EFFECT OF BENZYLEAMINOPURINE (BAP) AND PK ON GROWTH AND YIELD OF SUMMER MUNGBEAN (BARI mung-6)

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CERTIFICATE

*This is to certify that the thesis entitled "**EFFECT OF BENZYLEAMINOPURINE (BAP) AND PK ON GROWTH AND YIELD OF SUMMER MUNGBEAN (BARI mung-6)**" 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. NAZMUL HASAN KHANDAKER**. **Registration No.: 10-04165** 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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ABSTRACT

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period from April to June, 2017 to study the effect of benzyleaminopurine (BAP) and PK on growth and yield of summer mungbean (BARI mung-6). In this experiment, the treatment consisted of four doses of BAP *viz.* B_0 = 0 ppm BAP, B_{20} = 20 ppm BAP, B_{40} = 40 ppm BAP and B_{60} = 60 ppm BAP and three different doses of PK *viz.* F_0=Recommended dose of NPK, F_1=Recommended dose of N+ 125% recommended dose of PK, F_2=Recommended dose of N+ 150% recommended dose of PK. The experiment was laid out in a two factors randomized complete block design (RCBD) with three replications. Data on different growth parameters and yield contributing characters of mungbean were recorded. The collected data were statistically analyzed for evaluation of the treatment effect. A significant variation among the treatment was found while different concentration of BAP and PK were applied. The maximum plant height was recorded with the dose of 20 ppm BAP. The maximum leaf length and leaf breadth were recorded with the dose of 20 ppm BAP. Among the different doses, 20 ppm BAP ha^{-1} showed the highest number of pods $plant^{-1}$. The maximum seeds pod^{-1}, thousand seed weight (56.56 g) were recorded from 20 ppm BAP. The 20 ppm BAP was observed in the highest seed yield of 1.00 t ha^{-1}. The maximum plant height was observed from recommended dose of N+ 125% recommended dose of PK treatment. The highest leaf length and leaf breadth were recorded from recommended dose of N+ 125% recommended dose of PK treatment. The maximum number of pods $plant^{-1}$ was recorded from recommended dose of N+ 125% recommended dose of PK. Recommended dose of N+ 125% recommended dose of PK showed the highest number of seeds pod^{-1}, weight of 1000 seed. The highest seed yield (1.00 t ha^{-1}) was recorded from recommended dose of N+ 125% recommended dose of PK. The highest seed yield 1.13 t ha^{-1} was obtained from 20 ppm BAP and recommended dose of N+ 125% recommended dose of PK.

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LIST OF ACRONYMS

%	=	Percent
µg	=	Micro gram
^{0}C	=	Degree Celsius
AEZ	=	Agro-Ecological Zone
BAP	=	Benzylaminopurine
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
CV%	=	Percentage of coefficient of variation
cv.	=	Cultivar
DAS	=	Days after sowing
et al.	=	And others
G	=	gram (s)
ha^{-1}	=	Per hectare
HI	=	Harvest Index
Hr	=	Hour
Kg	=	Kilogram
LAI	=	Leaf Area Index
LSD	=	Least Significant Difference
Max	=	Maximum
Min	=	Minimum
mm	=	Millimeter
MoP	=	Muriate of Potash
N	=	Nitrogen
NAA	=	Naphthalene Acetic Acid
No.	=	Number
PK	=	Phosphorus and Potassium
NS	=	Not significant
ppm	=	Parts per million
RCBD	=	Randomized Complete Block Design
RDF	=	Recommended Dose of Fertilizer
SAU	=	Sher-e-Bangla Agricultural University
T	=	Tonne
TSP	=	Triple Super Phosphate

viz.	=	Videlicet (namely)
Wt.	=	Weight

CHAPTER I

INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] is an important legume and short durated pulse crop of Bangladesh and other South Asian Countries. Mungbean also known as green gram or golden gram is one of the most important pulse crops in Bangladesh. It belongs to the family Leguminosae. It is native to the Indian subcontinent and mainly cultivated in India, China, Thailand, Philippines, Indonesia, Myanmar, Bangladesh, Laos and Cambodia but also in hot and dry regions of Europe and the United States. It is used as foodstuffs in both savory and sweet dishes. Mungbean also improves physical, chemical and biological properties of soil by fixing nitrogen from atmosphere through symbiosis process.

In Bangladesh, mungbean grows well all over the country. Among the pulses, it ranks third in area and production but first in market price. According to FAO (2013) recommendation, a minimum per capita uptake of pulse should be 80 g day^{-1}, whereas it is 7.92 g day^{-1} in Bangladesh. This is because of fact that national production of the pulses is not adequate to meet our national demand. The total production of mungbean in Bangladesh in 2013-14 was 1.81 lac metric tons from the area of 1.73 lac hectares with an average yield 1.04 t ha^{-1} (MoA, 2014).

It is well known that plant growth regulator (PGR) plays an important role to enhance the growth and yield of different crops including pulses. Previous numerous authors stated that cytokinin (CK), auxin (IAA), gibberellin (GA), jesmonate (JA), salicylic acid (SA), benzyleaminopurine (BAP) etc. used to improve seed germination capacity, increase crop yield, to make plants resistant to diseases and unfavorable growth conditions (Kadiri *et al*., 1997; Saglam *et al*., 2002; Halter *et al*., 2005; Jankauskienė and Survilienė 2009; Mukhtar, 2008; Turan *et al*., 2009).

Balanced levels of endogenous growth regulators sush as BAP a cytokinin growth promoters greatly influence morphological and physiological characters of a plant. BAP application increased gas exchange characteristics and thereby increased photo-assimilate compared to that of the treatment consisting water stress without BAP (Sirohi *et al*., 1988).

BAP has positive influence on nutrient uptake by plants. The higher shoot dry matter produced by BAP treatments was associated presumably with higher gas exchange characteristics in presence of BAP (Nikolaou *et al*., 2003).

However, mungbean being a legume crop, it needs low nitrogen but require optimum doses of other major nutrients as recommended. Phosphorus (P) is a vital yield determining nutrient in legumes (Chaudhary *et al*., 2008). It is an important component of key molecules such as nucleic acids, phospholipids and ATP, and consequently, plants cannot grow without a reliable supply of this nutrient. Phosphorus is also essential for the seed formation. It is known to stimulate root growth and is associated with early maturity of crops. It not only improves the quality of fruits, forages, vegetables and grains but also plays an important role in disease resistance of plants (Brady and Weil, 1999).

Potassium (K) is the third macronutrient required for plant growth, after nitrogen (N) and phosphorus (P). Unlike N and P; K is not a component of cell structure. Instead, it exists in mobile ionic form, and acts primarily as a catalyst (Wallingford, 1980). It has an important role in plants for osmotic adjusment (Tisdale and Nelson, 1966) in arid environments for plants metabolism.

Phosphorus plays a remarkable role in plant physiological processes. It is an essential constituent of majority of enzymes which are of great importance in the transformation of energy in carbohydrate metabolism in different types of plants and is closely related in cell division and grain development. Phosphorus is a key constituent of ATP and it plays a significant role in the energy transformation in plants and also in various physiological processes (Sivasankar *et al*., 1982). It is also essential for energy storage and release in living cells. Phosphorus shortage restricted the plant growth and remains immature (Hossain, 1990). Experimental findings of Arya and Kalra (1988) revealed that application of phosphorus had no effect on the growth of mungbean, while number of grains pod^{-1}, weight of 1000-seeds were found to be increased with increasing level of phosphorus from zero to 50 kg P_2O_5 ha^{-1}. Phosphorus deficiency causes yield reduction by limiting plant growth (Poehlman, 1991). It influences nutrient uptake by promoting root growth and nodulation (Singh *et al*., 1999). Phosphorus enhances the uptake of nitrogen in the crop which increases protein content of mungbean (Soni and Gupta, 1999). Phosphorus is essential constituents of nucleoprotein, phospholipids, many enzymes and other plant substances.

Potassium (K) plays a crucial role in survival of crop plants under environmental stress conditions. K is essential for many physiological processes, such as photosynthesis, translocation of photosynthates into sink organs, maintenance of turgidity and activation of enzymes under stress conditions (Marschner, 1995; Mengel and Kirkby, 2001). Under low supply of K, chilling or frost induced photo-oxidative damage can be exacerbated causing more decreases in plant growth and yield. Potassium supply in high amounts can provide protection against oxidative damage caused by chilling or frost. A high K^+ concentration activated the plant's antioxidant systems which are associated with cold tolerance (Devi *et al*, 2012). Higher K tissue concentrations reduced chilling damage and increased cold resistance, ultimately increased yield and production. Frost damage was inversely related to K concentration and was significantly reduced by K fertilization.

Considering the above facts, the present research work was conducted to evaluate the influence of different dose of BAP and PK on the growth and yield of mungbean.

Therefore, the present investigation has been undertaken to fulfil the following objectives:

i) To find out the optimum dose of benzylaminopurine (BAP) for optimum growth and yield of mungbean.

ii) To find out the optimum doses of PK fertilizers for optimum growth and yield of mungbean.

iii) To study the interaction effect of BAP and PK levels on the growth and yield of mungbean.

CHAPTER II

REVIEW OF LITERATURE

Many research works on mungbean have been performed extensively in several countries especially in the South East Asian countries for its improvement of yield and quality. For that a very few studies regarding growth, development and yield of mungbean have been carried out in our country as well as many other countries of the world. So the research work so far done in Bangladesh is not adequate and conclusive. Nevertheless, some of the important and informative works regarding the BAP and NPK so far been done at home and abroad on this crop along with their findings have been reviewed in this chapter under following heading:

2.1 Effect of BAP on the growth and yield of mungbean

The regeneration of EMS treated seeds of two local varieties of mungbean was investigated under salt stress conditions. Three explants e.i. cotyledon, leaf and shoot apical meristem of mungbean obtained from in vitro grown EMS treated seeds of varieties NM-92 and Khalood were inoculated on MS medium containing various concentrations of 2, 4-D and BAP and IBA. The highest callus proliferation (98.3%) was obtained in EMS treated leaf of NM-92 followed by 96.5% in shoots of NM-92 control on MS medium supplemented with 1.8μM 2, 4-D and 3.56μM BAP. The increase in callus fresh weight was higher in leaf explants of both treated varieties. Similarly 57.3±1.3 callus cultures of treated leaf explants of NM-92 were survived on media containing 50mM NaCl. Similarly the highest regeneration (65.5±2.1%) was observed in NaCl selected callus cultures raised from shoots of EMS treated seeds (Rafiq *et al*., 2012).

