RESPONSE OF MUNGBEAN (*Vigna radiata* L.) TO PLANT GROWTH REGULATORS

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CERTIFICATE

This is to certify that the thesis entitled, **RESPONSE OF MUNGBEAN (*Vigna radiata* L.) TO PLANT GROWTH REGULATORS** *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 AGRICULTURAL BOTANY,*** *embodies the result of a piece of bona fide research work carried out by Jannatul Fardausy, Registration No.* 11- 04476 *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: May, 2017
Place: Dhaka, Bangladesh

Prof. Dr. Md. Ashabul Hoque
Supervisor

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RESPONSE OF MUNGBEAN (*Vigna radiata* L.) TO PLANT GROWTH REGULATORS

ABSTRACT

A field experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Dhaka-1207, from March 2017 to May 2017. This study was conducted with the objectives to study the response of plant growth regulators on flowering behavior, growth, and yield of Mungbean (*Vigna radiata* L.) viz BARI Mungbean-6. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications of each treatment. The unit plot size was 4 m x 3 m. There were one factors in the experiment comprising nine levels of Gibberellic Acid (GA_3), Indole Acetic Acid and Naphthalene acetic acid (Control, 50ppm IAA, 50ppm GA_3, 50ppm NAA, 100ppm IAA, 100ppm GA_3, 100ppm NAA, 50ppm IAA+ 50ppm GA_3+ 50ppm NAA and 100ppm IAA+100ppm GA_3+ 100ppm NAA designated as T_0, T_1, T_2, T_3, T_4,T_5, T_6, T_7 and T_8). The effect of different doses of foliar spraying (IAA, GA_3 and NAA) and their combined effect showed significant variations in flowering behavior, growth and yield of mungbean. The highest plant height (22 cm at 20DAS, 37.6cm at 40DAS and 48.9 cm at 60DAS), number of leaves per plant, number of branches per plant, inflorescences per plant (10.33), flower per inflorescence (10.77), flowers per plant (43.67), pod per inflorescence (11), pods per plant (24), 1000 seed weight (60 gm), pod length (8.467cm), average dry weight per plant (8.467gm), yield per plant (9.067 gm), yield per plot (1003 gm), yield per hectare (2050 kg) and minimum days required for first flowering (30.67 DAS) were found in T_7 treatment. In case of control minimum plant height, number of leaves per plant, number of branches per plant, inflorescences per plant (2.667), flower per inflorescence (2.33), flower per plant (17), pods per inflorescence (3), pods per plant (9), 100gm seed weight (50g), pod length (7.1 cm), average dry weight per plant (7.5g), yield per plant (6.333 gm), yield per plot (820 g), yield per hectre (700Kg) and maximum days required for first flowering were found. All these parameters were found to be increased with increasing concentration of growth regulators. It was observed that in case BARI Mungbean-6, 100 ppm NAA, IAA, GA_3 concentration there were inferior results than 50 ppm concentration of IAA, GA_3 and NAA.

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LIST OF ACCRONYMS AND ABBREVIATION

ABBREVIATION	ELABORATION
Advan.	Advance
Agri.	Agriculture
Agron.	Agronomy
Amer.	American
Assoc.	Association
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
Bot.	Botany
Ca	Calcium
Cont'd	Continued
cv.	Cultivar
DAT	Days After Transplanting
Dept.	Department
DMRT	Duncan's Multiple Range Test
dSm^{-1}	Deci-siemens per metre
ed.	Edition
et al.	and others
Exp.	Experimental
FAO	Food and Agricultural Organization
Fig.	Figure
FYM	Farm Yard Manure
g	Gram

LIST OF ACCRONYMS AND ABBREVIATION (Cont'd)

ABBREVIATION	ELABORATION
NAA	Napthelic Acid
gm^{-3}	Gram per mitre cube
Hort.	Horticulture
i.e	id est
IU	International Unit
j.	Journal
kg ha^{-1}	Kilograms per hectare
kg	Kilogram
cm	Centimeter
m	Meter
mg kg^{-1}	Milligram per kilogram
mol m^{-3}	Mole per metre cube
M. Sc.	Master of Science
nm	Nanometre
Nucl.	Nuclear
No.	Number
p.	Page
pp.	Particular pages
Prog.	Progressive
q ha^{-1}	Quintal per hectare
RCBD	Randomized Complete Block Design
Res.	Research
Rs	Real shit
SAU	Sher-e-Bangla Agricultural University
Soc.	Society
Sci.	Science

INTRODUCTION

Mung bean (*Vigna radiata* L.) is an important pulse crop in subtropical zones of the world that provides vegetable protein. It is also known as green gram. The mungbean (*Vignaradiata*) is a legume cultivated for its edible seeds and sprouts across Asia. The mung bean is thought to have originated from the Indian subcontinent where it was domesticated as early as 1500 BC. Cultivated mung beans were introduced to southern and eastern Asia, Africa, Austronesia, the Americas and the West Indies. It belonging to the papilionoid subfamily of the Fabaceae and has a diploid chromosome number of 2n=2x=22. The stems are many-branched, sometimes twining at the tips (Mogotsi, 2006). The leaves are alternate, trifoliolate with elliptical to ovate leaflets, 5-18 cm long and 3-15 cm broad. The flowers are papillonaceous, pale yellow or greenish in colour. The pods are long, cylindrical, hairy and pending. They contain 7 to 20 small, ellipsoid or cube-shaped seeds. The seeds are variable in colour: they are usually green, but can also be yellow, olive, brown, purplish brown or black, mottled and/or ridged (Lambrides *et al.*, 2006). . Seed colours and presence or absence of a rough layer are used to distinguish different types of mung bean.

There are 3 subgroups of *Vigna radiata*: one is cultivated (*Vigna radiata* subsp. *radiata*), and two are wild (*Vigna radiata* subsp. *Sub lobata* and *Vigna radiata* sub sp. *glabra*). The mung bean plant is an annual, erect or semi-erect, reaching a height of 0.15-1.25m. It is slightly hairy with a well-developed root system. Cultivated types are generally green or golden and can be shiny or dull depending on the presence of a texture layer (Lambrides *et al*., 2006). Golden gram, which has yellow seeds, low seed yield and pods that shatter at maturity, is often grown for forage or green manure. Green gram has bright green seeds, is more prolific and ripens more uniformly, with a lower tendency for pods to shatter. In India, two other types of mung beans exist, one with black seeds and one with brown seeds (Mogotsi, 2006).

The mung bean is a major edible legume seed in Asia (India, South East-Asia) and is also eaten in Southern Europe and in the Southern USA. The mature seeds provide an invaluable source of digestible protein for humans in places where meat is lacking or

where people are mostly vegetarian. It contains 51% carbohydrate, 24–26% protein, 4% mineral, and 3% vitamins providing protein in the diet, mungbean has the remarkable quality of helping the symbiotic root rhizobia to fix atmospheric nitrogen and hence to enrich soil fertility (Mondal*et al*, 2012).

A growth regulator, plant growth regulator, or PGR, is a natural or synthetic chemical that is sprayed or otherwise applied to a seed or plant in order to alter its characteristics. They are sometimes referred to as plant hormones. Growers can add PGRs to their crops in order to achieve a desirable goal, ranging from increasing insect and disease resistance to increasing root strength. Some PGRs also are used to stunt growth. Growth regulators can be either organic (naturally derived) or synthetic. Organic sources of PGRs includes naturally sourced amendments such as seaweed and liquid kelp. Commercial growers, including nurseries, generally use synthetic growth regulators. Currently, there are five classes of PGRs, including auxins, cytokinins, gibberellins, abscisic acid, and ethylene. Each type of growth regulator has a different effect on plants.

Gibberellic Acid (GA_3) is the most important growth regulator, which breaks seed dormancy, promotes germination, intermodal length, hypocotyls growth and cell division in cambial zone and increases the size of leaves. The chemical formula of Gibberellic acid is $C_{19}H_{22}O_6$, white to pale yellow solid, molar mass 346.37gm/mol, melting point 233 to 235^0C and solubility in water is 5 mg/l at 20^0C. GA_3 stimulates hydrolytic enzymes that are needed for the degradation of the cells surrounding the radicle and thus speeds germination by promoting seedling elongation growth of cereal seeds (Rood *et al*., 1990). Gibberellins (GAs) belong to a wide group at plant hormones and natural components called terpenoids, with huge application which GA_3 is the most popular (Hartmann *et al* 1999). Gibberellins increases growth at most plant species especially rosette plants (Arteca 1995).

IAA (indol-3-acetic acid), a naturally synthesized growth hormone, plays a very important role to enhance crop growth and development, which could increase the availability of food to the growing plant when required. With increasing plant density,

competition between plants increases which could result lower food production of individual plant that could hamper nodule production. Artificial applied auxin could increase root and shoot growth which could help to harvest more light, water, nutrients etc. to produce more food by individual plant. Therefore, artificially applied auxin might have a positive effect on nodulation process and increasing yield quality under different plant density. B.Ali and S.Hayat (2007) reported that IAA and 4-Cl-IAA Increases the Growth and Nitrogen Fixation in Mung Bean.

NAA is a synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rooting horticultural products; it is a rooting agent and used for the vegetative propagation of plants from stem and leaf cutting. It is also used for plant tissue culture. The spray application of NAA at variable concentration significantly increased the fruit yield of tomato, when compared to control. The nutrient contents were also increased in majority of cases. The present report describes the effect of naphthalene acetic acid as a growth regulator in reducing pre-harvest fruit drop and resulting in increased number of fruits and yield in tomato crop.

Keeping these thesis, the present study was undertaken with the following objectives:

- To investigate the effect of growth regulators on flowering behaviour, growth and yield of mungbean.
- To find out the effect of concentration of plant growth regulators over flowering behaviour, growth and yield of mungbean.
- To find out the suitable composition and concentration of plant growth regulators concentration for higher yield of mungbean.

REVIEW OF LITERATURE

Mungbean is one of the most important pulse crop in Bangladesh and received much attention to the researcher throughout the world. Plant Growth Regulators have different impact on the flowering behavior, growth and yield of Mungbean. GA_3, IAA and NAA among plant growth regulators show significant response to flowering behavior, growth and yield of mungbean. Research works have been done in various parts of the world more or less adequate, also in Bangladesh. Some of the important and informative works conducted home and abroad in this aspect, have been reviewed in this chapter.

2.1. Effect of GA_3 on flowering behavior, growth, and yield of mungbean

Archbold (1986) presented that Honeoye species treated with 100 ppm GA_3 in 1986, fruit average weight decreased and in 1987 it increased per plant yield, fruits and runner.

Bishnoi and krishnamoorty (1990) studied on the effect of water logging and gibberellic acid on nodulation and nitrogen fixation on peanut. In greenhouse experiments, groundnuts cv. MH-2 seedlings were subjected to 0, 7 and 14 d waterlogging and treatment with water, or 10 or 100 mg gibberellic acid(GA)/litre after the stress period at vegetative, flowering and pod filling stages (35, 50 and 80 d after sowing, resp.). Waterlogging decreased the number, FW, DW, leghaemoglobin content and nitrogenase activity of nodules regardless of growth stage. The effect of waterlogging at pod filling was more deleterious than at other growth stages. 10 mg GA/litre significantly increased the number, FW, DW and nitrogenase activity of the nodules and alleviated some of the effects of waterlogging.

