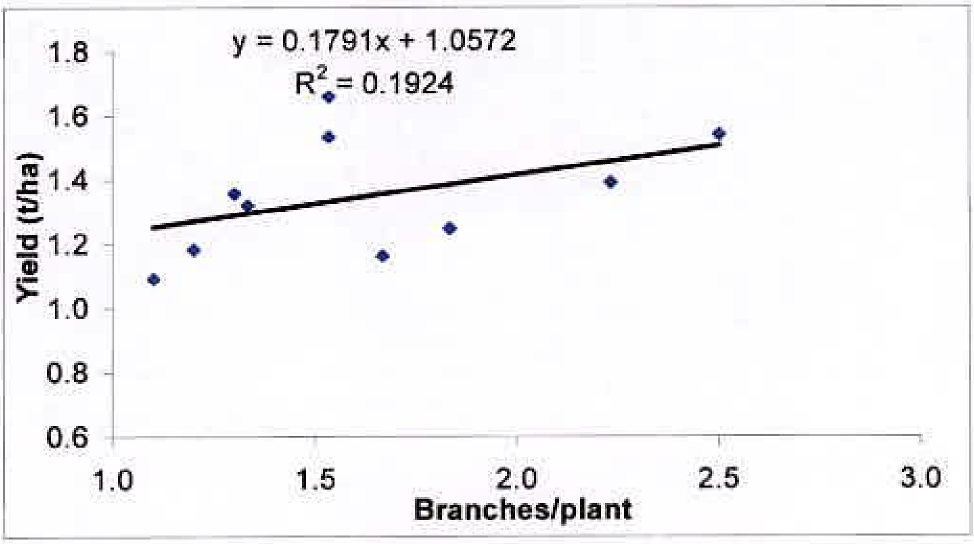

Fig. 9 Relationship between branch/plant and yield of mungbean

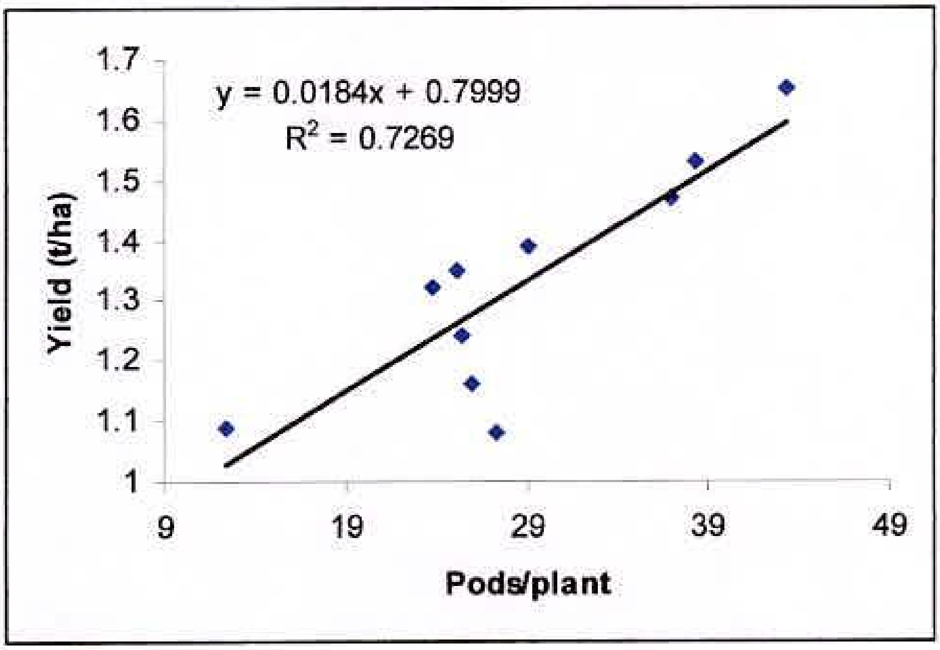

Fig. 10 Relationship between pods per plant and yield of mungbean

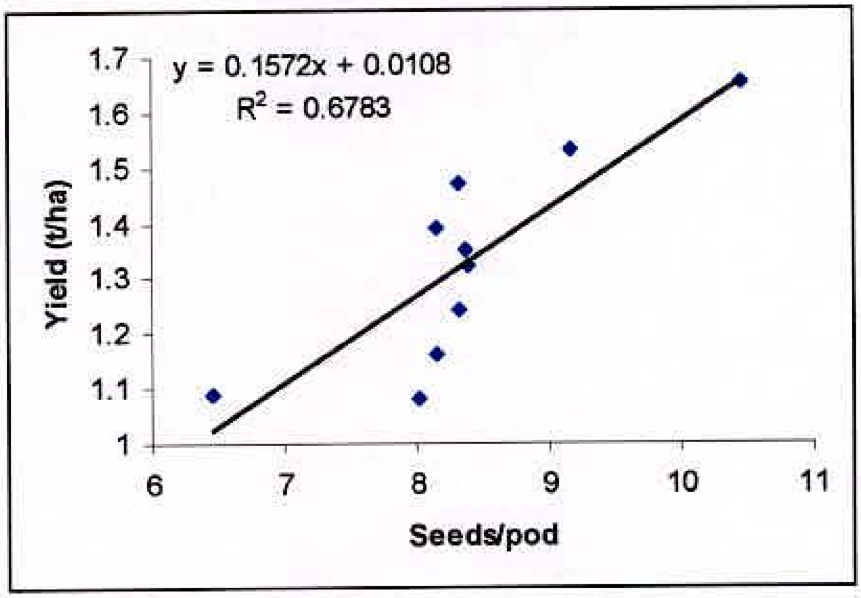

Fig. 11 Relationship between seeds/pod and yield of mungbean

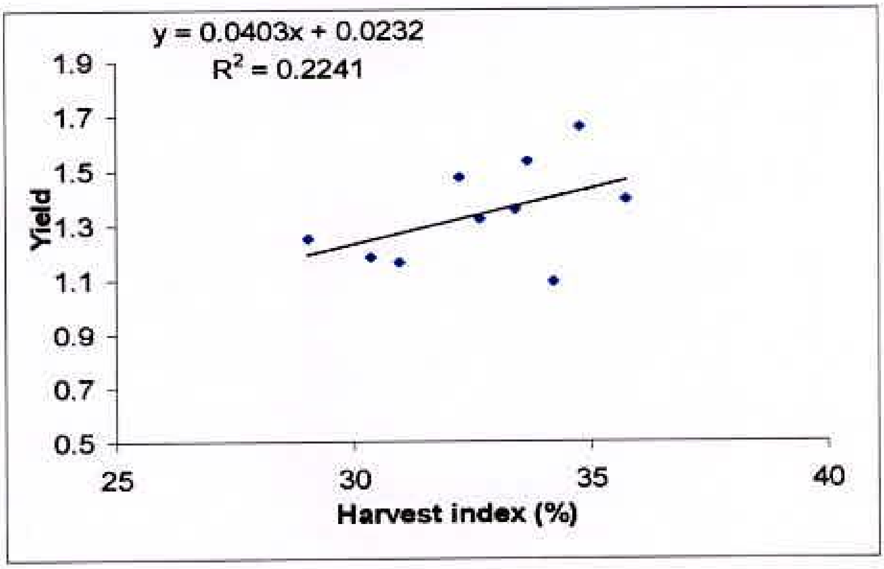

Fig. 12 Relationship between harvest index (%) and yield of mungbean

CHAPTER 5
SUMMARY AND CONCLUSION

CHAPTER 5

SUMMARY

An experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University; Dhaka to evaluate the effect of nitrogen and irrigation managements on the yield attributes and yields of mungbean (*Vigna radiata* L.) cv.BARI mung-5 during the period from March 2006 to May 2006. The trial comprised of ten treatments such as T_1= control, T_2=20 kg N ha^{-1} as basal, T_3=20 kg N ha^{-1} as basal with one irrigation at first flowering stage, T_4 =30 kg N ha^{-1} as basal, T_5=30 kg N ha^{-1} as basal with one irrigation at first flowering stage, T_6=40 kg N ha^{-1} as basal, T_7=40 kg N ha^{-1} as basal with one irrigation at first flowering stage, T_8=basal 10 kg N ha^{-1} and 10 kg N ha^{-1} as split with one irrigation at first flowering stage, T_9=basal 15 kg N ha^{-1} and 15 kg N ha^{-1} as split with one irrigation at first flowering stage and T_{10}=basal 20 kg N ha^{-1} and 20 kg N ha^{-1} as split with one irrigation at first flowering stage.