Chaudhury *et al*. (2007) investigated the effect of different concentrations of BAP (2.5-10 μM) on the regeneration of cotyledonary node in cowpea. They observed that BAP increased the number of shoots with increase in its concentration up to 5Mm. However, the frequency of shoot regeneration declined with increase in BAP concentration. Encouraging role of BAP was also observed by Diallo *et al*. (2008). They established regeneration protocol for cowpea from cotyledonary node explant using different concentrations of BAP and kinetin. They found BAP at 4.4 μM was the best for multiple shoot induction and further increase in BAP concentrations reduced the shoot proliferation and its subsequent elongation. They also observed that kinetin at 1 mg/L was the optimum for regeneration and kinetin promoted elongation rather than multiplication compared with BAP. However, they observed longer shoots on the medium fortified with auxins as compared to media containing BAP alone.

Addition of kinetin, zeatin, lower concentration of BAP and gibberellic acid (GA3) into culture medium effectively enhances the shoot elongation in vitro. Addition of GA3 promoted elongation of shoot buds in cowpea was verified by Mao *et al.* (2006). The best combination of growth regulators for shoot elongation in cowpea was reported as MS medium with 1.0 mg/L zeatin, 0.5

mg/L GA3 and 0.1 mg/L IAA (Adebola *et al.*, 2008). Solleti *et al.* (2008) examined the effect of kinetin and GA3 on elongation of shoots from cotyledonary node cultures of cowpea. The results revealed 0.5 μM kinetin enhance three-fold shoot elongation in 86% of cultures within 2 weeks. GA3 containing medium induced non-uniform and thinner elongated shoots. In black gram, GA3 at 0.6 mg/l concentration elongated 7.1 cm shoot length with an average 6 nodes per shoot (Muruganantham *et al.*, 2005). Lower concentration of BAP was amended for shoot elongation in cowpea (Raveendar *et al*., 2009) and in mungbean (Yadav *et al*., 2010). MS basal medium was also used to elongate shoots in cowpea (Brar *et al*., 1999; Tang *et al*., 2012).

2.2 Effect of PK on the growth and yield of mungbean

Dinesh *et al.* (2015) conducted for the management of soil acidity with fertility and lime levels to sustain the productivity of acid soil in Vindhyyan region of Uttar Pradesh (India). Results of the study demonstrated that significant improvement in plant height (49.23 cm), number of nodule (76.95), dry weight of nodule (49.75 mg), highest LAI (4.45), yield parameters, yields, protein (21.39%), nutrient content and total NPK uptake (96.68 kg ha^{-1}) were recorded with 100% RDF. Similar results were observed for all growth and yield parameters such as protein (%), nutrient (%) and total PK uptake by crop with application of 200 kg lime ha^{-1}. A significantly higher seed yield (6.22 q ha^{-1}) was recorded with 100 % RDF + 200 kg lime ha^{-1} as compared to other treatment combinations, which was at par with 100 % RDF + 300 kg lime ha^{-1} and 125 % RDF + 300 kg lime ha^{-1}.

Yasmin *et al*. (2016) conducted to see the effect of cowdung, NPK and Rhizobium inocula on nodules number, yield contributing attributes and yield of summer mungbean (var. Binamoog-8), in acid soil at the farm of Agricultural Training Institute, Khadim Nagar, Sylhet from April to July, 2014. Seven treatments were viz., Control (without Rhizobium inocula and fertilizers), Cowdung (CD), CD+RI, NPK, NPK+RI, ½(NPK)+RI and Rhizobium inocula (RI). The rate of Urea-(N), TSP-(P) and MoP-(K) were approximately 14, 14 and 17.5 kg ha^{-1}, respectively. CD was around 8 t $ha^{-1}$and RI was approximately 45 g kg^{-1} seed. The randomly selected 5 plants were uprooted at four times in 30, 45, 60 and 90 days after sowing (DAS) for nodules. The individual ripened pod was picked at 15 days interval from 45 to 90 DAS. Treatments had significant effects on all studied characters except percent sterile pods $plant^{-1}$ at 75 DAS, number of seeds pod^{-1} and 1000 seeds weight (g). Sole application of cowdung around 8 t ha^{-1} performed better in growth character, yield contributing characters which influenced to produce higher seed and stover yield (705 and 2031 kg ha^{-1}, respectively).

Amin *et al*. (2015) conducted with mungbean genotype IPSA-13 in the field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during September, 2012 to November, 2012 to study the root growth, nutrient concentration and seed yield of mungbean as influenced by N and K under waterlogged conditions. Nutrient supply in the soil had significant impact on better recovery in root development of 4-day waterlogged plants. Development of adventitious roots was one of the adaptive responses of IPSA-13 mungbean genotype. Root length was decreased due to the an aerobic condition. Plants waterlogged for 4-days allocated more dry matter in adventitious root development and hence root volume was higher in waterlogged plants. Root volume in flooded plants increased due to the development of adventitious roots. Root dry weight increased with combined application of N and K fertilizers. Flooded plants treated with 14 kg N ha^{-1} + 25 kg K ha^{-1} produced the highest TDM and seed yield, though the yield was statistically similar to that obtained when the levels of N and K were applied separately, as well as with that of 1% urea + 25 kg K ha^{-1}.

Hossen *et al.* (2015) conducted an experiment at the research field of the Horticulture Research Center at Labukhali, Patuakhali during the period from January to March 2014 to find out the most suitable BARI released mungbean variety and optimum rates of N concerning higher seed yield under the regional condition of Patuakhali (AEZ–13). Two BARI released mungbean varieties namely BARI mung–5 and BARI mung–6 and five levels of N fertilizer including control viz., 0 kg N ha^{-1}(N0), 30 kg N ha^{-1}(N30), 45 kg N ha^{-1}(N45), 60 kg N ha^{-1}(N60), and 75 kg N ha^{-1}(N75) were used for the present study as level factor A and B, respectively. In case of variety, BARI mung–6 produced significantly the longest pod (7.56 cm), maximum pods (9.14) plant^{-1}, maximum seeds (9.14) pod^{-1}, higher weight of 100–seed (4.48 g), the highest seed weight (4.33 g plant^{-1}) and the highest seed yield (1.56 t ha^{-1}) than

BARI mung–5 at harvest. In case of N fertilizer, the longest pod (7.96 cm), maximum pods plant^{-1} (10.45), maximum seeds pod^{-1} (9.70), higher weight of 100–seed (4.52 g), higher weight of seed (5.73 g plant^{-1}) and greater seed yield (1.85 t ha^{-1}) were also obtained in 45 kg N ha^{-1} compare to other N levels. The BARI mung–6 × 45 kg N ha^{-1} for seed yield was found under the regional condition of Patuakhali (AEZ-13).

The effect of phosphorus (P) and nitrogen (N) on the rooting response of mung bean (*Phaseolusaureus Roxb.*) cuttings was studied by Mahmood and Shaheed (2014). A wide range of P concentrations (8-62 mg L^{-1}) was used as well as for N (75-400 mg L^{-1}) separately and in combinations at different ratios. The optimal rooting response, (20.34) roots per cutting, was obtained by the combination of (20:250 mg L^{-1}) P:N.

Singh *et al*. (2014) carried out to study the effect of sulphur (S) and cobalt (Co) fertilization in combinations with Rhizobium inoculant (RI) and recommended NPK fertilization (RDF) on growth, yield and nutrient uptake of mungbean in an acidic soil of northeast India. Application of RI alone or in combination with S or Co (without NPK) could not significantly increase the grain yield, but combined application of RI+S+Co did increase it up to 450 kg ha^{-1} from 240 kg ha^{-1} at control. Noticeably, application of recommended NPK (without any other inorganic or organic inputs) led to a better grain yield (530 kg ha^{-1}), which was more than twice the yield at control. And further addition of RI+ S+ Co along with NPK (RDF) nearly tripled the yield (730 kg ha^{-1}) compared to that of control. Effect of RI, S and Co application on crop yield was mediated mostly through increased nodulation and nutrient uptake, which were correlated well with seed yield.

Achakzai *et al*. (2012) found that different Nitrogen levels influenced most of the growth attributes of the mungbean. Maximum days to flowering, number of branches plant^{-1}, number of leaves plant^{-1}, plant height, number of branches plant^{-1}, leaf area and grain yield recorded for plants subjected to the highest dose of applied N fertilizer at 100 kg ha^{-1}.

A field experiment was conducted by Quddus *et al*. (2012) on Mungbean Chickpea–T.Aman cropping pattern at Pulses Research Sub–Station, Madaripur under Low Ganges River Floodplain Soils (AEZ–12) during 2007–08 and 2008–09 to find out the suitable fertilizer doses for this pattern. Four treatments were set up for Chickpea and Mungbean viz., T_1 = Recommended fertilizer dose as per FRG, 2005 BARC ($N_{15}P_{18}K_{10}S_5Zn_{0.5}B_{0.5}$); T_2=$N_{21}P_{23}K_{30}S_{18}Zn_2B_{1.5}$; T_3 = $N_{23}P_{15}K_8$ and T4= Control (without fertilizer). Average of two years, the plant height of chickpea ranged from 36.95 to 44.15 cm. The highest plant height of Chickpea was recorded in T_2, which was statistically identical to T_1 and T_3 during 2008–09 and significantly higher over the other treatments during 2007–08. Average of two years, the highest plant height (45.38 cm) of mungbean was recorded in the treatment T_2, which was statistically identical to T_1. The lowest value (39.50 cm) was being noted in the treatment T_4.

Chesti *et al*. (2012) revealed that protein content of green gram increased significantly with phosphorus application up to 30 kg P_2O_5 ha^{-1}. The increase in protein content of green gram was 28% due to application of 30 kg P_2O_5 ha^{-1} over control. However, further increase in phosphorus level (60 kg P_2O_5 ha^{-1}) had no beneficial effect on protein content of green gram. Similar findings were also reported by Shahi *et al*. (2002).

Hussain *et al*. (2011) conducted an experiment to study the growth and yield responses of two cultivars of Mungbean (*Vigna radiata* L.) to different potassium levels. The experiment was laid out in Randomized Complete Block Design (RCBD) with factorial arrangements and replicated thrice. Treatments were comprised of five levels of potash fertilizer. Increased potassium levels significantly affected the plant height, growth and yield contributing parameters.

Choudhary and Yadav (2011) reported that application of 100 percent RDF recorded the highest dry matter m^{-1} row length which was 30.5, 16.0 and 6.8% higher over control, 50 and 75 percent RDF, respectively. Plant height and number of branches also followed similar trend for fertility levels.

Field studies was carried by out by Sangakkara *et al.* (2011) for testing the impact of fertilizer K on root development, seed yields, harvest indices, and N-use efficiencies of maize and mungbean, two popular small holder crops over major and minor seasons. Application of 120kg K ha^{-1} optimized all parameters of maize in the major wet season, whereas the requirement was 80 kg K ha^{-1} in the minor season. Optimal growth yields and N-use efficiencies of mungbean was with 80 kg K ha^{-1} in both seasons. Information regarding rates of fertilizer K that optimized N use and yield of maize and mungbean during each of the two tropical monsoonal seasons of South Asia is presented.

