EFFECT OF VARIETY AND NAA ON WATER RELATIONS AND YIELD OF MUNGBEAN IN KHARIF-II SEASON

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CERTIFICATE

*This is to certify that the thesis entitled "**EFFECT OF VARIETY AND NAA ON WATER RELATIONS AND YIELD OF MUNGBEAN IN KHARIF-II SEASON**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment 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.: 06-1957,** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that any help or sources of information as has been availed of during the course of this work has been duly acknowledged & style of the thesis have been approved and recommended for submission.

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The author

EFFECT OF VARIETY AND NAA ON THE WATER RELATIONS AND YIELD OF MUNGBEAN UNDER KHARIF II SEASON

BY

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ABSTRACT

The experiment was conducted at the Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka during the *Kharif* -II season from June to November, 2012 to study the effect of variety and NAA on the water relations and yield of mungbean. In experiment, the treatment consisted of two variety viz., V_1 = BARI mung 2, V_2 = BARI mung 5, and five different doses of NAA, viz., N_0 = 0 ppm NAA, N_1 = 20 ppm NAA, N_2 = 40 ppm NAA, N_3 = 60 ppm NAA, N_4 = 80 ppm NAA. The experiment was laid out in a two factors randomized complete block design (RCBD) with three replications. Variety and NAA had significant influence on water relations, yield and yield components of mungbean. The highest RWC was obtained from BARI mung 5 with 80 ppm NAA treatment. The highest exudation rate was obtained from BARI mung 2 with 40 ppm NAA treatment. The tallest plant (94.73 cm) was obtained from BARI mung 2 with 80 ppm NAA. The Longest pod was recorded in BARI mung 5, 20 ppm NAA and BARI mung 5 20 ppm interactions. The highest number of pods per plant was recorded in BARI mung 2. The maximum number of pods per plant was obtained from 20 ppm NAA. The maximum number of pods per plant was obtained from BARI mung 2 with 20 ppm NAA treatment. The maximum seed yield (1.39 t ha^{-1}) was found in BARI mung 5. The maximum seed yield (1.43 t ha^{-1}) was obtained from 20 ppm. The highest seed yield (1.51 t ha^{-1}) was obtained from BARI mung 5 with 20 ppm NAA while the lowest (1.00 t ha^{-1}) from BARI mung 5 with 0 ppm NAA.

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LIST OF ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
LAI	=	Leaf area index
ppm	=	Parts per million
et al.	=	And others
N	=	Nitrogen
TSP	=	Triple Super Phosphate
MoP	=	Muriate of Potash
RCBD	=	Randomized complete block design
DAS	=	Days after sowing
ha^{-1}	=	Per hectare
G	=	gram (s)
Kg	=	Kilogram
µg	=	Micro gram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
HI	=	Harvest Index
No.	=	Number
WUE	=	Water use efficiency
Wt.	=	Weight
LSD	=	Least Significant Difference
^{0}C	=	Degree Celsius
NS	=	Not significant
mm	=	millimeter
Max	=	Maximum
Min	=	Minimum
%	=	Per cent
cv.	=	Cultivar
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of coefficient of variance
Hr	=	Hour
T	=	Ton
viz.	=	Videlicet (namely)
RWC	=	Relative water content
NAA	=	Naphthalene acetic acid

CHAPTER I

INTRODUCTION

Mungbean [V*igna radiata* (L) Wilczek] is one of the most important pulse crops of global economic importance. The mungbean belongs to the family Leguminosae (Fabaceae) and sub-family Papilionaceae. It is originated in the South and Southeast Asia (India, Mayanmar, Thailand) (Poehlman, 1991). It is widely grown in India, Pakistan, Bangladesh, Mayanmar, Thailand, Philippinnes, China and Indonesia (FAO, 2005). It ranks 3rd both in acreage and protein content and 5th in production among the pulses grown in Bangladesh (BBS, 2008).

Pulses constitute the main source of protein for the people, particularly the poor sections of Bangladesh. These are also the best source of protein for domestic animals. Besides, the crops have the capability to enrich soils through nitrogen fixation. Mungbean contains 51% carbohydrates, 26% protein, 4% mineral and 3% vitamin. On the nutritional point of view, mungbean is one of the best among pulses (Khan *et al*. 1985). It is widely used as "Dal" in the country like other pulses.

Bangladesh is a developing country. The land of our country is limited. But the population is very high. More food need for increasing people. We have to produce more food in our limited land. To meet up the increased demand of food, farmers are growing more cereal crops. Due to the high population pressure, the total cultivable land is decreasing day by day along with the pulse cultivable land. So, at present the cultivation of pulse has gone to marginal land because farmers do not want to use their fertile land in pulse cultivation. Pulse cultivation is also decreasing because of its low yield & production. The long term cereal crop cultivation also effects soil fertility and productivity.

Mungbean covers an area of 23077 hectare and production was about 20000 metric tons. The average production of mungbean in the country is about 867 kg ha^{-1}(BBS, 2011). About 3 t ha^{-1} of seed yield have been reported in a trial in Taiwan but in Bangladesh the average yield is very low. The yield difference indicates the wide scope for increasing yield of mungbean.

The climatic conditions of Bangladesh favour mungbean production almost throughout the year. The farmers of Bangladesh generally grow mungbean by one ploughing and hardly use any fertilizer and irrigation due to its lower productivity and also to their poor socio-economic condition and lack of proper knowledge. As a result the yield becomes low. There is an ample scope for increasing the yield of mungbean with improved management practices.

The agro-ecological condition of Bangladesh is favourable for munbean cultivation almost throughout the year. The crop is usually cultivated during rabi season. But because of poor yield and marginal profit as compared to cereal crops, farmers prefer growing boro, maize and wheat than munbean during rabi season. Besides, the release of high yielding cultivars of cereals have pushed this crop to marginal and sub-marginal lands of less productivity and made its cultivation less remunerative. Recently, Bangladesh Agricultural Research Institute (BARI) has developed six and Bangladesh Institute of Nuclear Agriculture (BINA) has developed seven photo-sensitive high yielding cultivars mungbean, which are getting attention to the farmers. During kharif season the crop fits well into the existing cropping system of many areas in Bangladesh.

Napthelene acetic acid (NAA) is a plant growth regulator which can manipulate the growth and yield of crops. It can also play a significant role in increasing physiological processes of mungbean. The effects of NAA on growth, yield and yield attributes of mungbean was not clearly known in Bangladesh. It is reported that foliar application of IAA produced more mature pods per plant, 100 seed weight, plant height, pod size with consequent enhancement in seed yield of mungbean (Newaj, 2001) and effect of NAA was observed in case of rice (Azad, 2002). In case of groundnut, Reddy and Shah (1984) stated that foliar application of NAA along with other growth regulators produce more mature pods per plant, 100 kernel weight, pod yield and oil content of groundnut.

The experimental evidences on the effect of variety and NAA on the water relations and yield of mungbean under kharip-II seasons are limited under Bangladesh condition. The present study was therefore, undertaken with the following objectives.

1. To find out the effect of NAA on water relations of mungbean.
2. To find out the effect of NAA on growth, yield and yield components of two mungbean varieties.
3. To study the correlations among the water relations traits and yield and yield componets of mungbean.

CHAPTER 2

REVIEW OF LITERATURE

In this chapter, an attempt has been made to review the available information in home and abroad regarding the performance of two maungbean cultivars under different NAA concentration.

2.1 Effect of variety on the performance of mungbean

Quaderi *et al.* (2006) carried out an experiment in the field laboratory of the department of crop botany, Bangladesh Agricultural University, Mymensingh during the period from October 2000 to February 2001 to evaluate the influence of seed treatment with Indole acetic acid (IAA) at a concentration of 50 ppm, 100 ppm and 200 ppm on the growth, yield and yield contributing characters of two modern mungbean (*Vingna radiata* L.) varrieties viz. BARI mung 4 and BARI mung 5. The two factor experiment was laid out in Randomized Complet Block Design (RCBD) (factorial) with 3 replications. Among the mungbean varieties, BARI mung 5 performed better than that of BARI mung 4.

To study the nature of association between *Rhizobium phaseoli* and mungbean an experiment was conducted by Muhammad *et al.* (2006). Inocula of two Rhizobium strains, Tal-169 and Tal-420 were applied to four mungbean genotypes viz. NM-92, NMC-209, NM-98 and Chakwal Mung-97. A control treatment was also included for comparison. The experiment was carried out at the university of Arid Agriculture, Rawalpindi, Pakistan, during kharif, 2003. Both the strains in association with NM-92 had higher nodule dry weight, which was 13% greater than other strains × mungbean genotypes combinations. Strain Tal-169 was specifically more effective on genotype NCM-209 and NM-98 compared with NM-92 and Chakwal Ming-97. Strain Tal-420 increased branches per plant of all the genotypes. Strain Tal-169 in association with NCM-209 produced the highes yield of 671 kg ha^{-1} which was similar (590 kg ha^{-1}) in case of NCM-209 either inoculated with strain Tal-420 or uninoculated. Variety NM-92 produced the lowest grain yield (330 kg ha^{-1}) either inoculated with strain Tal-420 or uninoculated.

Islam *et al.* (2006) carried out an experiment at the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from March 2002 to June 2002 to evaluate the effect of biofertilizer (*Bradyrhizobium*) an plant growth regulators (GA_3 and IAA) on growth of 3 cultivars of summer mungbean (*Vingna radiata* L.). Among the mungbean varieties, BINA mung 5 performed better than that of BINA mung 2 and BINA mung 4 irrespective of seed treatment.