Abdel *et al.* (2011) studied on response of mungbean (Vignaradiata L., Wilczek) to gibberellic acid (GA_3) rates and varying irrigation frequencies. They investigate the response of mungbean local cultivar to irrigation frequencies and for improving its drought resistance capability by the application of 0, 100 and 200mg/l GA_3. Results showed that irrigating mungbean plants every 8 days drastically reduced plant height

(46.8%), internodes length (32.1%), number leaves per plant (64.3%), leaf area per plant 9158.5%), leaf area index (179.3%), inflorescence number per plant (119%) pod length (22.6%), pod number per plant (117%), seed number per pod (23.8), biomass yield (74.6%), yield (91.3%) and seed yield per plant (83.7%). However, this treatment highly increased number first fruiting node (180.1%) and weight of 1000 seeds (11.5%).

Choma and himelrick (1983) showed between 2 short day and long day species with application at (0, 50 and 100 ppm) GA_3, 50 ppm GA_3 increased runner and leave produced, and (50 and 100 ppm) GA_3 increased the yield.

Tsai and Arteca (1985) studied on effects of root applications of gibberellic acid on photosynthesis and growth in C_3 and C_4 plants. Relative growth rates (RGR) of barley, oat, squash, pepper, corn, sorghum, millet, pigweed and kocliia were increased above the control by 12.7%, 9.9%, 11.3%, 10.7%, 19.2% 10.1%, 11.5%, 16.4% and 32.7% respectively, four days following optimum GA_3 treatments. There was no effect of GA_3 on RGR in wheat, mung bean, and gomphrena. Gibberellic acid decreased the chlorophyll content expressed on an area basis by 20.0%, 13.9%, 20.9%, 17.1%, 11.9% and 28.0% in barley, squash, pepper, sorghum, pigweed and kochia, respectively.

Eshghi*et al*. (2012) reported (50,100) application of GA_3 did not increase fruit weight and production, but 100 ppm GA3 decreased inflorescence and increased runner in Merak species.

El-Shabasi*et al*. (2008) presented 100 ppm GA_3 increased flower production. Sharma and Singh (2009) showed 75 ppm GA_3 in Chandler variety affected growth pattern and decreased the fruit weight.

Iqbal*et al.* (2001) found the response of Chickpea (Cicerarietinum L.) growth towards the foliar application of Gibberellic Acid at different growth stages. The experiment

was designed to study the effect of foliar application of GA_3on chickpea growth. Fresh and dry weights of shoot increased by the application of GA_3accompanied by increased plant height. Number of branches decreased with GA_3 treatments. Application of G_3at vegetative stage showed more reduction than at flower initiation stage. Length and fresh weight of root remained unaffected, while dry weight of root increased with G_3 treatment.

Milanesi*et al.* (2008) studied the rate and time of GA_3 application and irrigation on plant morphology and yield of Lentil. here is little known about how, or whether, GA_3 affects development of lentils (*Lens culinaris*). In the field, lentil was treated at two times with four concentrations of GA_3 and with or without irrigation. Concentration of GA_3 affected plant height, numbers of branches and pods, 100 seed weight, and yield. The 10 mgL^{-1} concentration of GA_3 resulted in increased yield and increased percentage of pods with two seeds. The 50 mgL^{-1} concentration of GA_3 produced more branches. Application of GA_3 at flowering increased yield by 60%. Irrigation produced the greatest number of pods and the highest yield. Lentil production can be increased by applying concentrations of GA_3 between 10 and 50 mgL^{-1} at flowering.

Luangprasert (1994) applied (0,100,150,200) ppm GA_3 for one a week during 4 leave stage in Tioga species, showed in all treatments runner production increased with no effects on leave and branch crown production. Also with high amount at GA_3 application, fruit production decreased.

Hoque and Haque (2002) experimented on effects of Gibberellic Acid on physiological contributing characters of mungbean. Two varieties of mungbean (*Vignaradiata*L.) were investigated for effects of seed treatment and foliar application of GA_3 at 0, 50, 100 and 200 ppm on the growth, yield and yield contributing characters. Seed treatment with GA_3 at 50 ppm increased plant height, number of leaves, fresh and dry weight of pod, number of seeds, 1000-seed weight, harvest index, while 200 ppm increased number of pods and 100 ppm increased pod length, seed weight per plant, seed yield (kg ha^{-1}). Foliar application of GA_3 at 200 ppm had

higher plant height and number of leaf, while that at 100 ppm had greater number of pods, higher fresh and dry weight of pod, number of seeds, harvest index whereas 50 ppm of GA_3 resulted higher pod length, 1000-seed weight, seed yield per plant, seed yield (kg ha^{-1}).

Pagire (2013) studied on effect of p;ant growth regulators on growth ,seed yield and seed quality of pea variety. She found that that the seed yield of pea can be increased by the application of plant growth regulators. The combination of GA_3 (200 ppm) + CCC (250 ppm) and GA_3 singly at 200 ppm gave significantly higher yield over control. This increase in yield was mainly because of the increase in number and weight of pods, number of seeds per pod and weight of seeds per plant in pea. For obtaining higher seed yield and better quality of pea, the application of GA_3 200 ppm (seed soaking for 12 hours) + CCC 250 ppm (spray 15 days after sowing) was found beneficial for improving the above characters in pea.

Keykha*et al.*(2014) studied on effect of salicylic acid and gibberellic acid on some characteristics in mungbean (*Vignaradiata*). The experiment was conducted at the goharkuhkhash (In Iran) which is situated between 23° North latitude and 60° East longitude and at an altitude of 1329 m above mean Sea Level. The field experiment was laid out in randomized complete block design with factorial design with three replications. Analysis of variance showed that the effect of Salicylic acid and gibberellic acid on all characteristics was significant.

Bishnoi and krishnamoorthy (1991) studied on effect of waterlogging and gibberellic acid on growth and yield of chickpea. Chickpea plants were subjected to waterlogging for a period of S and 10 days during the vegetative, flowering and DOd-filling stages. After release of stress, plants were sprayed with 10 and 100 mgL^{-1} of gibberellic acid (GA_3). Waterlogging decreased the dry weight of leaf, stem and root at all the stages. GA. at 100 mgL^{-1}alleviated the effect of 5 days of waterlogging on dry weight of leaf and stem given at vegetative stage.

Paroussi*et al*. (2002) reported (0, 50,200 ppm) GA_3 increased bud flower in 3 variety of strawberry (Seascape, Laguna, Camarosa) especially in Seascape species.

Perez de Camacaro*et al*. (2008) by applying gibberellic acid due to promoting blooming and growth, showed that 20 ppm GA_3 treatment had the highest effect on leave, runner, crown, inflorescence and flower production.

Chudasamaand Thaker (2007) showed relationship between gibberellic acid and growth parameters in developing seed and pod of pigeon pea. The found changes in endogenous gibberellic acid (GA) levels were determined in developing seeds and pods of pigeon pea (*Cajanuscajan*). Antibodies against GA_3 were raised in rabbits and indirect ELISA developed to estimate GA level. Two varieties, black seeded variety (V_1) and B.D.N_2 (V_2), were selected on the basis of their seed index value. The pod length and number of seeds per pod were significantly different for the two varieties.

Utkarshae *et al.*(2011) showed the performance of chick pea under the influence of gibberellic acid and oxygenated peptone during germination. The experiments were carried out at the Post Graduate Research Center, to study the influence of Gibberellic Acid (50 ppm) and Oxygenated Peptone (1% aqueous solution) on chick pea (Cicerarietinum L. cv. Vijay) during germination by giving pre-sowing soaking treatment for 6 hours using petriplate method. Both the treatments enhanced the germination process. GA treatment was useful to increase shoot length, mobilization efficiency, emergence index, speed of germination and co-efficient of germination while oxygenated peptone showed an upper hand in root length, shoot/root ratio, biomass and vigour index. GA led to comparatively more synthesis of nucleic acids while oxygenated peptone showed more increase in total carbohydrates and soluble protein content.

2.2Effect of IAA on flowering behavior, growth, and yield of Mungbean

Ali*et al*. (2008) found that IAA and 4-Cl-IAA Increases the Growth and Nitrogen Fixation in Mung Bean. The seedlings at 7 and/or 14 days were percolated with 0, 10^{-10}, 10^{-8}, or 10^{-6} M of IAA or 4-Cl-IAA. The plants were sampled at 30 days after sowing (DAS) to assess the growth and various biochemical characteristics. The effect of the auxins lasted up to the harvest where the seed yield, 100 seed mass, and number of pods per plant were significantly affected by the auxins. At a moderate concentration (10^{-8} M), 4-Cl-IAA generated the best response. However, a comparable response was generated by the higher concentration (10^{-6} M) of 4-Cl-IAA. The application of the hormone twice (at 7 and 14 DAS) was much more effective than single application (at 7 or 14 DAS). It was concluded that IAA and 4-Cl-IAA improved the growth and nitrogen fixation in mungbean. The 4-Cl-IAA proved more effective than IAA.

Bai*et al.* (1987) applied eight foliar sprays of 25 mgL^{-1} NAA at 7 days intervals to Vignarediata and reported a significant increase in seed yield and yield components. The number of pods per plant was increased by spraying 40 mgL^{-1} NAA on groundnut once at either 45 days after sowing (DAS) and twice at 45 and 55 DAS.

El-Saeid*et al.* (2010) showed the response of cowpea plant to IAA. The foliage of the plants were sprayed twice at 70 and 80 days from sowing with Indole-3-acetic acid (IAA) solutions of (25, 50 and 100 mg/L) and the control plants were sprayed with distilled water. IAA treatments at the rate of 25 and 50 mg/L increased number of leaves, shoot dry weight, number of produced flowers per plant, number and weight of pods and seeds per plant. Meanwhile 50 and 100 mg IAA significantly decreased the number of flowers abscised from cowpea plant.

Fässler*et al.* (2010) investigate the effects of indole-3-acetic acid (IAA) on sunflower growth and heavy metal uptake in combination with ethylene diaminedisuccinic acid (EDDS). The hypotheses of this study were that the growth-promoting

phytohormoneauxin (indole-3-acetic acid, IAA) can alleviate toxic effects of metals on plants and increase metal phytoextraction in combination with the biodegradable chelating agent ethylene diaminedisuccinic acid (EDDS). To test these hypotheses we performed two sets of experiments with sunflowers (*Helianthus annuus* L.) in hydroponic solution. Root and shoot growth of metal-stressed plants were most effectively increased with 1010 M IAA, and also the extraction of both metals was significantly increased at this treatment level.

Newaj*et al.*(2002) studied on effect of Indoleacetic Acid (IAA) on Yield of Mungbean (Vignaradiata L.). The effect of foliar application with 300, 600 and 900 ppm IAA was investigated on yield and yield contributing characters of two varieties of mungbean (BARI 2 and BARI 4). IAA at 600 ppm significantly increased the number of seeds/plant, seed yield per plant, seed yield ($tonha^{-1}$) and 1000-seeds weight. The variety BARI 4 manifested better performance than BARI 2. BARI 4 plants treated with 600 ppm of IAA had the highest pod length, number of seeds, seed yield/plant and seed yield . So, the plants treated with IAA at 600 ppm performed better than those of control and other treatments.

