YIELD AND ECONOMICS OF MUNGBEAN AS INFLUENCED BY ORGANIC AND INORGANIC FERTILIZER MANAGEMENT

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JUNE, 2020

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Reg. No. 13 05272

A Thesis
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 (MS)
IN
AGRONOMY
SEMESTER: JANUARY– JUNE, 2018

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CERTIFICATE

This is to certify that thesis entitled ***"YIELD AND ECONOMICS OF MUNGBEAN AS INFLUENCED BY ORGANIC AND INORGANIC FERTILIZER MANAGEMENT"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE*** *in* ***AGRONOMY,*** *embodies the result of a piece of bona fide research work carried out by* ***MAHFUZA MUNTAHA****, Registration No.* ***13- 05272*** *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.

……………………………………………

Prof. Dr. Md. Abdullahil Baque
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Dated: June, 2020

Place: Dhaka, Bangladesh

Dedicated

to

My Beloved Parents

ACKNOWLEDGEMENTS

All praises are devoted to ***Almighty Allah****, the most gracious, the most merciful, the beneficent, the lord of the Day of Judgment and the supreme ruler of the universe, who enabled the author to complete the thesis successfully for the degree of Master of Science (MS) in Agronomy.*

The author expresses her deepest sense of gratitude, immense indebtedness and profound appreciation to her research supervisor ***Dr. Md. Abdullahil Baque****, Professor, Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka for planning the research work, vigilant supervision, constructive suggestions, sympathetic encouragement to conduct the research work as well as preparation and for going through the manuscript of the thesis.*

She also expresses her grateful appreciation and deep sense of respect to her research co-supervisor ***Dr. H. M. M. Tariq Hossain,*** *Professor***,** *Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka for proper guidance, continuous advice, painstaking suggestions, kind help and worthfull encouragement during the course of research work and preparation of this manuscript.*

She is immensely indebted to ***Prof. Dr. Md. Shahidul Islam****, Chairman, Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka for providing his help, heartiest co-operation, valuable advice, facilities and supports to conduct the experiment.*

The author would like to express her deepest respect and boundless gratitude to all the respected teachers of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207, for the valuable teaching, sympathetic co-operation and inspirations throughout the course of this study and suggestions and encouragement to research work. The author would like to express her cordial thanks to the departmental and field staffs for their active help during the experimental period.

Grateful thanks are expressed to all of her friends especially Md. Tadrisul Islam Talha, Md. Mehedi Hasan Sumon for their active encouragement, inspiration, direct and indirect help in the endeavor to complete this thesis.

At last but not the least, the author wishes to express her profound gratitude and deepest appreciation to her parents and all other maternal and paternal relatives for their ever ending prayer, encouragement, sacrifice and dedicated efforts to educate her to this level.

The Author

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ABSTRACT

An experiment was carried out at Sher-e-Bangla Agricultural University Agronomy field, Dhaka to investigate the yield and economics of mungbean as influenced by organic and inorganic fertilizer management during the period from October to December, 2018. The experiment comprised 12 different treatments with organic and inorganic fertilizer and their combinations viz., F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% Recommended Dose of Fertilizer (NPKSZnB) , F_3 = Vermicompost + 75% Recommended Dose of Fertilizer (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % Recommended Dose of Fertilizer (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control (no fertilizer). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The variety, BARI Mung-6 was used in this experiment as the test crop. Plant height, branches plant^{-1}, nodules plant^{-1}, pods plant^{-1}, pod length, seeds pod^{-1}, weight of 1000 seed, seed yield, stover yield, biological yield and harvest index, economics analysis were tested under different treatments. Results revealed that, F_3 treatment produced higher pod length (9.81 cm), number of pod plant^{-1} (9.53), number of seeds pod^{-1} (11.27), 1000- seed weight (71.90 g), seed yield (1.87 t ha^{-1}), stover yield (3.14 t ha^{-1}), Biological yield (5.01 t ha^{-1}). The treatments F_2 and F_9 also showed statistically similar results in respect of yield and yield contributing characters. The highest and comparable net returns was obtained with the application of vermicompost + 75% RDF (Tk. 90778 ha^{-1}) followed by Recommended Dose of Fertilizer (Tk. 69359 ha^{-1}). The treatment influenced significantly on most of the growth, yield parameters of mungbean. Application of Vermicompost and 75% RDF (F_3) treatment could be the best fertilizer management for cultivation of mungbean for higher yield.

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LIST OF ACRONYMS

AEZ = Agro-Ecological Zone

BARI = Bangladesh Agricultural Research Institute

BBS = Bangladesh Bureau of Statistics

FAO = Food and Agriculture Organization

N = Nitrogen

et al. = And others

TSP = Triple Super Phosphate

MoP = Muriate of Potash

RCBD = Randomized Complete Block Design

DAS = Days after Sowing

ha^{-1} = Per hectare

g = gram (s)

kg = Kilogram

SAU = Sher-e-Bangla Agricultural University

SRDI = Soil Resources and Development Institute

wt = Weight

LSD = Least Significant Difference

^{0}C = Degree Celsius

S = Sulfer

B = Boron

Zn = Zinc

% = Percent

NPK = Nitrogen, Phosphorus and Potassium

CV% = Percentage of Coefficient of Variance

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CHAPTER I

INTRODUCTION

Agricultural sector is called the backbone of Bangladesh economy providing employment to 45 % of the total population and contributes about 14.79% of GDP (BER, 2017). Pulses provide significant nutritional and health benefits, which help to reduce several non-communicable diseases such as colon cancer and cardiovascular diseases (Yude *et al*., 1993; Jukanti *et al.*, 2012).They contribute 2.3% value added to agriculture in Bangladesh (Niaz *et al*., 2013). Pulses are known as "the meat of the poor" because still pulses are the cheapest source of protein (Hamjah, 2014). The per capita consumption of pulse in our country is only 14.3 g day^{-1} (BBS, 2012) which is much lower than WHO recommendation of 45 g day^{-1}. Study conducted by Das *et al. (*2002) revealed that application of 100 per cent recommended dose of fertilizers to greengram through vermicompost significantly produced taller plants, more leaf area, root volume, nodule number, fresh nodule weight and dry matter yield as compared to control and 100 per cent RDF through FYM. To increase the producity of the soil the use of biofertilizer is a must. Nambiar and Abrol (1992) observed that, integrated use of chemical fertilizer with organic manure has been found to be quite promising in maintaining higher productivity and in greater stability to mungbean production. Recently growth and yield of mungbean have been affected by poor management and low soil fertility (Bradl, 2004). Nutrient elements are needed in relatively very small quantities for adequate plant morphology and production and their deficiency may cause great disturbance in the physiological and metabolic processes involved in the plant (Babaeian *et al.*, 2011; Meena *et al.*, 2013). Integrated use of organic manures, chemical fertilizers and bio-fertilizers on plant morphology and productivity of mungbean are meager (Meena, 2013, Meena and Sharma, 2013).

Mungbean is one of the most emergent pulse crops of Bangladesh. The present nutritional status of Bangladesh is a matter of leading concern since the most of the people are enduring from malnutrition (Mahbub *et al*., 2015). It is considered as the best of all pulses from the nutritional point of view, mungbean comprised of 51% carbohydrate, 26% protein, 4% minerals and 3% vitamins (Kaul, 1982, Uddin *et al*., 2009). Among all the pulses, it is in third position according to area and production but first in market price. Improving physical, chemical and biological properties of soil by fixing nitrogen from atmosphere through symbiosis process is an important character of mungbean. The climatic condition of Bangladesh is favorable for winter farming of mungbean but it can be cultivated in both summer and winter (Bose, 1982 and Miah *et al*., 2009). Production of mungbean can be increased by cultivation of summer mungbean through varietal development and proper management practices (Uddin *et al*., 2009). This poor yield of mungbean occured due to poor crop management practices and judicious application of fertilizer.

Use of fertilizer is an essential component of modern farming with about 50% of the world crop production (Pradhan, 1992). The use of fertilizer nutrients in different countries of Asia has increased considerably with a maximum in the republic of Korea (509 kg/ha/yr) as against only 102 kg/ha/yr in Bangladesh (Karim *et al*., 1994). It is true that sustainable production of crops cannot be maintained by using only chemical fertilizers and it was not possible to obtain higher crop yield by using organic manure alone (Bair, 1990). Sustainable crop production could be obtained through the integrated use of organic manure and chemical fertilizers. Fertilization is one of the most important practices for sustained increase of agricultural production. It was observed that the contribution of fertilization to improvement of crop production accounted for 30-50% of the total increase of the world crop yield. A suitable combination of organic and inorganic fertilizer is necessary for a sustainable agriculture that will provide food with good quality, maintain a sound environment. Integrated use of organic manures and chemical NPK fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining higher soil fertility status (Nambiar *et al.*,1998). The long-term research of BRRI revealed that the addition of cowdung at the rate of 5 t/ha/yr improved the rice productivity as well as prevented the soil resources from degradation (Miah, 1994). Bio-fertilizers like vermicompost, cowdung are eco-friendly input have tremendous potential of supplying nutrients which can reduce the chemical fertilizer dose by 24–45% (MoA, 2005).

Vermicompost, with high water-holding capacity and proper supply of macro- and micro- nutrients (Edwards and Burrows, 1988; Atiyeh *et al*., 2002; Arancon *et al*., 2004), has positive effect on biomass production and subsequently enhanced plant height. Improved growth, development and height of plants and other crops have previously been reported due to the presence of optimal amounts of vermicompost (Vadiraj *et al*., 1998). The results clearly demonstrated the effectiveness of vermicompost in increasing the biological yield. Considering the above facts the present work was conducted to evaluate the yield and economics of mungbean production with the following objectives:-

Objectives of the Research work:

1. To find out suitable combination of organic and inorganic fertilizer on growth and yield of mungbean.

2. To analyze the economics of different treatments.

CHAPTER II

REVIEW OF LITERATURE

The present study was conducted to find out the effect of organic and inorganic fertilizer on yield and economics of Mungbean (BARI Mung – 6). In this chapter, an attempt has been made to review the available information in home and abroad regarding the effect of organic and inorganic fertilizer on the growth and yield of mungbean and other legumes.

2.1 Effect of inorganic fertilizer

2.1.1 Effect of inorganic fertilizer on growth and development

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

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

Oad and Buriro (2005) conducted an experiment and observed the effect of different NPK level (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 mung bean cv. AEM 96 in Tandojam, Pakistan. The different NPK level significantly affected the crop parameters. The 10-30-30 kg NPK ha^{-1} was the best treatment, recording plant height of 56.2 cm.

Nursuaidah *et al.* (2014) revealed the growth and photosynthetic responses of longbean (*Vigna unguiculata*) and mungbean (*Vigna radiata*) response to fertilization and found that mungbean grown without fertilizer produced the highest nodules per plant.

Ramesh *et al.* (2006) stated that among different sources, chemical fertilizers recorded the higher number of pods plant^{-1} in pigeonpea which were at par with cattle dung application. Application of vermicompost, phospho-compost and poultry manure resulted in similar number of pods plant^{-1} which were at par with each other but significantly superior to control.

More *et al.* (2008) at Nagpur (Maharashtra), studied the influence of nutrient management treatments on yield attributes and yield of soybean and found that influence of treatment 30: 70: 100 kg NPK ha^{-1} (RDF) was most pronounced on the above parameters.