Yaqub *et al*. (2010) carried out pattern based experiment at Pakistan to evaluate the induction of short-duration (maturity period, 55-70 days) mungbean [*Vigna radiata* (L.) Wilczek] as a grain legume in the pre-rice niche of the rice-wheat annual double cropping system and found that induction of a short-duration grain legume in the rice-wheat system appears to be more attractive as it offers short-term additional benefits to farmers and is equally beneficial in sustaining the productivity of rice-wheat system over time. The mungbean crop (grown without mineral N fertilizer) produced 1,166 kg ha^{-1} of grain in addition to 4,461 kg ha^{-1} of the manure biomass (containing 52 kg N ha^{-1}) that was ploughed under before planting rice with urea-N applied in the range of 0-160 kg N ha^{-1}. Averaged across urea-N treatments, manuring significantly increased the number of tillers $plant^{-1}$ (11% increases), rice grain yield (6% increase), grain N content (4% increase) and grain N uptake (9% increase). Significant residual effects of manuring were observed on the subsequent wheat crop showing higher grain yield (21% increases), grain N uptake (29% increase) and straw yield (15% increase). The results suggested the feasibility of including mungbean in the pre-rice niche to improve the productivity of the annual rice-wheat double cropping system.

Kumar and Singh (2009) reported that balanced application of N, P, K, S, and Zn significantly increased the yield (2154 kg ha^{-1}) of Mungbean.

Sultana *et al*. (2009) reported that application of 20 kg N ha^{-1}as basal dose and 20 kg N $ha^{-1}$with one weeding at vegetative stage showed significantly higher values of all growth parameters like leaf area, shoot dry weight, number of branches $plant^{-1}$, pods $plant^{-1}$ and seed yield.

Ghosh and Jhosph (2008) observed that foliar spray of 2% DAP recorded significantly higher number of pods $plant^{-1}$, fertility coefficient, number of seeds pod^{-1}, seed yield, stover yield, test weight and harvest index over no foliar spray of DAP.

A field experiment was conducted by Ghosh *et al*. (2007) at the Fertilizer Research Station of Chandra Sekhar Azad University of Agriculture and Technology in Pura, Uttar Pradesh, during the summer season (March to June) of 2005. A maximum seed yield of 1254 kg ha^{-1} was obtained under T_9 ($N_{22}P_{60}K_{60}S_{20}Zn_{15}B_5$). Yield under T_9 was 123% above the control. Treatments supplying less N (T_8: $N_{15}P_{60}K_{60}S_{20}Zn_{15}B_5$) or no Zn ($T_{11}$: $N_{22}P_{60}K_{60}S_{20}Zn_0B_5$) provided yields that were statistically equivalent to T_9. Stover yield followed a similar trend and varied between 1068 kg ha^{-1}in the control to 2006 kg ha^{-1} under T_9.

A field experiments was conducted by Shil *et al.* (2007) on chickpea (cv. BARI Chola–5) in Calcareous Dark Grey Floodplain Soil under AEZ-11 at Jessore and Non Calcareous Grey Floodplain Soil under AEZ-13 at Rahmatpur during the rabi season of 2001–2002 and 2002–2003. The objective was to find out the optimum dose of B and Mo for yield maximization. Four levels each of B (0, 1, 2 and 2.5 kg ha^{-1}) and Mo (0, 1, 1.5 and 2 kg ha^{-1}) along with a blanket dose of N20P25K35S20Zn2 kg ha^{-1}&cowdung 5 t ha^{-1} were applied in this study. The combination of B- 2.5, Mo- 1.5 kg ha^{-1} and B-2.5, Mo-1kg ha^{-1} produced significantly higher yield in bot the years of study at Jessore and Rahmatpur, respectively.

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

Garg *et al*. (2005) reported that adequate supply of K increase the photosynthesis capacity of mungbean.

A field experiment was laid out by Oad and Buriro (2005) to determine the effect of different NPK levels (0-0-0, 10-20-20, 10-30-30, 10-30-40 and 10-40-40 kg ha^{-1}) on the growth and yield of mungbean cv. AEM 96 in Tandojam, Pakistan during the spring season of 2004. The different NPK levels significantly affected the crop parameters. The 10-30-30 kg NPK ha^{-1} was the best treatment, recording plant height of 56.3 cm, germination of 90.5%, satisfactory plant population of 162, prolonged days taken to maturity of 55.5, long pods of 5.02 cm, seed weight $plant^{-1}$ of 10.5 g, seed index of 3.52 g and the highest seed yield of 1,205 kg ha^{-1}. There was no significant change in the crop parameters beyond this level.

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

Bhattacharya *et al*. (2005) studied to assess the effect of balanced fertilization on the performance of greengram (*Vigna radiata* L.) and blackgram (*Vigna mungo*). Seven treatments included: recommended fertilizer as control ($N_0P_0K_0$) as N, NP, NPK, NPK plus 10 kg borax ha^{-1}, NPK + 1 kg ammonium molybdate ha^{-1}, and the complete N P K B Mo treatment. In both crops, plots receiving no fertilizer or N only exhibited similarly poor yields. Plots treated with the complete NPK, B, Mo treatment returned the highest green gram yield (1,398 kg ha^{-1}). A similar yield response was observed in black gram although the response to micronutrients appeared less prominent.

Janakiraman *et al*. (2004) conducted a field experiments to determine the growth and yield of groundnut and found significantly higher yield when Fe, Zn and B were applied with recommended doses of NPK fertilizers. Combined application of 50 kg N ha^{-1}, 25 kg P_2O_5ha^{-1}, 25 kg K_2O ha^{-1}along with $FeSO_4$ @10.0 kg ha^{-1}, $ZnSO_4$ @ 5.0 kg ha^{-1}and borax @ 1.0 kg ha^{-1} maximized the groundnut yield and net return.

Response of three mungbean cultivars (NM-98, NM-36-13-1-2 and NM-46-7-2) to three fertilizer levels viz., 50-0-0, 50-100-0 and 50-100-50 kg NPK ha^{-1} was studied during the autumn, 2001. The experiment was conducted by Ahmad *et al*. (2003) at Agronomic Research Area, University of Agriculture, Faisalabad. The results led to the conclusion that mungbean cultivar NM-46-7-2 applied 50-100 kg NP kg ha^{-1} produced more number of grains $plant^{-1}$, 1000-seed weight, grain yield and grain protein content than the other cultivars under study.

Samiullah and Khan (2003) reported that Potassium application not only enhanced the availability of other nutrient but also increased the photosynthetic activity and transportation of photosynthates from source to sink might be the main reason for increase in number of seed pod^{-1}.

Panda *et al*. (2003) conducted field experiments in West Bengal, India to evaluate the effects of NK application on the productivity of yambean (*Pachyrhizus erosus*)-pigeonpea (*Cajanus cajan*) intercropping system and its residual effect on the succeeding mungbean (*Vigna radiata*). Marketable tuber yield of yambean increased linearly with increasing NK levels, with the highest being recorded with NK at 80 kg ha^{-1} applied in 2 splits (22.9 t ha^{-1}) closely followed by 100 kg NK ha^{-1} applied in 2 splits (22.4 t ha^{-1}). For pigeonpea, the maximum grain (14.38 q ha^{-1}), stick (8.08 q ha^{-1}) and bhusi yield (9.96 q ha^{-1}) were recorded with 80 kg NK ha^{-1} applied in 2 splits. The highest level of NK (100 kg ha^{-1}) applied in 3 splits to yambean-pigeonpea intercropping system registered the maximum grain yield of the succeeding mungbean (9.43 q ha^{-1}), which was 33% higher than the untreated control.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the research plot of Sher-e-Bangla Agricultural University, Dhaka during the period from April, 2017 to June, 2017 to study the effect of benzyleaminopurine (BAP) and PK on growth and yield of summer mungbean (BARI mung-6). 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´ N latitude and 88^0 33´ E longitudes at an altitude of 9 m above the mean sea level. The soil is belonged to the Agro-Ecological Zone – Modhupur Tract (AEZ 28). 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-1.

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.

3.2 Plant materials

BARI mung-6:

BARI mung-6 was used as planting material. BARI mung-6 was developed by BARI released by NSB in 2003. 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 58 days after emergence. One of the main characteristics of this cultivar is synchronization of pod ripening. Average yield of this cultivar is about 1800 kg ha^{-1}. The seeds of BARI mung-6 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. The seeds had a 30% yield advantage over BARI mung-6.

3.3 Treatments

There were two factors in the experiment namely different doses of BAP and different doses of PK as mentioned below:

Factor-A: Benzyleaminopurine (BAP)- 4 levels

B_0 = 0 ppm BAP

B_{20} = 20 ppm BAP

B_{40} = 40 ppm BAP

B_{60} = 60 ppm BAP

Factor-B: PK- 3 levels

F_0= Recommended dose of NPK

F_1= Recommended dose of N+ 125% Recommended dose of PK

F_2= Recommended dose of N+ 150% Recommended dose of PK *Recommended dose of PK has been presented in section 3.6

3.4 Experimental design and layout

The experiment was laid out in a two factors 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 5.40 m^2 (3.6m ×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 17 March, 2017. Ploughing and cross ploughing were done with country plough followed by laddering. Land preparation was completed on 01^{st} April, 2017 and was ready for sowing of seeds.

3.6 Fertilizer application

The recommended dose of N, P and K were 20.27, 17 and 20 kg ha^{-1} , respectively. Nitrogen was applied as per recommendation and P and k as per treatment from urea, triple super phosphate and muriate of potash respectively, during final land preparation.

3.7 Seed sowing

Seeds were sown at the rate of 45 kg ha^{-1} in the 30 cm apart furrows on April 03, 2017 and the furrows were covered with the soils soon after seeding.

3.8 Intercultural operations

3.8.1 Weed control

Weeding was done at 20 and 35 days after sowing (DAS).

3.8.2 Thinning

Thinning was done once in all the unit plots with care so as to maintain an approximate 10 cm plant to plant distance in each plot at 15 DAS.

3.8.3 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 stages of plant growth. Due to frequent rains at later growth stages, it was essential to remove the excess water from the field.

3.8.4 Pest control

Hairy caterpillar was successfully controlled by the application of Malathion 57 EC @ 1.5 L ha^{-1} on the time of 45 DAS.

3.9 Determination of maturity

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

3.10 Harvesting and sampling

The crop was harvested at 60, 65 and 70 DAS from prefixed 1.0 m^2 areas. Before harvesting ten plants were selected randomly from each plot and were uprooted for data recording. The plants of prefixed (1 m^2) area were harvested plot wise and were bundled separately, tagged and brought to the threshing floor.

3.11 Threshing

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

3.12 Drying, cleaning and weighing

The seeds thus collected were dried in the sun for reducing the moisture in the seeds to a safe moisture level. The dried seeds and straw were cleaned and weighed.

3.13 Data recording

3.13.1 Plant height (cm)

The height of the selected plant was measured from the ground level to the tip of the plant at 20, 30,and 60, days after sowing (DAS).