To evaluate the effects of crop densities (10, 13, 20 and 40 plants/m^2) on yield and yield components of two cultivars (Partow and Gohar) and a line of mungbean (VC-1973A), a field experiment was conducted by Aghaalikhani *et al.* (2006) at Seed and Plant Improvement Institute of Karaj, Iran, in the summer of 1998. The results indicated that VC-1973A had the highest grain yield. This line was superior to the other cultivars due to its early and uniform seed maturity and easy mechanized harvest.

Tickoo *et al.* (2006) studied with mungbean cultivars Pusa 105 and Pusa Vishal, which were sown at 22.5 and 30 cm spacing and supplied with 36-46 and 58-46 kg NP ha^{-1} in field experiment which was conducted, in Delhi, India during the kharif season of 2000. Cultivar Pusa Vishal recorded higher biological and grain yield (3.66 and 1.63 t ha^{-1}, respectively) compared to cv. Pusa 105 respective of sowing time.

Rahman *et al.* (2005) conducted an experiment with mungbean in Jamalpur, Bangladesh, from February to June 1999, involving 2 planting methods, i.e. line sowing and broadcasting, 5 mungbean cultivars, namely Local, BARI mung 2, BARI mung 3, BINA mung 2 and BINA mung 5 and 5 sowing dates. Significantly the highest dry matter production ability was found in 4 modern mungbean cultivars, and dry matter partitioning was found highest in seeds of BINA mung 2 and lowest in local. However, the local cultivar produced the highest portion of dry matter in leaf and stem.

Studies were conducted by Bhati *et al.* (2005) from 2000 to 2003 to evaluate the effects of cultivars and nutrient management strategies on the productivity of different kharif legumes (mungbean, mothbean and clusterbean) in the arid region of Rajsthan, India. The experiment with mungbean showed that K-851 gave better yield than Asha and local cultivar. In another experiment, mungbean cv. PDM-54 showed 56.9% higher grain yield and 13.7% higher fodder yield than the local cultivar. The experiment with mothbean showed that RMO-40 gave 34.8-35.2% higher grain yield and 30.2-334% higher fodder yield over the local cultivar as well as 11.8% higher grain yield and 9.2% higher fodder yield over RMO-257. The experiment with clusterbean showed that improved cultivars of RGC-936 gave 136.0 and 73.5% higher grain yield and 124.0 and 67.3% higher fodder yield over the local cultivar and Maru Guar, respectively.

A field experiment was conducted by Raj and Tripathi (2005) in Jadhpur, Rajasthan, India, during the kharif seasons, to evaluate the effects of cultivar (K-851 and RMG-62) as well as nitrogen (0 and 20 kg ha^{-1}) and phosphorus levels (0 , 20 and 40 kg ha^{-1}) on the productivity of mungbean. K-851 produced significantly higher values for seed and straw yields as well as yield attributes (plant height, pods per plant, seed per pod and 1000 seed weitht) compared with K-85 (Rs. 6544 ha^{-1} and 1.02, respectively) than RMG-62 (Rs. 4833 ha^{-1} and 0.76, respectively).

Chaisri *et al.* (2005) conducted a yield trial involving 6 recommended cultivars (KPS 1, KPS 2, CN 36, CN 72 and PSU 1) and 5 elite lines (C, E, F, G, H) under Kasetsart mungbean breeding project in Lopburi Province, Thailand, during the dry (February-May 2002), early rainy (June-September 2002) and late rainy season (October 2002-January 2003). Line C, KPS 1, CN 60, CN 36 and CN 72 gave high yields in the early rainy season, while line H, line G, line

E, KPA 1 and line C gave high yields in the late rainy session. Yield trial of the 6 recommended mungbean cultivars was also conducted in the farmer's field.

Two summer mungbean cultivars, i.e. BINA mung 2 and BINA mung 5, were grown during the kharif-1 season (February-May) of 2001, in Mymensingh, Bangladesh, under no irrigation and with irrigation once at 30 days after sowing (DAS), twice at 30 and 50 DAS, and thrice at 20, 30 and 50 DAS by Shamsuzzaman *et al.* (2004). Data were recorded for days to first flowering, days to first leaf senescence, days to pod maturity, flower + pod abcission, root, stem+leaf, pod husk and seed dry matter content, pods per plant, seeds per pod, 100 seed weight, seed yield, biological yield and harvest index. The two cultivars tested were synchronous in flowering, pod maturity and leaf senescence, which were significantly delayed under different irrigated frequencies. BINA mung 2 performed slightly better than BINA mung 5 for most of the growth and yield parameters studied.

An experiment was conducted by Abid *et al.* (2004) Peshawar, Pakistan, during the summer season of 2002 to study the effect of sowing dates on the agronomic traits and yield of two mungbean cultivars namely, NM-92 and M-1. Data were recorded for days to emergence, emergence m^{-2}, days to 50% flowering, days to physiological maturity, plant height at maturity and grain yield. Sowing on 15 April took more number of days to emergence byt showed maximum plant height. The highest emergence m^{-2} and higher mean grain yield was recorded in NM-92 than M-1.

Ali *et al*. (2004) conducted an experiment with munghbean varieties at BARI, Joydebpur, Gazipur. to find out the response of inoculation with different plant genotypes of mungbean. Three varieties of mungbean viz. BARI mung 1, BARI mung 2, BARI mung 3 and Rhizobial inoculums (BARI Rvr 405) were used in this experiment. Inoculated plants gave significantly higher stover yield and seed yield compared to non inoculated plants. Among 3 varieties, BARI mung-1 produced the highest yield (1.35 t ha^{-1}).

A field experiment was conducted by Apurv and Tewari (2004) during khrif season of 2003 in Uttaranchal, India, to investigate the effect of *Rhizobium* inoculation and fertilizer on the yield and yield components of three mungbean cultivars (Pusa 105, Pusa 9531 and Pant mung 2). Pusa 9531 showed higher yield components and grain yield than Pusa 105 and Pant mung 2.

Solaiman *et al.* (2003) studied on the response of mungbean cultivars BARI mung 2, BARI mung 3, BARI mung 4, BARI mung 5, BINA mung-2 and BU mung-1 to *Rhizobium sp.* Strains TAL 169 and TAL 441. The inocultation of the seeds increased dry matter production.

Bhuiyan *et al.* (2003) conducted a field experiment at Regional Agricultural Research Station (RARS), Rahmatpur, Barisal, to study the response of inoculation with different plant genotypes. Four varieties of mungbean viz. BARI mung 2, BARI mung 3, BARI mung 4, BARI mung 5, and Rhizobial inoculum (*Bradyrhizobium strain* RVr-441) were used in this experiment.

From an experiment at BARI, Joydebpur, Gazipur. Ali *et al.* (2004) showed that inoculated plants gave significantly higher root weight, shoot weight.

Bhuiyan *et al*. (2003) conducted a field experiment at Regional Agricultural Research Station (RARS), Rahmatpur, Barisal. Each variety was tested with/without inoculation. Inoculated plants gave significantly higher root weight and shoot weight.

Bhuiyan *et al.* (2003) conducted a field experiment at Regional Agricultural Research Station (RARS), Rahmatpur, Barisal. Inoculated plants gave significantly higher stover yield and seed yield copared to non-inoculated plants. Among 4 varieties, BARI mung2 produced higher yield. The variety BARI mung 2 gave the highest seed yield (1.38 t/ha) with inoculation.

2.2. Effect of Naphthalene Acetic Acid on mungbean and other grain legume crops

Kelaiya *et al*. (1991) conducted an experiment with four growth regulators, such as, CCC (chlormequat), NAA, GA_3, and triacontanol and sprayed at 25, 50 and 75 days after sowing (DAS) on groundnut. In that experiment, they observed that where NAA was found to be most effective one in increasing the plant height.

Lakshmamma and Rao (1996a) conducted a field experiment during the rabi season at Rajendranagar, Andhra Pradesh. Blackgram was sprayed with 0, 5, 10 or 20 ppm NAA at 50% flowering stage. They found that application of NAA increased plant height of blackgram.

Singh *et al.* (1982) conducted an experiment on groundnut to determine the effect of NAA. They observed that two foliar spray of 100 ppm planofix (NAA) to groundnut at 40 and 50 days after sowing increased the number of leaves per plant.

Reddy and Shah (1984) reported that application of planofix (NAA) at the rate of 50 ppm significantly produced the higher number of leaves in groundnut.

Mahla *et al*. (1999) reported that spraying 20 ppm NAA on blackgram had greater effect in increasing the number of branches.

Das and Prasad (2003) conducted a study on sandy clay loam soil in New Delhi, India, during summer 1999. The treatments comprised of three mungbean cultivars and two levels on NAA (20 and 40 ppm). NAA sprayed at 30 days after sowing and at flowering stages and both the concentrations of NAA significantly increased the number of leaves.

Kelaiya *et al.* (1991) reported that groundnuts when sprayed with 40 ppm of NAA at 25 and 50 DAS increased plant dry weight. Application of 10 or 20 ppm planofix (NAA) on groundnut cv. DH3-30 increased the dry matter production when compared to the untreated control (Nawalagatti *et al.* 1991).