Jamro *et al.* (2018) conducted an experiment on various combination of Nitrogen and Phosphorus (NP) levels significantly affected crop parameters. The maximum crop stand m^{-2} (128.7), plant height cm (59.54), number of branches plant^{-1} (12.74), number of pods plant^{-1} (33.32), number of seeds plant^{-1} (376.2) seed weight plant^{-1} (17.61 g) seed index (32.05 g) and seed yield (2290.0 kg ha^{-1}) were found with the application of NP combination level of 50-75 kg ha^{-1}. Whereas, for varieties, V_1 i.e. AEM-96 surpass in all parameters as compared to V_2 i.e. NM-94, which gave maximum (120.11) crop stand m^{-2}, maximum (52.55 cm) plant height, 10.67 plant m^{-2}, maximum (24.03) branches plant^{-1}, maximum (15.07) pods plant^{-1}, maximum (30.01 g) seed weight plant^{-1} and maximum (2439.2 kg ha^{-1}) seed yield. Among the interactions the highest seed yield was recorded in variety AEM-96 with NP combination level of 50-75 kg ha^{-1} followed by the interaction of variety AEM-96 with NP combination of 50-50 kg ha^{-1}, whereas lowest seed yield kg ha^{-1} was recorded variety NM-94 with NP combination

25.00 kg ha^{-1} .The variety AEM-96 under NP combination level 50-75 kg ha^{-1} perform better and gave highest yield 2439.2 kg ha^{-1}.

A field experiment was carried out by Patel *et al.* (2017) during three consecutive seasons of kharif 2014, 2015 and 2016 at Pulses Research Station, S.D. Agricultural University, Sardarkrushinagar, Gujarat, to study the influence of nutrient, weed and pest management practices on performance of mungbean (*Vigna radiata* L.) He observed that different combinations of nutrient, weed and pest management practices affected significantly on seed yield of mungbean. Significantly higher seed yield of 911 kg/ha was recorded by combined application of nutrient, weed and pest management practices (T_8) and remained at par with treatment T_5 (NM+WM) recorded seed yield of 873 kg/ha. Combined application of nutrient, weed and pest management practices (T_8) secured the highest net return of Rs. 27621 /ha followed by T_5 (NM + WM) of Rs. 26814, while highest B: C ratio of 1.36 was noticed under T_3 (WM).

Jain and Singh (2003) studied on the effect of organic and phosphorus fertilizer on the growth and nutrition of chickpea. The organic treatments produced higher yield through improved plant height, dry matter accumulation and number of branches per plant respectively compared to the control treatment. Application of P at 50 kg per hectare showed 9.99, 34.33 and 16.46 per cent higher values for these growth parameters respectively, compared to the control.

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

Mondal *et al.* (2014) conducted a study with mung bean (V*igna radiata* L. Wilczek) in the Crop Research and Seed Multiplication Farm, Burdwan University, West Bengal, India. They found that pod length of mungbean was significantly increased by the split application of Nitrogen fertilizer at 21 DAS.

2.1.2 Effect of inorganic fertilizer on yield attributes and yield

Mathur *et al.* (2007) conducted an experiment at Jodhpur with 2 fertility levels (10 + 20 and 20 + 40 kg N + P_2O_5 /ha) stated that increase in fertility level from 10 + 20 to 20 +40 kg N + P_2O_5/ha significantly enhanced pods per plant (25.6%), seeds per pod (21.3%), 100-seed weight (7.3%) and biomass per plant (15.5%). As a result higher values of yield parameters, grain (9.6%) and straw (24.4%) yield of mungbean also increased significantly.

Leelavathi *et al.* (1991) observed that different rate of nitrogen showed significant difference in seed and dry matter production up to a certain level (60 kg N ha^{-1}).

Sadeghipour *et al.* (2010) conducted an experiment on the effects of different nitrogen and phosphorus levels on yield and yield components of mungbean variety Partow at the Research Farm of the Islamic Azad University of Shahre-rey, in Tehran, Iran in 2009. The experiment was laid out with factorial arrangement in a Randomized Complete Block Design with three replications. Five levels of nitrogen (0, 30, 60, 90 and 120 kg N ha^{-1}) and six levels of phosphorus (0, 30, 60, 90, 120 and 150 kg P_2O_5 ha^{-1}) were the treatment variables. Results showed that application of N and P fertilizers significantly increased the seed yield. The maximum seed yield (224.2 g m^{-2}) was obtained when 90 kg N ha^{-1} and 120 kg P_2O_5 ha^{-1} was applied. This increase in seed yield was mainly due to more number of pods plant^{-1}, number of seeds pod^{-1} and 1000 seeds weight. Thus, application of 90 kg N ha^{-1} and 120 kg P_2O_5 ha^{-1} seems to be optimum levels for harvesting highest yield of mungbean.

Yein (1982) conducted two year field experiment in Assam. India on mungbean (*Vigna radiata* L.) and stated that combined application of nitrogen and phosphorus significantly increased the dry weight of the plants.

Azadi *et al.* (2013) conducted an field experiment on the effect of different nitrogen level on seed yield and morphological characteristic of mungbean in the climate condition of Khorramabad and they found that the highest seed yield and pod length was obtained at 150 kg ha^{-1} urea.

A field experiment was carried out by Saleem *et al.* (2016) to assess the efficacy of maize based intercropping systems under different fertility treatments at National Agriculture Research Center Islamabad, Pakistan. Maximum seed yield of mungbean (1527 kg ha^{-1}) was in F_2 followed by F_5 with 1399 kg ha^{-1}. Maximum grain yield of wheat (3438.39 kg ha^{-1}) was recorded in preceded with sole PM @15 t ha^{-1} while minimum yield of wheat (2796.98 kg ha^{-1}) in control plots. Maize + mungbean intercropping recorded the highest MEY of 1819 kg ha^{-1} followed by sole mungbean (1303 kg ha^{-1}). Total system productivity of maize + mungbean-wheat system was the highest (3197 kg ha^{-1}) in terms of MEY followed by mungbean-wheat system (2514 kg ha^{-1}). Maize + mungbean - wheat in F_5 accrued maximum net benefit of Rs. 119589.92 ha^{-1}. Highest nitrate nitrogen, phosphorus, potassium and organic matter were recorded in PM amended plots in both years.

Sheoran *et al.* (2008) conducted a field experiment to study the performance of mungbean genotypes in relation to their nutritional requirement under rainfed conditions. Application of 12.5 kg N + 40 kg P_2O_5/ha increased the seed yield by 4.3% compared to 12.5 kg N + 20 kg P_2O_5/ha, which in turn, recorded significant yield increase by 15.4% over no fertilizer application (NoPo).

Mitra *et al.* (2000) studied on greengram in acid soil of Tripura and found the maximum number of pods per plant, seeds per pod, test weight, seed and total biomass yield with combined application of mussoorie rock phosphate (50 kg P_2O_5/ha) and PSB.

Singh *et al*. (2018) conducted a study at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (Uttar Pradesh) during the zaid season of 2016. The experiment comprised of nine treatments viz. T_1 : Control, T_2 : 20 kg P_2O_5 ha-1 , T_3 : 40 kg P_2O_5 ha^{-1} ,T_4 : 60 kg P_2O_5 ha^{-1} ,T_5 : 80 kg P_2O_5 ha^{-1} ,T_6 : 20 kg P_2O_5 ha^{-1}+ PSB,T_7 : 40 kg P_2O_5 ha^{-1} + PSB,T_8 : 60 kg P_2O_5 ha^{-1} + PSB,T_9 : 80 kg P_2O_5 ha^{-1} + PSB tested in Randomized Block Design and replication three times. The basic information, on the physico-chemical properties of the soil indicated that the soil of the experimental field was classified as silty loam which was low in organic carbon, nitrogen and phosphorus and medium in potassium. The crop recorded normal recommended cultural practices and plant protection measures. Results revealed that all the growth, yield attributes and quality increased significantly under the integrated treatment (80 kg P_2O_5 ha^{-1} + PSB). The growth characters viz., plant height, leaf area index, dry matter accumulation and number of branches plant-1 and yield attributes like number of pod plant^{-1} , number of grain pod^{-1} , 1000 - seed weight (g), biological yield, seed yield, stover yield (q ha^{-1}), harvest index (%) and NPK uptake of mung crop. On the basis of economics of different treatment, the maximum gross returns (Rs. 72371.00 ha^{-1}), net returns (Rs. 50873.00 ha^{-1}) and B: C ratio (2.37) was recorded under treatment (P + PSB) for mung crop.

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

Jahan *et al*. (2015) conducted an experiment at Regional Wheat Research Centre of the Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh for 2 consecutive years during 2007 and 2008 to find out the optimum nutrient management practice for seed yield, nutrient balance and economics of mungbean. Twelve nutrient management treatments were tested in RCBD with 3 replications. Treatments were without CRI T_1 =HYG (0-24-40-48-24-3-1.2), T_2 =MYG (0-20-36-40-20-2-1), T_3 =IPNS (5000-9-37-36-21-3-1.2), T_4 =STB (0- 20-36-40-22-2-1), T_5=FP (0-6-5-4-0-0-0), T_6=CON (0-0-0-0-0-0-0) and with CRI T_7=HYG+CRI, T_8=MYG+CRI, T_9=IPNS+CRI, T_{10}=STB+CRI, T_{11}=FP+CRI, T_{12}=CON+CRI kg ha^{-1} CDNPKSZnB for mungbean. The maximum seed yield of mungbean was obtained from STB+CRI (1.57 t ha^{-1}) followed by IPNS+CRI (1.54 t ha^{-1}), STB (1.54 t ha^{-1}), IPNS (1.52 t ha^{-1}), HYG+CRI (1.44 t ha^{-1}) and HYG (1.41 t ha^{-1}) in 2007. Similar trend was found in 2008. Numerically higher yield and yield contributing parameters were noticed in CRI plots than without CRI. N and K balance were found negative in all the treatments. P, S, Zn and B balance were found positive in case of HYG, MYG, IPNS and STB along with or without CRI nutrient managements. While in case of FP and CON, the balance was shown almost negative. The experiment showed that maximum gross return and margin was obtained from STB+CRI followed by STB. Slightly higher BCR (3.00) was recorded from STB followed by STB+CRI (2.91).

Agbenin *et al.* (1991) stated that applied N significantly increased growth components, dry matter yield and nutrient uptake over the control.

Kamal *et al.* (2001) carried out an experiment at the BARI farm during rainy season for 2000-2001 to determine the effect of various level of fertilizer and weeding of mungbean. Superior grain yield (1430 kg ha^{-1}) was found when fertilized @ 20-60-30 NPK kg ha^{-1} with two hand weeding at 20 and 30 DAE were used. This was followed by that obtained (1368 kg ha-1) by using inoculum + 60-30 PK kg ha^{-1} with two hand weeding at 20 and 30 DAE. The result is application of fertilizer @ 20-60-30 kg ha^{-1} combine with two hand weeding 17 at 20 and 30 DAE was economical for yield as well as quality seed production of mungbean.