3.13.2 Length and breadth of the largest leaf (cm)

Length and breadth of the largest leaf of each sample plant were recorded and sum total of them was divided by the total number of leaves of the sample plant to get the mean value.

3.13.3 Dry weight plant^{-1} (g)

The total dry matter was calculated from summation of leaves, stem, root and pod dry weight per plant.

3.13.4 Pod length (cm)

Pod length was measured in centimeter (cm) scale from randomly selected ten pods. Mean value of them was recorded as treatment wise.

3.13.5 Number of pods plant^{-1}

Number of pods plant^{-1} was counted from each selected plant sample and then averaged.

3.13.6 Number of seeds pod^{-1}

Number of seeds pod^{-1} was counted from 10 selected pod samples and then averaged.

3.13.7 1000- seed weight (g)

The 1000-seeds of each plot were counted and weighed with a digital electric balance. The 1000-seed weight was recorded in gram (g).

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

Seed yield was recorded on the basis of total harvested seeds 1m^{-2} and was expressed in terms of yield (t ha^{-1}). Seed yield was adjusted to 12% moisture content.

3.13.9 Stover yield (t ha^{-1})

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

3.13.10 Biological yield (t ha^{-1})

The biological yield was calculated with the following formula-

Biological yield= Grain yield + Stover yield

3.13.11 Harvest index (%)

Harvest index was calculated on dry basis with the help of following formula.

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

3.14 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, 1986).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to evaluate the effect of benzyleaminopurine and PK on growth and yield of summer mungbean (BARI mung-6). Results obtained from the 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 Plant height (cm)

- **Effect of BAP**

A statistically significant variation was observed on plant height of mungbean due to application of different levels of BAP at 20, 30, and 60 DAS (Figure 1). The maximum plant height was recorded with the dose of 20 ppm BAP (B_{20}) for all the sampling dates (20.29 cm, 33.92 cm and 54.40 cm, respectively at 20, 30, and 60 DAS) and that of the lowest for the control treatment comprised with no BAP application (18.74 cm, 27.17 cm and 44.59 cm at 20, 35 and 60 DAS, respectively).

- **Effect of PK**

The plant height was significantly influenced by different doses of PK at 20, 30, and 60 days after sowing. The maximum plant height (20.95 cm, 32.44 cm and 52.83 cm at 20, 30, and 60 DAS, respectively) was observed from F_1 (Recommended dose of N+ 125% recommended dose of PK) treatment. On the other hand, minimum plant height (18.59 cm, 27.61cm and 45.03 cm at 20, 30, and 60 DAS, respectively) was obtained from F_0 level of NPK application (Figure 2). Hussain *et al.* (2011) stated that increased amount of potassium levels significantly affected the plant height. Gowthmi and Rama (2013) stated that application of potassium nitrate and boric acid increased the plant height.

- **Interaction effect**

Interaction effect of BAP and PK showed statistically significant differences for plant height at 20, 30 and 60 DAS (Table 1). At 20 DAS, the tallest plant (22.00 cm) was recorded from $B_{20}F_1$ (20 ppm BAP ha^{-1} × Recommended dose of N+ 125% recommended dose of PK) and the shortest plant (17.83 cm) was recorded from B_0F_0 (0 ppm BAP ha^{-1}× Recommended dose of NPK) interaction. At 35 DAS the tallest plant (35.87 cm) was recorded from $B_{20}F_{1,}$ which was statistically similar with $B_{20}F_2$ and the shortest plant (24.47 cm) was recorded from B_0F_0, which was statistically similar with $B_{40}F_0$. At 60 DAS, the tallest plant (57.70 cm) was recorded from $B_{20}F_1$ interaction and the shortest plant (41.20 cm) was recorded from B_0F_0 interaction.

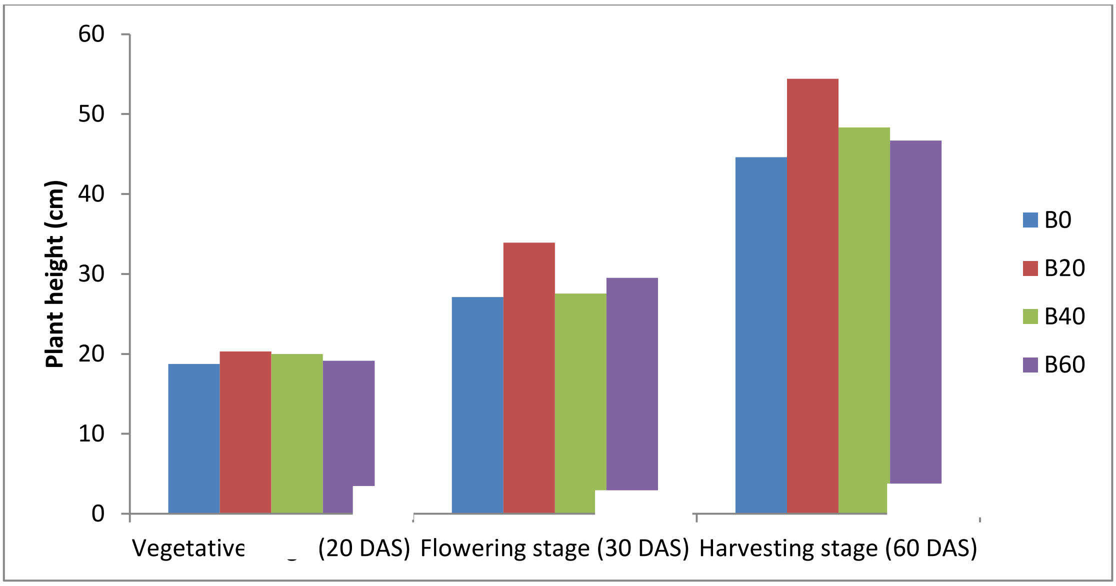

Figure 1. Effect of BAP on plant height of mungbean at vegetative,flowering and harvest Stage (LSD $_{0.05}$=0.73, 1.13 and 6.38 at 20, 30 and 60 DAS respectively)

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

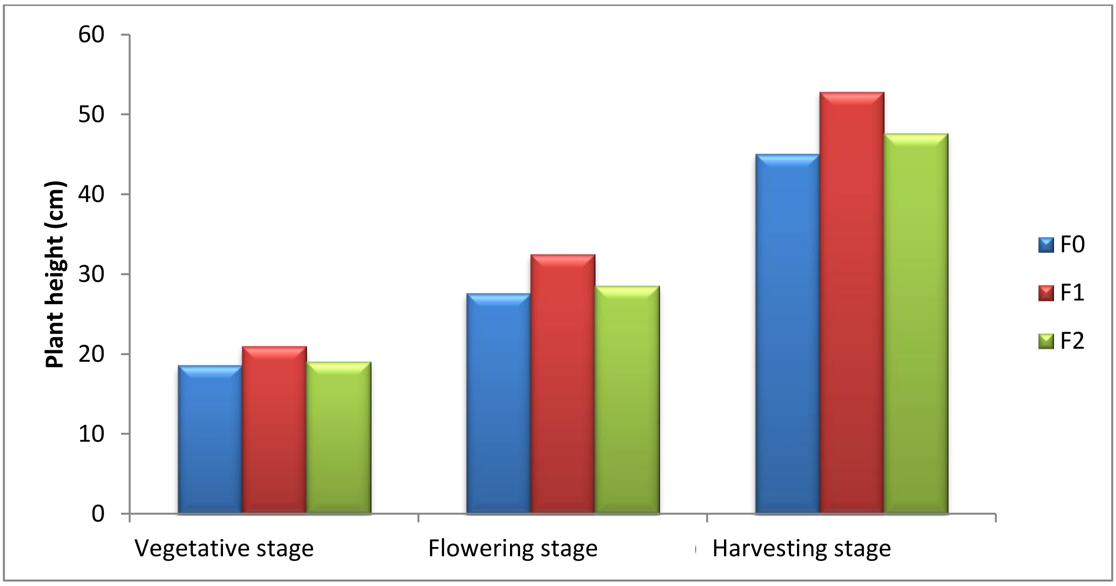

Figure 2. Effect of PK on plant height of mungbean at vegetative, flowering and harvest stage (LSD $_{0.05}$=0.92, 1.05 and 6.11 at 20, 30 and 60 DAS, respectively)

F_0= Recommended dose of NPK , F_1= Recommended dose of N+ 125% Recommended dose of PK, F_2= Recommended dose of N+ 150% Recommended dose of PK

Table 1. Interaction effect of BAP and PK on plant height of mungbean at vegetative, flowering and harvest stage

	Plant height (cm)					
Treatment	20 DAS		30 DAS		60 DAS	
B_0F_0	17.83	c	24.47	c	41.20	c
B_0F_1	19.43	a-c	31.73	a-c	47.60	a-d
B_0F_2	18.97	a-c	25.20	bc	44.97	b-d
$B_{20}F_0$	17.93	bc	32.33	ab	53.13	a-c
$B_{20}F_1$	22.00	a	35.87	a	57.70	a
$B_{20}F_2$	20.93	a-c	33.57	a	52.37	a-d
$B_{40}F_0$	20.37	a-c	24.60	c	43.80	b-d
$B_{40}F_1$	21.03	a-c	32.33	ab	54.03	ab
$B_{40}F_2$	18.50	bc	25.73	bc	47.13	a-d
$B_{60}F_0$	18.23	bc	29.03	a-c	42.00	cd
$B_{60}F_1$	21.33	ab	29.83	a-c	51.97	a-d
$B_{60}F_2$	17.83	c	29.63	a-c	46.13	a-d
LSD (0.05)	2.98		6.37		10.16	
CV (%)	9.01		16.64		16.14	

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

F_0= Recommended dose of NPK , F_1= Recommended dose of N+ 125% Recommended dose of PK, F_2= Recommended dose of N+ 150% Recommended dose of PK

4.2 Leaf length (cm)

- **Effect of BAP**

The leaf length was significantly influenced by Benzyleaminopurine (BAP). Treatment B_{20} (20 ppm BAP) produced maximum leaf length (9.86 cm) followed by S_{40} and the minimum (8.59 cm) leaf length was recorded in B_0 (control) treatment (Table 2). As the spacing was increased leaf area index was found to be increased.

- **Effect of PK**

The leaf length was significantly influenced by different levels of PK (Table 3). The highest leaf length (9.73 cm) was obtained from F_1 (Recommended dose of N+ 125% Recommended dose of PK), which was statistically similar with F_0 (Recommended dose of NPK) and the lowest (8.14 cm) was obtained from F_2 (Recommended dose of N+ 150% Recommended dose of PK).

- **Effect of interaction of BAP and PK**

Interaction effect of different doses of PK and different levels of BAP had a significant variation on leaf length. The highest leaf length (10.60 cm) was obtained from $B_{20}F_2$ (20ppm BAP ha^{-1} × Recommended dose of N+ 125% Recommended dose of PK) treatment while the lowest (7.57 cm) was recorded from B_0F_2 (0 ppm BAP ha^{-1} × Recommended dose of N+ 150% Recommended dose of PK) combination (Table 4).