Das and Prasad (2003) conducted a study on sandy clay loam soil in New Delhi, India, during summer 1999. The treatments comprised of three mungbean cultivars and two levels on NAA (20 and 40 ppm) which were applied by spraying at 30 days after sowing and at flowering stages. Both sprays of NAA significantly increased the total dry matter production, number of flowers, number of pods per plant, pod length, number of seeds per pod, and 1000 seed weight of summer mungbean.

The number of flower per plant is an important reproductive character that contributes much towards yield. There is evidence that this component is influenced by different concentrations of NAA.

Chellappa and Karicaratharaju (1973) studied the effect of soaking groundnuts seed in 5 or 10 ppm solution of NAA for 12 or 24 hours. They found that seeds treated with 5 ppm NAA for 12 hours resulted in the highest number of flowers.

Subbian and Chamy (1984) conducted that in field trial with 2 foliar applications of 0, 20 or 40 ppm of NAA on summer mungbean. The numbers of flowers, number of pods per plant were increased with increasing NAA rate and also increased seed yield from 0.8 to 1.2 t ha^{-1} with increasing NAA concentrations.

Lee (1990) found that soaking of groundnut seeds in solutions of 0, 50, and 100 ppm of GA_3 before sowing produced plants with greater number of flowers than those of the control.

Upadhyay (1994) conducted a field experiment at Faizabad, Uttar pradesh, Chickpea cv. K-850 was treated with 10, 20 or 30 ppm of NAA at bud initiation and pod formation stages. It was reported that growth regulator increased the number of flowers.

Arora *et al.* (1998) reported that NAA applied at 50 % flowering stage to chickpea increased the number of flowers as compared with the untreated ones. Flowering and fruiting were also reported to be increased by foliar spraying with NAA on groundnut (Manikanda and Hakim, 1999).

Studies have showed that external application of planofix (NAA) reduced the premature abscissions of flowers, young pods and thus increased the number of pods and consequently the yield of groundnut (Mani and Raja, 1976).

A foliar application of 40 ppm NAA on groundnut increased the number of pods per plant and eventually the pod yield (Gupta and Singh, 1982).

Venkaten Warlu *et al.* (1984) pointed out that both in rabi and kharif seasons, spraying NAA with various concentrations at 30 and 50 days after sowing increased the number of pods per plant and 1000 seed weight in groundnut.

Sharma *et al.* (1989) conducted a field trial with foliar applications of NAA at anthesis and 10 days later on mungbean. Results revealed that the NAA application increased the number of pods per plant, number of seed per pod and 1000 seed weight. Kalita *et al.* (1995) also reported that the regulatory effect of

NAA on groundnut cv. GG2 increased on number of pod of mungbean and 1000 seed weight.

Subbian and Chamy (1982) mentioned that two foliar sprays of 40-ppm planofix (NAA) when applied to summer mungbean at the flower initiation stage and 15 days later significantly increased the seed yield.

Bai *et al.* (1987) investigated the effect of growth regulators (NAA and GA) on the yield performance of mungbean. They found that 25 ppm of NAA and 50 ppm of GA increased the yield of mungbean when compared with control.

Gurprect *et al.* (1988) mentioned that grain yield was increased from 0.71 to 0.78 t ha^{-1} with applications of NAA in mungbean.

Kalita (1989) reported that applying a foliar spray at the rate of 50 ppm on NAA in mungbean increased seed yield from 0.64 to 0.88 t ha^{-1}. Sharma *et al.* (1989) conducted a field trial with foliar application of NAA at anthesis and 10 days later on mungbean. Results revealed that the NAA application increased the seed yield.

Subbin *et al.* (1989) performed two foliar sprays with 20 or 40 ppm planofix (NAA) in blackgram at the flower initiation stage and 15 days later in summer season found that seed yield of 1.46 t ha^{-1} was obtained by using 40 ppm NAA, compared 0.95 t ha^{-1}, when no growth regulator was used.

Jaiswal and Bhambil (1989) conducted a field experiment to determine the effect of growth regulators on mungbean. It was observed that GA_3 and NAA resulted in the reduction of yield and yield components. Rahman *et al.* (1989) in a pot experiment on grasspea showed that foliar application of 50ml/liter of GA_3 increased seed yield.

Sharma *et al.* (1989) reported from the result of a field trial with foliar applications of NAA at anthesis and 10 days later on mungbean. It was found that the NAA treated plants gave higher seed yield of 795-849 kg ha^{-1} compared with 611-694 kg of without NAA.

Kandagal *et al.* (1990) observed that a foliar application of 50 ppm of NAA at flowering stage of mungbean gave seed yield of 0.66 t ha^{-1} with the untreated control.

Chaplot *et al.* (1992) reported increases in seed yield of mungbean due to NAA application by 5.7-21%.

Baghel and Yadav (1994) revealed that blackgram when sprayed with 0-30 ppm of NAA, seed yield was generally increased and was highest with 30ppm concentration.

Kalita and Dey (1994) observed that greengram when sprayed with different concentrations of phosphorus alone or in combination with 50 or 100 of NAA improved yields and yield components.

Upadhyay (1994) conducted a filed experiment at Faizabad, Uttar pradesh, Chickpea cv. K-850 was treated with 10, 20 or 30 ppm of NAA at bud initiation and pod formation growth stages. Seed yield was generally increased by the growth regulator and it was highest with 20 ppm.

Lakshmamma and Rao (1996b) conducted a field experiment at Rajendranagar in Andhra Pradesh during rabi season. They found that blackgram when sprayed with 20 ppm of NAA at 50% flowering stage decreased flower drop and increased seed yield.

Das and Prasad (2003) conducted a study on sandy clay loam soil in New Delhi, India, during summer 1999. The treatments comprised of three summer mungbean cultivars and two levels on NAA (20 and 40 ppm). NAA sprayed at 30 days after sowing and at flowering stages and both the concentrations of NAA at 20 or 40 ppm significantly increased the grain yield.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka during the *Kharif* -II season from June to November, 2012 to study the effect of variety and NAA on the water relations and yield of mungbean under kharif-II season. Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1. Description of the experimental site

3.1.1. Site and soil

Geographically the experimental field was located at $23^0 77'$ latitude and $90^0 33'$ E longitudes at an altitude of 9 m above the mean sea level. The soil belonged to the Agro-ecological Zone – Modhupur Tract (AEZ 28) (Appendix I). The land topography was medium high and soil texture was silt clay with pH 8.0. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix III.

3.1.2. Climate and weather

The climate of the locality is subtropical, which is characterized by high temperature and heavy rainfall during *kharif* season (April-September) and scanty rainfall during *rabi* season (October-March) associated with moderately low temperature. The prevailing weather conditions during the study period have been presented in Appendix-II.

3.2. Planting materials

BARI mung-2

BARI mung-2 was developed by BARI and released by National Seed Board (NSB) in 1987. Its life cycle is about 60 to 65 days after emergence. Average yield of this cultivar is about 1000-1500 kg ha^{-1}. The seeds of BARI mung-2 for the experiment were collected from BARI, Joydepur Gazipur.

BARI mung-5

BARI mung-5 was developed by BARI and released by National Seed Board (NSB) in 1997. Plant height of the cultivar ranges from 40 to 45 cm. It is resistant to *Cercospora* leaf spot and tolerant to yellow mosaic virus. Its life cycle is about 55 to 60 days after emergence. Average yield of this cultivar is about 1700 kg ha^{-1}. The seeds of BARI mung-5 for the experiment were collected from BARI, Joydepur Gazipur. The seeds were large shaped, deep green and free from mixture of other seeds, weed seeds and extraneous materials.

3.3. Treatment

The experiment was consisted of the following two treatment factors:

Factor-A: Cultivar-2

V_1 = BARI mung 2

V_2 = BARI mung 5

Factor-B: Naphthalene acetic acid (NAA)-5

N_0 = 0 ppm

N_1 = 20 ppm NAA

N_2 = 40 ppm NAA

N_3 = 60 ppm NAA

N_4 = 80 ppm NAA

3.4. Experimental design and layout

The experiment was laid out in a randomized complete block design (RCBD) having three replications. Each replication had 12 unit plots to which the treatment combinations were assigned randomly. The unit plot size was 4.5 m^2 (3.0m ×1.5m). The blocks and unit plots were separated by 1.0 m and 0.50 m spacing, respectively.

3.5. Land preparation

The experimental land was opened with a power tiller on 15^{th} July, 2012. Ploughing and cross ploughing were done with country plough followed by laddering. Land preparation was completed on 30^{th} July, 2012 and was ready for sowing seeds.

3.6. Fertilizer application

The fertilizers were applied as basal dose at final land preparation where N, K_2O, P_2O_5, Ca and S were applied @ 20.27 kg ha^{-1}, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1}, respectively in all plots. All fertilizers were applied by broadcasting and mixed thoroughly with soil (Afzal *et al.*, 2003).

3.7. Sowing of seeds

Seeds were sown at the rate of 45 kg ha^{-1} in 30 cm a part furrows on 06 July, 2012 and the furrows were covered with the soils soon after seeding.

3.8. Germination of seeds

Seed germination occurred from 3rd day of sowing. On the 4th day the percentage of germination was more than 85% and on the 5th day nearly all seedlings came out of the soil.

3.9. Intercultural operations

3.9.1. Weed control

Weeding was done once in all the unit plots with care at 15 DAS.