Merlo *et at.* (1987) also reported that NAA application on soybean at flowering increased number of branches per plant and average pod weight but latter application increased plant dry matter.

Sinsiri and Laohasiriwong (2007)investigate the effect of different rates of indole-3-acitic acid (IAA) growth regulator in inducing root formation of detached leaves of cowpea cultivars under tunnel conditions. IAA levels used were 0, 250, 500, 750, 1,000, 1,500 and 2,000 mg L^{-1} of distilled water, thus the experiment consisted of 21 treatments. The results showed that root length, number of both roots and root hairs were highly affected by IAA treatments and the best IAA level was found with level 3 (500 mg L^{-1}). The effects due to IAA levels and cultivars were highly significant and the effects due to an interaction between factors A (cultivars) and B (IAA levels), in most cases, were highly significant.

Barazani and Friedman (1999) described on IAA the major root growth factor secreted from plant-growth-mediating bacteria. In this case high levels of IAA (76.6μM) were were excreted by four deleterious rhizobacteria (DRB) during 84hr of incubation. High concentrations of IAA released by deleterious rhizobacteri accounted for the suppression of root growth. Other unidentified fractions in the eluates of DRB also inhibited root elongation, but to a lesser extent. Like DRB, four isolates of PGPR (*Agrobacterium* sp., *Alcaligenespiechaudii*, and two different strains of *Comamonasacidovorans*) secreted IAA, but at lower levels (16.4 μM during a similar period of incubation). PGPR secreted growth promoting substances other than IAA, and these are now being investigated.

Hayat*et al.* (2009) investigated the impact of three auxins indole-3-acetic acid (IAA), 4-chloroindole-3-acetic acid (4-Cl-IAA), and indole-3-butyric acid (IBA) on nitrogen metabolism in chickpea (*Cicerarietinum* L.). Plants were raised from seeds soaked in water (control), 10^{-8} M of IAA, IBA, or 4-Cl-IAA, for 12 hours and were assessed for different parameters at 60 days after sowing. Observations showed that auxins, irrespective of the analogue significantly increased the nodulation, leghemoglobin content, nodule nitrogen content and the enzymes of nitrogen assimilation. Of the three auxins, 4-Cl-IAA was the most effective in increasing these parameters. The increase in seed yield was 27% higher than the water soaked control.

Ravichanadran and Ramaswami (1991) studied the source-sink relationship in soybean as influenced by TIBA. They found that pre-flowering application of TIBA (50 ppm) decreased LAI but increased the dry matter production, CGR and NAR. While, Bhagel and Yadav (1992) observed that NAA was superior to GA3 and IAA in enhancing LAI, NAR, CGR at all stages except CGR at pod filling stage in black gram.

Senthil*et al.* (2005) conducted experiment to study the effect of growth regulators on IAA oxidase, peroxidase and NRAse activities in groundnut under different salinity

levels and indicated that seed treatment with GA_3 and IAA solutions reduced the activity of IAA oxidase and increased the activity of NRAse enzyme. Similarly, Reddy *et al.*(2009) showed that nitrate reductase activity increased upto 60 DAS and then decreased.

Khudhur and Omer (2015) studied on effect of NAA and IAA on Stem Cuttings of DalbergiaSissoo (Roxb). In this research, the treatments were prepared to include hormone of Naphthalene acetic acid in four levels of: (0, 100, 300 and 500 ppm) and Indole acetic acid in four levels of: (0, 100, 300 and 500 ppm), and the bottom part of the cutting was dipped into above solutions for 30 seconds. The results showed that the maximum percentage of the shooted cuttings, shoot length, number of main branch, diameter of main branch, leaf area, number & length of root, dry weight & biomass &dry matter of shoot, fresh &dry weight of root, biomass &dry matter of root and chlorophyll a belonged to IAA treatment with concentration of 500 ppm, NAA treatment with concentration of 500 ppm.

Tagade*et al.* (1998) studied the influence of PGRs by soaking seeds of soybean in 25-150 ppm IAA and kinetin before sowing and noticed that leaf chlorophyll and nitrogen contents, seed yield and seed protein and oil contents increased with IAA concentration upto 100 ppm then decreased with increasing concentrations. While, Bora and Sarma (2006) showed that chlorophyll content decreased at higher GA3 concentration while it was increased by CCC.

Upadhyay*et al.* (1993) sprayed 0, 10, 20, or 30 ppm NAA at bud initiation and pod formation stages of chickpea (*Cicerarietinum L.*). The highest seed yield of 2.35 t ha -1 resulted from treatment with 20 ppm NAA. Application of NAA at 50 % flowering increased plant height and dry weight that reduced the flower drop percentage and led to increase seed yield.

Zaidi and Singh (1995) conducted an experiment where soybean seeds were soaked for 4 hours in distilled water or 100 or 200 ppm GA_3/ IAA. They were then sown in

pots and exposed to salinities of 0.8, 10 or 20 dS/m. The detrimental effects of salinity on dry matter production and distribution were eliminated by pre soaking in GA_3 or IAA.

2.3 Effect of NAA on flowering behavior, growth, and yield of Mungbean

Aslam*et al.* (2010) studied to find out the effect of NAA and available soil moisture depletions on yield and yield components of chickpea. They found that Chickpea yield and yield components were significantly affected by NAA and ASMDL. Plant growth regulator (Naphthalene acetic acid 4.5% a.i.) applied at 200 ml per hectare in three split doses at 45, 90 and 135 days after sowing (DAS) increased number of pods per plant, seeds per pod, 100 seed weight, biological yield and seed yield by 12.50, 6.98, 9.59, 2.61 and 13.98 %, respectively over control. ASMDL3 (80 % Available soil moisture depletion level) gave the maximum average yield value of 2929.56 kg ha -1 while water use efficiency of 21.56 kg ha -1 mm -1 was recorded in ASMDL4 (90 % Available soil moisture depletion level).

Sharief and El-hamedy (2017) showed the influence of growth regulators on Shedding of Broad Bean, Growth, Yield and Seed Quality. They found that accumulative NAA levels of to 60 ppm significantly increased total chlorophyll, plant height (cm),branches number/plant, number of shedding flowers, shedding %, pods and seeds number/plant, seeds number/pod, seed yield/plant, 1000 seed weight (g), seed yield (ton/ha) and protein % in both seasons. Naphthalene Acetic Acid foliar spraying up to 60 ppm exceeded of total chlorophyll, plant height (cm), branches number/plant, number of shedding flowers, pods number/plant, seeds number/pod, seeds number/plant, seed yield (g) /plant, 100-seed weight (g), seed yield (ton/ha) and protein % by 11.47, 23.92, 92.88, 20.53, 11.87, 23.48, 14.16, 24.91, 26.15 and 13.23%, respectively as the average of both seasons. .It could be recommended that foliar spraying of Naphthalene Acetic Acid up to 60 ppm and Kin of 45 ppm improved seed yield/ha by 38.2% compared without foliar application.

Adam G. and Jahan (2011) studied NAA on yield attributes ad yield of two varities of rice. The highest plant height was observed due to 200 ppm in both BRRI dhan-29 (V1) and BRRI dhan-50 (V_2). Number of tillers per plant were found to increase due to 100 ppm NAA only in BRRI dhan-29 and varied non-significantly. Yield attributes, viz. number of branches per panicle, number of grains per panicle and filled grains per panicle increased in BRRI dhan-29, following both 100 and 200 ppm NAA, whereas, most of the yield parameters decreased in BRRI dhan-50. Due to 100 and 200 ppm NAA, grain yield per plant increased by 27.67 and 6.85%, respectively in BRRI dhan-29 though not statistically significant. However, in BRRI dhan-50 grain yield per plant decreased by 26.54% due to 100 ppm and 27.67% due to 200 ppm. Out of the two concentrations 100 ppm NAA produced better stimulation.

Bruce (1990) observed that determinate soybean when treated with GA_3 and ethephon, GA_3 treatment mainly produced positive effects on number of pods per plant whereas ethephon decreased seed yield and 100 seed weight. Sharma et al. (1990) reported that in a soybean field trial cv. Bragg when sprayed with water (control), Paras, NAA, Biozyme and Atonik gave seed yield of 434, 477, 463, 492 and 477 grams, respectively. There were no differences in 100-seed weight.

Castro and Moraes (1981) sprayed soybean cultivar Davis with CCC (2000 ppm), 4000 ppm (Daminozide), GA (100 ppm) and NAA (100 ppm) or water and found that maximum pod weight, seed number and yield with GA. Basuchoudhari et al. (1986) gave different treatments 15 days before flowering of crop viz., defoliation (removal of 50 per cent alternate leaves) decapitation by spray of 500 and 1000 ppm GA and 200 and 400 ppm CCC. He reported that decapitation and CCC (400 ppm) significantly increased seed yield in soybean.

Deotale and Sorte (1996) found that among various concentrations of TIBA and B-9 (50,100,150,200 and 250 ppm), TIBA (100 ppm) showed stimulatory effect on CGR, NAR and leaf nitrogen content which ultimately increased the grain yield in soybean. While, Maske et al. (1998) found that GA3 was relatively more effective than NAA in

increasing CGR at 30-45 and 45-60 DAS and accelerating the yield contributing factors in soybean.

Ela Patel and Saxena (1995) studied the influence of PGRs like GA, kinetin, NAA, ethrel, IAA and ABA and found that kinetin and ethrel were most effective in increasing the protein, starch and amino acid contents of the developing seeds in mungbean. While, presoaking treatment of 500 µg/ml of CCC recorded highest protein content in pea seeds (Bora and Sarma, 2006).

Emongor (2007) observed that GA_3 applied cowpea plants had significantly higher dry matter content in whole plant, shoot and root than control plants. The response of cowpea cv. Blacke to increasing GA_3 concentration was quadratic with respect to dry matter accumulation. Similarly, Ibrahim *et al.* (2007) revealed that GA_3 (100 ppm) application led to increase in plant height, average number of leaves, leaf area per plant and dry weight of shoot in Viciafaba. Kalyankar*et al.* (2008) showed that foliar spray of GA_3 (150 ppm) increased number of leaves and leaf area. NAA (100ppm) was effective in increasing total dry weight.

FaranDurrani*et al.* (2006) showed the stimulatory effect of NAA and BAP on flowers, seeds, chlorophyll and protein-content in spinach. The study was based on to apply the growth regulators (NAA and BAP) in preflowering and flowering stages to estimate their effects on seed formation, seed setting, chlorophyll and protein contents in spinach (Spinaciaoleracea L.). Highly significant value was concluded for number of bolts per plant through NAA at 10^{-3}M concentration. Non-significant result was obtained in case of treatment for seed yield although maximum seed yield was recorded with concentraion of BAP (10^{-3}M) and NAA (10^{-4}M). At the same time, seed weight was noted as significantly increased; whereas maximum seed weight was achieved for NAA 10^{-5}M. The present research work indicated that chlorophyll content was not affected by the application of BAP and NAA at different combinations and concentrations. For protein analysis the treatments in which NAA

and BAP were applied in combination showed maximum variability in seed protein electrophoratic banding profile.