Table 2. Effect of BAP on leaf length and leaf breadth of mungbean

Treatment	Leaf length (cm)	Leaf breadth (cm)
B_0	8.59 b	6.54
B_{20}	9.86 a	7.27
B_{40}	8.94 ab	7.04
B_{60}	8.86 ab	7.24
LSD (0.05)	1.15	NS
CV (%)	8.34	9.36

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

*NS = Not significant

Table 3. Effect of NPK on leaf length, leaf breadth of mungbean

Treatment	Leaf length (cm)	Leaf breadth (cm)
F_0	9.32 a	6.69
F_1	9.73 a	7.46
F_2	8.14 b	6.93
LSD (0.05)	1.08	NS
CV (%)	8.34	9.36

F_0=Recommended dose of NPK , F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK

*NS = Not significant

Table 4. Interaction effect of BAP and PK on leaf length and leaf breadth of mungbean

Treatment	Leaf length (cm)	Leaf breadth (cm)
B_0F_0	9.63 a-c	6.07 e
B_0F_1	8.57 b-d	6.80 cd
B_0F_2	7.57 d	6.77 cd
$B_{20}F_0$	10.17 ab	6.60 de
$B_{20}F_1$	10.60 a	7.93 a
$B_{20}F_2$	8.80 a-d	7.27 bc
$B_{40}F_0$	8.63 b-d	6.47 de
$B_{40}F_1$	10.07 ab	7.50 ab
$B_{40}F_2$	8.13 cd	7.17 bc
$B_{60}F_0$	8.83 a-d	7.63 ab
$B_{60}F_1$	9.67 a-c	7.60 ab
$B_{60}F_2$	8.07 cd	6.50 de
LSD (0.05)	1.60	0.50
CV (%)	8.34	9.36

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP
F_0=Recommended dose of NPK , F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK

4.3 Leaf breadth (cm)

- **Effect of BAP**

The leaf breadth was not significantly influenced by Benzyleaminopurine (BAP). Treatment B_{20} (20 ppm BAP) produced maximum leaf breadth (7.27 cm) followed by B_{60} and the minimum (6.54 cm) leaf breadth was recorded in B_0 (control) treatment (Table 2).

- **Effect of PK**

The leaf breadth was not significantly influenced by different doses of PK (Table 3). The highest leaf breadth (7.46 cm) was obtained from F_1 (Recommended dose of N+ 125% Recommended dose of PK) and the lowest (6.69 cm) was recorded from in F_0 (Recommended dose of NPK) treatments.

- **Effect of interaction of BAP and NPK**

Interaction effect of different doses of PK and different levels of BAP had a significant variation on leaf breadth. The highest leaf breadth (7.93 cm) was obtained from $B_{20}F_2$ (20 ppm BAP ha^{-1} × Recommended dose of N+ 125% Recommended dose of PK) treatment while the lowest (6.07 cm) was recorded from B_0F_0 (0 ppm BAP ha^{-1} × Recommended dose of NPK) combination (Table 4).

4.4 Plant dry weight (g)

- **Effect of BAP**

Different level of BAP application in mungbean showed significant variation in dry matter weight at all stages of sampling (Figure 3). The result showed that control treatment (without BAP) produced the lowest dry matter $plant^{-1}$ for all sampling dates. The highest weights (0.19 g, 0.39 g and 1.74 g at 20, 30 and 60 DAS, respectively) were found with the highest BAP dose (60 ppm BAP).

- **Effect of PK**

Dry matter plant^{-1} of mungbean varied significantly due to application of different levels of PK at 20, 30 and 60 DAS (Figure 4). Data showed that the F_1treatment (Recommended dose of N+ 125% Recommended dose of PK) produced the heaviest plant dry matter 0.18 g, 0.38 g and 1.54 g at 20, 30and 60 DAS, respectively.

- **Interaction effect of BAP and PK**

Interaction effect of BAP and PK showed significant variation on total dry matter plant^{-1} at 20, 30 and 60 DAS (Table 5). At 20 DAS, the highest dry matter plant^{-1} (0.21 g) was recorded from the interaction of $B_{40}F_2$ (40 ppm BAP ha^{-1}× Recommended dose of N+ 125% Recommended dose of PK) and the lowest dry matter plant^{-1} (0.14 g) was recorded from B_0F_0 (0 ppm BAP ha^{-1}× Recommended dose of NPK) interaction. The interaction of $B_{40}F_1$ also showed the highest dry weight of 0.42 g for 30 DAS, which was statistically similar with $B_{20}F_1$, $B_{60}F_0$, $B_{60}F_1$ and $B_{60}F_2$ that of the lowest was recorded with B_0F_0 interaction (0.23 g), At 60 DAS, the highest dry weight of 1.91 g was recorded from $B_{40}F_1$ interaction, which was statistically similar with $B_{60}F_0$ interaction. On the other hand, the lowest dry matter weight (0.87 g) was recorded from B_0F_0 interaction.

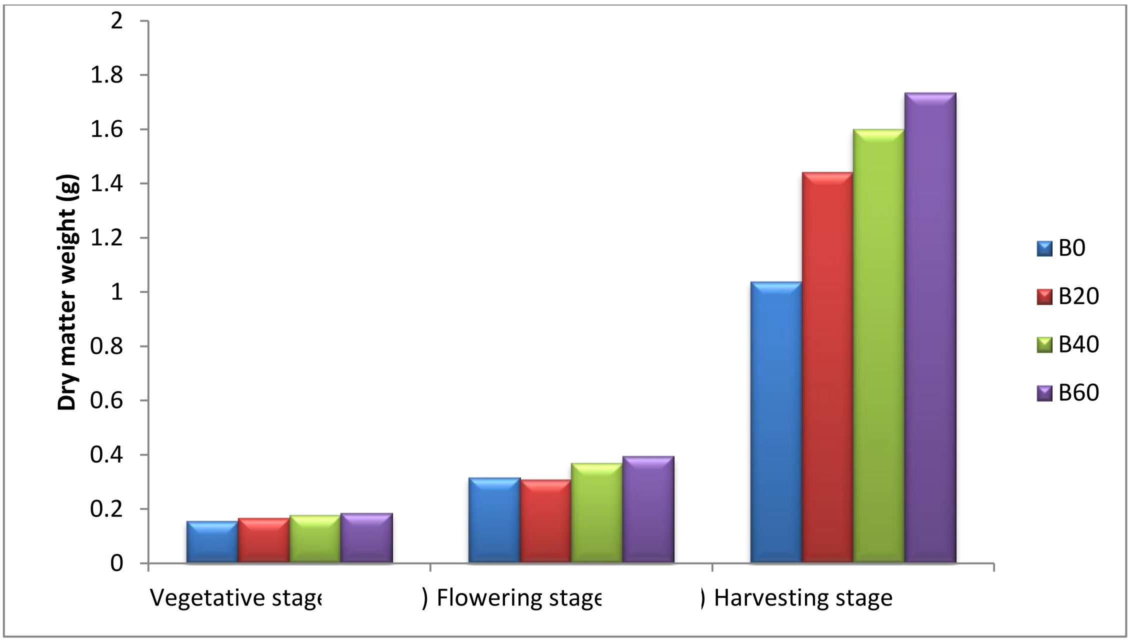

Figure 3. Effect of BAP on plant dry weight of mungbean at vegetative, flowering and harvest stage (LSD $_{0.05}$=0.037, 0.201 and 0.0228 at 20, 30 and 60 DAS, respectively)

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

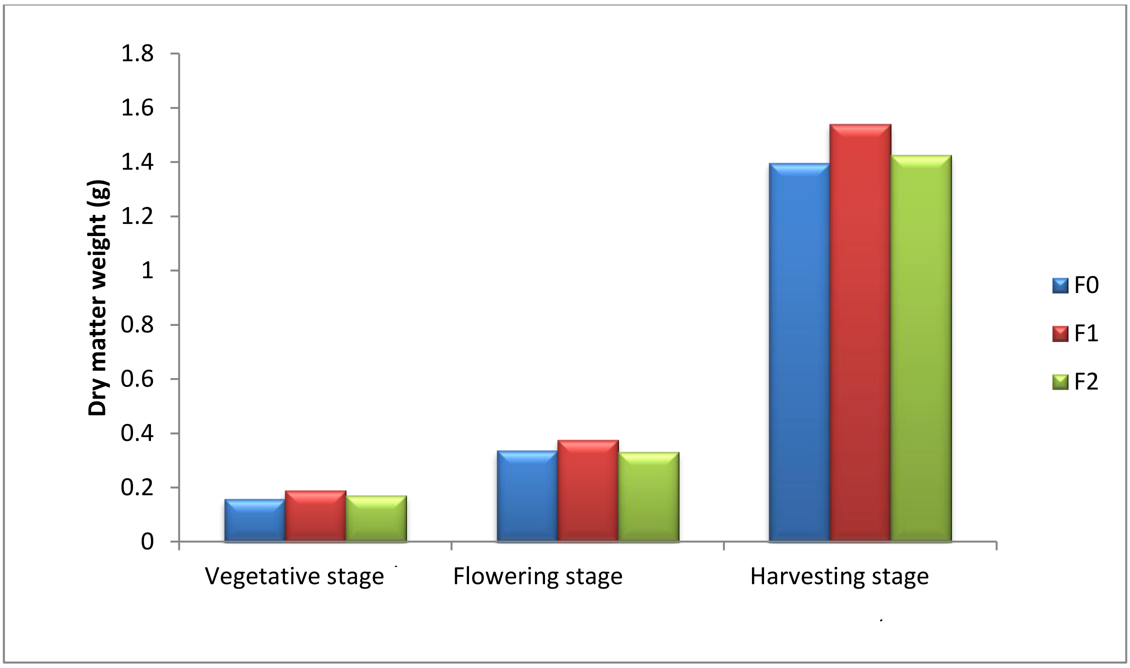

Figure 4. Effect of PK on plant dry weight of mungbean at vegetative flowering and harvest stage (LSD $_{0.05}$=0.035, 0.29 and 6.0 at 20, 30 and 60 DAS, respectively)

F_0=Recommended dose of NPK, F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK,

Table 5. Interaction effect of BAP and PK on plant dry weight of mungbean at vegetative, flowering and harvest stage

Treatment	Plant dry weight (g)					
	Vegetative stage		Flowering stage		Harvesting stage	
B_0F_0	0.14	e	0.30	ab	0.87	e
B_0F_1	0.17	b-d	0.32	ab	1.11	de
B_0F_2	0.16	c-e	0.33	ab	1.14	c-e
$B_{20}F_0$	0.16	c-e	0.32	ab	1.34	b-d
$B_{20}F_1$	0.18	bc	0.38	a	1.57	ab
$B_{20}F_2$	0.17	b-d	0.23	b	1.43	b-d
$B_{40}F_0$	0.15	de	0.34	ab	1.53	a-c
$B_{40}F_1$	0.21	a	0.42	a	1.57	ab
$B_{40}F_2$	0.17	b-d	0.35	ab	1.71	ab
$B_{60}F_0$	0.18	bc	0.38	a	1.86	a
$B_{60}F_1$	0.19	ab	0.39	a	1.91	a
$B_{60}F_2$	0.18	bc	0.41	a	1.43	b-d
LSD (0.05)	0.02		0.12		0.36	
CV (%)	6.04		10.82		14.38	

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

F_0=Recommended dose of NPK, F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK

4.5 Pod length (cm)

- **Effect of BAP**

Statistically significant variation was observed on pod length due to the application of different levels of BAP (Table 6). The maximum pod length (8.98 cm) was recorded from B_{60} (60 ppm BAP ha^{-1}), which was statistically identical with other, while the minimum pod length (7.97 cm) was recorded from B_0 (0 ppm BAP ha^{-1}).