3.9.2. Thinning

Thinning was done at 20 days after sowing. Plant to plant distance was maintained at 10 cm.

3.9.3. Irrigation and drainage

Pre sowing irrigation was given to ensure the maximum germination percentage. During the whole experimental period, there was a shortage of rainfall in earlier part; however, it was heavier at the middle of the growing period. So it was essential to remove the excess water from the field at the middle of the growing period (Appendix II).

3.9.4. Pest control

The infestation of pod borer was successfully controlled by the application of Malathion 57 EC @ 1.5 L ha^{-1} at 50% pod formation stage (55 DAS).

3.9.5. Preparation and application of plant growth regulator (NAA)

The NAA solution of 20, 40, 60 and 80 ppm concentrations were prepared by dissolving 20, 40, 60 and 80 mg of NAA in 1 litre of distilled water, respectively. NAA was applied in the form of fine foliar sprays. The spraying was done at 25 DAS with the help of a hand sprayer until all leaves were completely covered.

3.10. Determination of maturity

At the time when 80% of the pods turned black colour, the crop was considered to attain maturity.

3.11. Harvesting and sampling

The crop was harvested at 60, 70 and 75 DAS from prefixed 1.0 m^2 area. Before harvesting ten plants were selected randomly from each plot and pods from the selected 10 plants were collected at each harvesting time for recording data. The pods from the rest of the plants of prefixed 1 m^2 area were collected at each harvest in time plot wise and were bagged separately, tagged and brought to the threshing floor for yield data. The stover yield was taken from the plants of the same area by sun–drying.

3.12. Threshing

The pods were sun dried for three days by placing them on the open threshing floor. Seeds were separated from the pods by beating with bamboo sticks.

3.13. Drying, cleaning and weighing

The seeds collected by threshing were dried in the sun to reduce the seed moisture at safe moisture content level. The dried seeds were cleaned and weighed. The stovers were also sun dried and weighed.

3.14. Parameters studied

A. Water relation traits:

    Relative water content

    Exudation rate

B. Plant characters:

    Plant height

C. Yield contributing characters and yield:

    Pod length

    No. of pods plant^{-1}

    No. of seeds pod^{-1}

    1000- seed weight

    Seed yield

    Stover yield

    Biological yield

    Harvest index

Relative water content

Relative water content (RWC) was measured at first flowering. The leaf samples were cut with a sharp knife with petiole and were put in a polyethylene bag treatment wise. The bags were kept on a tray containing little water and were warpped with a moist towel to avoid light and desiccation. Then the samples were brought in the laboratory and their fresh weight, were recorded without any delay. The leaf samples were then dipped in water for 24 hour and their turgid weight were recorded after soaking the leaf surface water by paper towel. The samples were then oven-dried to constant weight. The relative water content was measured using the following formula:

Relative water content (RWC%)=[(fresh weight-dry weight)/(turgid weight-dry weight)] × 100.

Exudation rate

Exudation rate was measured from the stem at about 5 cm above from the ground. At first, dry cotton was weighed. A slanting cut on the stem was made with a sharp knife. Then the weighed cotton was placed on the cut surface. The exudation of the sap was collected from the stem for 1 hour at normal temperature. The final weight of the cotton with sap was taken. The exudation rate was calculated by deducting cotton weight from the cotton weight containing sap and was expressed per hour basis as follows:

Exudation rate= [(weight of cotton+sap)-(weight of cotton)]/time (hr)

Plant height

The heights of the 10 selected plants were measured from the ground level to the tip of the plant at harvest time. Thereafter, average plant height was calculated.

Pod length

Pod length was measured in centimeter (cm) scale from randomly selected 10 pods. Mean value of there pod lengths were recorded as treatment wise.

Number of pods per plant

Number of pods per plant was counted from the 10 randomly selected plant samples thrice as mungbean pods matured asynchronously and then the average pod number was calculated.

Number of seeds per pod

Number of seeds per pod was counted from 10 randomly selected pods of plants and then the average seed number per pod was calculated.

1000-seed weight

1000-seed were counted, which were taken from the seed sample of each plot separately, then weighed in an electrical balance and data were recorded.

Seed yield

Pods collected from plants of pre-demarkated central 1 m^2 area, were considered for taking yield data. Pods were collected thrice from that plants and the seeds collected from that pods were adjusted at 12 % moisture content by sun-drying. The weights of that seeds were taken and yield was expressed in ton per hectare.

Stover yield

Stover yield was determined from the central 1 m^2 area of each plot. After threshing, the plant parts were sun-dried weight was taken and finally converted to ton per hectare.

Biological yield

The biological yield was calculated with the following formula-

Biological yield= Grain yield + Stover yield

Harvest index

Harvest index was calculated with the help of following formula.

Harvest index (HI %) = (Seed yield/ Biological yield) × 100

3.15. Data analysis

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT-C and the mean differences were adjusted by Least Significance Difference (LSD) test (Gomez & Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

Result obtained from the present study have been presented and discussed in this chapter. The data have been presented in different tables and figures. The results have been presented and discussed, and possible interpretations are given under the following headings.

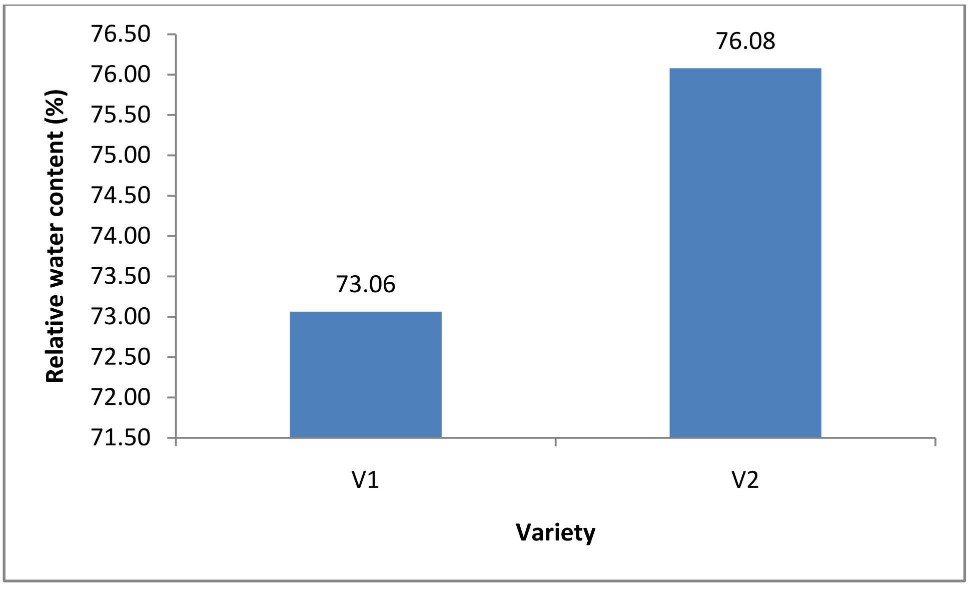
4.1. Relative water content

4.1.1. Effect of variety

Relative water content (RWC) signifies the water content of plant. The relative water content was influenced by the variety (Appendix IV). The highest RWC (76.08%) was obtained from V_2 (BARI mung 5) and that was lowest (73.06%) in V_1 (BARI mung 2) (Fig. 1). Varietal differences in RWC might be due to the morpho-physiological differences among the varieties. Variations in RWC due to mungbean varieties were also observed by Islam *et al.* (2006).

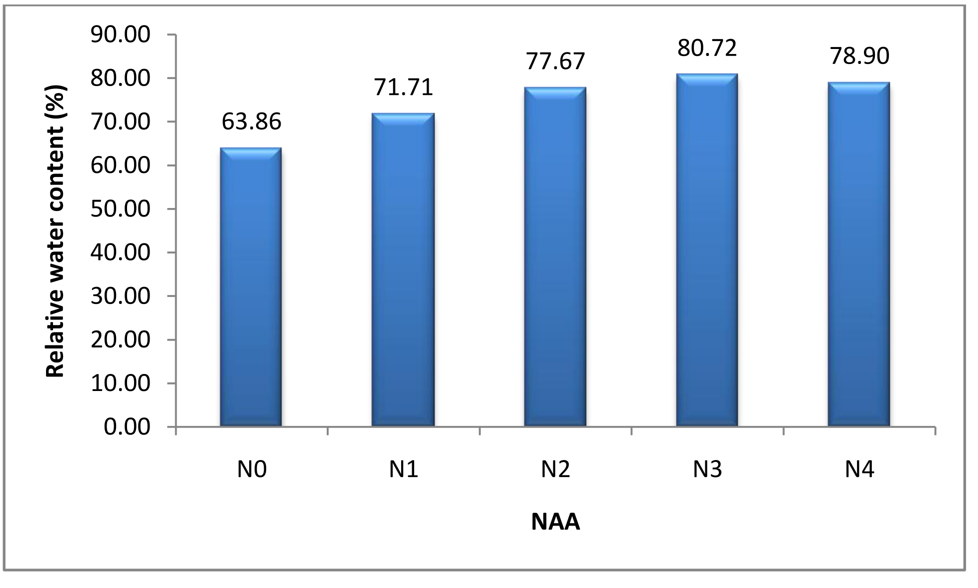
4.1.2 Effect of NAA

Relative water content was influenced by NAA (Appendix IV). The highest RWC (80.72%) was obtained from N_3 (60ppm NAA) and the lowest RWC (63.86%) was obtained in N_0 (0 ppm NAA) (Fig. 2).



