YIELD AND ECONOMICS OF MUNGBEAN AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT

SAYEDA FARHIN TAMANNA

DEPARTMENT OF AGRONOMY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207

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BY

SAYEDA FARHIN TAMANNA

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Approved by:

(Prof. Dr. Md. Abdullahil Baque)	**(Prof. Dr. Md. Fazlul Karim)**
Supervisor	**Co-supervisor**

(Prof. Dr. Md. Shahidul Islam)

Chairman

Examination Committee

DEPARTMENT OF AGRONOMY

Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar
Dhaka-1207

CERTIFICATE

*This is to certify that thesis entitled, "**YIELD AND ECONOMICS OF MUNGBEAN AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT**" 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 (MS) in AGRONOMY**, embodies the result of a piece of bona-fide research work carried out by **SAYEDA FARHIN TAMANNA** Registration no. **12-05035** 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.

Date:
Place: Dhaka, Bangladesh

Prof. Dr. Md. Abdullahil Baque
Department of Agronomy
Sher-e-Bangla Agricultural University,
Dhaka-1207

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YIELD AND ECONOMICS OF MUNGBEAN AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT

ABSTRACT

An experiment was carried out at Sher-e-Bangla Agricultural University farm, Dhaka to study the yield and economics of mungbean as influenced by integrated nutrient management during kharif-2 season from the month of October to December, 2018. The treatments of the experiment are various combination of organic and inorganic fertilizers on mungbean (BARI Mung-6). The treatments are T_1= Recommended dose of fertilizers (RDF),T_2= Poultry manure (PM) @ 3 t ha^{-1}, T_3= Compost @ 2 t ha^{-1}, T_4= PM + RDF, T_5= Compost + RDF, T_6= PM + 50% RDF, T_7= Compost + 50% RDF, T_8= PM+ NPK,T_9= Compost + NPK, T_{10}= PM + NP, T_{11}= Compost+ NP, T_{12}= PM + NK, T_{13}= Compost + NK, T_{14}= PM + PK, T_{15}= Compost + PK. The experiment was laid out in randomized complete block design (RCBD) with three replications. Results showed that different treatments significantly differed the yield contributing characters and economics of mungbean. The highest seed yield (1.80 t ha^{-1}) was recorded in T_{12} (PM + NK) treatment with highest BCR. On the other hand, the lowest seed yield (0.92 t ha^{-1}) was found in treatment T_3 (Compost) and the lowest BCR is 1.26 obtained from treatment T_5. The application of poultry manure along with urea and MoP can supplement other essential nutrients to plants and increase production with an increased BCR.

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ABBREVIATIONS AND ACRONYMS

AEZ	**=**	**Agro-Ecological Zone**
BBS	**=**	**Bangladesh Bureau of Statistics**
cm	**=**	**Centimeter**
CV %	**=**	**Percent Coefficient of Variation**
DAS	**=**	**Days After Sowing**
et al.	**=**	**And others**
e.g.	**=**	**exempli gratia (L), for example**
etc.	**=**	**Etcetera**
FAO	**=**	**Food and Agricultural Organization**
g	**=**	**Gram (s)**
kg	**=**	**Kilogram (s)**
i.e.	**=**	**id est (L), that is**
LSD	**=**	**Least Significant Difference**
WHO	**=**	**World Health Organization**
PM	**=**	**Poultry manure**
µg	**=**	**Microgram**
L	**=**	**Litre**
Ca	**=**	**Calcium**
K	**=**	**Potassium**
P	**=**	**Phosphorus**
N	**=**	**Nitrogen**
NP	**=**	**Nitrogen+ Phosphorus**
NK	**=**	**Nitrogen+ Potassium**
PK	**=**	**Phosphorus+ Potassium**
NPK	**=**	**Nitrogen+ Phosphorus+ Potassium**
PM	**=**	**Poultry manure**
RDF	**=**	**Recommended dose of fertilizer**
mg	**=**	**Miligram**
%	**=**	**Percentage**
^oC	**=**	**Degree Celceous**
var.	**=**	**Variety**
SAU	**=**	**Sher-e-Bangla Agricultural University**
m^2	**=**	**Meter squares**
ml	**=**	**Mili Litre**
M.S.	**=**	**Master of Science**
No.	**=**	**Number**

CHAPTER 1

INTRODUCTION

Agriculture sector plays an important role in overall economic development of Bangladesh. The agricultural sector contributes 14.74 percent to the country's GDP, provides employment about 41 percent of the labour force according to Quarterly Labour Force Survey 2015-16. At the global level, pulses are the second most important group of crops after cereals. Pulses are known as "the meat of the poor" because still pulses are the cheapest source of protein (Hamjah, 2014).

Mungbean (*Vigna radiata* L. Wilczek) is one of the most important pulse crops in the world. It belongs to the family Fabaceae. The global pulses production was 71 million tonnes from an area of 79 million hectare with an average yield of 910 kg per ha during 2015-16 (Anon., 2016). It is widely grown in Bangladesh. It is the second most important pulse crop in terms of area (42,559 ha) and production (36,954 t) but ranks the highest in consumer preference and total consumption (BBS, 2016). It is grown 3 times in a year covering 96076 acres having total yield of 32737 MT (BBS, 2015). In terms of both acreage and production it occupies third position after lentil and blackgram (BBS, 2019).

Mungbean is considered as the best of all pulses from the nutritional point of view. It provides significant amounts of protein ($240\ g\ kg^{-1}$) and carbohydrate ($630\ g\ kg^{-1}$) and a range of micronutrients in diets. Mungbean grain contains 19.5% to 28.5% protein, 59.9% carbohydrate, 75 mg calcium, 8.5 mg iron and 49 mg β-carotene per 100 g of split dal (Afzal *et al.*, 2004). According to FAO (2013) recommendation, per capita intake of pulse should be 80 g day^{-1}, whereas it is 10.92 g/day in Bangladesh thus the ideal ratio of cereal to pulse (10:1) is not maintained, which is now 30:1. It is recognized that pulses offer the most practical means of solving protein malnutrition in Bangladesh but there is an acute shortage of grain legumes in relation to its requirements, because the yield of legumes in farmers field is usually less than 1.0 t ha^{-1} against the potential yield of 2.0 to 4.0 t ha^{-1} (Ramakrishna *et al.*, 2000). Low yields of grain legumes including mungbean make the crop less competitive with cereals and high value crops (Saha *et al.,* 2002). Due to its supply of cheaper protein source it has a high market demand but the yield is very low compared to the advanced countries. Bangladesh, total production of pulses is only 0.65 million ton against 2.7 million tons requirement. This means the shortage is almost 80% of the total requirement (Rahman and Ali, 2007). The yield of pulse crops is low due to lack of awareness in adoption of improved technology (Kumar, 2013; Kumar, 2014).

Integrated Nutrient Management refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner. These are to maintain soil productivity, to ensure sustainable productivity, to prevent degradation of the environment and to reduce expenditure on the cost of chemical fertilizers (Sharma *et al.,* 2004). An important feature of the mungbean crop is its ability to establish a symbiotic partnership with specific bacteria, setting up the biological N_2-fixation in root nodules that supply the plant's needs for N_2 (Mahmood and Athar, 2008; Mandal *et al.,* 2009).

In the less developed countries many farmers cannot afford inorganic fertilizers. This has led to interest in bio-fertilization with emphasis on biological nitrogen fixation (Wagner, 1997). Use of inorganic fertilizer can be reduced with the introduction of organic fertilizers. Recently, the use of organic materials as fertilizers for crop production has received attention for source of multiple nutrients and ability to improve soil characteristics (Moller, 2009). Organic farming preserves the ecosystem. Symbiotic life forms are cultured ensuring weed and pest control and optimum soil biological activity which maintain soil fertility. The synthetic fertilizers are harmful for soil and aerial environment a threat to entire globe, because sustainable crop productivity (Tejada *et al.,* 2009). Organic materials hold great promise as a the inorganic fertilizers mainly contain major nutrients NPK in large quantities and are neglecting the use of organic manures and bio-fertilizers and hence have paved the way for deterioration of soil health and in turn ill-effects on plants, human being and livestock (Choudhry, 2005).

Poultry manure application improves soil retention and uptake of plant nutrients. It increases the moisture holding capacity of the soil and improves irrigation efficiency. Fresh chicken manure contains 0.8% potassium, 0.4% to 0.5% phosphorus and 0.9% to 1.5% nitrogen. Application of manure will produce crop yields equivalent or superior to those obtained with chemical fertilizers (Xie and MacKenzie,1986 ; Motavalli *et al.*, 1989) also improve crop quality (Eck *et al.*, 1990; Pimpini *et al.*, 1992). Christo *et al.* (2008) confirmed the superiority of poultry manure over other sources of organic manure.

Compost is decomposed organic material, such as leaves, grass clippings, and kitchen waste. Composting is a biological process in which microorganisms like bacteria, fungi and other organisms convert organic materials, such as leaves, manure, sludge, paper, grass clippings and food wastes into a soil like material called compost or humus (Stan *et al*., 2009). It provides many essential nutrients for plant growth and therefore is often used as fertilizer. Compost also improves soil structure so that soil can easily hold the correct amount of moisture, nutrients and air. It supplies 2.5 kg N, 1.0 kg P and 3 kg K from 1 ton material. Animal manure and compst can increase the water holding capacity and cation exchange capacity of the soil (Nkonglo *et al*.,2001).

Integrated management of chemical fertilizers and organic wastes may be an important strategy for sustainable production of crops. This may not only improve the efficiency of chemical fertilizers along with their minimal use in crop production beside increasing crop yield and improving available major and minor nutrients (Rautaray *et al*., 2003). As organic fertilizers are good source of nutrient, a balanced dose of poultry manure and compost with major nutrient (N, P, K) can be useful for productive performance and economic balance of mungbean.The present study was therefore, undertaken with the following objectives:

1. To determine the lower limit of inorganic fertilizer and make the best use of locally available organic resources.
2. To determine most useful combination between organic and inorganic fertilizer for mungbean cultivation and
3. To increase profitability in mungbean production

CHAPTER 2
REVIEW OF LITERATURE

The population of the world is increasing day by day, as a result the pressure on the existing land is increasing. The use of chemicals and agro chemicals is on its pick to get higher production for increased population, but this situation is leading to the imbalance use of fertilizer which has negative effect on soil and degrades environment. Importance of legumes in cropping system needs no further emphasis, as they are valuable items of human nutrition and soil fertility. Therefore, it has become necessary to encourage the pulse production through the use of integrated nutrient management with rich environment. Integrated nutrient work as driving force in sustainable crop production while improving soil health and fertility and balance economics of production.

The available literature on the influence of integrated fertilizer as inorganic fertilizer (NPK) and organic fertilizer (compost and poultry manure) on growth, yield and quality of mungbean has been reviewed in this chapter.