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

Kumar *et al*. (2019) observed the effect of foliar application of nutrients on yield and economics of blackgram under rain fed condition during *kharif* 2014 at the Research Farm of AICRP on MULLaRP, R.A.K. College of Agriculture, Sehore (M.P.). The experiment was laid out in Randomized Block Design with three replications having nine treatments namely Control, only water spray, Urea 2% spray at flowering**,** DAP 2 % spray at flowering and 15 days later**,** Urea phosphate 2 % spray at flowering**,** MOP 2 % spray at flowering**,** TNAU pulse wonder @ 5 kg ha^{-1} at flowering (contains- N, P, K, Boron, Fe and auxin), Brassinolide 0.75 ppm at flowering, Salicylic acid 100 ppm at flowering, 19:19:19 of NPK as 2 % spray at flowering. Application of 2 % DAP spray at flowering and 15 days later recorded highest yield and higher net return and being on par closely. Followed by application of 19:19:19 (NPK) as 2 % spray at flowering stage. It is concluded that application of 2 % DAP spray at flowering and 15 days later is more remunerative than application of 2 % 19:19:19 (NPK) spray at flowering stage. Further the different treatments had positive effect on yield, and economics of black gram.

2.2 Effect of organic fertilizer

2.2.1 Effect of organic fertilizer on growth and development

Vikram and Hamzehzarghani (2008) stated that inoculation of greengram seeds with PSB (PSB-14) recorded the highest nodule number, nodule dry weight, shoot dry matter and total plant dry matter at 45 DAS.

Khalilzadeh *et al.* (2012) conducted an study on growth characteristics of mungbean (*Vigna radiata* L.*)* and found that foliar application of urea and organic manure substantially improved number and dry weight of nodule.

Kausale *et al.* (2009) observed that nodule number, dry matter per plant, pod and haulm yield of groundnut crop increased with application of 100% RDF (25 : 50 N and P kg/ha), 10 t FYM/ha and Rhizobium or PSB seed inculcation.

Das *et al.* (2002) studied on the effects of vermicompost and chemical fertilizer application on the growth and yield of green gram *(Vigna radiate).* The dry matter and pod yield of green gram were increased with the application of vermicompost applied in integrated form. The yield was highest with 100% enriched vermicompost compared to sole organic manure. Greater dry matter content, pod yield, nutrient uptake (N, P and K), plant height, leaf area, root volume, number of nodules and fresh weight of nodules were obtained with treatments containing vermiconipost. Flowering was earlier by 7 days in vermicompost-treated plants compared with the control.

Armin *et al*. (2016) conducted a field experiment at Sher-e-Bangla Agricultural University during the period from February to April (kharif-I season) of 2012 to study the effect of different combinations of organic and inorganic fertilizers on growth and yield of mungbean (BARI Mung 6) using Randomized Completely Block Design with three replications. During the experiment, three different organic fertilizers (Poultry manure, vermicompost and farm yard manure) were combined with four doses of inorganic fertilizers (25%, 50%, 75% and 100% of optimum dose) and one control treatment using no fertilizer and one treatment using only 100% of the optimum doses were included. At 30 DAS and at harvest highest plant height, number of leaves plant^{-1} and branches plant^{-1} were found from the combination of vermicompost and 100% inorganic fertilizer which was statistically similar or closely followed by vermicompost and 75% inorganic fertilizer treatment. Maximum numbers of pods plant^{-1}, seeds pod^{-1} and seeds plant^{-1} were recorded in vermicompost and 100% inorganic fertilizer and it was closely followed by vermicompost and 75% inorganic fertilizer. Highest seed yield plant^{-1}, 1000-seed weight and seed yield ha^{-1} was recorded in vermicompost + 100% of optimum dose of inorganic fertilizer and it was statistically similar with the treatment of vermicompost + 75% of optimum dose of inorganic fertilizer. It was observed that, for the above parameters; poultry manure + 100% of optimum dose of inorganic fertilizer and farm yard manure + 100% of optimum dose of inorganic fertilizer showed better results than sole 100% inorganic fertilizer. In some cases, poultry manure + 75% of optimum dose of inorganic fertilizer and farm yard manure + 75% of optimum dose of inorganic fertilizer also performed better than sole 100% inorganic fertilizer. Lowest values for all of the growth and yield parameters obtained from the treatment using no fertilizer.

2.2.2 Effect of organic fertilizer on yield attributes and yield

Netwal (2003) was carried out a field experiment at Jobner during *kharif* season of 2001-02 and observed that application of vermicompost at 5 t/ha significantly increased the pods per plant, seeds per pod, harvest index and seed and straw yield of cowpea over control, 5 t FYM and 2.5 t vermicompost/ha.

Naeem *et al*. (2006) observed the effect of organic manures and inorganic fertilizers on growth and yield of mungbean (*Vigna radiata* L.). Experiment comprised of two varieties (NM-98 & M-1) and four fertility levels as NPK @ 25 - 50 - 50 kg ha^{-1}, poultry manure @ 3.5 t ha^{-1}, FYM @ 5 t ha^{-1} and Bio-fertilizer @ 8 g kg^{-1} seed. NPK fertilizers and organic manures were applied at the time of seed bed preparation. Wheat grain yield was recorded highest (1104 kg ha^{-1}) with the application of the inorganic fertilizers (NPK @ 25 - 50 - 50 kg ha^{-1}). Among organic nutrient a source, poultry manure @ 3.5 t ha^{-1} was found the best followed by FYM @ 5 t ha^{-1}. Both varieties were equal in grain yield. Numbers of pods, number of seeds per pod, 1000 grain weight were also almost higher in inorganic fertilizer treatment. The economic analysis revealed maximum net benefit from the treatment, where poultry manure was applied.

Bhattarai *et al.* (2003) found that application of full dose of fertilizer + 5 tonnes per hectare poultry manure recorded the maximum number of pods per plant, seeds per pod, test weight and seed yield of field pea.

A field experiment was conducted by Meena *et al*. (2015) during rainy (*kharif*) season of 2013 to find out the effect of bioinorganic nutrient combinations on yield, quality and economics of mungbean [*Vigna radiate* (L.) Wilczek]. The twelve treatments comprised one control, three levels of inorganic sources (75, 50 and 100% NPK of recommended dose) and other eight in combination *viz.* 50% RDF+ *Rhizobium* + Phosphorus solublizing bacteria (PSB), 50% RDF + 2.5 t/ha Vermicompost, 50% RDF+2.5 t/ha Vermicompost/ha + *Rhizobium* + PSB, 75% RDF+ *Rhizobium* + PSB, 75% RDF + 2.5 t/ha Vermicompost, 75% RDF + 2.5 t/ha Vermicompost + *Rhizobium* +PSB, 100%RDF+ *Rhizobium*+ PSB and 100% RDF + 2.5 t/ha Vermicompost were laid out in randomized block design with three replications. Amongst combinations, significant improvement in plant height at harvest, yield attributes, yield, protein per cent, nutrient content and uptake were recorded with application of nutrients through 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB as compared to other combinations, followed by treatments 100% RDF + 2.5 t/ha vermicompost and 100% RDF + *Rhizobium* + PSB. The highest and comparable net returns were obtained with the application of 100% RDF + *Rhizobium* + PSB (INR 52894.73) followed by 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB (INR 51582.60) and 75% RDF + +*Rhizobium* + PSB (INR 50664.74). The above studies show that bioinorganic combinations have their own roles play to higher productivity, not only solely supply all the nutrients to the soils but also create favorable conditions for betters growth to producing crop.

Bhavya *et al*. (2018) conducted a field experiment during kharif, 2016 to study the effects of phosphorus levels, biofertilizers (Phosphate solubilising bacteria) and organic manures (vermicompost) on yield, nutrient concentration and their uptake at flowering and harvest of green gram. The experiment was laid out in randomized block design with three replications having 12 treatment combinations viz. 3 levels of phosphorus (0, 75 and 100 % RDP) and its integration with PSB (500 g ha^{-1} seed) and vermicompost (5 t ha^{-1}). Experimental results revealed that grain yield and nutrient uptakes significantly influenced by phosphorus, vermicompost and PSB application. Application of higher dose of phosphorus along with PSB and vermicompost (100 % RDP + Vermicompost+ Phosphate solubilising bacteria) proved to be the best in improving the seed yield (1033.33 kg ha^{-1}). Application of inorganic P fertilizers, organic manures and PSB markedly influenced the nutrient concentration and their uptake. Results showed that application of vermicompost at 5 t ha^{-1}, seed inoculation with PSB and 100% RDP significantly increased the N, P, K and S concentration in grain, haulm and their uptake by greengram.

Experiment conducted by Islam *et al.* (2016) showed that VC (20%), TC (20%) and N:P:K fertilizer (farmer's practice) were used to determine the growth and yield attributes of bush bean (*Phaseolus vulgaris*), winged bean (*Psophocarpus tetragonolobus*) and yard long bean (*Vigna unguiculata*). Plants grown with VC (20%) produced the highest fresh biomass for bush bean (527.55 g $m^{-2)}$, winged bean (1168.61 g $m^{-2)}$ and yard long bean (409.84 g $m^{-2)}$. In all the tested legumes the highest pod weight, pod number, pod dry weight and pod length were found in the VC (20%) treatment. Photosynthetic rates in the three legumes peaked at pod formation stage in all treatments, with the highest photosynthetic rate observed in winged bean (56.17 μmol $m^{-2}s^{-1)}$ grown with VC (20%). The highest yield for bush bean (2.98 ton $ha^{-1)}$, winged bean (7.28 ton $ha^{-1)}$ and yard long bean (2.22 ton $ha^{-1)}$ were also found in VC (20%) treatment. Furthermore, protein content was highest in bush bean (26.50 g/100g), followed by yard long bean (24.74 g/100g) and winged bean (22.04 g/100g), under VC

(20%) treatment. It can be concluded that legumes grown with VC (20%) produced the highest yield and yield attributes.

Experiment conducted by Gopinathan and Prakash (2015) observed that at sampling periods, the seedlings of Green gram (*Vigna radiata*) Root length was measured from the base to the tip of the lengthiest root after the completion of the experiment and were found to be increased. The total numbers of nodules were counted numerically to find out the influence of plant growth promoting bacteria and organics on the root growth. The total number of flowers, number of pods and number of seeds present in the each pod were counted numerically to find out the Green gram yield as influenced by microorganisms and organic substrates and showed that in all respect the result indicated marked improvement in all parameters.

An experiment conducted by Jadhav *et al.* (1997) showed better affectivity of vermiculture to increase the rate of plant growth, thereby reducing the cost of crop production, improving soil fertility and saving the environment from the ill effects of chemical compounds. The results clearly indicate that vermiculture by using *P. ceylanensis* can be used in sustainable agricultural practices.

Fuller and Harvey (2006) observed that there was increase in the yield of crop used with vermicompost composition and the fertility level of soil were also maintained and yield obtained were healthy and were free from all diseases.

Deshmukh *et al.* (2014) observed that significantly increase in the yield parameters like pod yield per plant (107.77g), pod yield per plot (2.69 kg), pod yield per hectare (49.87q ha^{-1}). Similar findings were also observed by Ganie *et al*. (2009) in garden pea, Sajitha *et al*. (2007) in garden bean. From the above results it is evident that due to better assimilation of photosythates and added bio fertilizers might have resulted in the improvement of soil physical, chemical and biological properties, which in turn helped in better nutrient absorption by the plant, resulted in better yield. The highest net profit (66190.30 Rs. per hectare) in T_{18} i.e. NPK (20:40:20 kg per hectare with vermicompost) and highest B: C ratio (3.78) was observed in (N_2 PSB) validating the opinion that these bio fertilizers are complimentary in improving the yield of legumes. The similar results were also observed by Sammauria *et al*. (2009) in cluster bean.