V_1 = BARI mung 2 V_2 = BARI mung 5

Fig.1. Effect of variety on relative water content of mungbean



N_0 = 0 ppm NAA N_1 = 20 ppm NAA N_2 = 40 ppm NAA N_3 = 60 ppm NAA N_4 = 80 ppm NAA

Fig.2. Effect of NAA on the relative water content of mungbean ($LSD_{0.05}$=9.27)

4.1.3. Interaction effect of variety and NAA

Interaction of variety and NAA had a significant influence on relative water content of mungbean (Appendix IV). The highest RWC (81.47%) was obtained from V_2N_4 (BARI mung 5 with 80ppm NAA) treatment, which was statistically similar with V_1N_3 threatment while the lowest (54.99%) with V_1N_0 (BARI mung 2 with control) (Table 1).

4.2. Exudation rate

4.2.1. Effect of variety

Exudation rate is known as the flow of sap from cut end of stem against the gravitational force. Exudation rate is also influence significantly by variety (Appendix IV). The highest exudation rate (10.73 mg hr^{-1}) was obtained from V_1 (BARI mung 2) and the lowest (5.71 mg hr^{-1}) in V_2 (BARI mung 5) (Fig. 3). Morpho-physiological differences in mungbean plants of different varieties might influence the water uptake as well as transpirational stream and thereby influenced exudation rate.

4.2.2. Effect of NAA

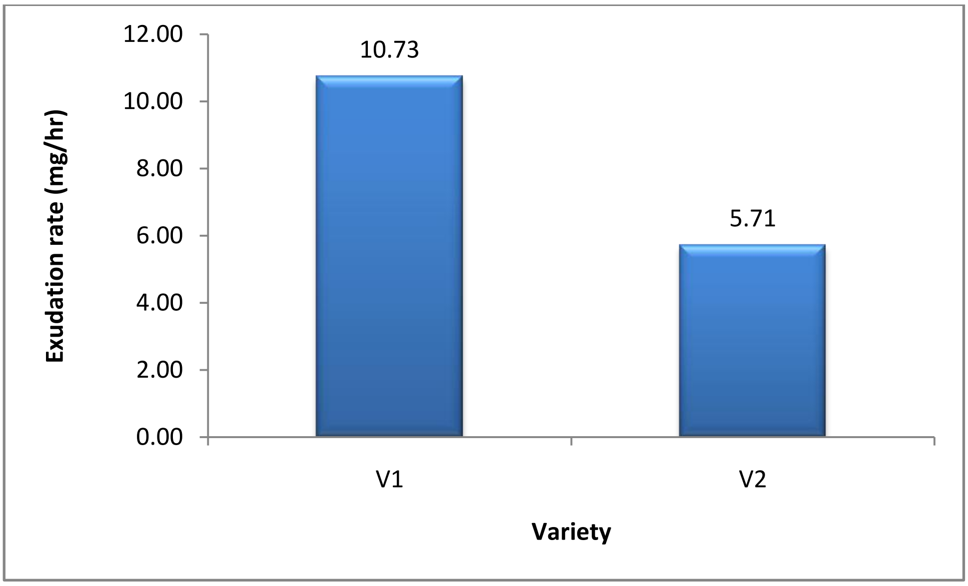
Exudation rate was not significantly influenced by NAA (Appendix IV). However, the highest exudation rate (8.95 mg hr^{-1}) was obtained from N_4 (80 ppm NAA) and the lowest RWC (7.40 mg hr^{-1}) from N_0 (0 ppm NAA) (Fig. 4).

Table 1. Interaction effect of variety and NAA on relative water content, exudation rate and plant height of mungbean

Treatment	Relative Water contain (%)		Exudation Rate (mg hr^{-1})		Plant Height (cm)	
V_1N_0	54.99	d	10.27	ab	85.07	c
V_1N_1	72.52	bc	9.07	abc	89.07	b
V_1N_2	80.08	ab	11.73	a	94.60	a
V_1N_3	81.39	a	11.40	a	88.47	b
V_1N_4	76.33	abc	11.20	a	94.73	a
V_2N_0	70.90	c	4.80	c	73.00	e
V_2N_1	72.73	bc	5.73	c	77.80	d
V_2N_2	75.25	abc	5.80	c	75.80	de
V_2N_3	80.04	ab	5.50	c	74.60	de
V_2N_4	81.47	a	6.70	bc	74.73	de
LSD $_{(0.05)}$	7.01		4.10		3.19	
CV (%)	18.8		19.1		6.99	

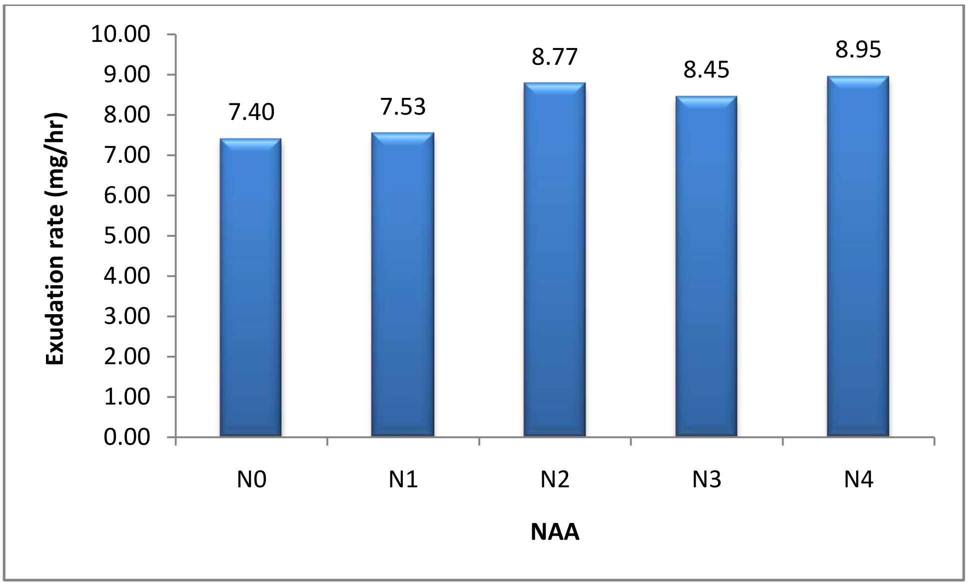
V_1 = BARI mung 2 V_2 = BARI mung 5

N_0 = 0 ppm NAA N_1 = 20 ppm NAA N_2 = 40 ppm NAA N_3 = 60 ppm NAA N_3 = 80 ppm NAA



V_1 = BARI mung 2 V_2 = BARI mung 5

Fig. 3. Effect of variety on the exudation rate of mangbean



N_0 = 0 ppm NAA N_1 = 20 ppm NAA N_2 = 40 ppm NAA N_3 = 60 ppm NAA N_4 = 80 ppm NAA

Fig. 4. Effect of NAA on the exudation rate of mungbean ($LSD_{0.05}$=5.42)

4.2.3. Interaction effect of variety and NAA

Interaction of Variety and NAA had a significant influence on exudation rate (Appendix IV). The highest exudation rate (11.71 mg hr^{-1}) was obtained from V_1N_2 (BARI mung 2 with 40 ppm NAA) treatment, while the shortest (4.80 m hr^{-1}) with V_2N_o (BARI mung 5 with control) (Table 1).

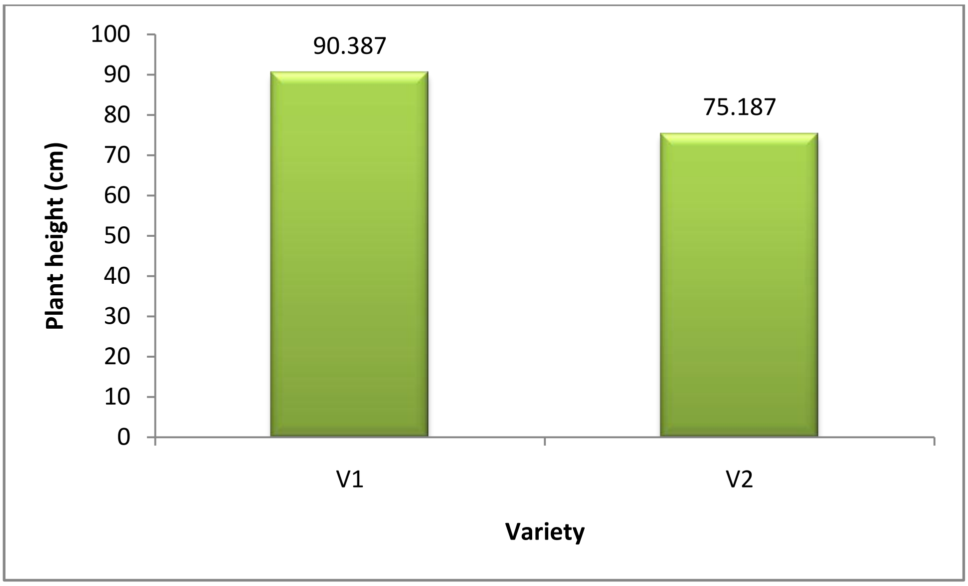
4.3. Plant height

4.3.1. Effect of variety

Plant height is one of the most important growth characters in mungbean. Variety showed significant influence on plant height (Appendix IV). The tallest plant (90.39 cm) was recorded in V_1 (BARI mung 2) and the shortest plant (75.19 cm) in V_2 (BARI mung 5) (Fig. 5). Probably the genetic make up of varieties was responsible for the variation in plant height.