2.1 Effect of inorganic fertilizer

2.1.1 Effect of inorganic fertilizer (NPK) on growth and development of crops

Mungbean is highly responsive to fertilizers and manures. It has a marked response to nitrogen (N), phosphorus (P) and potassium (K). These nutrients play a key role in plant physiological process.

Mathur *et al*. (2007) noticed in an experiment at Jodhpur with two fertility levels (10 + 20 and 20 + 40 kg N + P_2O_5 ha^{-1}) and ascertained that fertility level from 10 + 20 to 20 + 40 kg N + P_2O_5 ha^{-1}greatly enhanced mean plant height (24.4 %) and number of branches per plant (22.7%) of mungbean.

Soodi *et al*. (1994) narrated that number of nodules and dry weight of nodules per plant in mungbean were expanded with the application of 25 kg N ha^{-1}and/or along with 50 kg P_2O_5 ha^{-1}over no nitrogen.

At Rajendranagar (Hyderabad), Yakadri *et al*. (2002) carried out an experiment and reported that application of nitrogen (20 kg ha^{-1}) and phosphorus (60 kg ha^{-1}) caused significant difference in leaf area index indicating better partitioning of dry matter.

Sharma *et al*. (2003) conducted a field experiment at Palampur, Himachal Pradesh, to determine the effects of N (0, 10 and 20 kg ha^{-1}) and P (0, 30 and 60 kg ha^{-1}) on the growth and yield of V. radiata cv. Pusa Baisakhi and ascertained that crop growth rate, relative growth rate, photosynthetic efficiency, number of days to 50% flowering and maturity and seed yield enhanced with increasing rates of N and P.

Manpreet *et al*. (2004) on the basis of an experiment to investigate the response of P application (0, 20, 40 and 60 kg P_20_5 ha^{-1}) on mungbean and they revealed that the increase in P level provided significant improvement in the number of pods per plant, which accounted for significantly higher grain and stover yields at higher levels (40 and 60 kg ha^{-1}) compared to lower levels (0 and 20 kg ha^{-1}).

Netwal (2003) carried out a field experiment at Jobner during kharif season of 2001-02 and reported that application of vermicompost at 5 t ha^{-1} 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^{-1}.

Singh and Pareek (2003) conducted a field trail to investigate the effect of P fertilizer (at 0, 15, 30, 45 and 60 kg P_20_5 ha^{-1}) on the growth and yield of mungbean cv. RMG 62. They showed that the dry matter accumulation, pods $plant^{-1}$, number of seeds $plant^{-1}$ and seed yield were highest with application of P at 45 kg P_2O_5 ha^{-1}over the other P rates.

Satish *et al*. (2003) experiment on the response of mungbean cultivars to several P levels (0, 20, 40 and 60 kg P_2O_5 ha^{-1}) and recorded that total dry matter above-ground as well as the dry matter accumulation in leaves, stems and pods increased with increasing P level up to 60 kg P ha^{-1}.

Singh *et al.* (2001) studied that the effect of phosphorus (30, 60 and 90 kg P_20_5 ha^{-1}) application on mungbean biomass and found that maximum dry biomass $plant^{-1}$ (24.8 g $plant^{-1}$) was recorded from 60 kg phosphorus followed by 30 kg (24.7 g $plant^{-1}$).

Pangsakul and Jensen (1991) found that phosphorus supply increased top dry matter production at flowering and the dry matter production of seeds, straw, pod shells and roots at late pod filling stage of soybeans. Phosphorus supply did not influence the uptake of fertilizer or soil nitrogen in soybeans

Thakuria and Saharia (1990) stated that phosphorus levels significantly influenced the grain yield of summer greengram. The highest plant height, pods $plant^{-1}$ and grain yield were recorded with 20

Kausale *et al*. (2007) narrated in a field trail carried out on a medium deep black soil having low nitrogen content, medium amount of phosphorus and higher potassium content with an aim to determine the effect of nitrogen and phosphorus levels on dry matter segmentation viewed that application of 25 kg N $ha^{-1}$and 50 kg P ha^{-1}recorded significantly highest leaf, stem, total dry matter accumulation and number of root nodules at 30, 45, 60, 90 DAS and at harvest.

Jena *et al*. (1995) narrated that highest green and dry fodder yield of cowpea forage were received by fertility level of 20:40 kg N and P_2O_5/ha over other combinations. Growth of plant in tthe term of no. of branches per plant, leaves per plant and LAI were also showed significantly higher result with 20 kg N and 40 kg P_2O_5 ha^{-1}.

Oad and Buriro (2005) at Tandojam, Pakistan, during the time of spring in 2004 conducted a field trail to investigate the effect of several NPK levels (0-0-0, 10-2020, 10-30-30, 10-30-40 and 10-40-40 kg ha^{-1}) on the growth and yield of mungbean(Vigna radiata cv. AEM 96). The different NPK levels substantially affected the crop parameters and application of 10-30-30 kg NPK ha^{-1} was detected as the best treatment, recording plant height of 56.3 cm and germination of 90.5%, plant population of 162.0 and prolonged days taken to maturity of 55.5. kg $P_2 0_5$ ha^{-1}.

Masud (2003) observed in a pot experiment at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, the highest plant height with the application of 30 kg N ha^{-1} while Ghosh (2007) reported the highest plant height at applying 25 kg N ha^{-1}. Agbenin *et al.* (1991) found that applied N significantly increased growth components, dry matter yield and nutrient uptake over the control.

Azadi *et al*. (2013) conducted an experiment to evaluate and determine the appropriate nitrogen fertilization the morphological characteristics and seed yield of mungbean three cultivars. In this study, different levels of nitrogen fertilizer (control, 50, 100, 150 kg ha^{-1} urea) as sub-plots and three mungbean cultivars (Partow, Gohar, locally) was considered as the main factor. The result of analysis variance on morphological characteristics on seed yield showed that between different cultivar in the eyes of first pod height and seed yield were significant at 5% level probability. In addition, between different amounts of nitrogen fertilizer for stem diameter and number of node and seed yield showed significantly different. Interaction between urea fertilizer and cultivars, number of nodes and seed yield were significant effect at 1% and 5% level probability. The highest seed yield of 8.9 grams per square meter and the number of sub-branches with (1.5) and the height of the first pod from ground level with (25.51 cm) and stem diameter (1.13 cm) and number of nodes (8.28 pcs) and pod length (7.5 cm) was obtained at 150 kg ha^{-1} urea. Between different amount of nitrogen fertilizer, 150 kg/ha urea, showed higher values than the other. In this experiment, 150 kg/ha nitrogen fertilizer with partow cultivar (V1) is the most appropriate treatment and suitable for the region

2.1.2 Effect of inorganic fertilizer on yield attributes and yield of crops

Hossain *et al*. reported in 2011 that The maximum number of pods plant-^{1} (20.87), pods length (8.71 cm), seeds pod^{-1} (8.53), 1000 seeds (27.82 g) and seed yield (1.40 t ha^{-1}) obtained in fertilizer application at the rate of 45:80:55 kg NPK ha^{-1} + Rhizobium inoculation .

Malik *et al.* (2003) from a study conducted in Pakistan to determine the effect of varying levels of nitrogen (0, 25 and 50 kg/ha) and phosphorus (0, 50, 75 and 100 kg ha^{-1}) on the yield of mungbean cv. NM-98 reported that a fertilizer combination of 25 kg N + 75 kg P_2O_5 ha^{-1}resulted in the maximum seed yield (1112.96 kg ha^{-1}).

Sharma *et al.* (2003) at Palampur, got that photosynthetic efficiency, number of days to 50% flowering and maturity and seed yield of mungbean enhanced with increasing rates of N and P upto 20 and 60 kg ha^{-1}, respectively.

Yakadri *et al.* (2004) in a experiment at Rajendranagar (Hyderabad) discovered that application of 20 kg N + 60 kg P_2O_5 ha^{-1}substantially improved the seed and haulm yield of greengram over control.

Bhavya et al. (2018) found from 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.

Mathur *et al.* (2007) from an experiment carried out at Jodhpur with two fertility levels (10 + 20 and 20 + 40 kg N + P_2O_5 ha^{-1}) reported that improved in fertility level from 10 + 20 to 20 +40 kg N + P_2O_5 ha^{-1} significantly enhanced pods per plant (25.6%), seeds per pod (21.3%), 1000-seed weight (7.3%) and biomass per plant (15.5%). As a consequence of higher values of yield parameters, seed (9.6%) and stover (24.4%) yield of mungbean also increased significantly.

Sheoran *et al*. (2008) conducted a field experiment to study the performance of mungbean genotypes in relation to their nutritional requirement under rainfed conditions where the application of 12.5 kg N + 40 kg P_2O_5 ha^{-1} increased the yield compared to 12.5 kg N + 20 kg P_2O_5 ha^{-1}, which in turn, recorded significant yield enhanced by 15.4% over no fertilizer application (N_oP_o).

Gandhi *et al.* (1991) found that number of pods per plant, seeds per pod, weight of seeds per plant, seed yield and straw yield of cowpea were higher with integrated application of 25 kg N and 50 kg P_2O_5 ha^{-1}.

Abbas (1994) reported that application of NPK at the rate of 25-50-75 kg $ha^{–1}$ gave the highest grain yield of 1666 kg $ha^{–1}$. The maximum seed yield i.e., 224.2 g $m^{–2}$ was obtained when 90 kg N was applied.

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 + 2.5t/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).

Hossain and Islam (2017) reported that Bari mung-6 performed the highest seed yield with the application of recommended dose of 45 kg urea ha^{-1} + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}) and vermi-compost for mungbean production in Kharif –I season. The cumulative effect of + 100 kg TSP ha^{-1} + 58 kg MoP ha^{-1}) and vermi-compost performed the best result for var. BARI Mung 6 than BARI Mung 5.

A field trail was conducted at the Agronomy field laboratory by Mozumder (1998), Bangladesh Agricultural University, Mymensingh to study the effects of five nitrogen levels on two varieties of summer mungbean and reported that nitrogen produced negative effect on nodule production and starter dose of nitrogen (40 kg ha^{-1}) gave the maximum seed yield (1607 kg ha^{-1}).

Sharma *et al.* (2001) carried out an experiment to study the influence of various doses of nitrogen and phosphorous on protein content, yield and its attributes of mungbean. They reported that application of 20 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1} gave the average maximum test weight, biological and grain yields, harvest index and seed protein content. Singh et al. (2001) showed that 30 mg P_2O_5 ha^{-1} soil gave the highest plant height, nodule dry weight and yield of green gram. Yadav and Jakhar (2001) observed that grain and straw yields of mungbean increased upto 60 kg P_20_5 application ha^{-1}.

Mandal and Sikder (1999) conducted a greenhouse pot experiment to study the effect of nitrogen and phosphorous on growth and yield of mungbean grown saline soil of Khulna. They reported that growth and yield increased the setting of pods and seeds. Raj Singh et al. (1999) reported that application of 60 kg P_2O_5 ha^{-1} produced a maximum seed yield of 300.12 kg ha^{-1}, however, it did not differ significantly with 40 kg P_2O_5 ha^{-1}.