Dhakal *et al*. (2015) observed that Significant improvement in LAI, number of trifoliate, SPAD value of green leaf chlorophyll, dry matter accumulation, yield, harvest index (%) and nutrient content of mungbean were recorded due to application of 75% RDF + 2.5 t/ha vermicompost (VC) + *Rhizobium* (*Rh*) + phosphorus solublizing bacteria (PSB), followed by 100% RDF + 2.5 t/ha VC and 100% RDF + *Rh* + PSB. The highest seed yield of mungbean was obtained with the application of 75% RDF + 2.5 t/ha VC + *Rh* + PSB (12.34 q /ha) followed by 100% RDF + 2.5 t/ha VC (12.05 q /ha) and 100% RDF + *Rh*+ PSB (11.95 q /ha).

Hasan (2007) carried out a field experiment at the Sher-e-Bangla Agricultural University Farm, Dhaka 1207 during the *Kharif* season of 2007 to study the effect of vermicompost and NPK fertilizers on the yield of mungbean. The experimental soil was silty clay loam in texture having pH of 6.0. The treatments were 4 levels of vermicomposts viz. V0 (0 ha^{-1}). V1, (1 t ha^{-1}). V2 (2 t h^{-1}).V3 (4 t ha^{-1}). And 3 levels of chemical fertilizers viz. F0 = (0-0-0 kg ha^{-1}), F1 = medium (10-10-14 kg h^{-1}), F2 = high (20-20-28 kg ha^{-1}) of N-P-K with 12 treatment combinations and 3 replications. The results showed that with the increasing the doses of vermicompost and chemical fertilizers grain and straw yields of mungbean were increased significantly. The maximum significant grain and straw yields were obtained with the treatment combinations V3F. The highest doses of vermicompost and chemical fertilizers increased N. P and K concentrations in mungbcan plant significantly at maturity stage. Application of vermicompost and chemical fertilizers increased organic carbon, N, P and K status of postharvest soil significantly.

Mozumder *et al.* (2005) conducted an experiment on mungbean to evaluate the response of summer mungbcan cultivars *Iiinamoog-2* and *Kanui* to *Bra4vrhizobiwn* inoculation and N application. Results showed that the highest seed yield (1461 kg/ha) were obtained in the treatment with 40 kg N/ha along with *Bradj.rhizobizan* inoculation. The highest straw yield (4702 kg/ha) was obtained in the treatment with 60 kg N/ha with *Bradyrhizobiurn* inoculation.

Abbas *et al*. (2011) studied the effects of organic and inorganic fertilizers on mungbean (*Vigna radiata*. (L.)) yield under arid climate were studied at adaptive research farm Karor and at farmer's field during two kharif seasons of 2006 and 2007. In these experiments different combinations of organic and inorganic fertilizers were used for comparison. Experiments were laid in randomized complete block design with seven treatments. AZRI 2006, a promising variety of mung-bean (*Vigna radiata* L.) for arid climate was used as a test variety. The results revealed that different combinations of organic and inorganic fertilizers significantly affected the grain yield. Maximum grain yield was obtained from the application of DAP at 124 Kg along with 10 tons ha^{-1} of poultry litter during both years, while application of DAP at 62 Kg and 10 tons of FYM ha^{-1} ranked second for grain yield.

A field experiment was conducted by Kumawa *et al*. (2017) during rainy season on sandy loam soil to study the effect of organic manures, Phosphorus Solubilizing Bacteria (PSB) and levels of phosphorus on yield, economics and soil fertility of mungbean under rainfed condition. Results revealed that application of vermicompost @ 2 t/ha produced highest biological yield (24.33 q/ha), gross returns (Rs. 22657/ha) which was significantly superior to Farm Yard Manure (FYM) @ 4 t/ha and control. Whereas the higher B: C ratio, organic carbon, available N and P were recorded in FYM @ 4 t/ha which was comparable with vermicompost @ 2 t/ha. Seed inoculation with PSB significantly increased the biological yield (22.95 q/ha), gross returns (Rs. 20807/ha), B:C ratio (1.59) available N (137.51 kg/ha) and P (18.70 kg/ha) as compared to control. Similarly, the highest biological yield (24.33 q/ha), gross returns (Rs. 22527/ha), B:C ratio (1.69), organic carbon (0.166%), available N (139.87 kg/ha) and P (19.59 kg/ha) were recorded with the application 40 kg P_2O_5/ha of which was significantly superior to 20 kg P_2O_5/ha and control (0.0 kg/ha).

An experiment was conducted by Verma *et al.* (2018) involving five organic formulations viz., cow urine, vermiwash, neem seed extract, fish wash normal water (control) and three levels of NPK viz., 50% recommended dose of fertilizer (RDF), 75% RDF and 100% RDF with total 15 treatment combinations in randomized complete block design with three replications was conducted at Varanasi during Kharif season (July-April) 2014-15 to evaluate the effect of different organic formulations and NPK fertilization on pigeonpea. Results showed that increasing level of NPK up to 100% RDF significantly improved growth parameters, yield attributes, grain and straw yield. Among the treatment combinations, combined application of 100% RDF + vermiwash proved superior over other treatments, these recorded the highest growth yield attributes, gross returns, and net returns while B: C ratio was the highest under 100% RDF in combination with cow urine.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka to study the effect of organic and inorganic fertilizer on yield and economics of mungbean (cv. 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 Experimental site: The research work was carried out at experimental plot of Agronomy field of Sher-e-Bangla Agricultural University, Dhaka. It is situated at $23^{0}77'$ N latitude and $90^{0}33'$ E longitude at an altitude of 8.2 meter above the sea level.

3.1.2 Climate and Soil: Mungbean grows in a wide range of climatic conditions. A warm humid climate with temperature ranging from 25^{o} C to 35^{o} C, with 400-550 mm rainfall, well distributed during the growing period of 60 - 90 days, is suitable for its cultivation. It is grown on a wide range of soils like red laterite soils, black cotton soils and sandy soils. A well-drained loamy to sandy loam soil is best for its cultivation. The experimental area is characterized by subtropical rainfall during the month of July to October. Production depends on rainfall. The experimental site is medium high land in Agro-Ecological Zone of Madhupur Tract (AEZ no. 28).

3.2 Materials

(a) Seeds- BARI Mung- 6 was collected from Bangladesh Agricultural Research Institute (BARI).

(b) Fertilizers- Urea, TSP, MoP, Gypsum, ZnSO4, Boric Acid, Vermicompost. Vermicompost was collected from market.

3.2.1 Characterictics of BARI Mung - 6

- Plant height: 40-45 cm
- Pod plant^{-1}: 15-20
- Seed pod^{-1}:12-14
- 1000 Seeds wt.: 51.00-52.00 g
- Duration: 55-60 days
- Resistant to Yellow Mosaic Virus & Cercospora Leaf Spot
- Photo Insensitive
- Protein: 21.2%, CHO: 46.8%
- Head dhal Yield: 67.2%
- Synchrony in maturity & late potentiality
- Yield : 1600-1800 kg/ha
- Potential to sowing upto after harvest of wheat (up to 2nd week of April)
- It also can be grown for 3 seasons Kharif-1 (March – June), Kharif-2 (August–October), Late rabi (15 January-15 May) Suitable for all areas of Bangladesh.

3.2.2 Fertilizers and doses :

A. Organic fertilizers

a) Vermicompost (3 t ha^{-1})

B. Inorganic Fertilizer (Recommended Dose)

a) Urea for nitrogen @ 15 kg ha^{-1}

b) TSP for phosphorous@ 20 kg ha^{-1}

c) MoP for potassium @ 30 kg ha^{-1}

d) Gypsum for sulphur @ 10 kg ha^{-1}

e) Zinc sulphate for zinc @ 2.0 kg ha^{-1}

f) Boric acid for boron @ 1.5 kg ha^{-1}

3.3 Treatments:

F_1= Recommended Dose of Fertilizer (NPKSZnB)

F_2 = Vermicompost + 50% Recommended Dose of Fertilizer (NPKSZnB)

F_3 = Vermicompost + 75% Recommended Dose of Fertilizer (NPKSZnB)

F_4 = Vermicompost

F_5 = Vermicompost + PK

F_6 = Vermicompost + NK

F_7 = Vermicompost + NPK

F_8 = Vermicompost + NP

F_9 = 50 % Vermicompost + 50 % Recommended Dose of Fertilizer (NPKSZnB)

F_{10} = Vermicompost + NPKB

F_{11} = Vermicompost + B

F_{12} = Control

3.4.1 Experimental Design: The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. Total 36 unit plot was made for the experiment with 12 treatments. Each plot size was 2.25 m × 1.4 m with following plant spacing.

3.4.2 Layout of the experiment

The experiment was laid out according to the experimental design (RCBD). The field was divided into 3 blocks to represent 3 replications. There were 36 unit plots altogether in the experiment. The size of each unit plot was 2.25 m × 1.4 m. Distance maintained between replication and plots were 70 cm and 50 cm respectively. The treatments were assigned in plot at random. Details layout of the experimental plot was presented in Appendix III.

3.5 Land preparation

The field selected for the experiment was opened in the first week of October 2018 with a power tiller and was exposed to the sun for a week, after one week the land was harrowed, ploughed and cross- ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed.

3.6 Fertilization

Organic fertilizers (vermicompost) were applied along with urea, TSP, MoP, gypsum, zinc sulphate and boric acid as per treatments during the final land preparation.

3.7 Seed sowing: Seeds of the variety BARI Mung- 6 was sown on 04. 10. 2018 in lines maintaining proper distance in the well prepared plot.

3.8 Intercultural operations

3.8.1 Weed control

The crop was infested with some weeds during the early stage of crop establishment. Two hand weddings were done; first weeding was done at 15 days after sowing followed by second weeding at 15 days after first weeding.

3.8.2 Application of irrigation water

Irrigation water was added to each plot, first irrigation was done as pre sowing and other two were given 2-3 days after weeding.

3.8.3 Plant protection measures

The crop was infested by insects and diseases. Ripcord 10 EC @ 1 ml L^{-1} was applied two times at an interval of 1 week to control insect. On the other hand Diazinon 60 EC @ 2 ml L^{-1} was applied two times at an interval of 1 week to control disease.

3.9 Harvesting

The crops were harvested at a time due to synchronous maturity of pods. At first 50% of early matured pods were harvested by hand picking at 55 days after sowing. Finally 4 days after first harvesting all plants were harvested plot-wise by uprooting and were bundled separately, tagged and brought to the threshing floor of the SAU farm.

3.10 Drying

The harvested products were taken on the threshing floor and it was dried for about 3-4 days cleaned and weighed.