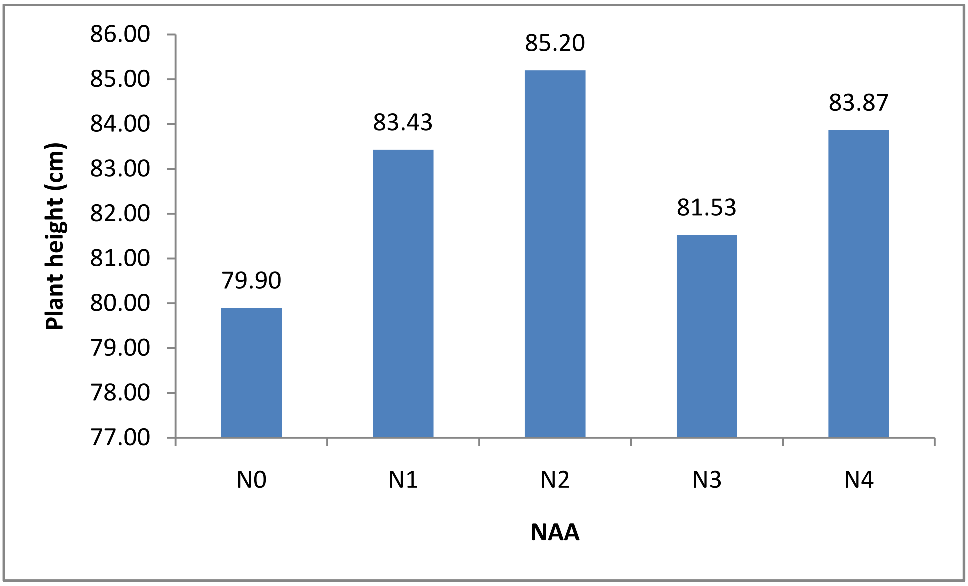
4.3.2. Effect of NAA

The variation in the plant height due to the NAA was statistically significant (Appendix IV). The tallest plant (85.20 cm) was obtained from N_2 (40 ppm NAA) and the shortest (79.90 cm) was obtained in N_0 (0 ppm NAA) (Fig. 6). This finding agrees well with those of some other scientists. Lakshmamma and Rao (1966a) reported that plant height of blackgram increased with NAA appliction. Kelaiya *et al*. (1991) reported that among four growth regulators such as CCC, NAA, GA_3 and triacontanol, NAA was the most effective to increase the plant height of groundnut.



V_1 = BARI mung 2 V_2 = BARI mung 5

Fig. 5. Effect of variety on the plant height of mangbean



N_0 = 0 ppm NAA N_1 = 20 ppm NAA N_2 = 40 ppm NAA N_3 = 60 ppm NAA N_3 = 80 ppm NAA

Fig. 6. Effect of NAA on plant height of mungbean ($LSD_{0.05}$=2.01)

4.3.3. Interaction effect of variety and NAA

Interaction of variety and NAA had a significant influence on plant height (Appendix IV). The tallest plant (94.73 cm) was obtained from V_1N_4 (BARI mung 2 with 80 ppm NAA) while the shortest (73.00 cm) from V_2N_0 (BARI mung 5 with 0 ppm NAA) combination (Table 1).

4.4. Pod Length

4.4.1. Effect of variety

Pod length is one of the most important yield contributing characters in mungbean (Appendix V). The longest pod (8.91 cm) was recorded in V_2 (BARI mung 5) and the shortest (7.29 cm) in V_1 (BARI mung 2) (Table 2). This result is agreement with the result of Sarkar *et al.* (2004) who reported that pod length differed from variety to variety. The probable reason of this difference could be the genetic make-up of the variety.

4.4.2. Effect of NAA

The variation in the pod length due to the NAA was statistically insignificant (Appendix V). Numerically the longest pod (8.30 cm) was obtained from N_1 (20 ppm NAA) and the smallest (7.97cm) was obtained in N_0 (0 ppm NAA) (Table 3).

4.4.3. Interaction effect of variety and NAA

Interaction of variety and NAA had a significant influence on pod length (Appendix V). The longest pod (9.31 cm) was obtained from V_2N_1 (BARI mung 5 with 20 ppm NAA) while the smallest (7.12 cm) from V_1N_0 (BARI mung 2 with 0 ppm NAA) combination (Table 4).

Table 2. Effect of variety on yield contributing characters of mungbean

Treatment	Pod length (cm)	Pods per plant (no.)	Seeds per pod (no.)	1000 seed weight (g)
V_1	7.29	14.13	10.11	35.887
V_2	8.91	11.03	10.84	48.96
CV (%)	5.32	4.96	5.93	8.68

V_1 = BARI mung 2 V_2 = BARI mung 5

Table 3. Effect of NAA on yield contributing characters of mungbean

Treatment	Pod length (cm)	Pods per plant (no.)	Seeds per pod (no.)	1000 seed weight (g)
N_0	7.97	12.17 d	10.37	40.30
N_1	8.30	12.87 a	10.70	44.05
N_2	8.19	12.57 bc	10.53	42.30
N_3	8.04	12.77 ab	10.27	43.57
N_4	8.00	12.53 c	10.5	41.9
LSD $_{(0.05)}$	NS	0.215	NS	NS
CV (%)	5.32	4.96	5.93	8.68

N_0 = 0 ppm NAA N_1 = 20 ppm NAA N_2 = 40 ppm NAA N_3 = 60 ppm NAA N_4 = 80 ppm NAA
NS=Non-significant

Table 4. Interaction effect of variety and NAA on yield contributing characters of mungbean

Treatment	Pod length (cm)	Pods per plant (no.)	Seeds per pod (no.)	1000 seed weight (g)
V_1N_0	7.12 c	13.67 b	9.80 d	33.97 c
V_1N_1	7.30 c	14.47 a	10.20 bcd	35.40 bc
V_1N_2	7.25 c	14.13 ab	10.47 abc	36.00 bc
V_1N_3	7.41 c	14.33 a	9.93 cd	39.40 b
V_1N_4	7.35 c	14.07 ab	10.13 bcd	34.67 bc
V_2N_0	8.82 ab	10.67 d	10.87 a	46.63 a
V_2N_1	9.31 a	11.00 cd	10.93 a	51.73 a
V_2N_2	9.12 ab	11.00 cd	10.93 a	48.60 a
V_2N_3	8.66 b	11.20 cd	10.60 ab	48.70 a
V_2N_4	8.64 b	11.27 c	10.87 a	49.13 a
LSD $_{(0.05)}$	0.50	0.51	0.51	4.85
CV (%)	5.32	4.96	5.93	8.68

V_1 = BARI mung 2 V_2 = BARI mung 5

N_0 = 0 ppm NAA N_1 = 20 ppm NAA N_2 = 40 ppm NAA N_3 = 60 ppm NAA N_3 = 80 ppm NAA

4.5. Number of pods per plant

4.5.1. Effect of variety

Number of pods per plant is one of the most important yield contributing characters in mungbean (Appendix V). The highest number of pods per plant (14.13) was recorded in V_1 (BARI mung 2) and the lowest (11.03) in V_2 (BARI mung 5) (Table 2). It was remarkable that both the highest and lowest pod bearing varieties were statistically similar.

4.5.2. Effect of NAA

There was a significant influence on number of pods per plant due to the NAA (Appendix V). The maximum number of pods per plant (12.87) was obtained from N_1 (20 ppm), but significantly different (12.17) from that of N_0 (control) (Table 3). This finding is strongly supported by Das and Prasad (2003), Venkaten *et al*. (1984). They stated that NAA at 20 ppm significantly increased the number of pods per plant of summer mungbean.

4.5.3. Interaction effect of variety and NAA

Interaction of variety and NAA had a significant influence on number of pods per plant (Appendix V). The maximum number of pods per plant (14.47) was obtained from V_1N_1 (BARI mung 2 with 20 ppm NAA) while the minimum (10.67) from V_2N_0 (BARI mung 5 with 0 ppm NAA) (Table 4).

4.6. Number of seeds per pod

4.6.1. Effect of variety

The number of seeds per pod was influenced by variety (Appendix V). The highest number of seeds per pod (10.84) was recorded in V_2 (BARI mung 5) and the minimum (10.11) in V_1 (BARI mung 2) (Table 2).

4.6.2. Effect of NAA

There was not significant influence on the number of seeds per pod due to the NAA (Appendix V). The maximum number of seeds per pod (10.70) was obtained from N_1 treatment and the minimum (10.37) was from N_0 treatment (Table 6). This finding is supported by Das and Prasad (2003), they found that application of NAA at 20 ppm increased the number of seeds per pod of summer mungbean.

4.6.3. Interaction effect of variety and NAA

Interaction of variety and NAA had a significant effect on number of seeds per pod (Appendix V). The highest number of seeds per pod (10.93) was obtained from V_2N_1 (BARI mung 5 with 20 ppm NAA) while the lowest (9.80) from V_1N_0 (BARI mung 5 with 0 ppm NAA) (Table 4).