Kumar *et al.* (2018) concluded that the potassium application is related to mung bean plant growth, total biomass and crops yield. Different potassium level of soils is significantly affected the mung bean plants yield and yield contribution parameters. Maximum mung bean yield was 689 kg ha^{-1} was obtained with the application of 85 Kg potash per hectare. Genotype HUM-1, and HUM-2 produced higher seed yield than JM-72. The interactive effect of three mung bean varieties and their potassium level was found significant in different parameters.

An experiment was conducted by Kumar *et al.* (2014) to study the effect of different potassium levels on mungbean under custard apple based Agri-Horti system at Agricultural Research Farm of Rajiv Gandhi South Campus, Barkachha, Mirzapur. Potassium application is directly related to growth, plant biomass and yield in crops. Results showed that application of different potassium levels gave varying yield. Lowest yield (700 kg ha^{-1}) was obtained with the application of 0 kg ha^{-1} and highest yield (1096 kg ha^{-1}) was obtained with the application of 120 kg ha^{-1} potassium. It is concluded that the application of 80 kg ha^{-1} potassium gave highest Benefit Cost ratio of mungbean and looks more remunerative in Vindhyan region.

Beg and Ahmad (2012) stated that the foliar application of Potassium on moong bean at the time of flowering at half and full basal fertilizer doses in different concentrations was applied and it was found that the treatment, 1.00 kg Potassium ha^{-1} was applied as foliar spray showed best result. It enhanced almost all the vegetative and yield characteristics of mungbean at both the basal fertilizer doses. Besides, potassium used as foliar spray at the time of flowering when the plant required maximum nutrients can enhanced the productivity and save a large amount of fertilizers.

Srinivas *et al*. (2002) carried out an experiment on the performance of mungbean at various levels of nitrogen and phosphorus where different rates of N (0, 25 and 60 kg ha^{-1}) and P (0, 25, 50 and 60 kg ha^{-1}) were tested. They recorded the highest number of pods plant^{-1}, 1000-seed weight and seed yield were received with the increasing rates of N up to 40 kg ha^{-1}followed by a decrease with further increase in N.

Mahboob and Asghar (2002) at the Agronomic Research Station, Farooqabad in Pakistan, investigated the response of seed inoculation at several nitrogen levels on mungbean at the Agronomic Research Station, Farooqabad in Pakistan. They revealed that various yield components was significantly affected with 50-50-0 N kg ha^{-1}, P kg ha^{-1}, K kg ha^{-1} application. Again they reported that seed inoculation with 5050-0 N kg ha^{-1} exhibited superior performance in respect of seed yield (955 kg ha^{-1}).

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

Tickoo *et al.* (2006) at India carried out an experiment during the summer season in 2000 on mungbean cv. Pusa 105 and Pusa Vishal which were maintained at 22.5 and 30.0 m spacing at the time of sowing with association of 36-46 and 58-46 kg of N and P per ha . Cultivar Pusa Vishal provided higher biological and seed yield (3.66 and 1.63 t ha^{-1}) compared to cv. Pusa 105 where nitrogen and phosphorus rates had no great effects on both the biological and grain yield of the crop.

Nadeem *et al.* (2004) studied the performance of mungbean (cv. NM-98) at various levels of fertilizer (0-0, 15-30, 30-60 and 45-90 kg N and P_20_5 under field conditions. The yield was greatly influenced due to the application of fertilizer and the maximum seed yield was acquired when 30 kg ha^{-1} N was applied along with 60 kg ha^{-1} P_20_5.

Rajender *et al.* (2002) investigated the effects of N (0, 10, 20 and 30 kg ha^{-1}) and P (0, 20, 40 and 60 kg ha^{-1}) fertilizer rates on mungbean genotypes MH 85-111 and T44. By increasing N rates up to 20 kg ha^{-1} substantially enhanced seed yield of mungbean .Further increase the rates of N did not influence seed yield. Yield contributing characters viz. number of pods $plant^{-1}$, numbers of seeds pod^{-1}, 1000-seed weight and stover yield became higher with raising rates of P. whereas seed yield enhanced with increasing rates of P up to 40 kg ha^{-1} only.

Karle and Pawar (1998) examined the response of summer mungbean under the application of varying levels of N and P fertilizers where they revealed that higher seed yield were oobtained with the application of 15 kg N ha^{-1} and 40 kg P_20_5 ha^{-1}.

A field trail at Tandojam, Pakistan, during the time of spring in 2004 conducted by Oad and Buriro (2005) to investigate the effect of several NPK levels (0-0-0, 10-2020, 10-30-30, 10-30-40 and 10-40-40 kg ha^{-1}) on the growth and yield of mungbean(*Vigna rediata* cv. AEM 96) . The different NPK levels substantially affected the crop parameters and application of 10-30-30 kg NPK $ha^{-1}$was detected as the best treatment, recording yield parameters in the term of pod length 5.02

cm, seed weight 10.5 g, seed index 3.5 g and the highest seed yield 1205.2 kg ha^{-1}.

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

Mandal and Sikdar (1999) laid out a greenhouse pot experiment where mungbean (BARI Mung-5) grown on saline soil and given 0, 50 or 100 kg N $ha^{-1}$and 0, 75 or 150 kg P ha^{-1}. Growth and yield increased significantly with N application while P significantly increased the setting of pods and seeds. Root growth was significantly improved by both individual and combined application of these two fertilizers.

Tank *et al*. (1992) revealed that mungbean fertilized with 20 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.

2.2 Effect of Organic Manures

2.2.1 Effect of organic manures on growth and development of different crops

Choudhary *et al.* (2011) found that application of vermicompost @ 0.7 t ha^{-1} +50% RDF provided excessive number of braches/plant (7.1) of mungbean crop and remained at par with poultry manure @ 0.85 t ha^{-1} + 50% RDF.

Dotaniya *et al*. (2014) stated that the increased available P content of soil might be due to release of CO_2 and organic acids during decomposition, which helps in solubilizing the native soil P. During decomposition of organic manures, various phenolic and aliphatic acids are produced which solubilize phosphatase and other phosphate bearing minerals and thereby lowers the phosphate fixation and increase its availability. Thus, incorporation of organic materials improves soil health and crop yield.

Khalilzadeh *et al.* (2012) conducted an experiment on growth characteristics of mungbean (*Vigna radiata* L.) affected by foliar application of urea and bio-organic fertilizers. They found that foliar application of urea and organic manure substantially improved the plant height.

Nursu‟aidah *et al.* (2014) carried out an experiment on 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 number of nodules per plant.

Dahama *et al.* (2007) while investigating the effect NPK (20-30-20 Kg ha^{-1}), Zn (25 kg ha^{-1}), Fe (5 kg ha^{-1}), FYM (10 t ha^{-1}) and vermicompost (5 t ha^{-1}), applied singly or in combination of both on green gram cv. RMG-62 at Bikaner (Rajasthan) reported that highest plant height was recorded at harvest with the treatment of NPK + vermicompost (43.8 cm) than the other treatments and control.

Menon *et al.* (2010) concluded that growth viz. plant height, dry matter, number of leaves of cowpea production were highest under the treatment including poultry manure and cow dung.

Ramesh *et al*. (2006) conducted a field experiment on pigeon pea with different treatments of organic manures (cattle dung @ 4 t ha^{-1}, vermicompost @ 3 t ha^{-1} and poultry manure @ 2 t ha^{-1}) and noted that among cattle dung given the maximum plant height, number of branches per plant and biomass accumulation where vermicompost remained intermediate while poultry manure recorded lower values of above parameters but was superior to control.

Amanullah *et al.* (2007) stated that the organic manure treatments, i.e. FYM @ 25 t ha-^{1}, poultry manure @ 10 t ha^{-1}, composted poultry manure @ 10 t ha^{-1}, FYM @ 12.5 t ha^{-1} +poultry manure @ 5 t ha^{-1}, FYM @ 12.5 t ha^{-1} + composted poultry manure @ 5 t ha^{-1} provided better growth and yield of pulses crop over control.

Choudhary *et al.* (2011) found that integration of 50% RDN through poultry manure to supplement the nitrogen to fenugreek recorded maximum growth attributes, viz. plant height, branches/plant, dry matter accumulation/m, nodules/plant and weight of nodules/plant of fenugreek crop over control.

Bhattarai *et al.* (2003) conducted a study at research farm of the Central Agricultural University, Imphal on field pea and reported that application of full recommended nutrient + 5 tons per hectare poultry manure provided the highest plant height and dry matter accumulation per plant over the rest of treatment.

Panda *et al.* (2012) observed significant effects of use of the organic amendments viz. groundnut cake, Pongamia cake, neem cake, mustard cake, cowdung, vermicompost, and poultry manure used individually or in combinations on growth, nodulation, yield, and profitability of cowpea, cv. Utkal Manika, grown on sandy loam soil.

Ghanshyam and Jat (2010) carried out an experiment for two sequential years where he noted that under the application of vermciompost @ 5 t ha-^{1} meaningfully improved the total number of nodules per plant being at par with application of FYM @ 5 t ha-^{1} and both were found superior outcome over control in both the years in green gram.

Madukue *et al.* (2008) in an experiment revealed that organic manure substantially influenced the nodulation of the cowpea and application of poultry manure provided the notable number of nodules (15.9) which was significantly different from the other values of nodules (12.2 and 10.3) recorded from cow dung-treated plots and untreated plots respectively.

Razieh *et al.* (2012) carried out an experiment to determine the effect of foliar spraying of Bio organic fertilizers and urea on root and vegetative growth of mung bean (*Vigna radiata* L.) in a greenhouse condition. The experiment was conducted with four replications in Randomized Complete Design with ten treatments (Urea, Nitroxin, Amino acid, Green hum, Biocrop L- 45, Nutriman N24 and Mas Raiz, cattle manure, water and control). Results showed that all traits were significantly affected by treatments except the number of second roots. Foliar application of urea and 7 organic manure substantially improved the plant height, leaf area, shoot and root dry weights, root and shoot length, volume and number of roots. Similarly shoot and leave number and nodules root were also improved by the foliar spraying of Green hum and Amino acid, respectively. While the lowest nodules root was observed in plants treated by nutriman N24 and urea. This improved growth of mainly due to nutrient availability in bio-organic fertilizer and uptake by plants.

Mohanty *et al.* (2015) found in North Central Plateau Zone of Odisha to evaluate the residual effect of three rice establishment methods and three nutrient management practices [RDF, 50% RDF+ 50% RDF through organic sources and 100% RDF through organic sources] and direct effect of three nutrient management practices viz., RDF, 50% RDF+ biofertilizer and no fertilizer on performance of greengram in rice-greengram cropping system. They concluded that application of either organic nutrition or INM to kharif rice benefits the succeeding greengram crop in a rice -greengram cropping sequence. Direct application of 50% recommended dose of fertilizer along with biofertilizer seed treatment to greengram is more productive and profitable in North Central Plateau Zone of Odisha.