Pagire And John (2016) studied on effect of different levels of naphthalene acetic acid (naa) and salicylic acid (sa) on growth, yield and biochemical aspects of green gram (al aspects of green gram (*Vignaradiata).* The study was conducted at Department of Biological Sciences, SHIATS, Allahabad (U.P.). A field experiment was conducted to study the effect of naphthalene acetic acid (25,50 ppm), salicylic acid (20, 40 ppm) and naphthalene acetic acid + salicylic acid (25+20, 25+40, 50+20, 50+40 ppm) on growth, yield and biochemical aspects of green gram (*Vignaradiata* L. Wilczek). Altogether, 9 treatments were given as foliar spray including control. The PGR were applied at 15, 30, 45 DAS. The experiment was laid out in CRD with 3 replications. The combination treatment T6, T7 and T8 shows the significantly increased in growth, yield and biochemical aspects of green gram as compared to individual treatment. Naphthalene acetic acid 50 + salicylic acid at 20 ppm were most effective indicating optimum doses respectively and SA was found to be superior than NAA for influencing metabolite contents.

Jadhav (2000) stated that the application of increasing concentrations of GA_3 and NAA increase the morphological and physiological parameters like CGR, RGR, NAR and LAR in soybean which inturn led to the increased yield and yield attributes. Similarly, Sarkar*et al.* (2002) showed that double spraying of GA_3 and IAA (100 ppm) at 20 and 42 days after sowing increased LAI, CGR and NAR in soybean (cv.BS-3). The foliar spray of GA_3 (100 ppm) at 30 DAS had the most regulatory effect to enhance root, stem, leaf and total dry matter, LAI, CGR, RGR and NAR in soybean (cv. PB-1) (Rahman*et al.*, 2004).

Kim and Kim (1993) sprayed soybean cv. Bog-way-kong and Jangyeong with ABA (50 ppm), BA (100 ppm), Ethrel (1000 ppm), NAA (20 ppm) and TIBA (100 ppm) at growth stage R1 and found that seed yield was significantly increased.

Kothule*et al.* (2003) reported that plant growth substances of different concentrations i.e. GA, NAA, CCC and salicylic acid each @ 100 and 200 ppm and urea @ 1 and 2% when applied exogenously as foliar spray improved morphological characters viz. plant height, number of branches, leaf area, total dry matter of plant and reduced the number of days to 50 per cent flowering in soybean. GA @ 200 ppm was found most effective in increasing plant height. While, Cato *et al*. (2006) revealed that TIBA (30, 40 or 50 gm/l) application at V_5phenological stage in soybean (cv. Pintado) was effective in reducing plant height without affecting parameters related to productivity.

Koti (1997) observed significant variations in chlorophyll content in determinate and indeterminate cultivars of soybean. While, Dhopte and Suradkar (1998) conducted a field experiment to study the effect of hormones (GA and NAA 20 ppm each) in soybean and found that the dry matter production, chlorophyll and root nodule numbers remained unaffected. Among hormones, NAA was more effective than GA.

Qing-hu and Cheng (1987) studied on effects of Naphthalene Acetic Acid, Kinetin and Wound on the Callus Formation with Relation to the Biosyntheses of Tryptophan and Indole Acetic Acid in the Cotyledon of Mung Bean. The results indicate that wound plays an important role in the callus formation. The size of wounded surface is directly proportional to the proliferation of the callus tissue. The levels of free Trp and endogenous 1AA decreased in the initial period of the callus formation of mung bean cotyledon but increased in the later period.

Nawalgatti*et al.* (1991) reported that there was increase in the LAI, DM production, NAR and CGR in groundnut cv. DH-3-30 with the foliar application of 500 or 1000 ppm cytozyme, CCC, Vipul or Paras, 50-60 ppm TIBA or 10 ppm NAA at 45 days after sowing. CCC was most effective followed by cytozyme and NAA (20 ppm).

Castro andAppezzato-da-Glória (1997) studied on Effects of growth regulators on groundnut development*(Arachishypogaea* L.). This research deals with the effects of plant growth regulators on groundnut growth *(Arachishypogaea* L. cv. Tatu-53).

Plants of groundnut with four leaves grown in pots under greenhouse conditions, were sprayed with chlormequat 2000 ppm, daminozide 4000 ppm, gibberellic acid 100 ppm, indolylacetic acid 100 ppm, mid check treatment. Daminozide 4000 ppm reduced plant height, internode number and the length of the fourth internode. Daminozide increased the number of leaves, retarded flowering, increased the number of flowers and presented a tendency to increase the dry weight of stems. Chlormequat 2000 ppm and indolylacetic acid 100 ppm reduced plant height and the lenght of the fourth internode of the groundnut plant stem.

Ravikumar and Kulkarni (1988) reported that foliar application of NAA (20 ppm), CCC (100 ppm) or TIBA (40 ppm) to 3 soybean cultivars at 50 per cent flowering had no effect on seed protein and oil contents compared with control. Similarly, Uppar and Kulkarni (1989) reported that application of TIBA (250 ppm), kinetin (15 ppm) and cycocel (2500 ppm) increased protein and oil contents in sunflower. While, Mishrinky et al. (1990) studied the effects of GA_3 and CCC on peas and observed that GA_3 tended to increase protein content of green pods.

Resmi and Gopalkrishnan (2004) reported that NAA (15, 30 or 45 ppm), 2, 4-D (2 ppm) and CCC (300, 400 or 500 ppm) increased seed yield, pod length, pod weight, pod number per plant and pod number per unit area of cowpea plants.

Salunkhe*et al.* (2008) studied the influence of plant growth regulators viz., TIBA (100 ppm), NAA (50 ppm), GA3 (50 ppm), CCC (500 ppm), CCC (1000 ppm) on soybean cultivars (JS-335 and PhuleKalyani). Among the PGR treatments NAA (50 ppm) was found to be the best. The variety JS 335 recorded higher grain yield (q ha-1) than PhuleKalyani and was found to be promising in major yield contributing characters and morphological traits.

Vishnu Vandana (1992) studied on NAA,GAA and THIA on growth, flowering, pod setting and yield of blackgram . A field experiment was·conducted at Students Farm, College of Agriculture, Rajendranagar during. Rabi season 1990-91 to study the effect

of naphthaleneacetic acid (NAA), gibberellic acid (GA) and triacontanol (TRIA) on growth, flowering, pod setting and yield of blackgram (*Vignamunge* L.) cv. LBG-20. Three concentrations of each of NAA (10, 20, 40 ppm), GA (10, 20, 40 ppm), TRIA (0.5, 1, 2 ppm), water spray and control were tested in a randomized block design. NAA, GA and TRIA increased vegetative growth viz., plant height, leaf number, leaf area, LAI and total plant ;phytomass. Among the treatments GA and NAA at 40 ppm and TRIA at 2 ppm recorded maximum value.

MATERIALS AND METHODS

The details of the materials and methods of this research work were described in this chapter. It consists of a short description of experimental site, climate and weather, experimental design, layout, materials used for experiment, sowing, treatments, land preparation, manuring and fertilizing, intercultural operations, harvesting, collection of data and statistical analysis which are given below:

3.1. Experimental site

The experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, and Dhaka 1207. The location of the site was $23^0 74^/$ N latitude and $90^0 35^/$ E longitude with an elevation of 8.2 meter from sea level (AppendixI).

3.2. Experimental period

The experiment was carried out from March 2017 to May 2017.

3.3. Soil type

The experimental site was situated in the subtropical zone. The soil of the experimental site lies in agro-ecological regions of "Madhupur Tract" (AEZ No. 28). Its top soil is clay loam in texture and olive grey with common fine to medium distinct dark yellowish brown mottles. The pH 4.47 to 5.63 and organic carbon contents is 0.8.

3.4 Weather

The monthly mean of daily maximum, minimum and average temperature, relative humidity, monthly total rainfall and sunshine hours received at the experimental site during the period of the study have been collected from Bangladesh Meteorological Department, Agargaon, Dhaka 1207.

3.5 Materials used for experiment

BARI Mung-6 was used as planting material. The seeds of BARI Mung-6 was collected from Bangladesh Agricultural Research Institute, Joydepur, Gazipur. This variety is suitable for summer season. The plant height of the variety ranges

from 60-70 cm. It is resistant to *Cercospora* leaf spot and yellow mosaic diseases. Its life cycle ranges from 60-65 days after sowing (DAS) and average yield is 1400-1600 kg ha^{-1}.

3.6 Treatments

There is single factor in this experiment with three replication. This factor is treatment. Nine levels of treatment as Gibberellic acid in the form of GA_3, IAA and NAA individually and combined. The factors were as follows:

Factor A: Levels of GA_3, IAA and NAA
T_0: Control
T_1: 50 ppm IAA
T_2: 50 ppm GA_3
T_3: 50 ppm NAA
T_4: 100 ppm IAA
T_5: 100 ppm GA_3
T_6: 100 ppm NAA
T_7: 50 ppm IAA +50 ppm GA_3+50 ppm NAA
T_8: 100 ppm IAA+100ppm GA_3+100 ppm NAA

There were all together nine treatments with three replication in nine plotin each block were as follows: R_1T_0, R_1T_1, R_1T_2, R_1T_3, R_1T_4, R_1T_5, R_1T_6, R_1T_7, R_1T_8, R_2T_0, R_2T_1, R_2T_2, R_2T_3, R_2T_4, R_2T_5, R_2T_6, R_2T_7, R_2T_8, R_3T_0, R_3T_1, R_3T_2, R_3T_3, R_3T_4, R_3T_5, R_3T_6, R_3T_7, R_3T_8.

3.7. Experimental design and layout

Field layout was done after final land preparation. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The whole plot was divided into three blocks each containing eighteen (9) plots of 4m x 3 m size, giving 27 unit plots. The space was kept 1.0 m between the blocks and 0.5 m between the plots were kept. The layout of the experiment is shown in Figure 1.