3.11 Recording of data

The data were recorded on the following parameters

a. Plant height

b. Branches plant^{-1}

c. Nodules plant^{-1}

d. Pods plant^{-1}

e. Pod length

f. Seeds pod^{-1}

g. 1000 seed weight

h. Seed yield

i. Stover yield

j. Biological yield

k. Harvest index

l. Benefit Cost Ratio (BCR)

3.12 Data collection

It was done on the basis of following parameter-

3.12.1 Plant height at different DAS (30, 60 DAS and at harvest)

At different stages of crop growth (30, 60 DAS and at harvest), the height of five randomly selected plants from the inner rows per plot was measured from ground level to the tip of the plant portion and the mean value of plant height was recorded in cm.

3.12.2 No. of branches plant^{-1}

Branches were counted at the ripening stage. Branches of 5 plants randomly from each plot were counted and averaged.

3.12.3 No. of Nodules plant^{-1}

The 5 plants plot^{-1} was uprooted and total number of nodules from the plants was counted at 30, 60 DAS and harvest and the mean value was determined**.**

3.12.4 Pod length

Length of 5 pods from each plot were measured randomly and averaged after harvesting.

3.12.5 No. of pods plant^{-1}

Pods were counted at the ripening stage. Pods of 5 plants randomly from each plot were counted and averaged.

3.12.6 No. of seeds pod^{-1}

It was done after harvesting. At first, number of seeds pod^{-1} was counted. Seeds of 5 pods randomly from each plot were counted and averaged.

3.12.7 1000 seed weight

Thousand seed of BARI Mung - 6 were counted randomly and then weighed plot wise.

3.12.8 Seed yield

Grains obtained from 1 m^2 area from the center of each unit plot was dried, weighted carefully and then converted into t ha^{-1}.

3.12.9 Stover yield

Stover obtained from each individual plot was dried, weighed carefully and the yield expressed in t ha^{-1}.

3.12.10 Biological yield

The summation of seed yield and above ground stover yield was the biological yield. Biological yield =Grain yield + Stover yield.

3.12.11 Harvest index

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

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

Here, Biological yield = Grain yield + stover yield

3.13 Economics

To find out more profitable treatment, economics of different treatments were worked out in terms of net return/ha on the basis of prevailing market rate so that the most remunerative treatment could be recommended. The net return was worked out by using following formula: Net return = Gross return - Cost of cultivation Treatment wise benefit: Cost ratio was calculated to ascertain economic viability of the treatment using the following formula:

B: C ratio = Net returns / Cost of cultivation

3.14 Statistical analysis

The collected data on different growth and yield parameters and nutrient contents of mungbean were statistically analyzed. The means for all treatments were calculated and the analyses of variances for all the characters were performed by 'F' variance test using MSTAT-C computer package program. The collected data were computed and analyzed statistically using the analysis of variance (ANOVA) technique and the mean differences were adjusted by Least Significance Difference (LSD) test at 5% level of probability (Gomez & Gomez, 1984).

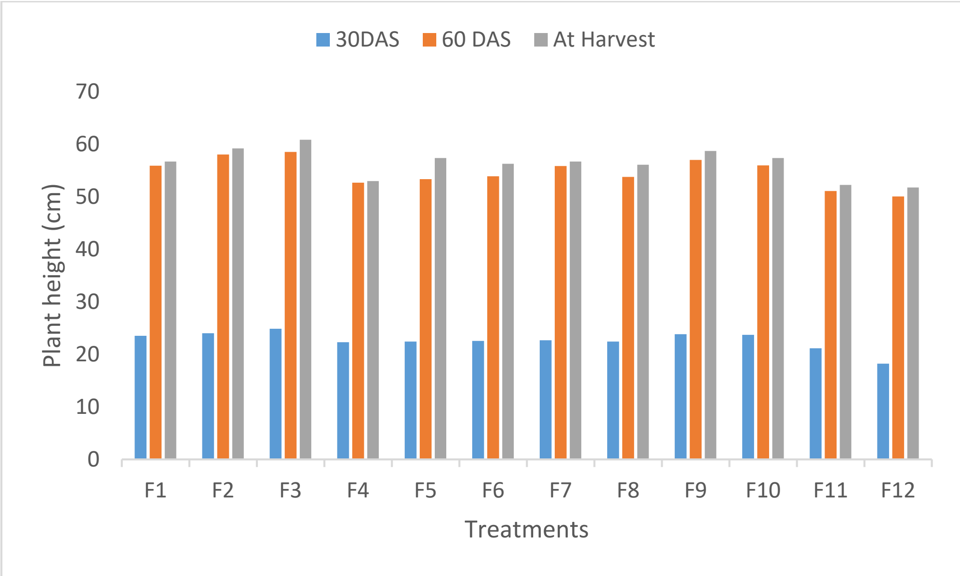
CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to find out the effect of organic and inorganic fertilizer management on yield and economics of mungbean. The results obtained from the study have been presented, discussed and compared in this chapter through different tables, figures and appendices. The analyses of variance of data in respect of all the parameters have been shown in Appendix V –VII. The results have been presented and discussed with the help of tables and graphs has been given under the following headings.

4.1 Plant height

The data on plant height of mungbean at different growth stages as influenced by organic and inorganic fertilizers are presented in Figure 1. The plant height at 30 days after sowing (DAS) differed significantly due to combined application of organic and inorganic fertilizers. Significant higher plant height (24.89 cm) was recorded in F_3 and it was followed by F_2 (24.03 cm) and F_9 (23.83 cm). Lowest plant height at 30 DAS was found from the treatment using no fertilizer (F_{12}: 18.20 cm). The plant height at 60 days after sowing (DAS) also differed significant due to different treatments. Significantly higher plant height (58.53 cm) was recorded in F_3 and it was statistically similar with the application of vermicompost + 50% RDF (F_2: 58.07 cm). Lowest plant height at harvest was found from the treatment using no fertilizer (F_{12}: 50.06 cm).The plant height at harvest was not differed Significantly. higher plant height (60.84 cm) was recorded in F_3 and it was statistically similar with the application of vermicompost + 50% of optimum dose of inorganic fertilizer (F_2: 59.19 cm). Lowest plant height at harvest was found from the treatment using no fertilizer (F_{12}: 51.80 cm). Combination of organic and inorganic fertilizers was found better by Meena *et al*. (2015).

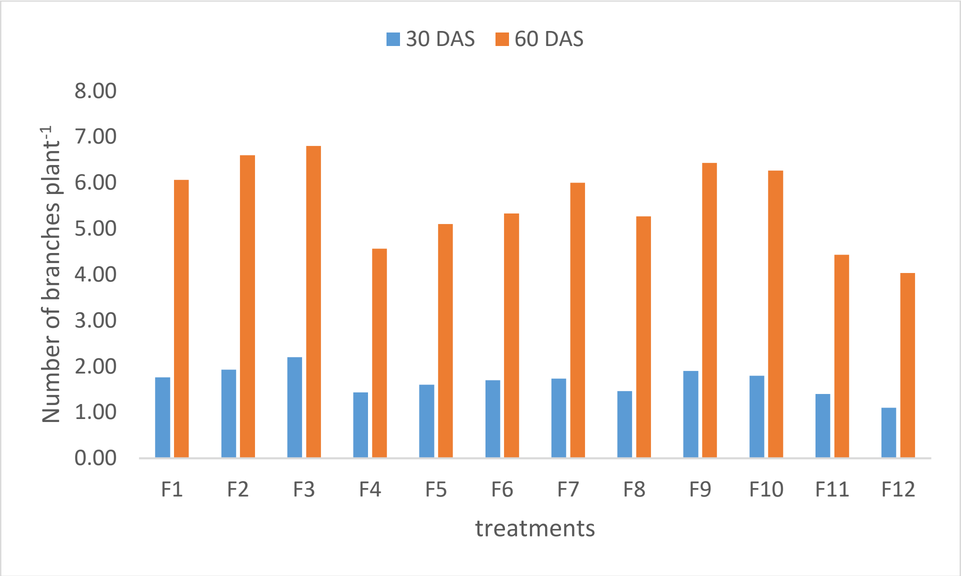


F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

Fig. 1: Effect of organic and inorganic fertilizer on plant height of mungbean

4.2 Number of branches plant^{-1}

Effect of Combined fertilizer management significantly influenced the number of branches plant^{-1} (Figure 2). At 30 DAS and 60 DAS the highest number of branches plant^{-1} (2.2 and 6.8) was recorded from the combination of Vermicompost + 75% RDF (F_3) treatment which was statistically similar to F_2 (1.933 and 6.6) treatment (Vermicompost + 50% RDF) and F_9 (1.9 and 6.4) treatment (50% Vermicompost + 50% RDF).The lowest number of branches plant^{-1} (1.1 and 4.03) was recorded from control conditions at 30 DAS and 60 DAS. Jain and Singh (2003) observed the effect of organic and phosphorus fertilizer on the growth and nutrition of chickpea.



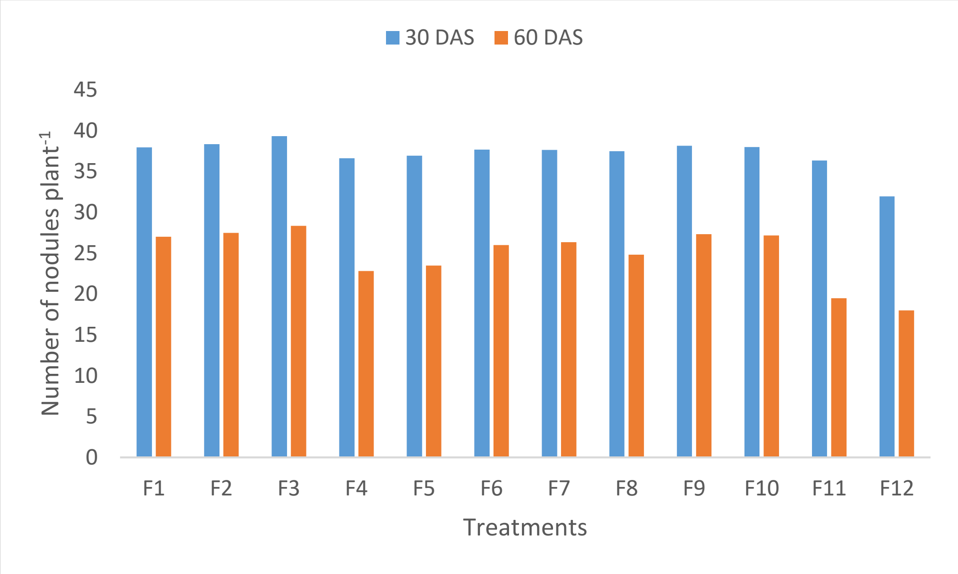
F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

Fig. 2: Effect of organic and inorganic fertilizer on number of branches plant^{-1} of mungbean

4.3 Number of nodules plant^{-1}

Number of nodules plant^{-1} of mungbean differed significantly due to application of different treatments of fertilizers (Figure 3). The highest number of nodules plant^{-1} (39.33) at 30 DAS was recorded from Vermicompost + 75 % RDF (F_3) treatment which followed by F_2 (38.33) treatment (Vermicompost + 50 % RDF, F_9 (38.17) treatment (50 % Vermicompost + 50 % RDF). The lowest number of nodules plant^{-1} (31.93) was found in control condition. Present study showed that Vermicompost + 75 % RD produced maximum number of nodules. At 60 DAS the highest number of nodules plant^{-1} 28.33) was recorded from Vermicompost + 75 % RDF (F_3) treatment which followed by F_2 (27.5) treatment (Vermicompost + 50 % RDF, F_9 (27.33) treatment