Gadi *et al.,* (2017) did the experiment that was laid out in Randomized Block Design with thirteen treatments in three replications. Among all the treatments, application of 10-40-20 NPK kg ha^{-1} + 10 kg ha^{-1} N through poultry manure + GA3 75+75 ppm was recorded maximum plant height, root length, more numbers of branches per plant, highest number of leaves per plant, maximum numbers of nodules, maximum dry weight per plant and maximum grain yield at 30, 45, 60 and 75 days after sowing. Poultry manure with organic form of nitrogen enabled a faster and better growth of crop. The application of organic manures, inorganic fertilizers and growth regulators could be ascribed to their direct influence on dry matter production at successive stages by virtue of increased photosynthetic efficiency.

Bhattarai *et al*. (2003) conducted a field experiment on clayey soil at research farm of the Central Agricultural University, Imphal and observed that application of full recommended nutrient + 5 tonnes per hectare poultry manure recorded the highest plant height and dry matter accumulation per plant in fieldpea.

Mohbe *et al.,* (2015) results revealed that poultry manure (T8) showed, best performance in initial plant height at 15 DAS, pod formation 8.0 and 17.53 at 45 and 60 DAS respectively, Highest nodule formation at 60 DAS 27.27, maximum yield per plant 9.31 gram and maximum seed yield per plot 1368 gram.

Christo *et al.* found that highest number of pods per plant (23.28pods) were recorded from the plants that received 9ton/ha of the manure. Analysis of the data also revealed that various levels of poultry manure have significantly (p=0.05) affected pod weight per plant. Poultry manure rates also exhibited significant influence on number of seeds per pod. Plants that received 9ton/ha of the poultry manure produced the highest number of seeds per pod (11.98). The plants that received the highest manure rate (9ton ha^{-1}) produced the highest plant height at maturity while the least was obtained from the control plots. Application rate of poultry manure significantly influenced days to 50% flowering. The plants without any manure had the shortest days (35.00 days) to 50% flowering which was significantly different from all others.

Application of PM @ 5 t ha^{-1} + Rhizobium + PSB recorded significantly higher the number of pods per plant by 37.35, 23.01, 6.77 and 14.21 per cent over B0, B1, B2 and B3, respectively. Application of PM @ 5 t ha^{-1} + Rhizobium +PSB significantly increased the seeds per pod over control, PM @ 2.5 t ha^{-1}, PM @ 5 t ha^{-1} and PM @ 2.5 t ha^{-1} + Rhizobium + PSB representing an increase of 56.89, 28.60, 8.40 and 18.23 per cent, respectively. The availability and optimum supply of nutrients to plants favorably influenced the flowering and grain formation, which in turn increased the pods $plant^{-1}$, grains pod^{-1} and test weight. Found by Mathur *et al*. (2003) and Bhatt *et al*. (2013) in greengram.

Abbas *et al.* conducted an experiment and found that application of DAP at 124 kg ha^{-1} along with 10 tons of poultry litter ha^{-1} (T7) produced maximum grain yield (1280 and 1212 Kg ha^{-1}) at ARF Karor compared to control (794.8 kg ha^{-1}).

Similarly, at farmer's field with the same above organic and inorganic fertilizer the grain yield was recorded as 1306 and1164 kg ha^{-1} during the years 2006-07 as compared to control (834.4 Kg ha^{-1}).

2.2.2. Effect of Organic fertilizers on yield attributes and yield of different crops

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

Mathur *et al.* (2007) from an experiment conducted at Jodhpur with 2 fertility levels (10 + 20 and 20 + 40 kg N + P_2O_5 ha^{-1}) reported that increase in fertility level from 10 + 20 to 20 +40 kg N + P_2O_5 ha^{-1} 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 consequence of higher values of yield parameters, grain (9.6%) and straw (24.4%) yield of mungbean also increased significantly.

It was reported by Gadi and Shankar (2017) that the application organic manures, combination with inorganic fertilizers and growth regulator (GA3) will helps increase the nutrient uptake through various of organic nutrients and growth regulator helps cell division and elongation of cells in plants. The application of 10-40-20 NPK kg ha^{-1} + 10 kg ha^{-1} N through poultry manure + GA375 + 75 ppm was recorded maximum number of pods per plant, higher number of grains per pod, maximum 1000-seed test weight, and grain yield per ha and straw yield per ha.

Boateng *et al*. (2006) reported that PM application registered 53% increases of nitrogen (N) level in the soil, from 0.09% to 0.14%, and exchangeable cations increase with different levels of PM application.

Laila (2011) showed that marketable yields of maize were significantly increased by 107 and 124 % due to application of compost at the rates of 5 and 7 ton fed-1, respectively, over that of control treatment.

Moreover, Soheil *et al.* (2012) reported that compost increases available form of nutrients for plant in soil and then increases root growth and nutrient uptake by plant that results in plant stem height and dry weight rise up.

Gamal (2009) found that application of 5 ton ha^{-1} compost increased sorghum grain yield by 45% as compared to no compost plots, while the grain yield was higher at composted plots (10 ton ha^{-1}) by 19% than no compost plots in different sites

Mohammed *et al.* (2004) has compared the use of composted organic wastes as alternative to synthetic fertilizers for enhancing crop productivity and agricultural sustainability in two season (wet and dry). Yield results from the dry season trail showed gradual increase in crop yield as compost application rate was increased from 0 tons per acre (control) to 120 tons per acre of compost application

Adeoya *et al.* (2011) in an experiment showed that these plots ware treated by poultry waste along had highest yield (854 kg ha^{-1}) performance of cowpea crop over control and other treatments.

Amanullah *et al.* (2007) revealed that the organic manure treatments, i.e. FYM @ 25 t ha^{-1}, poultry manure @ 10 t ha^{-1}, composted poultry manure @ 10 t ha^{-1}, FYM @ 12.5 t ha^{-1} + poultry manure @ 5 t ha^{-1}, FYM @ 12.5 t ha^{-1} + composted poultry manure @ 5 t ha^{-1} along with the control provided higher nutrient uptake in legumes crop and available nutrients in postharvest soil.

Ramesh *et al.* (2006) revealed that the application of poultry manure @ 2 t ha^{-1} given substantially higher number of pods/ plant and seed yield of pigeonpea crop over control.

In an experiment, Rao and Shaktawat (2002) reported that the application of poultry manure @ 5 t ha^{-1} significantly higher number of pods per plant (18.6 pods /plant) in groundnut crop over control.

Madukue *et al.* (2008) revealed that the yield of cowpea was notably improved by applying of poultry manure with a mean yield of 744.7 kg $ha-^{1}$, which was greatly distinguishable from values (571.9kg $ha-^{1}$ and 505.0kg ha^{-1}) noted under control and cow dung treated plots respectively.

Singh *et al.* (2008) carried out a field to investigate the effect of different organic manures, viz cattle dung manure, vermicompost and poultry manure application on soybean, [Glycine max (L.) Mer.], chickpea (*Cicer arietinum* L.) and wheat (*Triticum durum)* seeds yield quality parameters and their effect on soil biological properties under soybean - durum wheat and soybean - chickpea cropping systems and recorded that the application of cattledung manure + vermicompost reported highest seed yields of chickpea (1 551 kg $ha-^{1}$) distinguished to other organic combinations and control (1185 kg ha^{-1}).

Jan *et al.* (2010) noted an increase in plant N uptake by the combined application of organic and inorganic sources of N. Data reveal that maximum plant P uptake of 12.2 Kg ha^{-1} was recorded by the application of compost of city garbage and half SSP with 400% increase over control

Awaad *et al.* (2009) showed that combined application of organic materials with rock phosphate increased N uptake of plants significantly as a synergistic effect of improved P on N availability. Plants P uptake by mung bean increased significantly ($p \leq 0.05$) over control.

It was observed by Eghball *et al.* (2003) that with the residual effect of N- based compost, the P uptake of crop increased significantly.

Govi *et al.* (1996) concluded that compost of organic waste alone and in combination (25% of volume) with a substrate from straw bedded horse dung is good compost for better crops growth and improved P availability.

Sharif *et al*. showed that maximum and significantly ($p \leq 0.05$) increased mungbean grain yield, total dry matter and straw yield of 858 kg ha^{-1}, 8167 kg ha^{-1} and 7309 kg ha^{-1}, respectively were observed by the residual effect of composts of RP fed dung applied with half dose of SSP.

Arif *et al.* explained that combined application of organic manures and inorganic fertilizers improve the growth and yield of rice. Application of poultry manure @ 10t ha^{-1} in combination with 50% of RDF increased grain yield of rice by 32%. The higher yield obtained with integrated use of organic manure and inorganic fertilizers was attributed to increased nutrient availability and uptake, resulting in greater number of fertile tillers, number of grains per panicle, number of panicles per hill, filled grains per panicle, 1000 grain weight, biological yield, grain yield and harvest index.

Otieno *et al.* (2007) found that compost contained different nutrients especially N and P which may cause increase in nodulation and grain yield. Moreover, economic analysis shows the importance of compost incorporation in improving grain yield of mungbean leading to better output in terms of net profit. . According to Otieno *et al*. (2007) nodulation increased due to slow mineralization of N from compost. Nodulation inhibited when higher rate of N was applied as compared to lower rates.

Mahimairaja *et al.* (1995) said that Composting manures and biological waste materials with phosphate rocks has been practised widely as a low-input technology to improve the fertilizer value of the manures.

CHAPTER 3

MATERIALS AND METHODS

The experiment was carried out at the Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka-1207 during the kharif-II season from October to December, 2018 to study the yield and economics of mungbean as influenced by integrated nutrient management. This chapter presents a brief statement of the experimental site, experimental period, climatic condition, crop or planting materials, land preparation, experimental design and layout, crop growing procedure, treatments, intercultural operations, data collection, preparation and chemical analysis of soil and plant samples along with statistical analysis.

3.1 Description of the experimental site

3.1.1 Location of experiment

The research work was carried out in the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site is 90°33´ E longitude and 23°77´ N latitude with an elevation of 8.2 m from the sea level. Location of the experimental site is presented in Appendix I.

3.1.2 Soil

The soil of the experimental sites belongs to the “The Modhupur Tract”, AEZ – 28. Texture of upper level soil was silty clay and color content was olive-gray with ordinary fine to medium distinct dark yellowish brown mottles with 0.45% organic carbon content. The Soil pH was 5.6 and the topography was medium high. The research area was plain having available irrigation and drainage system and above flood level.

3.1.3 Climate

The experimental site was geographically located under the subtropical climate which includes 3 distinct cropping seasons, Rabi season from November to February and the kharif-1 season from March to April and kharif-II from May to October. Details on the meteorological data of air temperature, relative humidity, rainfall and sunshine hour during the period of the experiment was collected from the Weather Station of Bangladesh, Sher-e-Bangla Nagar, presented in Appendix II.