4.7. 1000-seed weight

4.7.1. Effect of variety

There was difference in 1000 seed weight of mungbean differed due to variety (Appendix V). The highest thousand seed weight (48.96 g) was obtained from V_2 (BARI mung 5) and the lowest (35.89g) from V_1 (BARI mung 2) (Table 2). This result was in agreement with the result of Sarkar *et al*. (2004).

4.7.2. Effect of NAA

There was no significant influence in the thousand seed weight due to the NAA (Appendix V). The maximum thousand seed weight (44.05) was obtained from N_1 treatment and the minimum (40.30 g) from N_0, which was followed by N_4 (Table 3). Das and Prasad (2003) observed that 1000 seed weight was increased with 20 ppm NAA on summer mungbean

4.7.3 Interaction effect of variety and NAA

Interaction effect of variety and NAA had a significant influence on 1000-seed weight (Appendix V). The highest 1000-seed weight (51.73 g) was obtained from V_2N_1 (BARI mung 5 with 20 ppm NAA) while the lowest (33.97 g) from V_1N_0 (BARI mung 5 with 0 ppm NAA) (Table 4).

4.8. Seed yield

4.8.1. Effect of variety

The seed yield of mungbean was influence by variety (Appendix VI). The maximum seed yield (1.39 t ha^{-1}) was found in V_2 (BARI mung 5). The lowest yield (1.23 t ha^{-1}) was found in from V_1 (BARI mung 2) (Table 5).

4.8.2. Effect of NAA

There was significant influence in seed yield due to NAA (Appendix VI). The maximum seed yield (1.43 t ha^{-1}) was obtained from N_1 (20ppm) and the minimum (1.09 t ha^{-1}) in N_0 (control) treatment (Table 6). This result is supported by Bai *et al*. (1987) who observed that application at 25 ppm of NAA on mungbean increased seed yield. Das and Prasad (2003) and Upadhyay (1994) also reported a lower dose of NAA to be the best increasing yield. They found that spraying 20 ppm of NAA on mungbean increased seed yield when compared to control.

4.8.3. Interaction effect of variety and NAA

Interaction of variety and NAA had a significant influence on seed yield of mungbean (Appendix VI). The highest seed yield (1.51 t ha^{-1}) was obtained from V_2N_1 (BARI mung 5 with 20 ppm NAA) while the lowest (1.00 t ha^{-1}) from V_1N_0 (BARI mung 5 with 0 ppm NAA) (Table 7).

Table 5. Effect of variety on yield and harvest index of Mungbean

Treatment	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1	1.227	1.53	2.76	44.447
V_2	1.386	1.83	3.22	43.103
CV (%)	11.55	11.65	11.6	5.6

V_1 = BARI mung 2 V_2 = BARI mung 5

Table 6. Effect of NAA on yield and harvest index of Mungbean

Treatment	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
N_0	1.09 b	1.40 b	2.49 b	43.78
N_1	1.43 a	1.84 a	3.27 a	43.77
N_2	1.38 a	1.78 a	3.16 a	43.78
N_3	1.28 ab	1.64 ab	2.92 ab	43.78
N_4	1.36 a	1.75 a	3.10 a	43.77
LSD $_{(0.05)}$	0.20	0.30	0.45	NS
CV (%)	11.6	11.7	11.6	5.6

N_0 = 0 ppm NAA N_1 = 20 ppm NAA N_2 = 40 ppm NAA N_3 = 60 ppm NAA N_4 = 80 ppm NAA

Table 7. Interaction effect of variety and NAA on yield and harvest index of Mungbean

Treatment	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1N_0	1.00 c	1.24 c	2.24 e	44.45 a
V_1N_1	1.35 ab	1.69 ab	3.05 cd	44.44 a
V_1N_2	1.36 ab	1.70 ab	3.06 bcd	44.45 a
V_1N_3	1.19 bc	1.49 bc	2.69 d	44.45 a
V_1N_4	1.24 abc	1.54 bc	2.78 d	44.44 a
V_2N_0	1.48 ab	1.95 a	3.42 ab	43.10 b
V_2N_1	1.51 a	1.99 a	3.50 a	43.10 b
V_2N_2	1.40 ab	1.85 ab	3.26 abc	43.11 b
V_2N_3	1.36 ab	1.80 ab	3.16 abc	43.10 b
V_2N_4	1.18 bc	1.56 bc	2.74 d	43.11 b
LSD $_{(0.05)}$	0.26	0.33	0.34	0.02
CV (%)	11.6	11.7	11.6	5.6

V_1 = BARI mung 2 V_2 = BARI mung 5

N_0 = 0 ppm NAA N_1 = 20 ppm NAA N_2 = 40 ppm NAA N_3 = 60 ppm NAA N_3 = 80 ppm NAA

4.9. Stover yield

4.9.1. Effect of variety

The Stover yield was influenced by variety (Appendix VI). The maximum stover yield (1.83 t ha^{-1}) was found in V_2 (BARI mung 5), the lowest stover yield (1.53 t ha^{-1}) was observed from V_1 (BARI mung 2) (Table 5).

4.9.2. Effect of NAA

There was significant influence in the stover yield due to NAA (Appendix VI). The maximum stover yield (1.84 t ha^{-1}) was obtained from N_1 (20 ppm NAA) and the minimum (1.40 t ha^{-1}) from N_0 (control) (Table 6).

4.9.3. Interaction effect of variety and NAA

Interaction of variety and NAA had a significant influence on stover yield. The highest stover yield (1.99 t ha^{-1}) was obtained from V_2N_1 (BARI mung 5 with 20 ppm NAA) while the lowest (1.24 t ha^{-1}) from V_1N_0 (BARI mung 2 with 0 ppm NAA) (Table 7).

4.10. Biological yield

4.10.1. Effect of variety

Biological yield was influence by variety (Appendix VI). The maximum biological yield (3.22 t ha^{-1}) was found in V_2 (BARI mung 5), the lowest yield (2.76 t ha^{-1}) was observed from V_1 (BARI mung 2) (Table 5).

4.10.2 Effect of NAA

There was a significant influence in the biological yield due to NAA (Appendix VI). The maximum biological yield (3.27 t ha^{-1}) was found from N_1 (20 ppm NAA) and the minimum (2.49) from N_0 (NAA) (Table 6).

4.10.3. Interaction effect of variety and NAA

Interaction of variety and NAA had a significant influence on biological yield of mungbean (Appendix VI). The highest biological yield (3.50 t ha^{-1}) was obtained from V_2N_1 (BARI mung 5 with 20 ppm NAA) while the lowest (2.24 t ha^{-1}) from V_1N_0 (BARI mung 2 with 0 ppm NAA) (Table 7).

4.11. Harvest index (HI)

4.11.1. Effect of variety

Harvest index indicates the ratio of partitioning of dry matter towards reproductive and vegetative parts. The ratio of economic yield to biological yield is termed as harvest index. Higher HI might be beneficial in obtaining higher economic yield. A variation in HI was found in mungbean due to different variety (Appendix VI). The highest HI (44.45%) was found in V_1 (BARI mung 2) and the lowest (43.10%) in V_2 (BARI mung 5) (Table 5).

4.11.2 Effect of NAA

There was a no significant influence in harvest index due to NAA (Appendix VI). The maximum HI (44.78%) was obtained from $N_{0,}$ $N_{2,}$ N_3 treatment and the minimum (43.77%) was obtained in N_1 (20 ppm) (Table 6).

4.11.3 Interaction effect of variety and NAA

Interaction of variety and NAA had a significant influence on HI (Appendix VI). The highest HI (44.45%) was obtained from V_1N_2 (BARI mung 2 with 40 ppm) while the lowest (43.10%) from V_2N_0 (BARI mung 5 with control) (Table 7).

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted at the Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka during the *Kharif -II* season from June to November, 2012 to study effect of variety and NAA on the water relations and yield of mungbean under *kharif-II* season. In the experiment, the treatment consisted of two variety viz. V_1 = BARI mung 2, V_2 = BARI mung 5, and five different dose of NAA**,** N_0 = 0ppm, N_1 = 20 ppm NAA, N_2 = 40 ppm NAA, N_3 = 60 ppm NAA, N_4 = 80 ppm NAA. The experiment was laid out in a two factors randomized complete block design (RCBD) with three replications. The fertilizers were applied as basal dose at final land preparation where N, K_2O, P_2O_5 Ca and S were applied @ 20.27 kg ha^{-1}, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1} respectively in all plots. Necessary intercultural operations were done as and when necessary.

Results showed that a significant influence was observed among the treatments regarding majority of the parameters observed. The collected data were statistically analyzed for evaluation of the treatment effect.

The relative water content was influenced due to the different variety. The highest RWC (76.08%) was higher in V_2 (BARI mung 5) compared to V_1 (BARI mung 2). The highest RWC (80.72%) was obtained from N_3 (60ppm NAA) treatment. Interaction of variety and NAA had a significant influence on relative water content of mungbean. The highest RWC (81.47%) was obtained from V_2N_4 (BARI mung 5 with 80ppm NAA) treatment.

The higher exudation rate (10.73 mg/hr) was obtained from V_1 (BARI mung 2) compared to V_2 (BARI mung 5). Exudation rate was not significantly influenced by NAA. The highest exudation rate (8.95 mg/hr) was obtained from N_4 (80 ppm NAA). Interaction of Variety and NAA had a significant influence on exudation rate. The highest exudation rate (11.71 mg/hr) was obtained from V_1N_2 (BARI mung 2 with 40 ppm NAA) treatment.