(50% Vermicompost + 50% RDF). The lowest number of nodules plant^{-1} (18) was found in control condition. Das *et al.* (2002) studied the effects of vermicompost and chemical fertilizer application on the growth and yield of green gram *(V. radiata).*



F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

Fig. 3: Effect of organic and inorganic fertilizer on number of nodules plant^{-1} of mungbean

4.4 Pod length

There was significant variation among the effect of organic and inorganic fertilizer management on the length of pod of mungbean (Table 1). Length of pod of mungbean increased with increasing the levels of micronutrient. The tallest length of pod (9.81 cm) was recorded with the combination of Vermicompost + 75 % RDF (F_3) treatment which was followed by F_2 (9.11 cm) treatment (Vermicompost + 50 % RDF), F_9 (8.96 cm) treatment (50 % Vermicompost + 50% RDF), F_{10} (8.73 cm) treatment (50% Vermicompost + 50% RDF) and F_1 (8.42 cm) treatment (Recommended Dose). The shortest length of pod (6.92 cm) was recorded from (F_4) treatment followed by F_{12} (7.33

cm) treatment. Experiment conducted by Islam *et al.* (2016) showed that VC (20%), TC (20%) and N:P:K fertilizer (farmer's practice) were used to determine the growth and yield attributes of bush bean (*Phaseolus vulgaris*), winged bean (*Psophocarpus tetragonolobus*) and yard long bean (*Vigna unguiculata).*

Table 1: Effect of organic and inorganic fertilizer on pod length of mungbean

Treatments	Pod length (cm)
F_1	8.42 ABCD
F_2	9.11 AB
F_3	9.81 A
F_4	6.92 D
F_5	8.01 BCD
F_6	8.29 ABCD
F_7	8.41 ABCD
F_8	8.12 BCD
F_9	8.96 AB
F_{10}	8.73 ABC
F_{11}	7.75 BCD
F_{12}	7.33 CD
LSD(0.05)	1.622
CV%	11.51

F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

4.5 Number of pods plant^{-1}

Statistically significant differences were found for number of pods plant^{-1} of Mungbean. (Table 2). The highest number of pods plant^{-1} (9.53) was recorded from Vermicompost + 75 % RDF (F_3) treatment which was statistically similar to F_2 (8.47) treatment (Vermicompost + 50 % RDF) and which was followed by F_9 (8.07) treatment (50 % Vermicompost + 50 % RDF) whereas, the lowest (5.40) was observed from Control (F_{12}) treatment followed by F_4 (5.80) treatment (Vermicompost), F_5 (6.27) treatment (Vermicompost + PK), F_6 (6.50) treatment (Vermicompost + NK). Similar result found by Armin *et al*. (2016).

Table 2: Effect of organic and inorganic fertilizer on number of pods plant^{-1} of mungbean

Treatments	No. of pod plant^{-1}
F_1	8.47 AB
F_2	7.00 BCDEF
F_3	9.53 A
F_4	5.80 EF
F_5	6.27 DEF
F_6	6.50 CDEF
F_7	6.60 CDEF
F_8	6.47 CDEF
F_9	8.07 ABC
F_{10}	7.07 BCDE
F_{11}	5.40 F
F_{12}	7.83 BCD
LSD(0.05)	1.626
CV%	13.56

F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

4.6 Number of seeds pod^{-1}

Number of seeds pod^{-1} of mungbean showed different results (Table 3). The maximum number of seeds pod^{-1} (11.27) was recorded from F_3 (Vermicompost + 75 % RDF) treatment which was similar with F_2 (10.87) treatment (Vermicompost + 50 % RDF) and F_9 (10.80) treatment (50 % Vermicompost + 50 % RDF) whereas, the minimum (9.20) was observed from Control treatment which was followed by F_{11} (9.50) treatment (Vermicompost + B), F_4 (9.83) treatment (Vermicompost), F_5 (9.87) treatment (Vermicompost + PK). Present study showed that Vermicompost + 75 % RDF produced maximum number of seeds.

Table 3: Effect of organic and inorganic fertilizer on number of seeds pod^{-1} of mungbean

Treatments	No. of seed pod^{-1}
F_1	10.67
F_2	10.87
F_3	11.27
F_4	9.83
F_5	9.87
F_6	10.20
F_7	10.60
F_8	10.10
F_9	10.80
F_{10}	10.73
F_{11}	9.50
F_{12}	9.20
LSD(0.05)	NS
CV%	11.88

F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

4.7 1000- seed weight

Effect of organic and inorganic fertilizer exhibited significant variation in 1000- seed weight of mungbean (Table 4). The highest 1000 grain weight (71.90 g) was recorded from the F_3 (Vermicompost + 75 % RDF) treatment which was statistically similar to F_1 (70.07 g) treatment (Recommended Dose) and F_9 (69.83 g) treatment (50 % Vermicompost + 50% RDF). The lowest 1000- seed weight (54 g) was observed from the Control (F_{12}) treatment which was statistically similar to F_{11} (59.67 g) treatment (Vermicompost + B) and followed by F_4 (63.95 g) treatment (Vermicompost), F_5 (64.27 g) treatment (Vermicompost + PK), F_8 (64.37 g) treatment (Vermicompost + NP). Vermicompost + 75 % RDF produced maximum 1000 – seed weight in this study. 1000 – seed weight was taken without removing moisture. Sadeghipour *et al.* (2010) conducted a field experiment in order to investigate the effects of different nitrogen and phosphorus levels on yield and yield components of mungbean variety.

Table 4: Effect of organic and inorganic fertilizer on 1000 - seed weight of mungbean

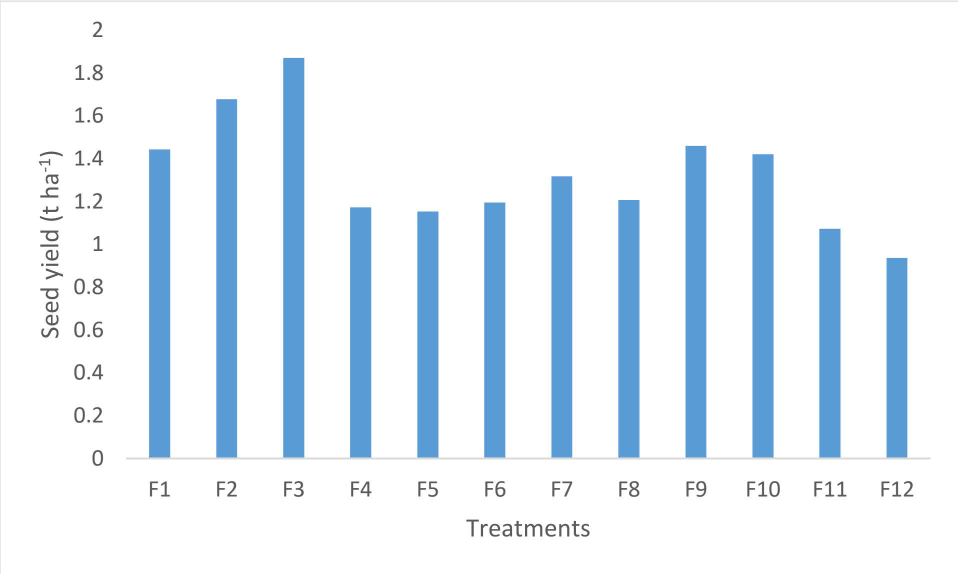
Treatments	1000 - seed weight (g)
F_1	70.07 AB
F_2	68.77 AB
F_3	71.90 A
F_4	63.95 ABC
F_5	64.27 ABC
F_6	67.37 AB
F_7	68.63 AB
F_8	64.37 ABC
F_9	69.83 AB
F_{10}	69.70 AB
F_{11}	59.67 BC
F_{12}	54.00 C
LSD(0.05)	11.07
CV%	9.90

F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

4.8 Seed yield

Statistically significant difference was recorded for the effect of organic and inorganic fertilizer on seed yield of mungbean (Figure. 4). The maximum grain yield (1.87 t ha^{-1}) was observed from the combination of Vermicompost + 75 % RDF (F_3) which was followed by F_2 (1.68 t ha^{-1}) (Vermicompost + 50 % RDF), T_9 (1.46 t ha^{-1}) treatment (50 % Vermicompost + 50 % RDF) and F_{10} (1.42 t ha^{-1}) (Vermicompost + NPKB) whereas, the minimum (0.94 t ha^{-1}) was observed from the F_{12} Control treatment which was followed by F_{11} (1.07 t ha^{-1}) treatment (Vermicompost + B) that was similar to F_4

(1.17 t ha^{-1}) (Vermicompost) and F_5 (1.15 t ha^{-1}) (Vermicompost + PK). This study revealed that Vermicompost + 75 % RDF produced highest grain yield. Bhavya *et al*. (2018) conducted an experiment and showed simiar result.

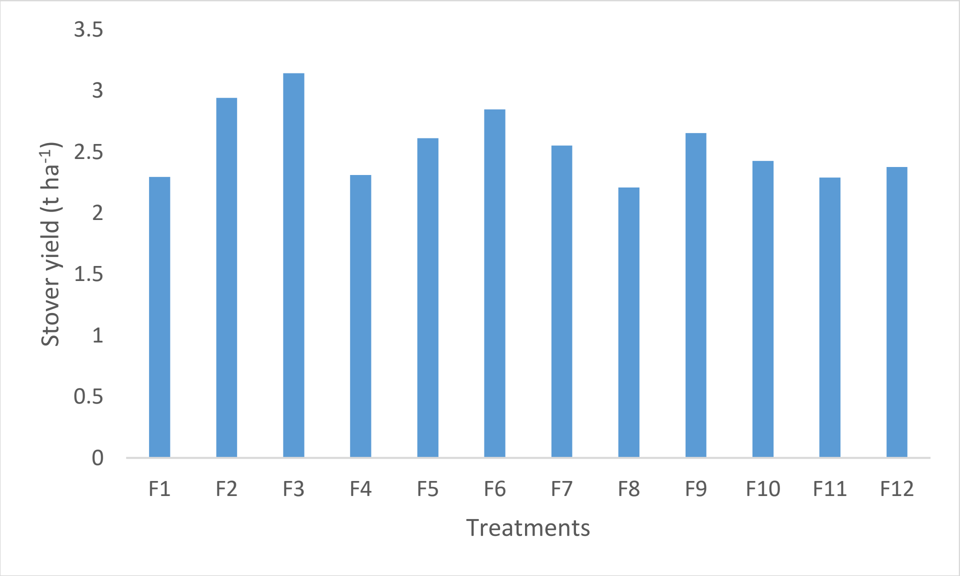


F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

Fig. 4: Effect of organic and inorganic fertilizer on Seed yield of mungbean

4.9 Stover yield

Stover yield of mungbean were significantly influenced by organic and inorganic fertilizer treatments (Figure 5). The highest stover yield (3.14 t ha^{-1}) was observed from Vermicompost + 75 % RDF (F_3) which was followed by F_2 (2.94 t ha^{-1}) treatment (Vermicompost + 50 % RDF) and F_6 (2.85 t ha^{-1}) treatment (Vermicompost + NK). The lowest stover yield (2.21 t ha^{-1}) was observed from Control (F_{12}) treatment which is similar with F_4 (2.31 t ha^{-1}) treatment (Vermicompost), F_{11} (2.29 t ha^{-1}) treatment (Vermicompost + B). Similar result found by Hasan. (2007).