3. 2 Planting materials

Mungbean variety BARI Mung-6 was used in this study. The salient characteristics of the variety is presented below:

BARI Mung-6

In 2003, BARI Mung-6 was released by BARI. Plant height of this variety ranges from 40 to 45 cm and can be grown in Kharif-I, Kharif-II and Rabi. The variety requires 75 to 80 days to mature, and under proper management practices it may give 1.6-2.0 t ha^{-1} seed yield . It is resistant to Cercospora leaf spot and yellow mosaic virus. The plant leaves look light green. One thousand seed weight is about 51-55 g and seed are deep green in colors. Seeds are larger than local variety and light brown yellow in color. Seed contains 20-25 % protein. 1000 seeds weight is 35-40g.

Poultry manure

Poultry manure improves soil retention and uptake of plant nutrients. It contains 0.5% to 0.9% nitrogen, 0.4% to 0.5% phosphorus, and 1.2% to 1.7 % potassium. Poultry manure contains all 13 of the essential plant nutrients that are used by plants. These include nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), manganese (Mn), copper (Cu), zinc (Zn), chlorine (Cl), boron (B), iron (Fe), and molybdenum (Mo).

Compost

Compost is decomposed organic material, such as leaves, grass clippings, and kitchen waste. Provides many essential nutrients for plant growth. It supplies 2.5 kg N, 1.0 kg P and 3 kg K from 1 ton material. It contains 2% nitrogen, 0.5–1% phosphorus, and 2% potassium

3.3 Experimental details

3.3.1 Treatments

The experiment comprised of several fertilizer treatments

T_1= Recommended dose of fertilizers (RDF): N- 15 kg ha^{-1}, P- 20 kg ha^{-1},K- 30 kg ha^{-1}, Zn- 2.0 kg ha^{-1}, S-10 kg ha^{-1}, B- 1.5 kg ha^{-1}
T_2= Poultry manure (PM) - 3 t ha^{-1},
T_3= Compost- 2 t ha^{-1},
T_4= PM + RDF,
T_5= Compost + RDF,
T_6= PM + 50% RDF,
T_7= Compost + 50% RDF,
T_8= PM+ NPK,
T_9= Compost + NPK,
T_{10}= PM + NP,
T_{11}= Compost+ NP,
T_{12}= PM + NK,
T_{13}= Compost + NK,
T_{14}= PM + PK,
T_{15}= Compost + PK.

3.4 Experimental design and layout

The experiment was laid out in a two factors randomized complete block design (RCRD) having three replications. Each replication had 15 unit plots to which the treatments were assigned randomly. The unit plot size was 2.7 m^2 (2.25m x 1.2m). The blocks and unit plots were separated by 70cm in and 50cm in spacing, respectively. The experimental lay out was done on 20th September, 2018. The layout of the experiment field is shown in Appendix III.

3.5 Land preparation

The experimental land was opened with a power tiller on 17th September, 2018. Ploughing and cross ploughing were done with country plough followed by laddering. Land preparation was completed on 19th September and was ready for lay out and seed sowing gradually. Different wastes like crop residues, weed stubble etc. were removed.

3.6 Fertilizer application

Organic fertilizers (poultry manure and compost) were applied on the selected plot before 7 days of seed sowing so that the toxic materials of row organic fertilizers could not harm the crops seed and can release nutrients. Poultry manure was applied @ 3 t ha^{-1} and compost @ 2 t ha^{-1}. Inorganic fertilizer for the supply of N, P and K were applied @ 15 kg N ha^{-1}, 20 kg P ha^{-1}, 30 kg K ha^{-1} in the form of urea, TSP and MP respectively during final land preparation as basal dose. Zn, S and B were applied respectively @ 2.0 kg Zn ha^{-1} from ZnO, @ 10 kg S ha^{-1} from $ZnSO_4$ and @ 1.5 kg B ha^{-1} from Boric acid as per treatment during final land preparation.

3.7 Seed sowing

Mungbean was sown in research field at 4th October, 2018. Healthy seeds of BARI Mung-6 variety was sown by hand as uniformly as possible in furrows. Light irrigation was given into the furrow before seed sowing. Seeds were sown maintaining 30 cm line to line distance in the early morning and immediately covered with soil to avoid early sunlight.

3.8 Germination of seeds

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

3.9 Intercultural operations

3.9.1 Thinning

Thinning was done at 7 days after sowing to maintain optimum plant population with a plant spacing of 10 cm.

3.9.2 Irrigation and weeding

Weeding was done two times. First weeding was done at 20 days and second weeding was done at 35 days after sowing. Irrigation was done as per requirements.

3.9.3 Protection against insect and pest

At the early stage pest did not infest the mungbean crop. Ripcord 10 EC @ 1 ml L^{-1} was applied two times at an interval of one week to control insect.

3.9.4 Crop sampling and data collection

Five plants from each treatment were randomly selected at different growth stage of plant for data recording. The following parameters were recorded during the study:

1. Plant height (cm)
2. Number of leaves plant^{-1}
3. Number of branches plant^{-1}
4. Number of nodules plant^{-1}
5. Number of pods plant^{-1}
6. Number of seeds pod^{-1}
7. Pod length (cm)
8. 1000 seed weight (g)
9. Seed yield (t ha^{-1})
10. Stover yield (t ha^{-1})
11. Biological yield (t ha^{-1})
12. Harvest index (%)

3.10 Harvesting

The crops were started to harvest at the time of contemporaneous maturity of maximum pods. At first 80% of matured pods were harvested by hand picking at 65 days after sowing and 7 days after first harvesting 2nd harvest was done. Finally, all plants were harvested plot-wise by uprooting at the same days of second pod picking and were bundled separately. Then all harvested plants were tagged and brought to the threshing floor of the SAU farm. At last, all of the harvested pods were kept apart in properly tagged gunny bags.

3.11 Data collection and recording

Data recording procedures:

i. Plant height

Five plants were randomly selected from each plot and measured from base of the plant to the tip of the main shoot with the help of scale. The average of five plants at 30 DAS and harvest were taken and expressed as the plant height in centimeters.

ii. Number of leaves plant^{-1}

The numbers of green trifoliate leaves present on each plant were recorded from the randomly selected five plants at 40 DAS. The mean number of leaves per plant was computed and expressed in number plant^{-1}.

iii.Number of branches plant^{-1}

The branches were counted from the 5 randomly selected plants at 30 DAS and harvest time and mean value was determined as branches plant^{-1}.

iv. No. of nodules plant^{-1}

Five plants from selected rows was uprooted from each treatment and total number of nodules from five plants was counted at 30 DAS and at harvest and the mean value was determined.

v. Number of pods plant-^{1}

Total Number of pods of 5 plants from the plot was noted and the mean number was expressed as pods per plant.

vi. Number of seeds pod^{-1}

The number of seeds per pod was calculated and recorded randomly from selected plants at the time of harvest. Data were recorded as the average of 25 pods selected at random from harvested pods from each plot.

vii. Pod length (cm)

Length of 5 pods selected from 5 plants from each plot was noted and the mean number was expressed per pod basis. This data was taken at harvest.

viii. Weight of 1000 seeds (g)

One thousand cleaned and dried seeds were counted randomly from each treatment plot and weighed by using a digital electric balance and the weight was expressed in gram after harvest.

ix. Seed yield (t ha^{-1})

The plants of the central 1.0 m^2 area plot were harvested for measuring seed yield. The seed were threshed from the plants, cleaned, dried and then weighed. The seed yield of kg plot^{-1} was converted to t ha^{-1}.

x. Stover yield (t ha^{-1})

The stover of the harvested 1 m^2 crop in each plot was sun dried to a constant weight. Then the stovers were weighted and thus the stover yield plot^{-1} was determined. The yield of stover in kg plot^{-1} was converted to t ha^{-1}.

xi. Biological yield (kg ha^{-1})

The total of seed yield and stover yield is regarded as biological yield and it was determined by the using the following formula –

Biological yield (t ha^{-1}) = Seed yield (t ha^{-1}) + Stover yield (t ha^{-1})

xii. Harvest index (%)

Harvest index was calculated from the ratio of grain yield to biological yield and expressed in percentage. It was calculated by using the following formula.

$$\text{Harvest index} = \frac{seed\ yield}{biological\ yield} \times 100$$

3.12 Cost and return analysis

Added cost and added benefit were calculated. Besides, the gross return was calculated on the basis of different treatments which were directly related to the price that received from, the product. Cost of calculation was involved with wage rate (land preparation, weeding, seed sowing, and fertilizers application), pesticides, irrigation, fertilizers cost. Land used cost or rental value of land was not considered here. Benefit cost ratio (BCR) of different treatments were calculated as follows:

$$BCR = \frac{gross\ return}{cost\ of\ cultivation}$$

3.13 Statistical analysis

The data recorded for different parameters were statistically analyzed with the help of Statistix 10 software to determine the significant dissimilation among several treatments on growth, yield and yield contributing characters of mungbean. 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 and Gomez, 1984).

CHAPTER 4

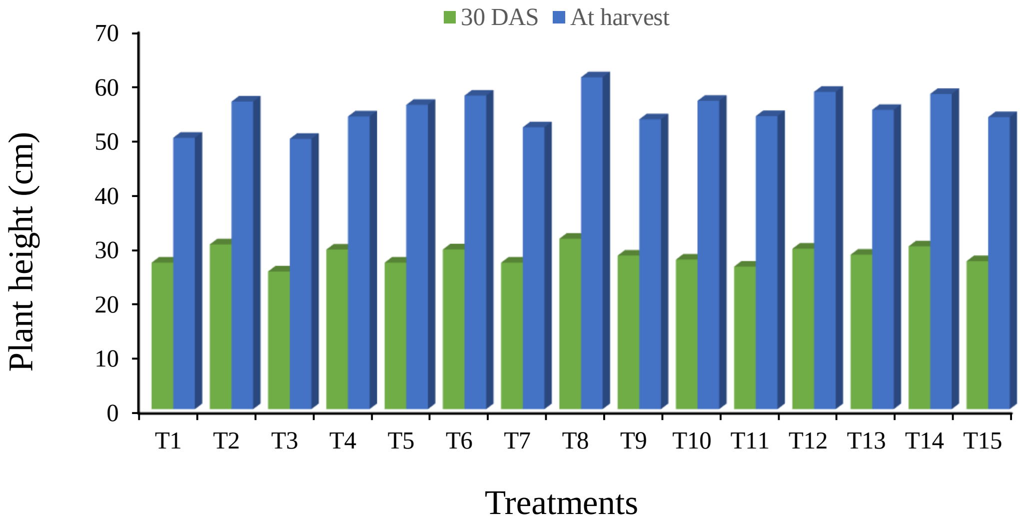
RESULTS AND DISCUSSION

The experiment was conducted entitled yield and economics of mungbean as influenced by integrated nutrient management. This capter represents the result of different parameters under various treatment of the experiment and discussion about the results also. Summary of mean square values at different parameters are given in the appendices. Possible graphs and tables also presented where it is needed.