Variety showed significant influence on plant height. The tallest plant (94.73 cm) was obtained from V_1 (BARI mung 2) when plants were treated with 80 ppm NAA.

Variety showed difference in pod length. The variation in the pod length due to the NAA was statistically insignificant. The longest pod (9.31 cm) was obtained from V_2 with treatment N_1.

Variety had an influence on the number of pods per plant. The highest number of pods per plant (14.13) was recorded in V_1. The maximum number of pods per plant (12.87) was obtained from N_1. Interaction of variety and NAA had a significant influence on number of pods per plant. The maximum number of pods per plant (14.47) was obtained from V_1N_1 treatment. The number of seeds per pod was influenced by variety. The highest number of seeds per pod (10.84) was recorded in $V_{2.}$ The maximum number of seeds per pod (10.70) was obtained from N_1 treatment. Interaction of variety and NAA had a significant effect on number of seeds per pod. The highest number of seeds per pod (10.93) was obtained from V_2N_1treatment.

There was difference in 1000 seed weight of mungbean differed due to variety and NAA treatment. The highest 1000-seed weight (51.73 g) was obtained from V_2 when plant was treated with N_1 treatment.

The seed yield of mungbean was influence by variety. The maximum seed yield (1.39 t/ha) was found in V_2 (BARI mung 5). The lowest yield (1.23 t/ha) was found in from V_1 (BARI mung 2). There was significant influence in seed yield due to NAA. The maximum seed yield (1.43 t/ha) was obtained from N_1 (20ppm) and the minimum (1.09 t/ha) in N_0 (control) treatment. Interaction of variety and NAA had a significant influence on seed yield of mungbean. The highest seed yield (1.51 t/ha) was obtained from V_2N_1 (BARI mung 5 with 20 ppm NAA) while the lowest (1.00 t/ha) from V_1N_0 (BARI mung 5 with 0 ppm NAA).

The stover yield per hectare was significantly influenced by variety and sowing time. The maximum stover yield (1.83 t/ha) was found in V_2. The maximum stover yield (1.84 t/ha) was obtained from N_1 treatment. The highest stover yield (1.99 t/ha) was obtained from V_2N_1.

The maximum biological yield (3.22 t/ha) was found in V_2. The maximum biological yield (3.27 t/ha) was found from N_1 treatment. The highest biological yield (3.50 t/ha) was obtained from V_2N_1 treatment.

The highest HI of 44.45% was observed in treatment $V_{1.}$ The maximum HI (44.78%) was obtained from $N_{0,}$ $N_{2,}$ and N_3 treatment. The highest HI (44.45%) was obtained from V_1N_2 treatment.

Consider the stated findings, it may be concluded that BARI mung 5 with 20 ppm NAA would be beneficial for the farmers.

However, in this experiment performance of only two BARI released mungbean varieties were observed only at four doses of NAA. So, the response of other varieties to different doses of NAA should be studied in order to make a clear recommendation on the subject.

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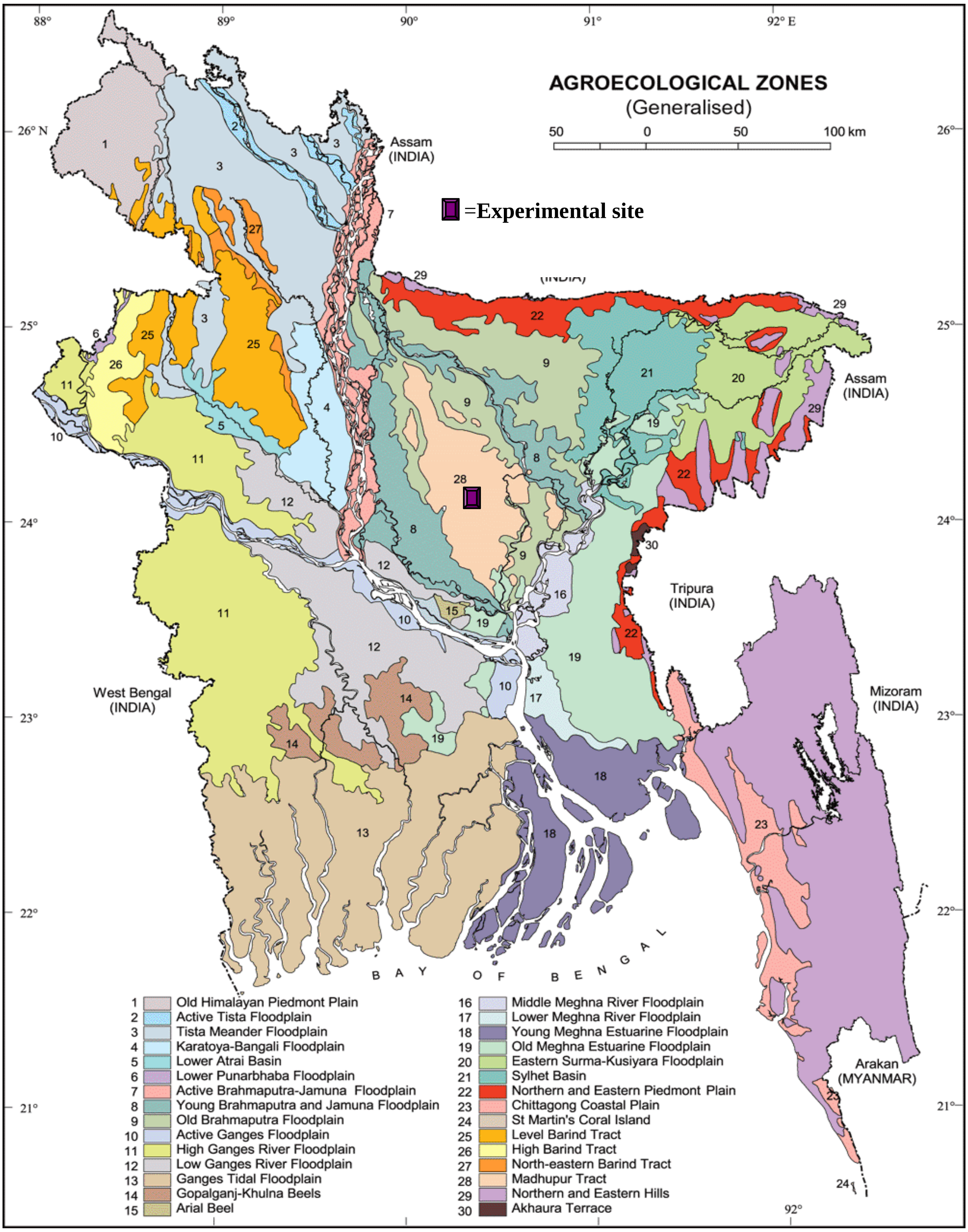
APPENDICES

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



Appendix II. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from June to November 2012

Month	Air temperature (^0C)			RH (%)	Total rainfall (mm)
	Maximum	Minimum	Mean		
June	33.25	25.07	29.18	79.58	310
July	33.00	26.72	29.86	77.00	167
August	34.00	27.05	30.53	78.55	350
September	32.85	26.15	29.50	79.05	165
October	33.20	25.50	29.35	75.5	170
November	30.00	20.90	25.45	69.30	0

Source: Metrological Centre, Agargaon, Dhaka (Climate Division)

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

Constituents	Percent
Sand	26
Silt	45
Clay	29
Textural class	Silty clay

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
Potassium	0.30 µg/g soil

Source: Soil Resources Development Institute (SRDI), Khamarbari, Dhaka

Appendix IV. Analysis of variance of the data on Relative Water contain, Exudation Rate and plant height of mungbean as influenced by variety and NAA

Source	Degrees of freedom	Mean square		
		Relative Water contain	Exudation Rate	Plant Height
Replication	2	390.056	9.211	67.633
Factor A	1	68.131	189.505	1732.8
Factor B	4	283.536*	3.043 ^{NS}	25.969 ^{NS}
AB	4	121.389*	1.846*	36.217*
Error	18	196.715	5.718	33.448

NS-non significant

* = Significant at 5% level of probability

Appendix V. Analysis of variance of the data on yield contributing characters of mungbean as influenced by variety and NAA

Source	Degrees of freedom	Mean square				
		Pod length	Pod per plant	Seeds per pod	Number of seed per plant	1000 seed weight
Replication	2	0.049	0.148	2.257	426.033	12.394
Factor A	1	19.732	72.385	4.033	5824.133	1281.84
Factor B	4	0.12 ^{NS}	0.435*	0.165 ^{NS}	156.417*	13.126 ^{NS}
AB	4	0.18*	0.009*	0.09*	314.55*	10.199*
Error	18	0.186	0.389	0.386	488.033	13.575

NS-non significant

* = Significant at 5% level of probability

Appendix VI. Analysis of variance of the data on yield and harvest index of mungbean as influenced by variety and NAA

Source	Degrees of freedom	Mean square			
		Seed yield	stover yield	Biological yield	Harvest index
Replication	2	0.007	0.013	0.039	0
Factor A	1	0.189	0.654	1.545	13.561
Factor B	4	0.108*	0.178*	0.564*	0.001 ^{NS}
AB	4	0.008*	0.012*	0.039*	0.001
Error	18	0.023	0.038	0.12	0.0001

NS-non significant

* = Significant at 5% level of probability