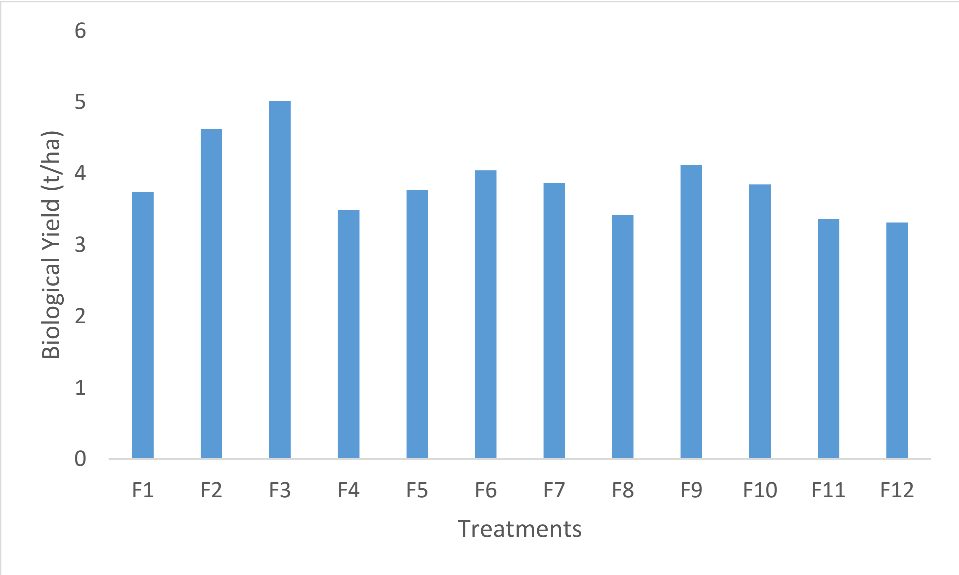
F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

Fig. 5: Effect of organic and inorganic fertilizer on Stover yield of mungbean

4.10 Biological yield

Effect of organic and inorganic fertilizer management showed significant variation in biological yield of mungbean (Figure 6). The maximum biological yield (5.01 t ha^{-1}) was observed from the combination of Vermicompost + 75% RDF (F_3) which was followed by F_2 (4.62 t ha^{-1}) treatment (Vermicompost + 50 % RDF), F_9 (4.11 t ha^{-1}) treatment (50 % Vermicompost + 50 % RDF) which was statistically similar to F_{10} (4.04 t ha^{-1}) treatment (Vermicompost + NPKB). The minimum biological yield (3.31 t ha^{-1}) was observed from the combination of Control (F_{12}) treatment which was statistically identical to F_{11} (3.36 t ha^{-1}) treatment (Vermicompost + B), F_8 (3.42 t ha^{-1}) treatment (Vermicompost + NP) and F_4 (3.49 t ha^{-1}) treatment (Vermicompost). Hasan

(2007) carried out a field experiment at the Sher-e-Bangla Agricultural University Farm, Dhaka 1207 during the *Kharif* season of 2007 to study the effect of vermicompost and NPK fertilizers on the yield of mungbean. The maximum significant grain and straw yields were obtained with the treatment combinations V3F.

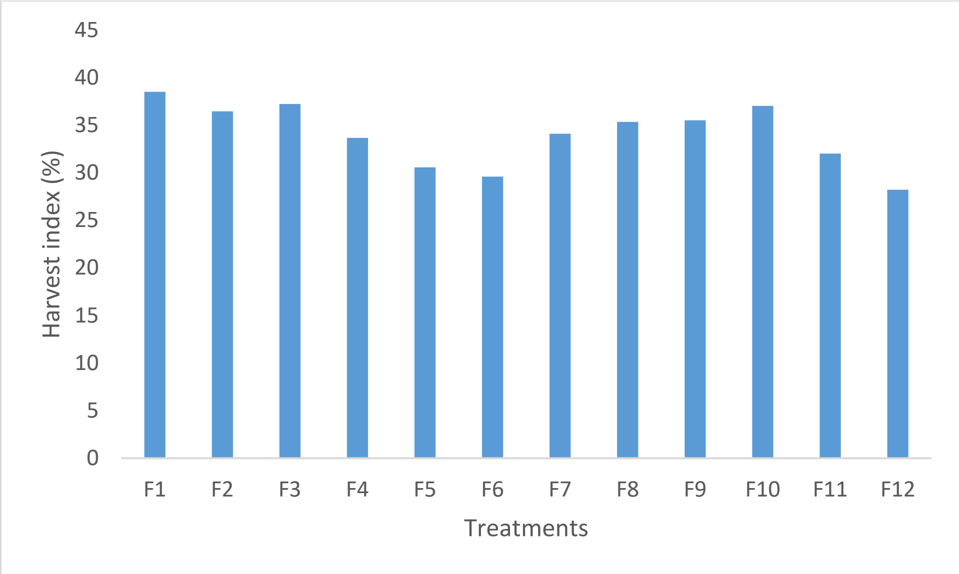


F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

Fig. 6: Effect of organic and inorganic fertilizer on Biological yield of mungbean

4.11 Harvest Index

A significant difference was found in harvest index due to organic and inorganic management (Figure 7). The maximum harvest index (38.50 %) was recorded from the combination of Vermicompost + 50% RDF (F_2) which was followed by F_3 (37.22 %) treatment (Vermicompost + 75% RDF), F_9 (37 %) treatment (50 % Vermicompost + 50 % RDF), whereas, the minimum (28 %) was found in control condition which was followed by F_6 (29.58 %) treatment (Vermicompost + NK). Netwal (2003) was carried out a field experiment at Jobner during *kharif* season of 2001-02 and observed that application of vermicompost at 5 t/ha significantly increased the pods per plant, seeds per pod, harvest index and seed and straw yield of cowpea over control, 5 t FYM and 2.5 t/ha vermicompost.



F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

Fig. 7: Effect of organic and inorganic fertilizer on Harvest Index of mungbean

4.12 Economic analysis

The highest and comparable net returns (Table 5) were obtained with the application of Vermicompost and 75% RDF (Tk. 90778 ha^{-1}) followed by Recommended Dose of Fertilizer (Tk. 69359 ha^{-1}) and 50% Vermicompost and 50% RDF (Tk. 68196 ha^{-1}). The maximum benefit cost ratio recorded with F_3 treatment (2.54) followed by F_1 treatment (2.51). The lowest net return was observed at F_{11} treatment (Tk. 29833 ha^{-1}) and lowest BCR (1.53) found in Vermicompost + B (F_{11}). Considering the highest Gross income

F_3 treatment is economically viable. A field experiment was conducted by Kumawa *et al*. (2017) during rainy season. Results revealed that application of vermicompost @ 2 t/ha produced highest biological yield (24.33 q/ha), gross returns (Rs. 22657/ha) which was significantly superior to Farm Yard Manure (FYM) @ 4 t/ha and control. Whereas the higher B: C ratio, organic carbon, available N and P were recorded in FYM @ 4 t/ha which was comparable with vermicompost @ 2 t/ha.

Table 5: Effect of organic and inorganic fertilizer on Economic analysis of mungbean

Treatments	Cost of production (tk/ha)	Gross income (tk/ha)	Net income (tk/ha)	BCR
F_1	45841	115200	69359	2.51
F_2	57204	134400	77196	2.34
F_3	58822	149600	90778	2.54
F_4	53967	93600	39633	1.73
F_5	55641	92000	36359	1.65
F_6	55245	95200	39955	1.72
F_7	56169	105600	49431	1.88
F_8	55419	96800	41381	1.74
F_9	48604	116800	68196	2.40
F_{10}	57969	113600	55631	1.96
F_{11}	55767	85600	29833	1.53
F_{12}	32967	75200	42233	2.28

F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% RDF (NPKSZnB) , F_3 = Vermicompost + 75% RDF (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % RDF (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control

Output price: Mungbean seed @ Tk. 80 kg^{-1}

Input price: Urea=Tk. 20 kg^{-1}, TSP= Tk. 22 kg^{-1}, MoP= Tk. 15 kg^{-1}, Gypsum= Tk. 24 kg^{-1}, Zinc sulphate= Tk. 200 kg^{-1}, Boric acid= Tk. 200

kg^{-1}, Vermicompost= Tk. 8 kg^{-1}, wage rate==Tk. 500 day^{-1}, mungbean seed= Tk. 200

kg^{-1}.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Research Field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during October to December, 2018 to study the effect of organic and inorganic fertilizer on the yield and economics of mungbean (BARI Mung- 6). The experimental field belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28. The soil of the experimental field belongs to the General soil type, Deep Red Brown Terrace Soils under Tejgaon soil series. The experiment consists of 12 fertilizer treatments. they are, F_1= Recommended Dose of Fertilizer (NPKSZnB), F_2 = Vermicompost + 50% Recommended Dose of Fertilizer (NPKSZnB) , F_3 = Vermicompost + 75% Recommended Dose of Fertilizer (NPKSZnB), F_4 = Vermicompost , F_5 = Vermicompost + PK, F_6 = Vermicompost + NK, F_7 = Vermicompost + NPK, F_8 = Vermicompost + NP, F_9 = 50 % Vermicompost + 50 % Recommended Dose of Fertilizer (NPKSZnB), F_{10} = Vermicompost + NPKB, F_{11} = Vermicompost + B, F_{12} = Control (no fertilizer). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The variety, BARI Mung-6 was used in this experiment as the test crop. There were 12 treatment combinations. The total numbers of unit plots were 36. The size of unit plot was 3.15 m^2 (2.25 m × 1.40 m). Results showed that plant height, number of branches plant^{-1}, number of nodules plant^{-1}, pod length, number of pod plant^{-1}, number of seeds pod^{-1}, 1000 grain weight, seed yield, stover yield, biological yield and harvest index, economic analysis was significantly influenced by organic and inorganic fertilizer management.

The plant height at 30 days after sowing (DAS), at 60 DAS and at harvesting differed significantly due to combined application of organic and inorganic fertilizers. Higher plant height (24.89 cm, 58.53 cm and 60.84 cm) was recorded in F_3 and it was followed by F_2 (24.03 cm, 58.07 cm and 59.19 cm) respectively. Lowest plant height at 30 DAS, at 60 DAS and at harvesting was found from the treatment using no fertilizer (F_{12}: 18.20 cm, 50.06 cm and 51.80 cm).

At 30 DAS and 60 DAS the highest number of branches plant^{-1} (2.2 and 6.8) was recorded from the combination of Vermicompost + 75% RDF (F_3) treatment which was statistically similar to F_2 (1.933 and 6.6) treatment (Vermicompost + 50% RDF). The lowest number of branches plant^{-1}(1.1 and 4.03) was recorded from control conditions at 30 DAS and 60 DAS.