4.1 Plant height (cm)

4.1.1 Effect of various treatments on plant height

Plant height at 30 days after sowing and height at harvest showed significant difference among various treatments (Figure 1). The maximum plant height was recorded 31.30 cm and 61 cm respectively at 30 days and at harvest. It was found at F_8 treatment. The lowest plant height was recorded at T_3 treatment and the height was 25.26 cm and 49.66 cm at 30 DAS and at harvest, respectively. Tarun *et al. (*2013) found that the maximum height of the plant (84.70 cm) was found with treatment T_5: (75 kg N+40 kg P_2O_5+40 kg K_2O+5 tonnes Vermicompost ha^{-1} +20 kg $ZnSO_4$ ha^{-1}), followed by T_4 treatment (90 kg N+30 kg P_2O_5+30 kg K_2O +5 tonnes Vermicompost per ha,). The increased vegetative growth in the treatment T_5 and T_4 might be due to vermi-compost application, which increased the microbial growth in the soil and solubilizes the native nitrogen, phousphorus, potassium and other nutrients in okra.



T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compos t+ N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

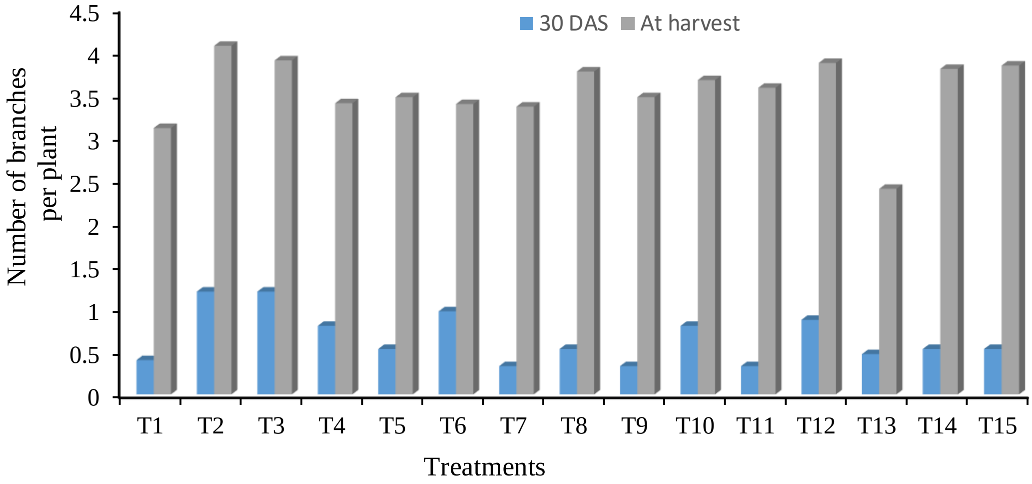
Figure 1. Effect of integrated nutrient management on plant height of mungbean ($LSD_{0.05}$ = 4.2 and 10.32 for 30 and at harvest respectively)

4.2 Number of branches per plant

4.2.1 Effect of various nutrient treatments on number of branch per plant

The nutrient treatments had significant effect on number of branch per plant at 30 DAS and at harvest respectively. The highest number of branch (1.2 and 4.06, gradually at 30 DAS and at harvest) was recorded at T_2 treatment which is statistically similar to the treatment T3 (1.16). The lowset number of branch at 30 DAS is 0.33 at T_7 treatment which is similar with the treatment T_9 and T_{11}. The lowest number of branch at harvest was recorded 2.4 in treatment T_{13} (Figure 2). Singh *et al.* (2001) reported in mustard the highest number of total branches/plant were recorded with the application of 100% recommended dose of fertilizers

(RDF) + FYM 5 t ha^{-1} + VC 2.5 t ha^{-1} + Azotobacter was significantly higher than all other treatments.



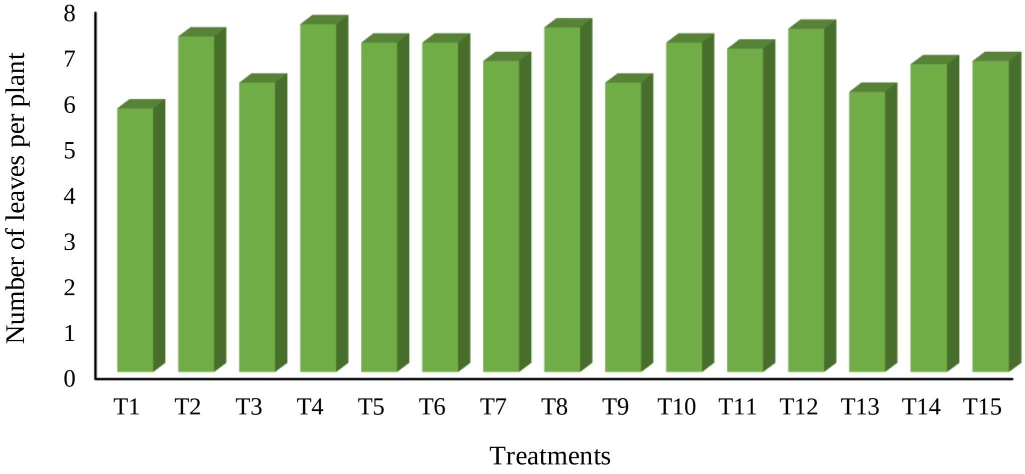
T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compos t+ N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

Figure 2. Effect of integrated nutrient management on number of branches per plant of mungbean ($LSD_{0.05}$ = 0.15 and 0.83 for 30 and at harvest respectively)

4.3 Number of leaves per plant

4.3.1 Effect of various treatments on number of leaves per plant

The number of leaves per plant showed significant difference in different treatments (Figure 3). The highest number of leaves was recorded in the treatment T_4 (7.6) which is statistically similar with the treatments T_8 (7.5) and T_{12} (7.5) . On the other hand the lowest number of leaves per plant was found in treatment T_1 (5.6). Menon *et al.* (2010) reported that growth viz. plant height, dry matter, number of leaves of cowpea production were highest under the treatment including poultry manure and cow dung.



T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost+ N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

Figure 3. Effect of integrated nutrient management on number of leaves per plant of mungbean ($LSD_{0.05}$ = 1.58)

4.4 Number of nodules per plant

4.4.1 Effect of various treatments on number of nodules per plant

Different treatments have significant effect on nodule formation at 30 DAS (Table 1). The highest number of nodules was recorded in treatment T_4 (36.83). The lowest number of nodules at 30 DAS was found in treatment T_{13}. But the number of nodules at 60 DAS showed no significant difference among the treatments. The highest number of nodules found in treatment T_4 (27.73) and lowest number of nodules found in treatment T_2 (24.83). Dhakal *et. al.* (2016) reported that the maximum number of root nodules/plant at flower initiation and peak flowering stages were recorded in the treatment of 75% RDF+ vermicompost + bio-fertilizers+ rhizobium +PSB in greengram.

Table 1. Effect of integrated nutrient management on number nodules per plant of mungbean

Treatment	At 30 DAS	At harvest
T_1	32 a-c	25.67
T_2	31.17 c	24.83
T_3	36 a-c	27.00
T_4	36.83 a	27.83
T_5	36.77 a	26.83
T_6	35.6 a-c	26.33
T_7	36.2 a-c	26.17
T_8	35.3 a-c	26.00
T_9	34.13 a-c	25.17
T_{10}	36.63 a	27.67
T_{11}	33.33 a-c	27.17
T_{12}	36.27 ab	27.17
T_{13}	31.17 c	25.5
T_{14}	35.67 a-c	27.67
T_{15}	31.67 bc	25.33
LSD(0.05)	5.0594	NS
CV%	8.75	11.42

In a column, having similar letter(s) are statistically similar and those having dissimiliar letter(s) differs significantly by LSD at 0.05% levels of probability.

**NS= Non significant by LSD at 0.05% levels of probability

T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost + N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

4.5 Pods per plant

4.5.1 Effect of various treatments on pods per plant

The number of pods per plant was affected by different treatments and showed significant variation (Table 2). The highest number of pods (13.4) was found in treatment T_{12} which is statistically similar with the treatments T_8 (13.36) and T_{10} (13.26). The lowest number of pods (10.13) was recorded in treatment T_3 which is statistically similar with T_1, T_9, T_{15}, T_4, T_{11} and T_7 treatments. Tomar *et al*. (2004), who observed that soybean plants treated with Bradyrhizobium inoculants significantly increased the number of pods plant^{-1}. Singh *et al.* (2016) found that the highest number of siliqua/branch was recorded with the integration of 100% recommended dose of fertilizers (RDF) + FYM 5 t/ha + vermicompost (VC) 2.5 t/ha + Azotobacter, which was significantly higher than the control, chemical fertilizers alone in mustard. Ramesh *et al.* (2006) carried out a field experiment at Bhopal, reported that among different sources, chemical fertilizers recorded the higher number of pods/plant in pigeon pea which were at par with cattle dung application

Table 2. Effect of integrated nutrient management on pods per plant of mungbean

Treatment	Number of pods per plant
T_1	12.00 a-c
T_2	12.40 ab
T_3	10.13 c
T_4	11.73 a-c
T_5	12.20 ab
T_6	12.60 ab
T_7	11.13 bc
T_8	13.36 a
T_9	12.00 a-c
T_{10}	13.26 a
T_{11}	11.67 a-c
T_{12}	13.4 a
T_{13}	11.87 a-c
T_{14}	12.80 ab
T_{15}	11.73a-c
LSD(0.05)	1.87
CV%	9.24

In a column, having similar letter(s) are statistically similar and those having dissimiliar letter(s) differs significantly by LSD at 0.05% levels of probability.

T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost+ N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

4.6 Length of pod

4.6.1 Effect of various treatments on length of pod

The treatments had no significant impact on the length size of pods of mungbean (Table 3). All the result is statistically similar. Yet the highest pod size is recorded 8.84 cm in treatment T_8. The lowest pod size is 8.14 cm in treatment T_3.

Table 3. Effect of integrated nutrient management on length of pod of mungbean

Treatments	**Length of pod** (cm)
T_1	8.67
T_2	8.47
T_3	8.14
T_4	8.43
T_5	8.77
T_6	8.26
T_7	8.83
T_8	8.84
T_9	8.57
T_{10}	8.72
T_{11}	8.42
T_{12}	8.79
T_{13}	8.31
T_{14}	8.57
T_{15}	8.56
LSD(0.05)	NS
CV%	9.91

In a column, having similar letter(s) are statistically similar and those having dissimiliar letter(s) differs significantly by LSD at 0.05% levels of probability.