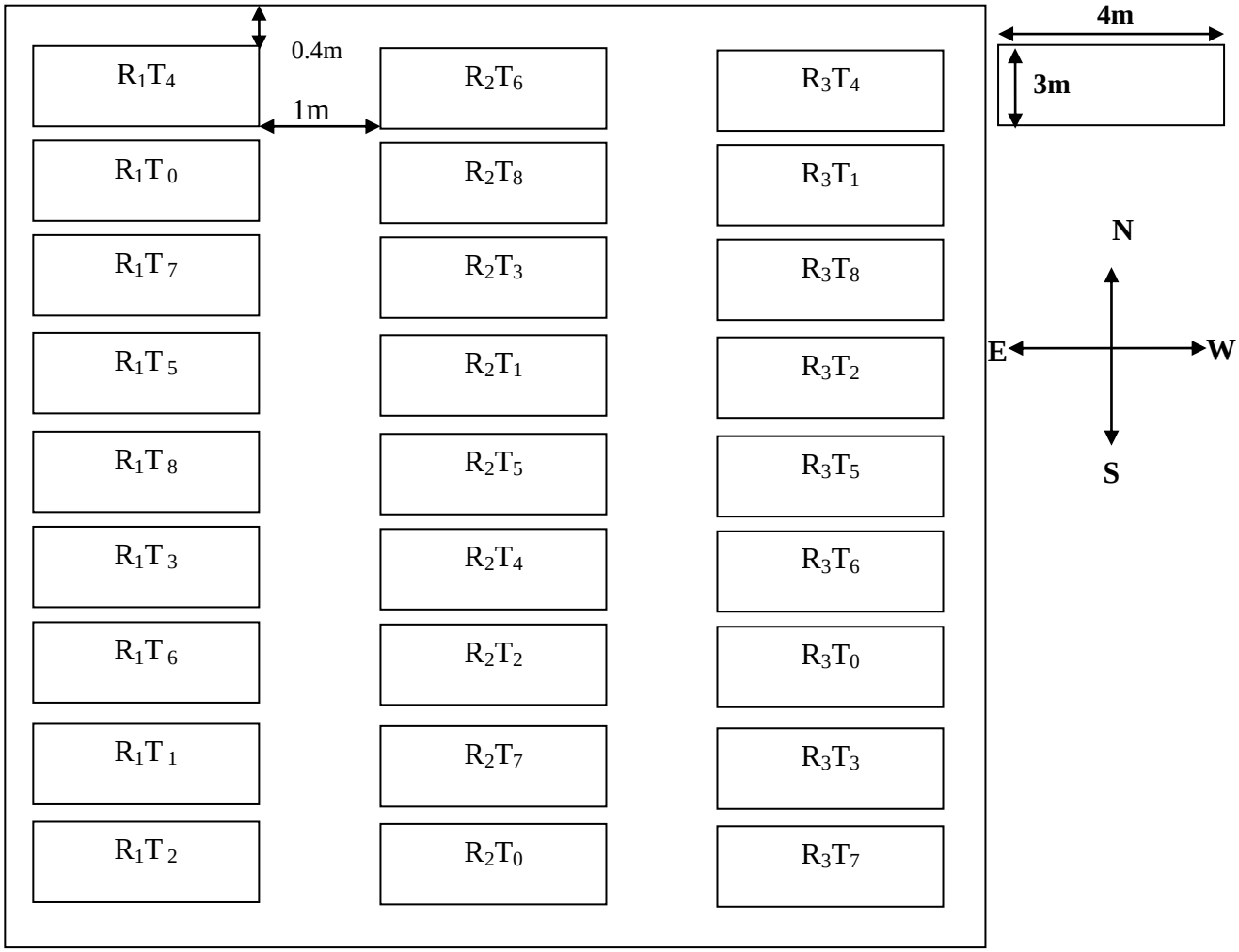

Fig. 1: Layout of the experimental plot

3.8. Growing of crops

3.8.1 Seed Collection

Seeds of experimental crop were collected from BARI.

3.8.2. Land preparation

The experimental field was thoroughly ploughed and cross ploughed and cleaned prior to seed sowing and application of fertilizers and manure were done in the field. The experimental field was prepared by thorough ploughing followed by laddering to have a good tilth. Finally the land was properly leveled before transplanting. Then plots were prepared as per the design.

3.8.3 Application of fertilizers

Urea, Triple Super Phosphate (TSP) and Murate of Potash (MP) were used as sources of nitrogen, phosphorus and potash. BARI recommended dose were applied. All the fertilizers were applied as a basal dose during final land preparation.

Table1. Fertilizer applied for the experimental field preparation.

Nutrient	**Source**	**Dose ($Kgha^{-1}$)**
N (Nitrogen)	Urea (46% N)	30
P (Phosphorus)	TSP (48% P_2O_5)	48
K (Potassium)	MP (60% K_2O)	30

3.8.4 Seed Sowing

Seeds were sown on 05 March, 2017. The seed rate was maintained at 30 kg ha-1. Seeds were treated with fungicide provex to protect them from seed borne diseases. Seeds were placed in rows having different distance of 20 cm, 30 cm, 40 cm and depth of 2-3 cm.

3.9. Preparation of plant growth regulator solutions

3.9.1 Preparation of IAA solution

For the preparation of 50ppm solution, 50 mg IAA was measured and dissolved in a small quantity of ethanol and the volume was adjusted to 1L with distilled water. In same way, 100 mg IAA was measured and dissolved in a small quantity of ethanol and the volume was adjusted to 1L with distilled water to prepare 100 ppm IAA.

3.9.2 Preparation and application of GA_3

The stock solution of 1000 ppm of GA_3 with small amount of ethanol to dilute and then mixed in 1 liter of water turn as per requirement of 50 ppm and 100ppm solution were mixed with 1 liter of water.

3.9.3 Preparation of NAA solution

Naphthalene acetic acid (NAA) in different concentrations *viz.* 50 and 100 ppm prepared following the procedure mentioned below. 50 ppm solution of NAA was prepared by dissolving 50 mg of it with distilled water. Then distilled water was added

to make the volume 1 liter 50 ppm solution. In a similar way, 100 ppm concentrations were made.

3.10 Intercultural operation

3.10.1. Weeding and thinning

Weeding was done as per requirement. Thinning was done to maintain plant to plant distance 10 cm. The first thinning was done at 8 DAS and second was done at 15 DAS.

3.10.2. Irrigation and drainage

Two irrigations was applied, first one at 10 DAS and second at 30 DAS. At the later stage of experiment there was little rainfall; so drainage provision was maintained to drain out excess water.

3.10.3. Insect control

The insecticide Malathion 57EC was sprayed @ 1.5 1 ha^{-1} at the time of 50% pod formation stage to control pod borer.

3.11. General observation

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

3.12. Determination of maturity

At the time when 80% of the pods turned blackish in color, the crop was assessed to attain maturity.

3.13. Harvesting and sampling

The crops were harvested from central 1.0 m^2 area of each plot for yield data on different dates as they attained maturity. Five randomly selected plants from each plot

were marked for recording data on plant height, pods plant^{-1}, pod length and seed weight plant-1. Pods were collected thrice throughout the growing period.

3.14. Threshing

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

3.15 Drying, cleaning and weighing

The collected seeds were dried in the sun for reducing the moisture to about nearly14% level. The dried seeds and stover were cleaned and weight of seeds plot^{-1} was recorded.

3.16. Recording of data

Different growth and yield data were recorded from the experiment.

3.16.1 Plant height

The height of pre-selected five plants were measured from the ground level to tip of the plants and then averaged. Plant height was taken at 20, 40 and 60 days after sowing from the selected plants.

3.16.2 Number of leaves

Number of leaves was measured from the sample plants and recorded from 20, 40 and 60 days of planting to observe the growth rate of the plants.

3.16.3 Number of Branches

Number of branches was measured from the sample plants and recorded from 20, 40 and 60 days of planting to observe the growth rate of the plants.

3.16.4. Days to first flowering

Dates of first flowering were recorded treatment wise and the period of time for first flowering in days was calculated from the date of sowing.

3.16.5 Number of inflorescence plant^{-1}

Numbers of inflorescence plant-1 were recorded at 35, 50 and 60 DAS. Data were recorded from 5 plant selected at random from the outer side rows (started after 2 rows from outside) of each plot.

3.16.6 Number of flower/inflorescence

Numbers of flower inflorescence^{-1} were recorded at 35, 50 and 60 DAS. Data were recorded from 5 plant selected at random from the outer side rows (started after 2 rows from outside) of each plot.

3.16.7 Number of flower plant^{-1}

Numbers of flower plant^{-1}were recorded at 35, 50 and 60 DAS. Data were recorded from 5 plant selected at random from the outer side rows (started after 2 rows from outside) of each plot.

3.16.8 Number of pod inflorescence^{-1}

Numbers of pod inflorescence^{-1}were recorded at 50 and 60 DAS. Data were recorded from 5 plant selected at random from the outer side rows (started after 2 rows from outside) of each plot.

3.16.9 Number of pod plant^{-1}

Numbers of pod plant^{-1}were recorded at 50 and 60 DAS. Data were recorded from 5 plant selected at random from the outer side rows (started after 2 rows from outside) of each plot.

3.16.10Number of seeds pod $^{-1}$

Number of seeds pod-1was counted from ten randomly selected pods of 5 selected plants and then the average seed number was calculated.

3.16.11 1000 seed weight (g)

A composite sample was taken from the yield of ten plants. The 1000-seeds of each plot were counted and weighed with a digital electric balance. The 1000-seed weight was recorded in (gm).

3.16.12 Pod length (cm)

Pod length was calculated from ten randomly selected pods of five selected plants and then the average pod length was calculated.

3.16.13 Average dry weight per plant (gm)

Dry matter production and its partitioning Five plants uprooted at random in each treatment and partitioned into their component parts *viz*., stem, leaf and reproductive parts and were air dried and then transferred to hot air oven at 80^{o}C for 72 hrs until constant weights were obtained and their dry weights were recorded. The dry weight of different plant parts and total dry weight was recorded at 20, 40 and 60 days after sowing and at harvest and expressed on per plant basis.

$$\text{Average dry weight per plant} = \frac{\text{Total weight of five dry plant (gm)}}{5}$$

3.16.14 Seed yield plant^{-1}

Five tagged plants were uprooted at maturity and processed for seed yield, from which, the average was calculated and expressed as seed yield per plant in grams.

3.16.15 Seed yield plot^{-1}

The crop was harvested and threshed respective plots wise. Seeds were separated, cleaned and dried in the sun. Then seed yield plot^{-1} was recorded at 12% moisture level.

3.16.16 Seed yield hectre^{-1}

The crop was harvested and threshed respective plots wise. Seeds were separated, cleaned and dried in the sun. Then seed yield plot-^{1} was recorded at 12% moisture level. The yield plot-1was converted to hectare basis.

3.17 Analysis of data

Data statistically analyzed by randomized complete block design through MSTAT-C software and Duncan's multiple range tests was used to analyze the growth, yield and quality characters of tomato to find out the statistical significance.

RESULTS AND DISCUSSION

This chapter comprises the presentation and discussion of the results those have been obtained from the response of plant growth regulators on flowering behavior, growth, and yield of Mungbean ***(****Vigna radiata* L.).The effects due to different doses of Indole Acetic Acid (IAA), gibberellic acid (GA_3), Naphthaleneacetic acid (NAA) and their composition the morpho-physiological and yield contributing characters have been presented in tables and figures. Results of the different parameters studied in thus experiment have been presented and discussed under the following headings.

4.1. Response of IAA, GA_3 and NAA on growth attributes of Mungbean

4.1.1 Plant Height

Data on plant height were recorded periodically at 20, 40 and 60 days after sowing (DAS). The plant height was significantly affected due to the different varieties at different days after sowing. The tallest plant height (22 cm, 37.6cm and 48.9 cm at 20, 40 and 60 DAS, respectively) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the shortest plant height (8 cm, 22.67 cm and 33.6 cm at 20, 40 and 60 DAS, respectively) was obtained in T_0 (control).

Also shown that plant height obtained from T_8 is less that T_7 (Table 2). Plant height in T_4 is less than T_1 plant height in T_5 are less than T_2 and plant height of T_6 is less than T_3. This variation is due to the amount of plant growth regulators where shown 100ppm concentration results less output than 50ppm concentration. Similar findings of plant heights were obtained by *Sajid et al.* (2016), Aktar (2015) and Shinde (2010).

4.1.2. Number of leaves

Data on number of leaves were recorded periodically at 20, 40 and 60 days after sowing (DAS). The number of leaves was significantly affected due to the different varieties at different days after sowing. The maximum number of leaves (13 no., 16.33 no and 21 no at 20, 40 and 60 DAS, respectively) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of leaves (2.33 no, 6 no and 8 no at 20, 40 and 60 DAS, respectively) was obtained in T_0 (Table 2). Also shown that

number of leaves obtained from T_8 is less thatT_7 . Also number of leaves in T_4 is less than T_1 number of leaves in T_5 are less than T_2 and number of leaves of T_6 is less than T_3 . This variation is due to the amount of plant growth regulators where shown 100ppm concentration results less output than 50 ppm concentration. Similar findings of number of leaves were obtained by Sajid*et al.* (2016), Aktar (2015) and Shinde (2010).