The highest number of nodules plant^{-1} (39.33 and 28.33) at 30 DAS and at 60 DAS was recorded from Vermicompost + 75 % RDF (F_3) treatment which followed by F_2 (38.33 and 27.5) treatment (Vermicompost + 50 % RDF). The lowest number of nodules plant^{-1} (31.93 and 18) at 30 DAS and 60 DAS was found in control condition.

The tallest length of pod (9.81 cm) was recorded with the combination of Vermicompost + 75 % RDF (F_3) treatment which was followed by F_2 (9.11 cm) treatment (Vermicompost + 50 % RDF). The shortest length of pod (6.92 cm) was recorded from (F_4) treatment followed by F_{12} (7.33 cm) treatment.

The highest number of pods plant^{-1} (9.53) was recorded from Vermicompost + 75 % RDF (F_3) treatment which was statistically similar to F_2 (8.47) treatment (Vermicompost + 50 % RDF) and which was followed by F_9 (8.07) treatment (50 % Vermicompost + 50 % RDF) whereas, the lowest (5.40) was observed from Control (F_{12}) condition.

The maximum number of seeds pod^{-1} (11.27) was recorded from F_3 (Vermicompost + 75 % RDF) treatment which was which was similar to F_2 (10.87) treatment (Vermicompost + 50 % RDF) and F_9 (10.80) treatment (50 % Vermicompost + 50 % RDF) whereas, the minimum (9.20) was observed from Control treatment which was followed by F_{11} (9.50) treatment (Vermicompost + B).

The highest 1000 - grain weight (71.90 g) was recorded from the F_3 (Vermicompost + 75 % RDF) treatment which was statistically similar to F_1 (70.07 g) treatment (Recommended dose). The lowest 1000 - seed weight (54 g) was observed from the Control treatment (F_{12}).

The maximum grain yield (1.87 t ha^{-1}) was observed from the combination of Vermicompost + 75 % RDF (F_3) treatment which was followed by F_2 (1.68 t ha^{-1}) treatment (Vermicompost + 50 % RDF) whereas, the minimum (0.94 t ha-1) was observed from the F_{12} (Control) treatment which was followed by F_{11} (1.07 t ha-1) treatment (Vermicompost + B).

The highest stover yield (3.14 t ha^{-1}) was observed from Vermicompost + 75 % RDF (F_3) treatment which was followed by F_2 (2.94 t ha^{-1}) treatment (Vermicompost + 50 % RDF). The lowest stover yield (2.21 t ha^{-1}) was observed from Control (F_{12}) treatment.

The maximum biological yield (5.01 t ha^{-1}) was observed from the combination of Vermicompost + 75% RDF (F_3) treatment which was followed by F_2 (4.62 t ha^{-1}) treatment (Vermicompost + 50 % RDF). The minimum biological yield (3.31 t ha^{-1}) was observed from the combination of Control treatment (F_{12}).

The maximum harvest index (38.50 %) was recorded from the combination of Vermicompost + 75% RDF (F_2) treatment which was followed by F_3 (37.22 %)

treatment (Vermicompost + 50% RDF) whereas, the minimum (28 %) was found in control condition.

The highest and comparable net returns were obtained with the application of Vermicompost and 75% RDF (Tk. 90778 ha^{-1}) followed by Recommended Dose of Fertilizer (Tk. 69359 ha^{-1}) and 50% Vermicompost and 50% RDF (Tk. 68196 ha^{-1}). The maximum benefit cost ratio recorded with F_3 treatment (2.54) followed by F_1 treatment (2.51). The lowest net return was observed at F_{11} treatment (Tk. 29833 ha^{-1}) and lowest BCR (1.53) found in Vermicompost + B (F_{11}).

CONCLUSION

The results in this study indicated that the plants of mungbean (BARI Mung- 6) performed better in respect of seed yield in F_3 treatment than the control treatment (F_{11}), which was poor. It can be therefore, concluded from the above study that the treatment combination of Vermicompost and 75% RDF was found to the most suitable combination for the highest yield and economics of mungbean. However, to reach a specific conclusion and recommendation, more research work on fertilizer management of mungbean should be done to increase mungbean production.

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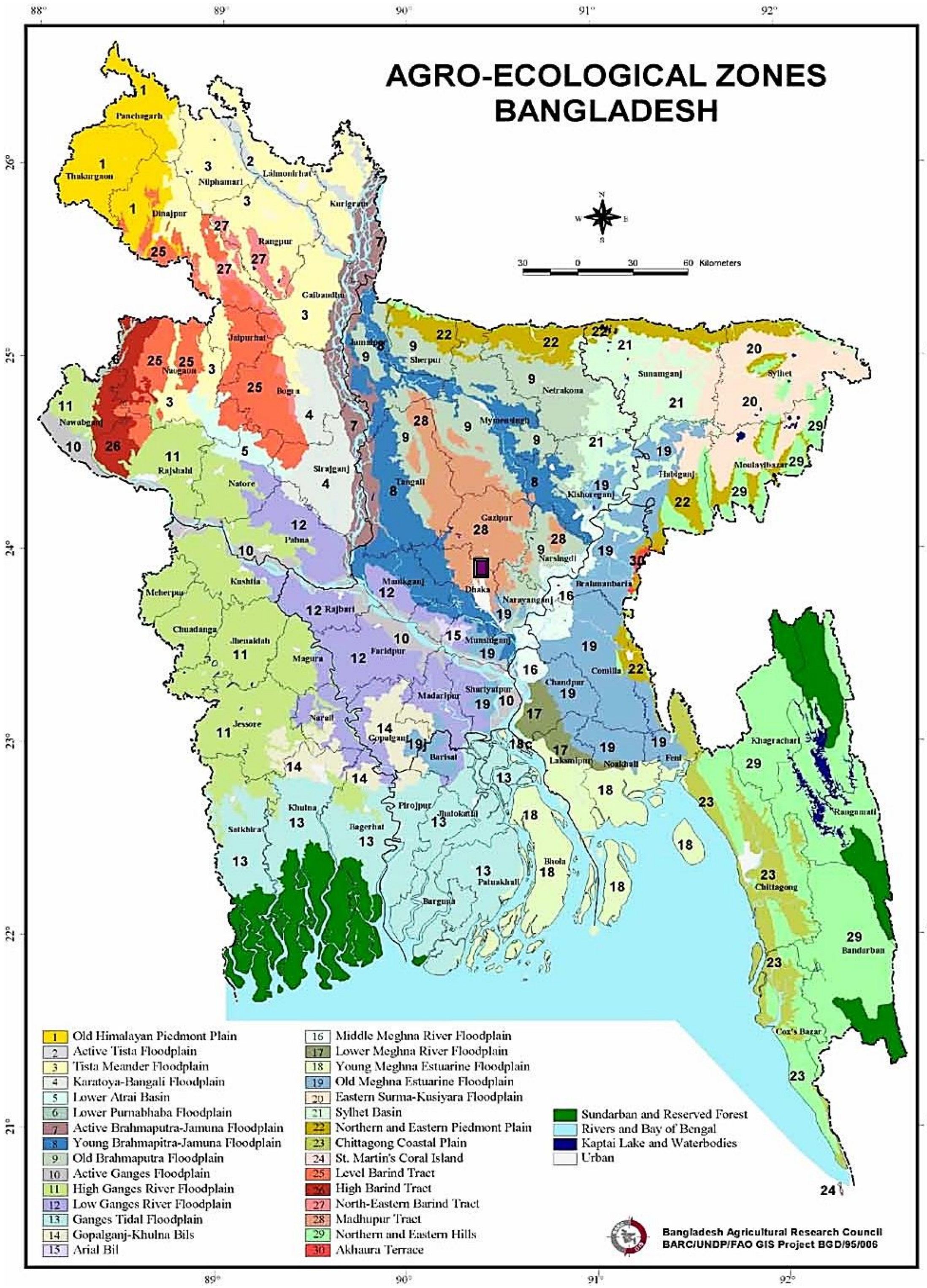
APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II. Characteristics of soil of experimental field

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy Farm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% Clay	30

Chemical properties of the initial soil

Characteristics	Value
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.077
Available P (ppm)	20.00
Exchangeable K (mel 100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix III: Monthly meteorological information during the period from June 2018 to November 2018

Year	Month	Temperature			Relative Humidity (%)	Total Rainfall (mm)	Sunshine (Hour)
		Max (°C)	Min (°C)	Mean (°C)			
2018	**June**	34	28	30	73	88.6	300
	July	33	27	30	76	46.53	268
	August	34	27	30	76	66.92	302
	September	34	27	30	71	64.14	292.5
	October	33	26	30	59	33	238
	November	33	25	29	51	12.3	210.5

Source: Bangladesh Metrological Department (Climate and weather division) Agargaon, Dhaka.

Appendix IV. Layout (RCBD) of experimental field

R_1F_1	R_2F_7	R_3F_{12}
R_1F_2	R_2F_8	R_3F_{11}
R_1F_3	R_2F_9	R_3F_{10}
R_1F_4	R_2F_{10}	R_3F_9
R_1F_5	R_2F_{11}	R_3F_8
R_1F_6	R_2F_{12}	R_3F_7
R_1F_7	R_2F_1	R_3F_6
R_1F_8	R_2F_2	R_3F_5
R_1F_9	R_2F_3	R_3F_4
R_1F_{10}	R_2F_4	R_3F_3
R_1F_{11}	R_2F_5	R_3F_2
R_1F_{12}	R_2F_6	R_3F_1

Unit Plot Size = 2.25 m × 1.4 m

Plot Spacing = 50 cm

Between replication = 70 cm

Appendix V: Analysis of variance of the data on plant height, branching plant^{-1}, nodules plant^{-1} of mungbean as influenced by organic and inorganic fertilizer management

Source of variation	df	Plant height			Branching plant^{-1}		Nodules plant^{-1}	
		30 DAS	60 DAS	Harvest	30 DAS	60 DAS	30 DAS	60 DAS
Replication	2	23.479	41.592	101.118	0.117	0.603	3.880	1.444
Treatment	11	8.863	21.116	23.209	0.255*	2.527*	10.179	32.801*
Error	22	5.330	24.126	25.649	0.044	0.458	12.285	9.619

* Significant at 5% level of probability

Appendix VI : Analysis of variance of the data on pod length, no. of pods plant^{-1}, no. of seeds pod^{-1}, 1000 seed weight of mungbean as influenced by organic and inorganic fertilizer management

Source of variation	df	Pod length	No. of pod plant^{-1}	No. of seed pod^{-1}	1000-grains weight
Replication	2	3.655	0.271	0.842	15.331
Treatment	11	1.870	4.242*	1.152	79.141
Error	22	0.917	0.922	1.497	42.724

* Significant at 5% level of probability

Appendix VII : Analysis of variance of the data on Seed yield, straw yield, biological yield, harvest index of mungbean as influenced by organic and inorganic fertilizer management

Source of variation	**df**	**Seed yield**	**Straw yield**	**Biological yield**	**Harvest Index**
Replication	2	0.273	0.855	2.090	1.350
Treatment	11	0.207*	0.261*	0.792*	32.317*
Error	22	0.004	0.026	0.030	3.283

* Significant at 5% level of probability

Plate 1: Layout of experimental field

Plate 2: Seed sowing

Plate 3: Seedling stage

Plate 4: Nodule data collection

Plate 4: Data collection of plant height

Plate 5: Maturity stage