**NS= Non significant by LSD at 0.05% levels of probability

T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost + N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

4.7 Number of seeds per pod

4.7.1 Effect of various treatments on seeds per pod

Different treatments showed significant number of seeds per pod in mungbean (Table 4). The highest number of pods was found in T_{12} (11.93) which is statistically similar with all the treatments except T_3 (9.53). The lowest number of pods was produced in treatment T_3 (9.53). Jain and Trivedi (2005) reported that the soybean plants treated with Bradyrhizobium alone or in combination with different levels of chemical fertilizers gave highest number of seeds pod^{-1}. Dhakal *et al.* (2016) found amongst combinations, significant improvement in number of pods/plant (32.49), seeds/pod (13.06), hundred seed weight (3.71 g) was observed in 75% RDF + 2.5 t ha^{-1} VC + rhizobium + PSB ascompare to other combinations and control.

Table no 4. Effect of integrated nutrient management on seeds per pod of mungbean

Treatment	Seeds per pod
T_1	11.67 a
T_2	11.6 a
T_3	9.53 b
T_4	11.53 a
T_5	11.63 a
T_6	10.57 ab
T_7	11.33 ab
T_8	11.67 a
T_9	11.33 ab
T_{10}	11.3 ab
T_{11}	11.3 ab
T_{12}	11.93 a
T_{13}	10.4 ab
T_{14}	11.22 ab
T_{15}	11.6 a
LSD(0.05)	1.88
CV%	10.10

In a column, having similar letter(s) are statistically similar and those having dissimiliar letter(s) differs significantly by LSD at 0.05% levels of probability.

T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost + N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

4.8 1000 seed weight (g)

4.8.1 Effect of various treatments on 1000 seed weight

Weight of 1000 seeds of mungbean is positively affected by the treatments and showed significant variations among the results (Table 5). The highest value of 1000 seed weight (72.30 g) was recorded in T_{12} and the lowest value was (63.07 g) in treatment T_{11}. Farhad *et. al.* (2017) reported that the maximum 100- seed weight (12.4g) was recorded in T_6 (50 % recommended dose + 1.2 kg ha^{-1} Biofertilizer) treatment which was statistically at par with T_3, T_4 and T_5 treatments in soybean.

Table no 5. Effect of integrated nutrient management on 1000 seed weight of mungbean

Treatment	1000 seed weight (g)
T_1	71.77 a
T_2	71.07 a
T_3	68.27 ab
T_4	69.9 ab
T_5	69.00 ab
T_6	71.77 a
T_7	72.23 a
T_8	70.73 a
T_9	69.5 ab
T_{10}	71.27 a
T_{11}	63.07 b
T_{12}	72.30 a
T_{13}	71.43 a
T_{14}	72.27 a
T_{15}	71.83 a
LSD(0.05)	7.33
CV%	6.22

In a column, having similar letter(s) are statistically similar and those having dissimiliar letter(s) differs significantly by LSD at 0.05% levels of probability.

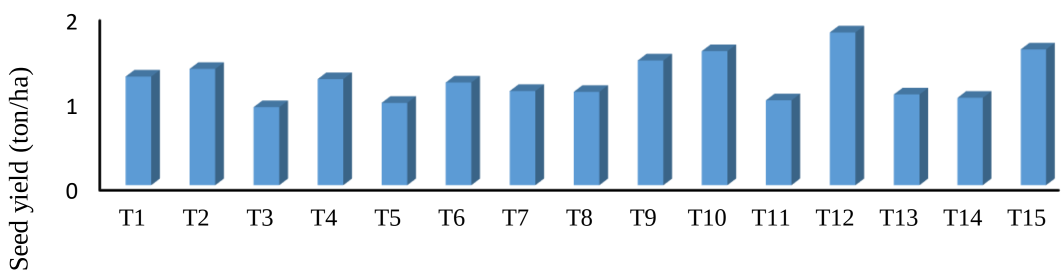
**NS= Non significant by LSD at 0.05% levels of probability

T1= Recommended dose of fertilizers (RDF)
T2= Poultry manure (PM)
T3= Compost
T4= PM + RDF
T5= Compost + RDF
T6= PM + 50% RDF
T7= Compost + 50% RDF
T8= PM+ NPK
T9= Compost + NPK
T10= PM + NP
T11= Compost + N
T12= PM + NK
T13= Compost + NK
T14= PM + PK
T15= Compost + PK

4.9 Seed yield

4.9.1 Effect of various treatments on seed yield

Application of different organic or inorganic fertilizer nutrient sources showed significant effect of seed yield of mungbean (Figure 4). Among different organic or inorganic fertilizer sources, the highest yield (1.8 t ha^{-1}) was obtained from treatment F_{12} which is statistically similar with T_{15} (1.60 t ha^{-1}) and T_{10} (1.58 t ha^{-1}) and the lowest seed yield (0.92 t ha^{-1}) was obtained from treatment F_3. Singh *et al.* (2018) reported that the highest seed yield was recorded with 100% recommended dose of fertilizers (RDF) + FYM 5 t ha^{-1} + VC 2.5 t ha^{-1}+ Azotobacter . The combined inoculation of rhizobium + PSB with fertilizers enhanced the yield attributes of greengram reported by Yadav *et al.* (2007).



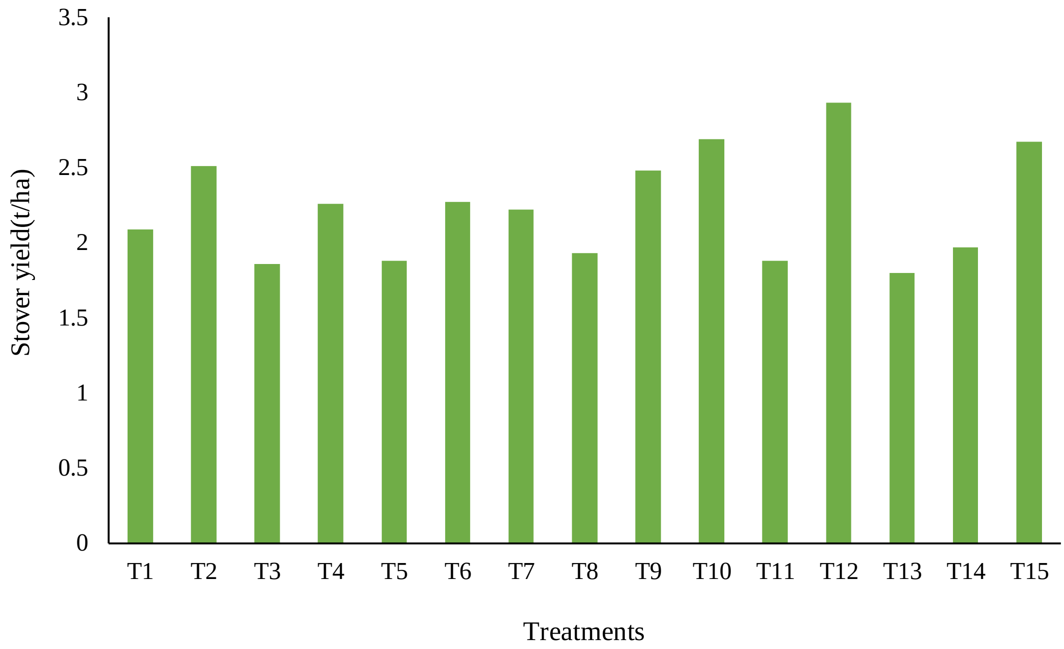
T1= Recommended dose of fertilizers (RDF)
T2= Poultry manure (PM)
T3= Compost
T4= PM + RDF
T5= Compost + RDF
T6= PM + 50% RDF
T7= Compost + 50% RDF
T8= PM+ NPK
T9= Compost + NPK
T10= PM + NP
T11= Compost+ N
T12= PM + NK
T13= Compost + NK
T14= PM + PK
T15= Compost + PK

Figure 4. Effect of integrated nutrient management on seed yield (t ha^{-1}) of mungbean ($LSD_{0.05}$ = 0.24)

4.10 Stover yield

4.10.1 Effect of various treatments on stover yield

Different organic and inorganic fertilizer application significantly affected the stover yield (Figure 5). The highest stover yield (2.93 t ha^{-1}) was recorded in T_{12} treated plot which is statistically similar with T_{15} (2.67 t ha^{-1}) and T_{10} (2.69 t ha^{-1}). The lowest stover yield (1.80 t ha^{-1}) was found from T_{13} treated plots. Raman and Suganya (2018) found that among the INM practices, RDF 100% + pressmud compost @ 5 t ha^{-1} (T_5) significantly resulted in the stover yield of 9031.08 kg ha^{-1} in maize.



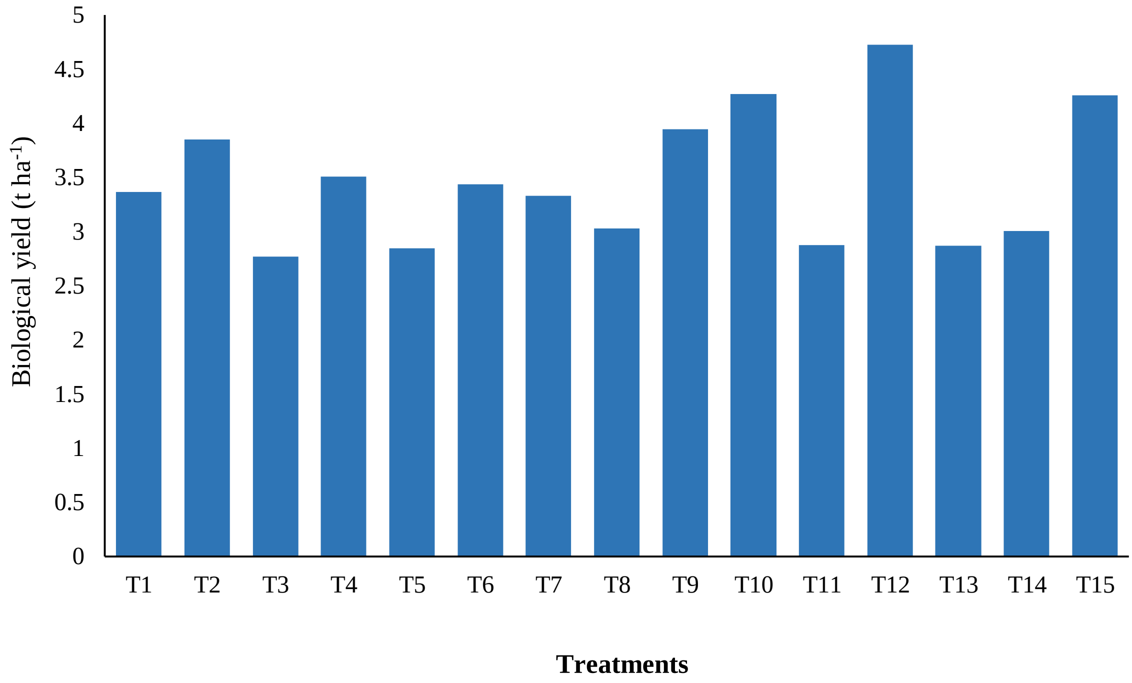
T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost + N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

Figure 5. Effect of integrated nutrient management on stover yield (t ha^{-1}) of mungbean($LSD_{0.05}$ = 0.39)

4.11 Biological yield

4.11.1 Effect of various treatments on biological yield

The result exposed that the effect of various treatments on biological yield was significant (Figure 6). The maximum biological yield (4.60 t ha^{-1}) was obtained in treatment T_{12} which is statistically similar with T_{15} (4.26 t ha^{-1}) and T_{10} (4.27 t ha^{-1}) and the minimum biological yield (2.33 t ha^{-1}) was found in T_3. Combination of organic and inorganic fertilizers was found better by Meena *et al*. (2015).