- **Effect of PK**

Pod length was not varied significantly due to application of different doses of PK (Table 7). Among the PK treatments, the F_2 (Recommended dose of N+ 150% Recommended dose of PK) showed the highest pod length (8.71 cm). The lowest (8.47 cm) result was recorded from F_0 treatment.

- **Interaction effect of BAP and PK**

Interaction effect of BAP and PK showed statistically significant differences for pod length (Table 8). The maximum pod length (9.13 cm) was observed from $B_{60}F_2$ (60 ppm BAP ha^{-1} + Recommended dose of N+ 150% Recommended dose of PK) and the minimum pod length (7.87cm) was recorded from B_0F_0 (0 ppm BAP ha^{-1} + Recommended dose of NPK), which was statistically similar with B_0F_1 interaction.

Table 6. Effect of BAP on pod length, pods plant^{-1}, seeds pod^{-1} and 1000-seed weight of mungbean

Treatment	Pod length (cm)		Pods plant^{-1} (no.)		Seeds pod^{-1} (no.)		1000-seed weight (g)	
B_0	7.97	b	21.78	c	10.18	b	48.22	b
B_{20}	8.68	ab	34.53	a	11.39	a	56.56	a
B_{40}	8.75	ab	30.84	ab	11.21	a	50.89	b
B_{60}	8.98	a	28.93	b	11.30	a	49.33	B
LSD (0.05)	0.89		5.04		0.83		3.81	
CV (%)	5.30		11.75		6.45		9.62	

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

Table 7. Effect of PK on pod length, pods plant^{-1}, seeds pod^{-1} and 1000- seed weight of mungbean

Treatment	Pod length (cm)		Pods plant^{-1} (no.)		Seeds pod^{-1}(no.)		1000-seed weight (g)	
F_0	8.60	a	28.45	b	10.90	b	48.25	b
F_1	8.47	a	29.49	a	11.36	a	54.33	a
F_2	8.71	a	29.14	ab	10.83	b	51.17	ab
LSD (0.05)	1.43		0.92		0.47		5.27	
CV (%)	5.30		11.75		6.45		9.62	

F_0=Recommended dose of NPK , F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK

Table 8. Interaction effect of BAP and PK on pod length, pods pod^{-1}, seeds pod^{-1} and 1000- seed weight of mungbean

Treatment	Pod length (cm)		Pods plant^{-1} (no.)		Seeds pod^{-1} (no.)		1000-seed weight (g)	
B_0F_0	7.87	c	19.67	d	9.43	c	45.33	c
B_0F_1	7.87	c	22.87	cd	10.87	ab	53.33	a-c
B_0F_2	8.17	bc	22.80	cd	10.23	bc	46.00	c
$B_{20}F_0$	8.92	ab	34.13	ab	11.50	ab	55.00	a-c
$B_{20}F_1$	8.63	a-c	34.80	a	11.70	a	58.00	a
$B_{20}F_2$	8.50	a-c	34.67	a	11.13	ab	56.67	ab
$B_{40}F_0$	8.59	a-c	30.93	ab	11.32	ab	47.33	bc
$B_{40}F_1$	8.63	a-c	30.40	ab	11.33	ab	54.00	a-c
$B_{40}F_2$	9.03	ab	31.20	ab	10.98	ab	51.33	a-c
$B_{60}F_0$	9.03	ab	29.07	ab	11.23	ab	45.33	c
$B_{60}F_1$	8.77	ab	29.87	ab	11.53	ab	52.00	a-c
$B_{60}F_2$	9.13	a	27.87	bc	10.97	ab	50.67	a-c
LSD (0.05)	0.77		5.77		1.20		8.35	
CV (%)	5.30		11.75		6.45		9.62	

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

F_0=Recommended dose of NPK , F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK

4.6 Pods plant^{-1}

- **Effect of BAP**

Different doses of BAP showed significant variation in respect of number of pods plant^{-1} (Table 6). Among the different doses, B_{20} (20 ppm BAP ha^{-1}) showed the highest number of pods plant^{-1} (34.53), which was statistically identical with that of other treatment and the minimum number of pods plant^{-1} (21.78) was recorded from B_0 (0 ppm BAP ha^{-1}).

- **Effect of PK**

Number of pods plant^{-1} of mungbean varied significantly due to application of different levels of PK. The maximum number of pods plant^{-1} (29.49) was recorded from F_1 (Recommended dose of N+ 125% Recommended dose of PK), while the minimum number of pods plant^{-1} (28.45) was recorded from F_0 (Recommended dose of NPK) (Table 7). Tank *et al*. (1992) found that mungbean fertilized with 50 kg N ha^{-1} along with 40 kg P_2O_5 ha^{-1} produced significantly higher number of pods plant^{-1} over the unfertilized control.

- **Interaction effect of BAP and PK**

Interaction effect of BAP and PK showed statistically significant differences for number of pods plant^{-1}. The maximum number of pods plant^{-1} (34.80) was recorded from $B_{20}F_1$ (20 ppm BAP ha^{-1} × Recommended dose of N+ 125% Recommended dose of PK) which was statistically similar with the interaction of $B_{20}F_2$. Significantly the lowest number of pods plant^{-1} (19.67) was observed in

B_0F_0 (0 ppm BAP ha^{-1} × Recommended dose of NPK) treatment combination (Table 8).

4.7 Seeds pod^{-1}

- **Effect of BAP**

Significant variation was observed in number of seeds pod^{-1} of mungbean due to different doses of BAP application (Table 6). The maximum seeds pod^{-1} (11.39) was recorded from B_{20} (20 ppm BAP ha^{-1}), which was statistically similar with of B_{40} (40 ppm BAP ha^{-1}) and B_{60} (60 ppm BAP ha^{-1}) (11.21 and 11.30, respectively) while the minimum number of seeds pod^{-1} (10.18) was recorded from B_0 (0 ppm BAP ha^{-1}).

- **Effect of PK**

Different doses of PK had significant effect on number of seeds pod^{-1}(Table 7). Among the different doses, F_1 (Recommended dose of N+ 125% Recommended dose of PK) showed the highest number of seeds pod^{-1} (11.36) which was statistically identical with other treatment. On the contrary, the lowest number of seeds pod^{-1} (10.83) was observed with F_2 (Recommended dose of N+ 150% Recommended dose of PK) treatment.

- **Interaction effect of BAP and PK**

The combined effect of different doses of BAP and PK on number of seeds pod^{-1} of mungbean was significant (Table 8). The highest number of seeds pod^{-1} (11.70) was recorded from $B_{20}F_1$ (20 ppm BAP ha^{-1}× Recommended dose of N+ 125% Recommended dose of PK) treatment combination. On the other hand, the lowest number of seeds pod^{-1} (9.43) was found in B_0F_0 (0 ppm BAP ha^{-1}× Recommended dose of NPK) treatment.

4.8. 1000-seed weight (g)

- **Effect of BAP**

Weight of 1000- seed differed significantly due to application of different levels of BAP on mungbean (Table 6). The maximum weight of thousand seeds (56.56 g) was recorded from B_{20} (20 ppm BAP ha^{-1}), while the minimum weight of thousand seeds (48.22 g) was recorded from B_0 (0 ppm BAP ha^{-1}), which was statistically similar with of B_{40} (40 ppm BAP ha^{-1}) and B_{60} (60 ppm BAP ha^{-1}) treatments.

- **Effect of PK**

Weight of 1000- seed differed significantly due to application of different levels of PK on mungbean (Table 7). The highest weight of 1000- seed (54.33 g) was observed by applying PK at F_1 (Recommended dose of N+ 125% Recommended dose of PK). PK treated plots showed statistically higher thousand seed weight than control plots (no PK). Among the PK treated plots there observed a statistically similar result, although the values are numerically different. Mahboob and Asghar (2002) studied the effect of seed inoculation at different nitrogen levels on mungbean at the Agronomic Research Station, Farooqabad in Pakistan. They revealed that various yield components like 1000 grain weight was affected significantly with 50-50-0 kg N-P-K ha^{-1} application. Again they revealed that seed inoculation with 50-50-0 kg N-P-K ha^{-1} exhibited superior performance in respect of seed yield (955 kg ha^{-1}).

- **Interaction effect of BAP and PK**.

Interaction effect of BAP and PK showed statistically significant difference for 1000- seed weight (Table 8). The maximum 1000 seed weight (58.00 g) was recorded from $B_{20}F_1$ (20ppm BAP ha^{-1}× Recommended dose of N+ 125% Recommended dose of PK) and that of minimum (45.33 g) from the interaction of B_0F_0 (0 ppm BAP ha^{-1}× Recommended dose of NPK), which was statistically similar with B_0F_2 and $B_{60}F_0$ treatment combinations (Table 8).

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

Effect of BAP

Seed yield showed significant variation due to different level of BAP application in mungbean (Figure 5). All doses of BAP showed increase of seed yield over control. However, significantly the highest increase was observed in the highest seed yield (1.00 t ha^{-1}) obtained from B_{20} treatment (20 ppm BAP). On the other hand, the lowest seed yield (0.81 t ha^{-1}) was observed from B_0 treatment (control).

- **Effect of PK**

Effect of different levels of PK on seed yield $hectare^{-1}$ of mungbean was significant (Figure 6). The highest seed yield (1.00 t ha^{-1}) was recorded from F_1 (Recommended dose of N+ 125% Recommended dose of PK). The minimum seed yield (0.82 t ha^{-1}) was recorded from F_0 treatment. Malik *et al*. (2006)

reported that phosphorus application at 40 kg P ha^{-1} affected the crop positively, while rates below and above this rate resulted in non-significant effects. Bhattacharya *et al.* (2005) observed the highest seed yield with 90 kg P ha^{-1}, which was as per with 60 kg P ha^{-1} and both were significantly superior to 30 kg P ha^{-1}. Likewise, 60 kg P ha^{-1} significantly improved the yield attributes except test weight compared to the control condition.