The experiment was set up in randomized complete block design (RCBD) with three replications. The plot was fertilized @ 100 kg Triple Super Phosphate and 67 kg Muriate of Potash per hectare Nitrogen fertilizer was given following Treatments. Mungbean seeds of cv. BARI mung-5 were sown on 1st March, 2006 and harvested on 30 May, 2006. Data on different growth and yield attributes were recorded and analyzed statistically following LSD test at 5% level.

Among the treatments maximum plant height in each growth stage was found in T_5, which was significant while minimum was found in T_1 and T_6 but plant

height with T_3, T_4, T_7, T_8, T_9 and T_{10} were more or less same at different samplings. Irrespective of treatments plant height rapidly increased as up to 40 DAS thereafter a slower rate of growth was noticed nitrogen and irrigation application influenced the number of branches per plant in all treatments except control. Branches per plant were highest with T_5 in each sampling except 55 DAS and lowest with control. Number of branches per plant increased sharply from 40 DAS and continued up to 70 and after that no significant improvement was noticed at 85 DAS.

After 40 DAS the highest number of leaves per plant was produced in T_5 and lowest in control. Other treatments gave intermediate number of leaves per plant at each growth stage. Numbers of leaves per plant were almost similar from 55 DAS to maturity with these treatments. Irrespective of treatment difference, number of leaves increased from 25 DAS to 55 DAS and thereafter leveled off. The number of flowers per plant was highest at 55 DAS and 70 DAS and thereafter decreased. T_3 and T_5 showed next higher number of flowers per plant from at 40 DAS to 70 DAS T_2, T_4 and T_9 showed statistically similar number of flowers from 55 DAS to 70 DAS which were similar. Control treatment was produced lower number of flowers in each growth stage. .

The accumulation of leaf dry matter was very slow at early growth stage from 25 DAS to 40 DAS. Then it rapidly increased up to 55 DAS and then continued until harvest. T_5 was found superior to other treatments in accumulation of dry matter in leaf that was statistically significant and T_1 was inferior.
Stem dry weight was slow at early stage (25 to 40 DAS) thereafter it increased sharply up to 55 DAS. The increment continued until harvest at a slow rate.

The highest dry weights of stem were observed in T_3, T_4, T_5 and T_7 at each growth stage and the lowest in control. Nitrogen and irrigation application showed significant variation in reproductive organ of mungbean. The maximum dry weight of reproductive organ was observed in T_5 followed by T_3 and T_7 and the lowest in control. The rest of the treatments were statistically more or less similar.

The lag phase of growth of mungbean was noticed up to 40 DAS. Thereafter rapid growth took place as indicated by the increased above ground dry matter which was measured from 40 DAS to 85 DAS. T_5 showed the influence in producing greater above ground dry matter in all growth stages. Control treatment significantly maintained minimum above ground dry matter was produced throughout the life cycle of the plant. T_5, T_3 and T_7 gave significant highest number of pods per plant (36.97 to 43.30), which were statistically similar while control gave the lowest (12.41).

Number of seeds per pod and 1000-seed weight did not change with treatment variation, which indicated greater genetic influence.

The highest seed yield per plant and total seed yield were observed in T_5 that was 5.53 g/plant and 1.65 t/ha respectively. The second highest seed yields per unit were 5.11 g/plant and 1.53 t/ha respectively which attained in T_3. The lowest yields per plant were recorded from control, which were 3.64 g/plant and 1.091 t/ha respectively.

The highest Harvest Index was observed in T_5 and T_{10} and the lowest Harvest Index in T_4.The relation between branches per plant, pods per plant, seeds per pod, harvest index and seed yield were positive but insignificant.

CONCLUSION

From the results, it may be concluded that mungbean gave maximum production of growth characters; yield attributes and yield when treated with 30 kg N ha^{-1} as basal and one irrigation during first flowering stage (35 DAS).

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APPENDICES

APPENDICES

Appendix I. Field view of the experimental plot

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

Mechanical composition:

Particle size constitution

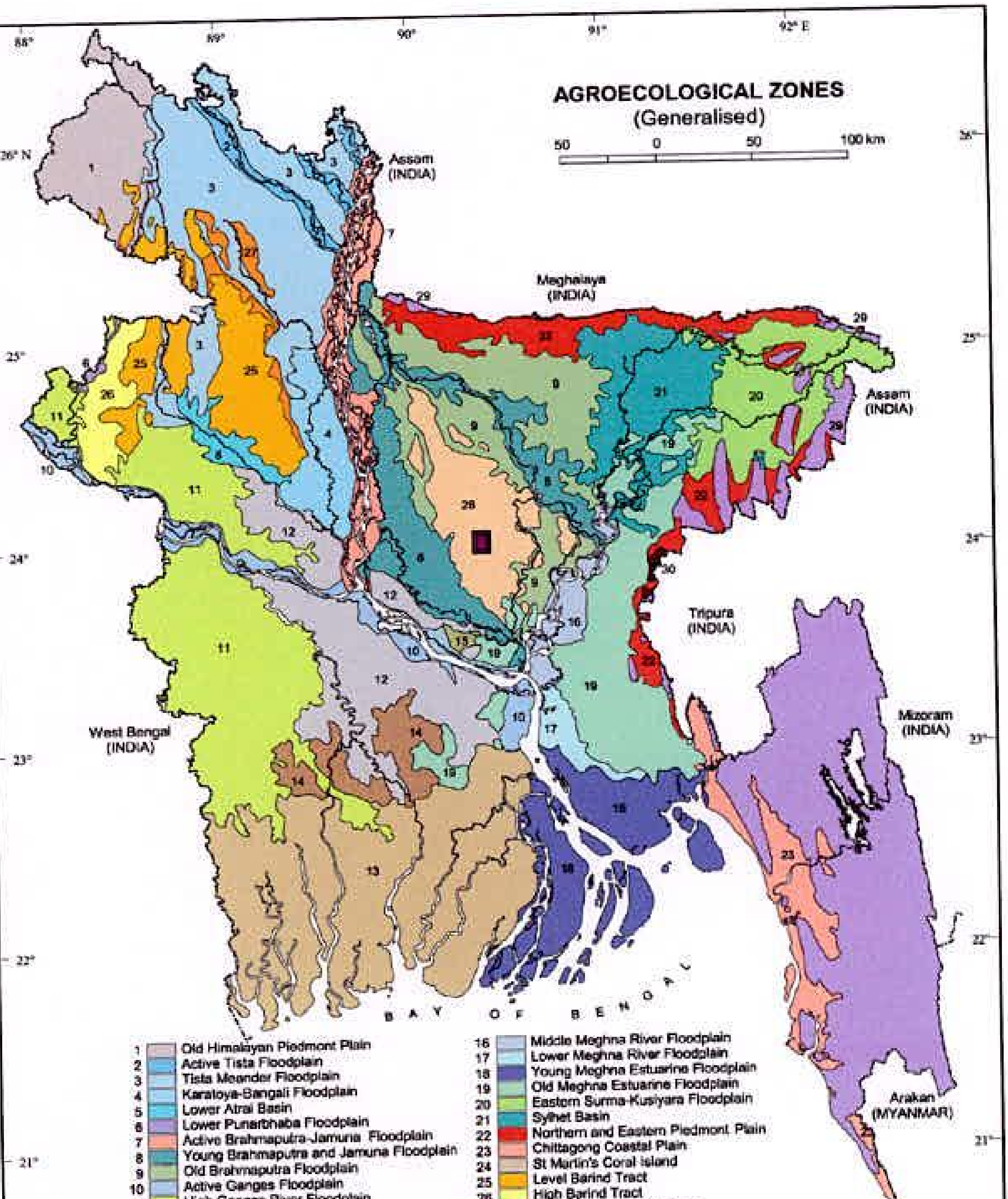
Sand	:	26%
Silt	:	45%
Clay	:	29%
Texture	:	Silty clay
pH	:	5.6

Chemical composition:

Soil characters	**Value**
Organic carbon (%)	0.45
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 Resources Development Institute (SRDI), Khamarbari, Dhaka

Appendix III. Experimental location on the map of Agro-ecological Zones of Bangladesh

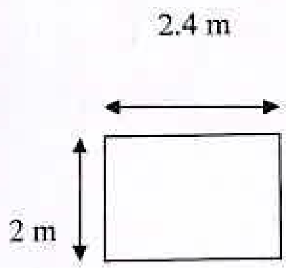


Appendix IV. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from February 2006 to May 2006.