Table 2:Response of IAA, GA_3 and NAA on plant height, number of leaves and umber of branches of mungbean

Treatment	Plant Height (cm)			Number of leaves			Number of branches		
	20 DAS	**40 DAS**	**60 DAS**	**20 DAS**	**40 DAS**	**60 DAS**	**20 DAS**	**40 DAS**	**60 DAS**
T_0	8 h	22.67 f	33.50 g	2.333 g	6.000 g	8.000 g	2.000 g	4.333 i	6.667 e
T_1	14 de	31.50 c	40.30 d	8.667 cd	11.00 d	13.67 d	7.667 de	8.667 e	10.33 bc
T_2	18 c	34.17 b	44.07 c	11.00 b	12.67 bc	17.67 bc	9.667 c	11.33 c	11.67 b
T_3	11 fg	37.13 c	38.20 e	6.333 ef	8.333 ef	11.33 ef	5.000 f	6.667 g	8.333 cde
T_4	13 ef	27.27e	38.83 e	7.667 de	9.333 e	12.33 de	6.667 e	7.667 f	8.667 cd
T_5	15 d	29.27 d	41.33 d	9.667 bc	11.67 cd	16.00 c	8.667 cd	9.667 d	11.67 b
T_6	10 g	26.00 e	35.67f	5.000 f	7.000 fg	10.00 f	4.333 f	5.667 h	7.000 de
T_7	22 a	37.60 a	48.90 a	13.00 a	16.33 a	21.00 a	13.00 a	17.00 a	17.67 a
T_8	20 b	34.63 b	46.13 b	11.00 b	13.67 b	18.67 b	11.00 b	14.00 b	15.33 b
CV (%)	4.98	2.77	1.57	9.17	5.95	5.63	7.64	4.14	10.99
SE	0.24	0.28	0.213	0.253	0.211	0.268	0.192	0.130	0.392

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

T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA

4.1.3 Number of branches

The number of branches was significantly affected due to the different varieties at different days after sowing. The maximum number of branches (13 no, 17 no and 17.67 no at 20, 40 and 60 DAS, respectively) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of branches (2, 4.33 and 6.67 at 20, 40 and 60 DAS, respectively) was obtained in T_0 (Table 3).

Also shown that number of branches obtained from T_8 is less thatT_7 . Also number of branches in T_4 is less than T_1 number of branches in T_5 are less than T_2 and number of branches of T_6 is less than T_3. This variation is due to the amount of plant growth regulators where shown 100ppm concentration results less output than 50ppm concentration. Similar findings of number of branches were obtained by Sajid*et al.* (2016), Aktar (2015) and Shinde (2010).

4.2. Response of plant growth regulators on flowering and yield characters of Mungbean .

Plant growth regulators showed significant on flowering and yield characters of Mungbean. In the research, it was founded that results on days to first flowering, inflorescence per plant, flower per inflorescence, flower per plant, pod per inflorescence and pod per plant in variation.

4.2.1 Days to first flowering

Days to first flowering was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The minimum days to first flowering (30.67 DAS) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the maximum days to first flowering (42.33 DAS) was obtained in T_0 (Table 3). Also shown that days to first flowering obtained from T_8 is higher than T_7 . Also days to first flowering in T_4 is higher than T_1 days to first flowering in T_5 are higher than T_2 and days to first flowering at T_6 treatment is higher than T_3.

4.2.2 Number of Inflorescences per plant

Number of inflorescences per plant was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum number of inflorescences per plant (10.33) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of inflorescences per plant (2.667) was obtained in T_0. Also shown that number of inflorescences per plant obtained from T_8 treatment is less than T_7 . Also number of inflorescences per plant in T_4 treatment is less than T_1, number of inflorescences per plant in T_5 treatment are less than T_2 and number of inflorescences per plant at T_6 treatment is less than T_3 (Table 3).

Table 3: **Response of IAA, GA_3 and NAA on flowering and Inflorescences plant^{-1} of mungbean**

Treatment	Days to 1st flowering	Inflorescences/plant
T_0	42.33 a	2.667 g
T_1	36.33 cd	6.333 cd
T_2	33.67 de	8.000 bc
T_3	38.33 bc	4.333 efg
T_4	37.33 bc	5.333 def
T_5	37.00 c	6.000 de
T_6	40.00 ab	4.000 fg
T_7	30.67 f	10.33 a
T_8	32.33 ef	9.000 ab
CV (%)	3.25	12.98
SE	0.394	0.269

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

T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA

4.2.3 Number of flowers per inflorescence

Number of flower per inflorescence was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum number of flower per inflorescence (10.77) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of flowers per inflorescence (2.33) was obtained in T_0 (Fig 2). Also shown that number of number of flowers per inflorescence obtained from T_8treatmentis less than T_7 . Also number of flowers per inflorescence in T_4 treatment is less than T_1, number of flowers per inflorescence in T_5 treatment are less than $T_2$and number of flowers per inflorescence at T_6 treatment is less than T_3 . This variation is due to the amount of plant growth regulators where shown 100ppm concentration results higher flowers per inflorescence than 50ppm concentration.

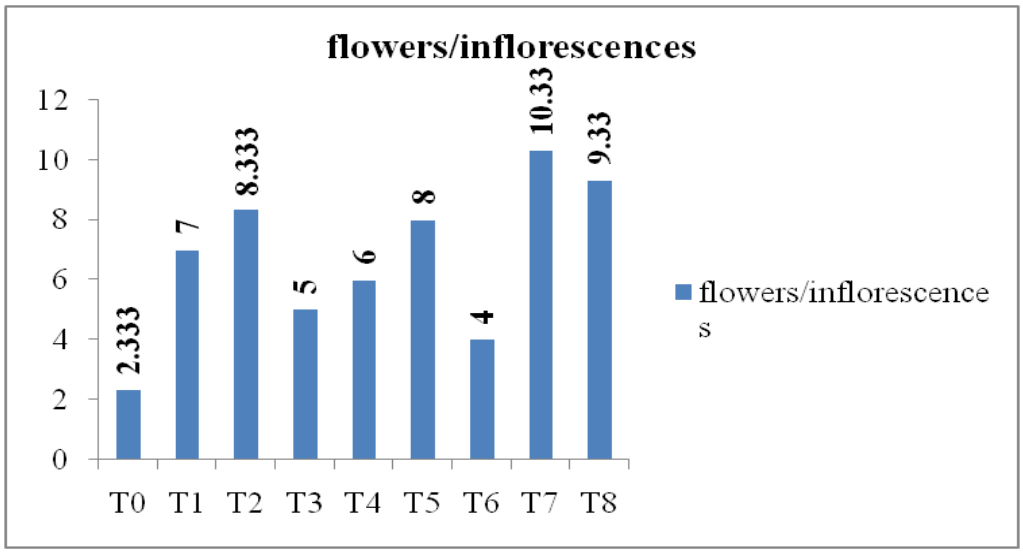

Figure 2: Response of IAA, GA_3 and NAA on flowers/inflorescene of Mungbean (LSD $_{(0.05)}$ = T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA).

4.2.4 Number of flowers per plant

Number of flowers per plant was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum number of flowers per plant (43.67) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of flowers per plant (17) was obtained in T_0 (Figure 3). Also

shown that number of flowers per plant obtained from T_8 treatment is less than T_7 . Also number of flowers per plant in T_4 treatment is less than T_1 ,number of flowers per plant in T_5 treatment are less than T_2 and number of flowers per plant at T_6 treatment is less than T_3.This variation is due to the amount of plant growth regulators where shown 100ppm concentration results higher flowers per plant than 50ppm concentration.

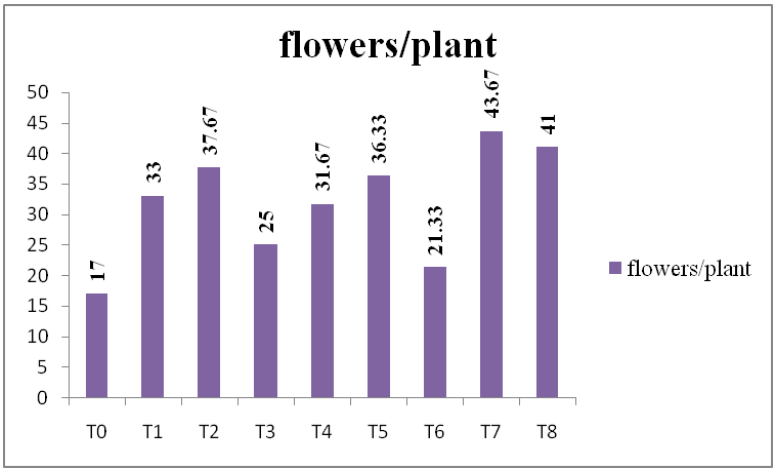

Figure 3: Response of IAA, GA_3 and NAA on flowers/plant of Mungbean (LSD $_{(0.05)}$ = T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA).

4.2.5 Number of pods per inflorescence

Number of pods per inflorescence was recorded and found significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum number of pods per inflorescence (11no) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of pods per inflorescence (3no) was obtained in T_0 (control). Also shown that number of pods per inflorescence obtained from T_8 treatment is less than T_7 . Also number of pods per inflorescence in T_4 treatment is less than T_1 , number of pods per inflorescence in T_5treatment are less than T_2 and number of pods per inflorescence at T_6 treatment is less than T_3 (Fig 4).

This variation is due to the amount of plant growth regulators where shown 100ppm concentration results higher pods per inflorescence than 50ppm concentration. Similar

findings of number of pods per inflorescence were obtained by Quamruzzaman and Yasmin(2016).

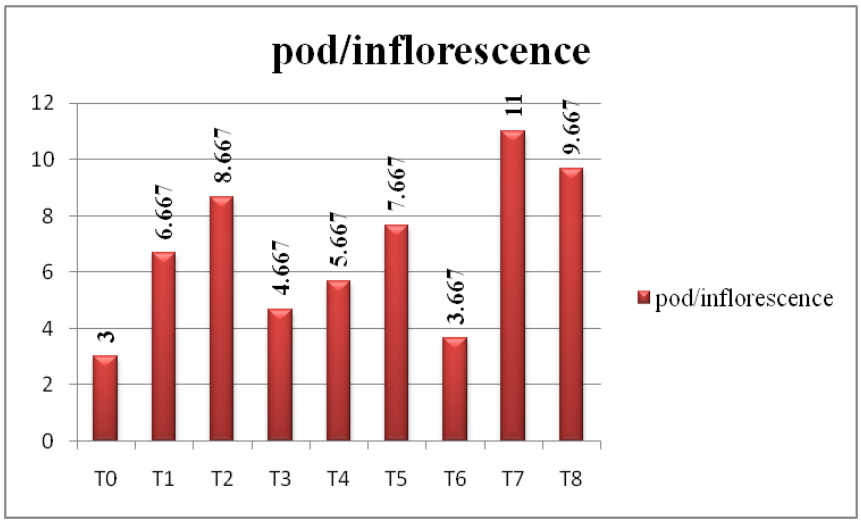

Figure 4: Response of IAA, GA_3 and NAA on number of pods/inflorescence of Mungbean (LSD $_{(0.05)}$ = T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA).