- **Interaction effect of BAP and PK**

Seed yield of mungbean varied significantly due to the interaction of BAP and PK. It appears that treatment combination of $B_{20}F_1$ (20 ppm BAP ha^{-1}× Recommended dose of N+ 125% Recommended dose of PK) produce significantly the highest seed yield (1.13 t ha^{-1}) and the minimum seed yield (0.63 t ha^{-1}) was observed from B_0F_0 (0 ppm BAP ha^{-1}× Recommended dose of NPK) treatment (Table 11).

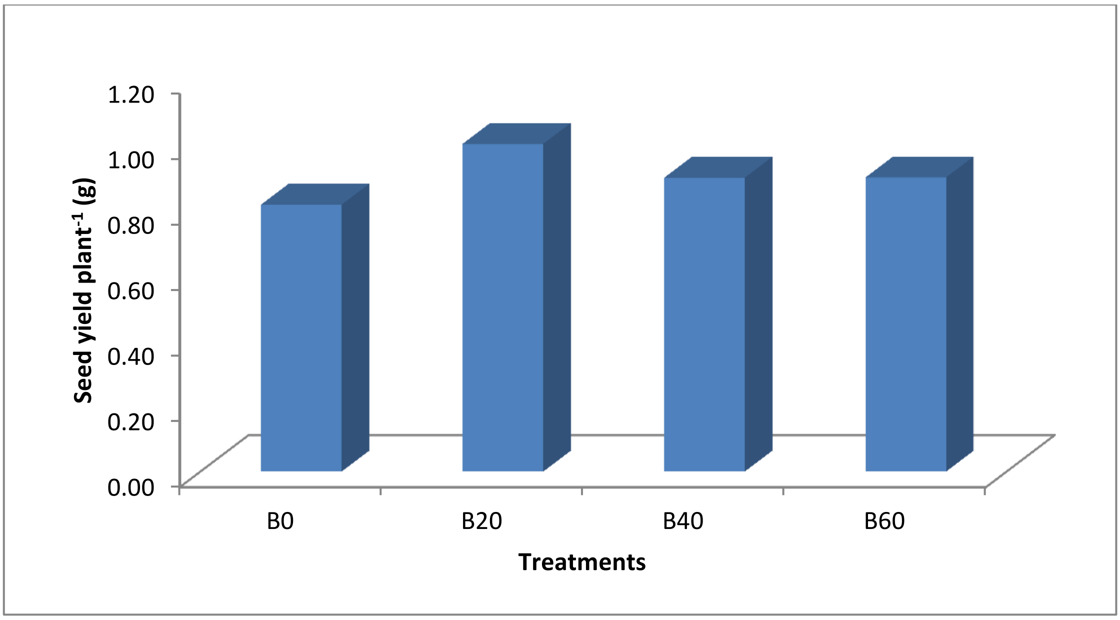

Figure 5. Effect of BAP on seed yield plant^{-1} of mungbean (LSD $_{0.05}$=3.45)

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

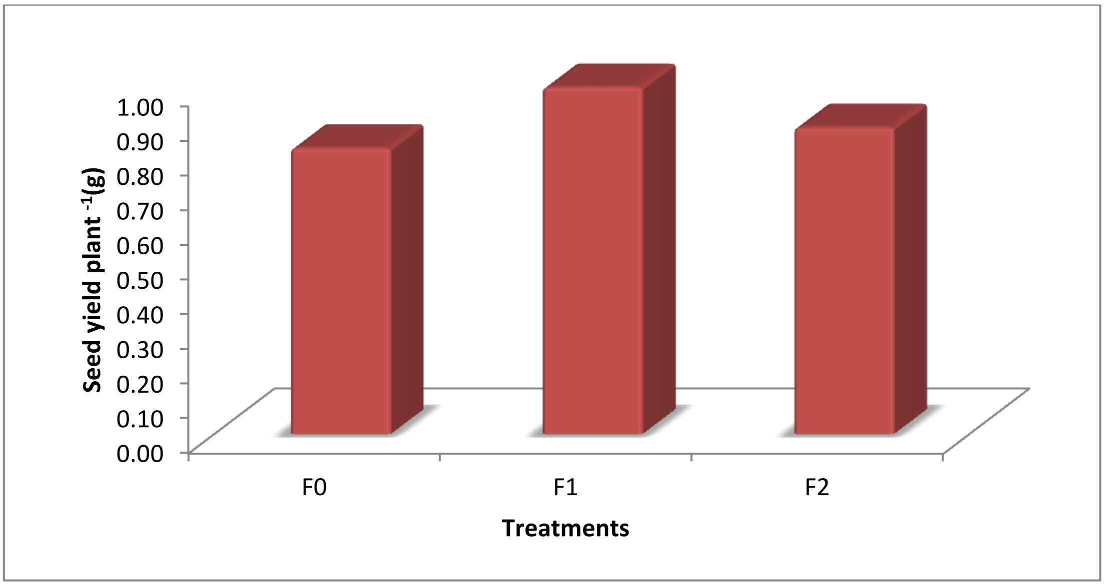

Figure 6. Effect of PK on seed yield plant^{-1} of mungbean (LSD $_{0.05}$=1.812)

F_0=Recommended dose of NPK , F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK

Table 9. Effect of BAP on stover yield, biological yield and harvest index of mungbean

Treatment	Stover yield (tha^{-1})	Biological yield (tha^{-1})	Harvest index (%)
B_0	0.70 c	1.51 b	53.94 a
B_{20}	1.27 a	2.27 a	44.06 b
B_{40}	1.23 a	2.13 ab	42.10 b
B_{60}	1.20 b	2.10 ab	42.75 b
LSD (0.05)	0.12	0.36	8.13
CV (%)	5.27	9.22	8.67

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

Table 10. Effect of PK on stover yield, biological yield and harvest index of mungbean

Treatment	Stover yield (tha^{-1})	Biological yield (tha^{-1})	Harvest index (%)
F_0	0.54 c	1.36 b	60.60 a
F_1	1.77 a	2.76 a	36.20 c
F_2	0.99 b	1.88 b	46.99 b
LSD (0.05)	0.11	0.85	10.32
CV (%)	5.27	9.22	8.67

F_0=Recommended dose of NPK , F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK

Table 11. Interaction effect of BAP and PK on seed yield, stover yield, biological yield and harvest index of mungbean

Treatment	Seed yield (tha^{-1})		Stover yield (tha^{-1})		Biological yield (tha^{-1})		Harvest index (%)	
B_0F_0	0.63	c	0.50	h	1.14	g	55.73	bc
B_0F_1	0.92	ab	0.91	e	1.84	e	50.18	cd
B_0F_2	0.89	b	0.68	f	1.57	ef	56.57	bc
$B_{20}F_0$	0.99	ab	0.44	i	1.43	fg	69.01	a
$B_{20}F_1$	1.13	a	2.43	a	3.56	a	31.66	f
$B_{20}F_2$	0.89	b	0.93	e	1.82	e	48.72	cd
$B_{40}F_0$	0.79	bc	0.63	fg	1.42	fg	55.51	bc
$B_{40}F_1$	0.99	ab	1.66	c	2.67	c	37.39	ef
$B_{40}F_2$	0.91	b	1.39	d	2.30	d	39.43	e
$B_{60}F_0$	0.89	b	0.58	g	1.47	fg	60.32	b
$B_{60}F_1$	0.96	ab	2.06	b	3.02	b	31.68	f
$B_{60}F_2$	0.85	b	0.96	e	1.81	e	46.88	d
LSD (0.05)	0.19		0.05		0.31		7.14	
CV (%)	10.05		5.27		9.22		8.67	

B_0=0 ppm BAP, B_{20}=20 ppm BAP, B_{40}=40 ppm BAP, B_{60}=60 ppm BAP

F_0=Recommended dose of NPK , F_1=Recommended dose of N+ 125% Recommended dose of PK, F_2=Recommended dose of N+ 150% Recommended dose of PK

4.10 Stover yield (t ha^{-1})

- **Effect of BAP**

Application of different doses of BAP showed significant variation in terms of stover yield of mungbean (Table 9).The highest stover yield (1.27 t ha^{-1}) was obtained from the B_{20} (20 ppm BAP), which was statistically similar with B_{40} (40 ppm BAP) treatments. The control treatment showed significantly the lowest stover yield (0.70 t ha^{-1}).

- **Effect of PK**

Stover yield of mungbean varied significantly due to application of different levels of PK (Table 10). The maximum stover yield 1.77 t ha^{-1} was recorded from F_1 (Recommended dose of N+ 125% recommended dose of PK), which was statistically identical with F_2 (Recommended dose of N+ 150% recommended dose of PK) (0.99 t ha^{-1}). While the minimum stover yield (0.54 ha^{-1}) was recorded from F_0 (Recommended dose of NPK) treated plots.

- **Interaction effect of BAP & PK**

It was observed that interaction effect of BAP and NPK showed significant differences to produce stover yield (Table 12).The maximum stover yield (2.43 t ha^{-1}) was recorded from $B_{20}F_1$ (20 ppm BAP ha^{-1}× Recommended dose of N+ 125% Recommended dose of PK) and the minimum stover yield (0.44 t ha^{-1}) was observed from $B_{20}F_0$ (B_{20}=20 ppm Recommended dose of NPK) (Table 12).

4.11 Biological yield (t ha^{-1})

- **Effect of BAP**

A statistically significant difference was recorded for biological yield of mungbean due to the application of different level of BAP (Table 9). The highest biological yield (2.27 t ha^{-1}) was recorded from B_{20} (20 ppm BAP) which was statistically identical with other treatment. The minimum biological yield (1.51 t ha^{-1}) was recorded from B_o (0 ppm) treatment.

- **Effect of PK**

Application on PK fertilizer exerted significant influence on the biological yield of mungbean (Table 10). The maximum biological yield (2.76t ha^{-1}) was recorded from F_1 treatment. Application of recommended dose of NPK (F_0 treatment) gave the lowest biological yield (1.36 t ha^{-1}), which was statistically similar with F_2 treatment.

- **Interaction effect of BAP and PK**

Biological yield of mungbean varied significantly due to interaction of BAP and PK (Table 11). The maximum biological yield $hectare^{-1}$ (3.56 t) was recorded from $B_{20}F_1$ (20 ppm BAP ha^{-1}× Recommended dose of N+ 125% Recommended dose of PK) and the minimum biological yield $hectare^{-1}$ (1.14 t) was recorded from B_0F_0 (20 ppm BAP with Recommended dose of NPK).

4.12 Harvest index (%)

- **Effect of BAP**

BAP had a significant effect on the harvest index of mungbean (Table 9). The maximum harvest index (53.94%) was observed by applying BAP at 20 ppm. The lowest harvest index (42.10%) was recorded from B_{40} (40 ppm BAP), which was statistically similar with B_{20} and B_{60}.

- **Effect of PK**

Application of different doses of PK showed significant variation in terms of harvest index of mungbean (Table 10). The highest harvest index (60.60%) was found with F_0 treatment, the lowest harvest index (36.20%) was recorded from F_1 treatment.