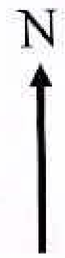
Year	Month	Air temperature (^0C)			Relative humidity (%)	Rainfall (mm)	Sunshine (h)
		Maximum	Minimum	Mean			
2006	February	21.26	19.43	20.34	51.27	0	148
	March	36.2	22	29.1	46.13	0	155
	April	33.74	23.81	28.77	61.4	185	253
	May	32.5	24.95	28.72	64.27	180	96

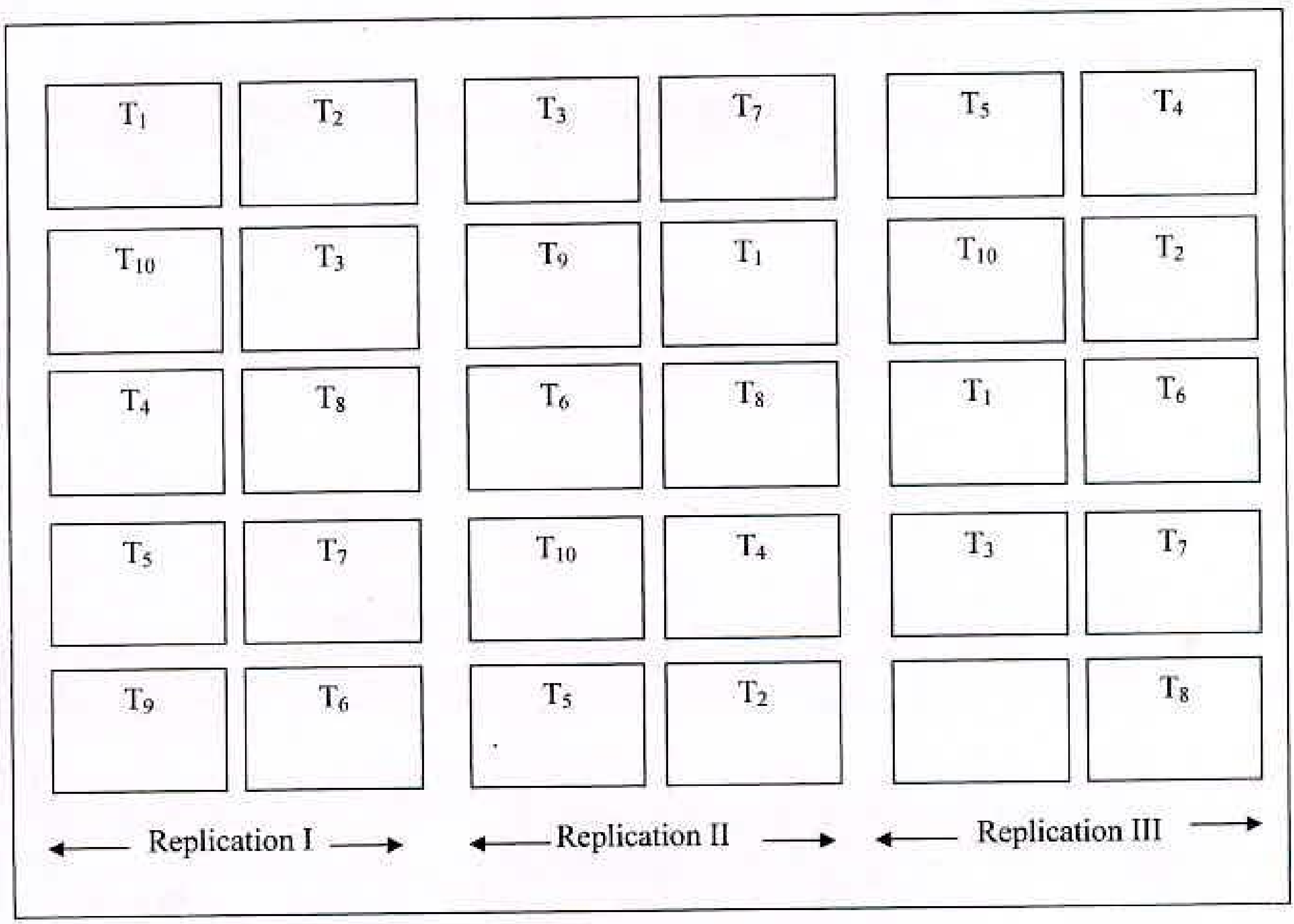
Source: Bangladesh Meteorological Department (Climate division), Dhaka-1212.

APPENDIX –V. Experimental layout



Plot size: 2.4 m×2 m
Between Plot: 1m
Between replication: 1.5 m





LIST OF PLATES

Plate 1. Field view of experimental plots at 15 days after sowing of mungbean

Plate 2. Field view of experimental plots at vegetative stage of mungbean

Plate 3. Field view of experimental plots at flower initiation stage of mungbean

Plate 4. Field view of experimental plots at pod initiation stage of mungbean