4.2.6 Number of pods per plant

It is found that number of pods per plant varied in different level of treatment. The maximum number of pods per plant (24 no) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of pods per plant (9 no) was obtained in T_0. Also shown that number of pods per plant obtained from T_8 treatment is less than T_7 . Also number of pods per plant in T_4 treatment is less than T_1 ,number of pods per plant in T_5 treatment are less than T_2 and number of pods per plant at T_6 treatment is less than T_3 (Fig 5). This variation is due to the amount of plant growth regulators where shown 100ppm concentration results higher pods per plant 50ppm concentration. Similar findings of plant heights were obtained by Md. Quamruzzaman and MarzanaYasmin (2016).

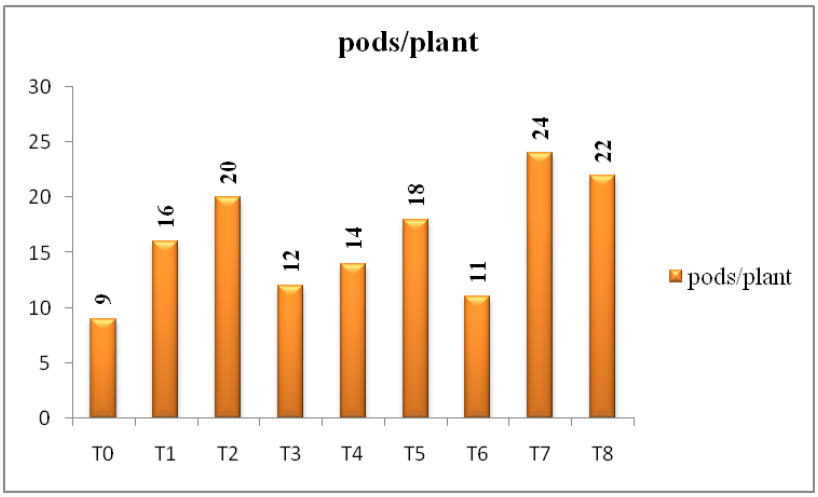

Figure 5: Response of IAA, GA_3 and NAA on number of pods/ plant of Mungbean (LSD $_{(0.05)}$ = T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA)

4.2.7 1000 seed weight (gm)

1000 seed weight was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum 1000 seed weight (60 gm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum 1000 seed weight (50 gm) was obtained inT_0 (Table 4). Also shown that 1000 seed weight obtained from T_8 treatment is less than T_7 . Also 1000 seed weight in T_4 treatment is less than T_1, 1000 seed weight in T_5 treatment are less than T_2 and 1000 seed weight at T_6 treatment is less than T_3.

4.2.8 Pod length (cm)

Pod length was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum pod length (8.467cm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum pod length (7.1 cm) was obtained in T_0 (Table 4). Also shown that pod length obtained from T_8 treatment is less than T_7. Also pod length in T_4 treatment is less than T_1, pod length in T_5 treatment are less than T_2 and pod length at T_6 treatment is less than T_3 (Table 4). This variation is

due to the amount of plant growth regulators where shown 100ppm concentration results higher pod length than 50ppm concentration. Similar findings of pod length were obtained by Moinul*et al.*(2014).

Table 4: Response of IAA, GA_3 and NAA on 1000 seed weight and pod length of Mungbean

Treatment	1000 seed weight (gm)	Pod length (cm)
T_0	50 h	7.1 e
T_1	54.90 e	8.1 abc
T_2	57.80 c	8.4 ab
T_3	53.10 f	7.6 cde
T_4	53.63 f	7.9 bcd
T_5	56.20 d	7.533 cde
T_6	51.47 g	7.3 de
T_7	60.00 a	8.467 ab
T_8	58.87 b	8.6 a
CV (%)	0.75	3.34
SE	0.138	0.087

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

T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA.

4.2.9Average dry weight per plant (gm)

Average dry weight per plant was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum average dry weight per plant (8.467) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum average dry weight per plant (7.5) was obtained in T_0. Also shown that average dry weight per plant obtained from T_8 treatmentis less than T_7 . Also average

dry weight per plant in T_4 treatment is less than T_1, average dry weight per plant in T_5 treatment are less than $T_2$and average dry weight per plant at T_6 treatment is less than T_3(Fig 6) .

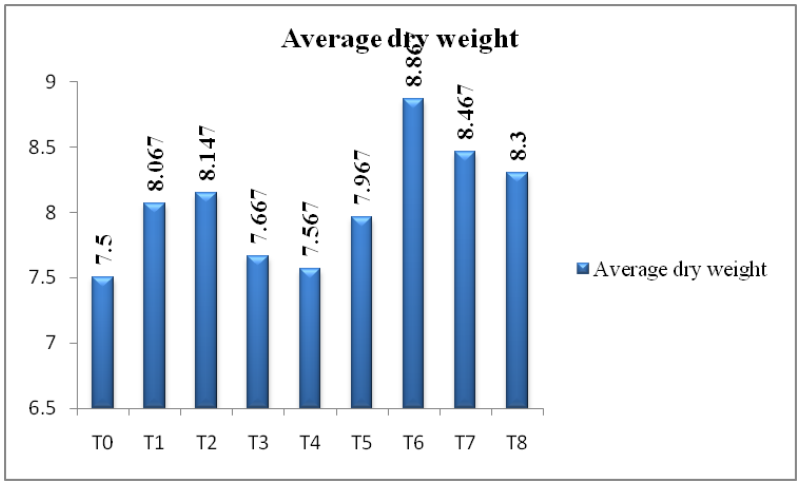

Figure 6: Response of IAA, GA_3 and NAA on average dry weight of Mungbean (LSD $_{(0.05)}$ = T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA)

4.2.10 Yield per plant (gm)

Yield per plant was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum yield per plant (9.067 gm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum yield per plant (6.333 gm) was obtained in T_0 (Figure 7). Also shown that yield per plant obtained from T_8 treatment is less than T_7 . Also yield per plant in T_4 treatment is less than T_1 , yield per plant in T_5 treatment are less than T_2 and yield per plant at T_6 treatment is less than T_3. This variation is due to the amount of plant growth regulators where shown 100ppm concentration results higher yield per plant than 50ppm concentration. Similar findings of yield per plant were obtained by Quamruzzaman and Yasmin (2016) and M.I. Moinul et al (2014). This variation is due to the amount of plant growth regulators where shown 100ppm concentration results higher yield per plant than 50ppm concentration. Similar findings of yield per plot were obtained by Quamruzzamanand Yasmin (2016).

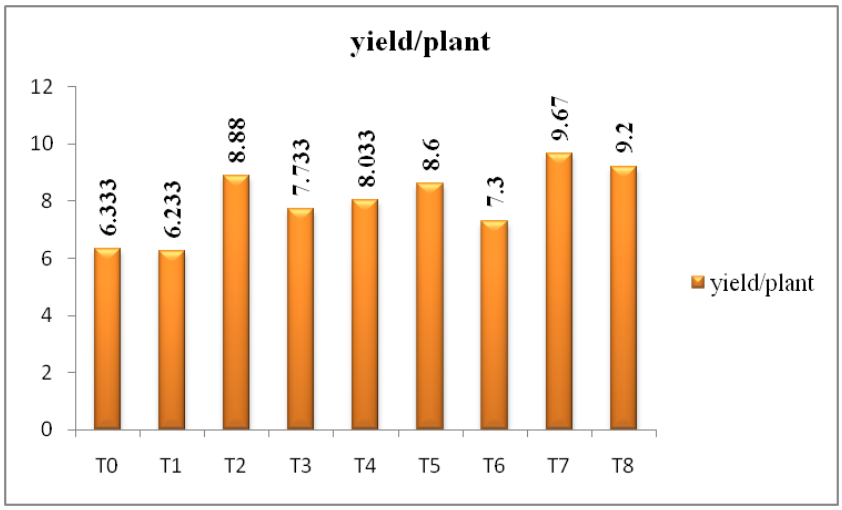

Figure 7: Response of IAA, GA_3 and NAA on yield/plant Mungbean (LSD $_{(0.05)}$ = T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA).

Table 5: Response of IAA, GA_3 and NAA on yield plot^{-1} and yield hectare^{-1} characters of Mungbean

Treatment	Yield/plot (gm)	Yield/ha (kg)
T_0	820	700
T_1	890	1200
T_2	843.3	1767
T_3	853.3	870
T_4	873.3	940
T_5	923.3	1600
T_6	843.3	846
T_7	1003	2050
T_8	973.3	1900
CV (%)	0.31	1.48
SE	0.935	6.486

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

T_0=control, T_1= 50 ppm IAA, T_2= 50 ppm GA_3, T_3 = 50ppm NAA, T_4= 100 ppm IAA, T_5= 100 ppm GA_3, T_6=100 ppm NAA, T_7= 50ppm IAA+ 50ppm GA_3 +50ppm NAA and T_8= 100ppm IAA + 100 ppm GA_3 + 100ppm NAA.

4.2.11 Yield per plot (gm)

Yield per plot was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum yield per plot (1003 gm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum yield per plot (820 gm) was obtained in T_0 (Table 5). Also shown that yield per plot obtained from T_8treatmentis less than T_7 . Also yield per plot in T_4 treatment is less than T_1, yield per plot in T_5 treatment are less than T_2 and yield per plot at T_6 treatment is less than T_3.

4.2.11. Yield per hectare (Kg)

Yield per hectare was significantly affected due to the mungbean at different level of IAA, GA_3 and NAA. The maximum yield per hectare (2050 kg) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum yield per hectre (700 kg) was obtained in T_0 (Table 5). Also shown that yield per hectre obtained from T_8treatmentis less than T_7 . Also yield per hectre in T_4 treatment is less than T_1, yield per hectre in T_5 treatment are less than T_2 and yield per hectre at T_6 treatment is less than T_3. This variation is due to the amount of plant growth regulators where shown 100ppm concentration results higher yield per hectare than 50ppm concentration

SUMMARY AND CONCLUSION

A field experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Dhaka, during the *Kharif* season from March 2017 to May 2017 to study the response of plant growth regulators on flowering behavior, growth, and yield of Mungbean (*Vignaradiata* L.). Different concentration of Gibberellic Acid (GA_3), Indole Acetic Acid and Naphthaleneacetic acid were applied as plant growth regulator. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications of each treatment. The unit plot size was 4m x 3m. There was one factors in the experiment comprising nine levels of Gibberellic Acid (GA_3), Indole Acetic Acid and Naphthaleneacetic acid (Control, 50ppm IAA 50ppm GA_3, 50ppm NAA, 100ppm IAA, 100ppm GA_3, 100ppm NAA, 50ppm IAA+ 50ppm GA_3+ 50ppm NAA and 100ppm IAA+100ppm GA_3+ 100ppm NAA designated as T_0, T_1, T_2, T_3, T_4,T_5, T_6, T_7 and T_8).