- **Interaction effect of BAP & PK**

Harvest index in mungbean was also significantly varied due to variation of different level of BAP and PK combination (Table 11). The maximum harvest index (69.01%) was recorded from $B_{20}F_0$ (20 ppm BAP + Recommended dose of NPK) and the minimum harvest index (33.66%) was recorded from $B_{20}F_{1,}$ which was statistically similar with $B_{60}F_1$ treatment combination.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the research plot of Sher-e-Bangla Agricultural University, Dhaka during the period from April to June, 2017 to study the effect of benzyleaminopurine (BAP) and PK on growth and yield of summer mungbean (BARI mung-6). In this experiment, the treatment consisted of four levels of BAP *viz.* B_0 = 0 ppm BAP, B_{20} = 20 ppm BAP, B_{40} = 40 ppm BAP and B_{60} = 60 ppm BAP and three different doses of PK viz. F_0= Recommended dose of NPK, F_1= Recommended dose of N+ 125% Recommended dose of PK, F_2= Recommended dose of N+ 150% Recommended dose of PK. The experiment was laid out in a two factors randomized complete block design (RCBD) with three replications. Data on different growth parameters and yield contributing parameters of mungbean were recorded. The collected data were statistically analyzed for evaluation of the treatment effect. A significant variation among the treatment was found while different concentration of BAP and PK were applied.

A statistically significant variation was observed for plant height of mungbean due to application of different levels of BAP at 20, 30, and 60 DAS (Table 1). The maximum plant height was recorded with the dose of 20 ppm BAP (B_{20}) (20.29 cm, 33.92 cm and 54.40 cm, respectively for 20, 30, and 60 DAS).The leaf length was significantly influenced by Benzyleaminopurine (BAP). Treatment B_{20} (20 ppm BAP) produced maximum leaf length (9.86 cm). The leaf breadth was not significantly influenced by Benzyleaminopurine (BAP). Treatment B_{20} (20 ppm BAP) produced maximum leaf breadth (7.27 cm). Different levels of BAP application in mungbean showed significant variation in dry matter weight at all stages of the sampling. Different doses of BAP exerted showed significant variation in respect of number of pods plant^{-1}. Among the different doses, B_{20} (20 ppm BAP ha^{-1}) showed the highest number of pods plant^{-1} (34.53). Statistically significant variation was observed on pod length due to the application of different levels of BAP. The maximum pod length (8.98 cm) was recorded from B_{60} (60 ppm BAP ha^{-1}). The maximum seeds pod^{-1} (11.39), thousand seed weight (56.56 g) were recorded from 20 ppm BAP. Seed yield showed significant variation due to different levels of BAP application in mungbean. The highest increase was observed in the highest seed yield (1.00 t ha^{-1}). The highest stover yield (1.27 t ha^{-1}) and the highest biological yield hectare^{-1} (2.27 t ha^{-1}) and harvest index (53.94%)was obtained from the B_{20} (20 ppm BAP) treatment.

Plant height was significantly influenced by PK. The maximum plant height (20.95 cm, 32.44 cm and 52.83 cm at 20, 30, and 60 DAS, respectively) was observed at F_1 (Recommended dose of N+ 125% recommended dose of PK) treatment. The leaf length was significantly influenced by different levels of PK. The highest leaf length (9.73 cm) was obtained from F_1 (Recommended dose of N+ 125% recommended dose of PK).The leaf breadth was not significantly influenced by different levels of PK. The highest leaf breadth (7.46 cm) was obtained from F_1 (Recommended dose of N+ 125% recommended dose of PK) treatment. Dry matter plant^{-1} of mungbean varied significantly due to application of different doses of PK at 20, 30 and 60 DAS. Data showed that the F_1 treatment (Recommended dose of N+ 125% recommended dose of PK) produced the heaviest plant dry matter 0.18 g, 0.38 g and 1.54 g at 20, 30and 60 DAS, respectively. Number of pods plants^{-1} of mungbean varied significantly due to application of different doses of PK. The maximum number of pods plant^{-1} (29.49) was recorded from F_1 (Recommended dose of N+ 125% recommended dose of PK) treatment. Pod length was not varied significantly due to application of different doses of PK. Among the PK treatments plots, the F_2 (Recommended dose of N+ 150% recommended dose of PK) treatment showed the highest pod length (8.71 cm). Different doses of PK had significant effect on number of seeds pod^{-1}, weight of 1000 seed. Among the different doses, F_1 treatment (Recommended dose of N+ 125% recommended dose of PK) showed the highest number of seeds pod^{-1} (11.36), weight of 1000 seed (54.33 g). Effect of different doses of PK on seed yield hectare^{-1} of mungbean was significant. The highest seed yield (1.00 t ha^{-1}) was recorded from F_1 (Recommended dose of N+ 125% Recommended dose of PK) treatment. The maximum stover yield (1.77 t ha^{-1}) and biological yield (2.76 t ha^{-1}) were recorded from F_1 (Recommended dose of N+ 125% Recommended dose of PK) treatment. The highest harvest index (60.60%) was found from F_0 treatment.

Interaction effect of BAP and PK had a significant variation on all parameter. The tallest plant (22.00 cm, 35.87 cm and 57.70 cm at 20, 30 and 60 DAS, respectively) was recorded from $B_{20}F_1$ (20 ppm BAP ha^{-1} × Recommended dose of N+ 125% Recommended dose of PK) treatment combination. The highest leaf length (10.60 cm) was obtained from $B_{20}F_2$ (20 ppm BAP ha^{-1} × Recommended dose of N+ 125% Recommended dose of PK) treatment. The highest leaf breadth (7.93 cm) was obtained from $B_{20}F_2$ (20 ppm BAP ha^{-1} × Recommended dose of N+ 125% Recommended dose of PK) treatment. At 20 DAS, the highest dry matter $plant^{-1}$ (0.21 g) was recorded from the interaction of $B_{40}F_2$ (40 ppm BAP ha^{-1}× Recommended dose of N+ 125% Recommended dose of PK). The interaction of $B_{40}F_1$ also showed the highest dry weight at 0.42g at 30 DAS. The highest dry weight of 1.91g was recorded from $B_{40}F_1$ interaction. The maximum number of pods $plant^{-1}$ (34.80) was recorded from $B_{20}F_1$ (20 ppm BAP ha^{-1} × Recommended dose of N+ 125% Recommended dose of PK). The maximum pod length (9.13 cm) was observed from $B_{60}F_2$ (60 ppm BAP ha^{-1} Recommended ×dose of N+ 150% Recommended dose of PK). The highest number of seeds pod^{-1} (11.70) was recorded from $B_{20}F_1$ (20 ppm BAP ha^{-1}× Recommended dose of N+ 125% Recommended dose of PK) treatment combination. The maximum

1000 seed weight (58.00 g) was recorded from $B_{20}F_1$ (20 ppm BAP $ha^{-1}\times$ Recommended dose of N+ 125% Recommended dose of PK). The treatment combination of $B_{20}F_1$ (20 ppm BAP $ha^{-1}\times$ Recommended dose of N+ 125% Recommended dose of PK) produce significantly the highest yield (1.13 t ha^{-1}). The maximum stover yield (2.43 t ha^{-1}) was recorded from $B_{20}F_1$ (20 ppm BAP $ha^{-1}\times$ Recommended dose of N+ 125% Recommended dose of PK) treatment combination. The maximum biological yield $hectare^{-1}$ (3.56 t) was recorded from $B_{20}F_1$ (20 ppm BAP $ha^{-1}\times$ Recommended dose of N+ 125% Recommended dose of PK). The maximum harvest index (69.01%) was recorded from $B_{20}F_0$ (20 ppm BAP + Recommended dose of NPK) treatment combination.

From the above findings it can be concluded that most of the parameters gave the best performance which was achieved from B_{20}, 20 ppm BAP. Again, application of recommended dose of N+ 125% Recommended dose of PK showed the best performance regarding most of the yield and yield contributing parameters. In case of combined effect, 20 ppm BAP and Recommended dose of N+ 125% Recommended dose of PK gave the best result considering yield and yield contributing parameters. The highest seed yield 1.13 t ha^{-1} was obtained from 20 ppm BAP and Recommended dose of N+ 125% recommended dose of PK. So, this treatment combination ($B_{20}F_1$) can be treated as the best treatment under the present study.

CHAPTER VI

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APPENDICES

Appendix I. 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 Resource Development Institute (SRDI), Khamarbari, Dhaka

Appendix II. Analysis of variance of the data on plant height, leaf length and leaf breadth of mungbean as influenced by BAP, PK and their interaction

Sources of variation	Degrees of freedom	Mean square				
		Plant height			leaf length	leaf breadth
		20 DAS	30 DAS	60 DAS		
Replication	1	22.44	71.22	66.00	1.81	6.57
Factor A	2	3.38*	86.81*	145.23*	2.73*	1.01*
Factor B	4	18.72*	4.09*	127.21*	8.11*	0.67 NS
AB	6	4.90*	35.47*	36.03*	0.90*	1.09*
Error	-7	3.10	24.14	61.32	6.60	1.85

NS-non significant

* = Significant at 5% level of probability

Appendix III. Analysis of variance of the data on plant dry weight of mungbean as influenced by BAP, PK and their interaction

Sources of variation	Degrees of freedom	Mean square		
		Dry matter weight		
		20 DAS	30 DAS	60 DAS
Replication	1.00	0.001	0.003	0.12
Factor A	2.00	0.001 NS	0.016*	0.82*
Factor B	4.00	0.001 NS	0.007*	0.07 NS
AB	6.00	0.001*	0.005*	0.09*
Error	-7.00	0.002	0.005	0.04

NS-non significant

* = Significant at 5% level of probability

Appendix IV. Analysis of variance of data on pod length, yield contributing characters and 1000-seed weight of mungbean as influenced by BAP and PK

Sources of variation	Degrees of freedom	Mean square			
		Number of pod per plant	Pod length	Number of seed per plant	Thousand seed weight
Replication	1.00	44.46	3.26	2.14	37.00
Factor A	2.00	258.55*	1.72 NS	2.88*	123.36*
Factor B	4.00	4.77*	0.17 NS	0.13*	2.25*
AB	6.00	3.06*	0.12	0.70*	44.92*
Error	-7.00	11.62	0.21	0.51	24.30

NS-non significant

* = Significant at 5% level of probability

Appendix V. Analysis of variance of the data on yields and harvest index of mungbean as influenced by BAP, PK and their interaction

Sources of variation	Degrees of freedom	Mean square			
		Seed yield	Stover yield	Biological yield	Harvest index
Replication	1.00	0.139	0.325	0.046	628.474
Factor A	2.00	0.004*	0.649*	0.669*	297.159*
Factor B	4.00	0.019*	1.087*	1.008*	569.238*
AB	6.00	0.071*	1.631*	2.157*	546.464*
Error	-7.00	0.033	0.001	0.034	17.783

* = Significant at 5% level of probability