Application of IAA, GA_3 and NAA in individual or combined form had a significant effect on plant height. The highest plant height (22 cm, 37.6cm and 48.9 cm at 20, 40 and 60 DAS, respectively) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the shortest plant height (8 cm, 22.67 cm and 33.6 cm at 20, 40 and 60 DAS, respectively) was obtained in T_0 (control). Application of IAA, GA_3 and NAA in individual or combined form had a significant effect on number of leaves. The maximum number of leaves (13 no., 16.33 no and 21 no at 20, 40 and 60 DAS, respectively) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of leaves (2.33 no, 6 no and 8 no at 20, 40 and 60 DAS, respectively) was obtained in T_0.

Application of IAA, GA_3 and NAA in individual or combined form had a significant effect on number of branches. The maximum number of branches (13 no, 17 no and 17.67 no at 20, 40 and 60 DAS, respectively) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of branches (2, 4.33 and 6.67 at 20, 40 and 60 DAS, respectively) was obtained in T_0. Application of IAA, GA_3 and

NAA in individual or combined form had a significant effect on days required to first flowering. The minimum days to first flowering (30.67 DAS) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the maximum days to first flowering (42.33 DAS) was obtained in T_0 .

The effect of IAA, GA_3 and NAA in individual or combined on number of inflorescences per plant was influenced significantly. The maximum number of inflorescences per plant (10.33) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of inflorescences per plant (2.667) was obtained in T_0.

Foliar spraying of IAA, GA_3 and NAA shows effect on flowers per inflorescence of mungbean. The maximum number of flower per inflorescence (10.77) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of flowers per inflorescence (2.33) was obtained in $T_{0.}$ Also shown that number of number of flowers per inflorescence obtained from T_8 treatmentis less than T_7 . Also number of flowers per inflorescence in T_4 treatment is less than T_1, number of flowers per inflorescence in T_5 treatment are less than $T_2$and number of flowers per inflorescence at T_6 treatment is less than T_3 .

Statistically significant variation was found in number of flowers per plant in different doses of IAA, GA_3 and NAA individually and in combined. The maximum number of flowers per plant (43.67) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of flowers per plant (17) was obtained in $T_{0.}$

The treatment combinations of IAA, GA_3 and NAA on pods per inflorescence were significant. The maximum number of pods per inflorescence (11) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of pods per inflorescence (3no) was obtained in T_0 (control).

Statistically significant variation was found in number of pods per plant in different doses of IAA, GA_3 and NAA. The maximum number of pods per plant (24 no) was

obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum number of pods per plant (9 no) was obtained in T_0 . There were significant differences among the different levels of IAA, GA_3 and NAA in respect of 1000 seed weight. The maximum 1000 seed weight (60 gm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum 1000 seed weight (50 gm) was obtained in T_0 .

Statistically significant variation was found in pod length in different doses of IAA, GA_3 and NAA. The maximum pod length (8.467cm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum pod length (7.1 cm) was obtained in T_0 . There were significant differences among the different levels of IAA, GA_3 and NAA in respect of average dry weight per plant. The maximum average dry weight per plant (8.467gm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum average dry weight per plant (7.5g) was obtained in T_0.

Statistically significant variation was found in yield per plant in different doses of IAA, GA_3 and NAA. The maximum yield per plant (9.067 gm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum yield per plant (6.333 gm) was obtained in T_0 .

There were significant differences among the different levels of IAA, GA_3 and NAA in respect of yield per plot . The maximum yield per plot (1003 gm) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum yield per plot (820 gm) was obtained in T_0. Statistically significant variation was found in yield per hectre in different doses of IAA, GA_3 and NAA. The maximum yield per hectare (2050 kg) was obtained from T_7 (50 ppm IAA +50 ppm GA_3+50 ppm NAA) and the minimum yield per hectre (700 kg) was obtained in T_0.

From the present study, the following conclusion may be drawn:

- Effect of IAA, GA_3 and NAA played positive role on the Flowering behavior, Growth, and yield of Mungbean.

- Flowering behavior, Growth, and yield of Mungbean were also gave influenced by the individual application of IAA, GA_3 and NAA.

- Growth, and yield of Mungbean were also gave influenced by the combined application of IAA, GA_3 and NAA.

- Flowering behavior, growth, and yield of mungbean were also gave influenced by the different concentration of IAA, GA_3 and NAA.

- Individual application of IAA, GA_3 and NAA at 50ppm shows slight influence on flowering behavior, growth, and yield of mungbean.

- Individual application of IAA, GA_3 and NAA at 100ppm shows slight less influence on flowering behavior, growth, and yield of mungbean.

- Application of IAA, GA_3 and NAA at 50ppm in combination shows significant result in growth, and yield of mungbean.

- Application of IAA, GA_3 and NAA at 100ppm in combination shows less significant result in growth, and yield of mungbean.

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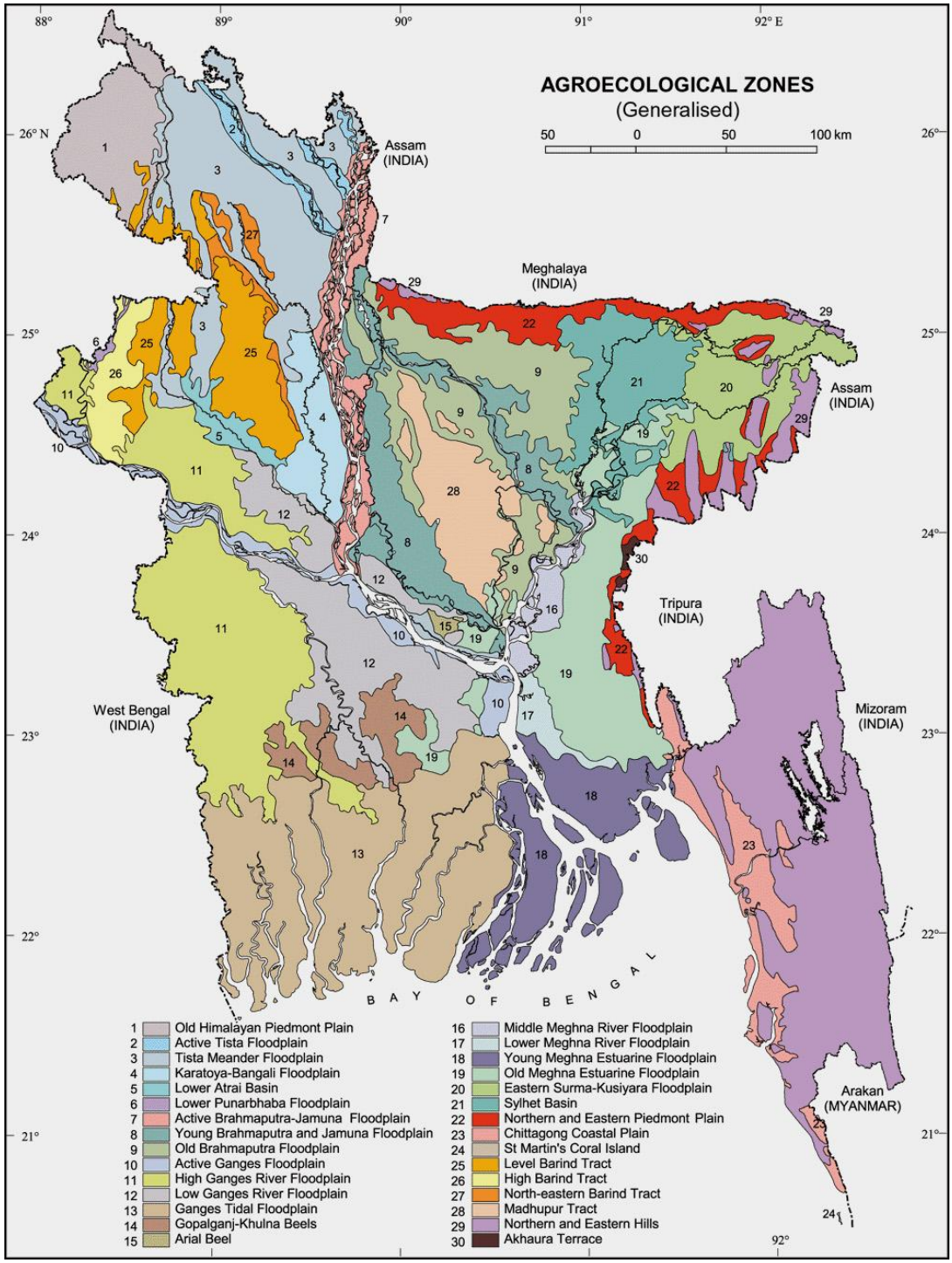
APPENDICES

Appendix I: Experimental site at Sher-e-Bangla Agricultural University, Dhaka-1207



The map of Bangladesh showing experimental site

Appendix II: Monthly records of meteorological observation at the period of experiment (February, 2017 to May, 20167)

Name of months	Temperature (^{0}C)		Relative humidity (%)
	Maximum	Minimum	
February, 2017	32	15	51
March, 2017	32	17	64
April, 2017	36	20	72
May, 2017	36	22	57

Source: timeanddate.com/weather/bangladesh/Dhaka

Appendix III: Morphological characteristics of soil of the experimental plot

Morphological features	Characteristics
Location	Research farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow Red Brown Terrace Soil
Land Type	Medium high land
Soil Series	Tejgaon fairly leveled
Topography	Fairly level
Flood Level	Above flood level
Drainage	Well drained

Appendix-IV: Analysis of variance of different growth characters of mungbean

Sources of variation	Degrees of freedom	Mean sum of square					
		Plant height			No. of leaves per plant		
		20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
Replication	2	0.303	2.891	0.107	1.037	1.778	0.481
Treatment (T)	8	70.291*	66.042*	73.320*	33.537*	33.250*	56.037*
Error	16	0.560	0.712	0.410	0.579	0.403	0.648

* Significant at 1% level

Appendix-V: Analysis of variance of different growth characters of mungbean

Sources of variation	Degrees of freedom	Mean sum of square					
		No. of branches per plant			Days to first flowering	Inflorescences/plant	Flowers/ inflorescence
		20 DAS	40 DAS	60 DAS			
Replication	2	4.00	2.111	1.593	0.111	7.444	2.926
Treatment (T)	8	35.917*	50*	45.287*	41.250*	18.667*	33.315*
Error	16	0.333	0.153	1.384	1.403	0.653	0.426

* Significant at 1% level

Appendix-VI: Analysis of variance of different yield characters of mungbean

Sources of variation	Degrees of freedom	Mean sum of square				
		Flower/ plant	Pods/ inflorescence	Pods/ plant	1000 seed weight	Pod length
Replication	2	4.593	3.815	9.00	7.129	10.11
Treatment (T)	8	246.25*	22.565*	80.08*	34.53*	0.872*
Error	16	0.759	0.065	0.126	0.171	0.069

* Significant at 1% level

Sources of variation	Degrees of freedom	Mean sum of square			
		average dry weight (gm)	Yield per plant (gm)	Yield per plot (gm)	Yield per hectare (kg)
Replication	2	2.645	0.750	2070.370	15737.037
Treatment (T)	8	0.602*	2.544*	11631.481*	767287.037*
Error	16	0.206	0.041	7.870	378.704

* Significant at 1% level

Plate 1 (a-f): Different steps of mungbean in experimental plot

a. Seeds of mungbean

b. Young plant

c. Experiment field

d. Ripening stage

e. Pods at ripening stage

f. Harvested mungbean