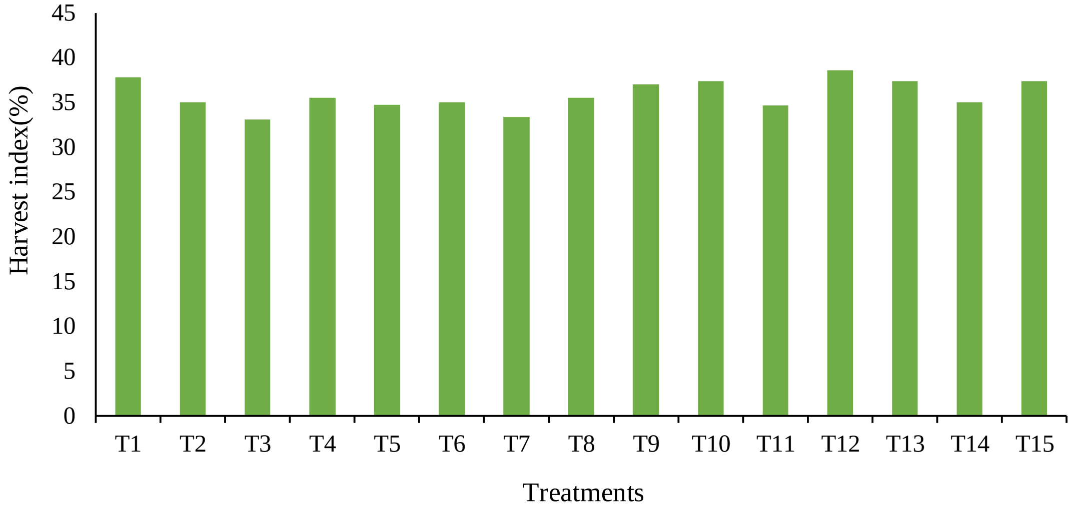
T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost+ N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

Figure 6. Effect of integrated nutrient management on biological yield (t ha^{-1}) of mungbean($LSD_{0.05}$ = 0.60)

4.12 Harvest index(%)

4.12.1 Effect of various treatments on harvest index(%)

Harvest index affected by different organic or inorganic fertilizer treatments was insignificant (Figure 7). The highest harvest index (38.62%) was obtained from treatment T_{12}. Treatment T_3 showed the lowest harvest index (33.13%). 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 10 nutrient content of mungbean were recorded due to application of 75% RDF + 2.5 t ha^{-1} vermicompost (VC) + Rhizobium (Rh) + phosphorus solublizing bacteria (PSB), followed by 100% RDF + 2.5 t/ha VC and 100% RDF + Rh + PSB. Dhakal *et al.* (2016) observed straw yield, biological yield and harvest index in treatment of 75% RDF+2.5 t ha^{-1} VC+ rhizobium + PSB in green gram.



T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost + N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

Figure 7. Effect of integrated nutrient management on harvest index (%) of mungbean ($LSD_{0.05}$ =NS)

4.13 Economic return analysis

Benefit cost ratio (BCR) varied in different treatments as affected by cost of production and yields. Cost of production was involved within wage rate, seed cost, pesticides and fertilizers cost. The gross returns ranged from 72000-140000 taka ha^{-1} where the highest return was found at T_{12} followed by T_{15}, T_{10} and T_9 treatment. The lowest gross return was found at T_5 (Table 7). Data of cost and return analysis showed that the highest net income was at T_{12} followed by T_{10} and T_{15} treatment and lowest found at control T_5 treatment.

Regarding BCR, the highest benefit cost ratio 2.83 found in T_{12} treatment followed by T_{10}, T_1, T_{15} treatment. However, net income Tk. 138400 was highest in T_{12} treatment. It was found that the unit cost of fertilizer is higher in T_{12} is less than many other treatments. Therefore, BCR were increased remarkably in T_{12}, T_{10}, T_1 and T_{15} treatment. Considering the highest gross margin T_{12} treatment is economically viable.

Table7. Effect of integrated nutrient management on economic analysis of mungbean

Treatments	Yield ($t\ ha^{-1}$)	Cost of production ($tk\ ha^{-1}$)	Gross income($tk\ ha^{-1}$)	Net income ($tk\ ha^{-1}$)	BCR
T_1	1.28	41524	102400	60876	2.46
T_2	1.37	44036	106400	62336	2.42
T_3	0.92	54156	72800	21643	1.34
T_4	1.25	57503	99200	56759	1.72
T_5	0.97	61532	77600	16068	1.26
T_6	1.21	52314	96000	43686	1.87
T_7	1.11	56344	88800	32456	1.57
T_8	1.1	49394	89600	40206	1.81
T_9	1.47	53424	116800	63376	2.18
T_{10}	1.58	48622	126400	77778	2.59
T_{11}	1.00	51651	80000	27349	1.54
T_{12}	1.80	48883	138400	89957	2.83
T_{13}	1.07	51472	85600	33128	1.66
T_{14}	1.03	48851	84800	35359	1.73
T_{15}	1.60	51880	127200	72320	2.45

Here,

T_1= Recommended dose of fertilizers (RDF)
T_2= Poultry manure (PM)
T_3= Compost
T_4= PM + RDF
T_5= Compost + RDF
T_6= PM + 50% RDF
T_7= Compost + 50% RDF
T_8= PM+ NPK
T_9= Compost + NPK
T_{10}= PM + NP
T_{11}= Compost + N
T_{12}= PM + NK
T_{13}= Compost + NK
T_{14}= PM + PK
T_{15}= Compost + PK

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

Input price: Urea=Tk. 20 kg^{-1}, T.S.P= 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}, poultry manure= Tk. 4.00 kg^{-1}, Compost= Tk 8 $kg^{-1,}$ wage rate=Tk. 500 day^{-1}, mungbean seed= 200 Tk. kg^{-1}.

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted at the Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka-1207 during the kharif II season from October to December, 2018 to study the yield and economics of mungbean as influenced by integrated nutrient management. This chapter represents the summery and conclusion of the research. The experiment comprised of several fertilizer treatments T_1= Recommended dose of fertilizers (RDF),T_2= Poultry manure (PM), T_3= Compost, T_4= PM + RDF, T_5= Compost + RDF, T_6= PM + 50% RDF, T_7= Compost + 50% RDF, T_8= PM+ NPK, T_9= Compost + NPK,T_{10}= PM + NP, T_{11}= Compost+ NP, T_{12}= PM + NK, T_{13}= Compost + NK, T_{14}= PM + PK, T_{15}= Compost + PK.

Various fertilizer treatments have various effect on growth and yield character of mungbean. Plant height at 30 days after sowing and height at harvest showed significant difference among various treatments. The maximum plant height was recorded 31.30 cm and 61 cm observed at 30 days and at harvest respectively was found at F_8 treatment. The lowest plant height was recorded at T_3 treatment and the height was 25.26 cm and 49.66 cm at 30 DAS and at harvest, gradually. The highest number of branch (1.2 and 4.06, gradually at 30 DAS and at harvest) was recorded at T_2 treatment which is statistically similar to the treatment T_3 (1.16). The lowset number of branch at 30 DAS is 0.33 at T_7 treatment which is similar with the treatment T_9 and T_{11}. The lowest number of branch at harvest was recorded 2.4 in treatment T_{13}.The highest number of leaves was recorded in the treatment T_4 (7.6). On the other hand the lowest number of leaves per plant was found in treatment T_1 (5.6). The highest number of nodules was recorded in treatment T_4 (36.83) which is statistically similar with treatment T_5 (36.76). The lowest number of nodules at 30 DAS was found in treatment T_{13}. But the number of nodules at 60 DAS showed no significant difference among the treatments. The highest number of nodules found in treatment T_4 (27.73) and lowest number of nodules found in treatment T_2 (24.83). The treatments had no significant impact on the length size of pods of mungbean. The highest number of pods (13.4) was found in treatment T_{12} which is statistically similar with the treatments T_8 (13.36) and T_{10} (13.26). The lowest number of pods (10.13) was recorded in treatment T_3. All the result is statistically similar. Yet the highest pod size is recorded 8.84 cm in treatment T_8. The lowest pod size is 8.14 cm in treatment T_3. The highest number of seeds per pods was found in T_{12} (11.93) which is statistically similar with the treatments T_1 (11.67), T_2(11.6), T_4(11.53), T_8(11.67), T_{15}(11.6). The lowest number seeds per pods was produced in treatment T_3 (9.53). The highest value of 1000 seed weight (72.30) was recorded in T_{12} and the lowest value was 63.07 g in treatment T_{11}. Among different organic or inorganic fertilizer sources, the highest yield (1.8 t ha^{-1}) was obtained from treatment F_{12} which is statistically similar with T_{15} (1.60 t ha^{-1}) and T_{10} (1.58 t ha^{-1}) and the lowest seed yield (0.92 t ha^{-1}) was obtained from treatment F_3. The highest stover yield (2.93 t ha^{-1}) was recorded in T_{12} treated plot. The lowest stover yield (1.80 t ha^{-1}) was found from T_{13} treated plots. The maximum biological yield (4.60 t ha^{-1}) was obtained in treatment T_{12} and the minimum biological yield (2.33 t ha^{-1}) was found in T_3. The highest harvest index (38.62%) was obtained from treatment T_{12}. Treatment T_3 showed the lowest harvest index (33.13%). Economic analysis of the different treatments showed that highest gross return (138400 tk.), highest net return (89957tk) and highest BCR (2.83) were also found in T_{12} (PM + NK) treatment.

CONCLUSION

From the above discussion it may be concluded that the highest yield (1.8 ton ha^{-1}) of munbgean was obtained from treatment T_{12} (PM+NK) among various fertilizer treatments. Regarding BCR, the highest benefit cost ratio 2.83 found in T_{12} treatment followed by T_{10}, T_1, T_{15} treatment. Therefore, judicious application of fertilizers is needed and based on this research results it could be suggested that application of poultry manure along with urea and MoP can supplement other nutrients essential to plants and increase production with an increased BCR. However, to reach a specific conclusion and recommendation, more research work on integrated nutrient management in mungbean cultivation should be done in different Agro-Ecological Zones.

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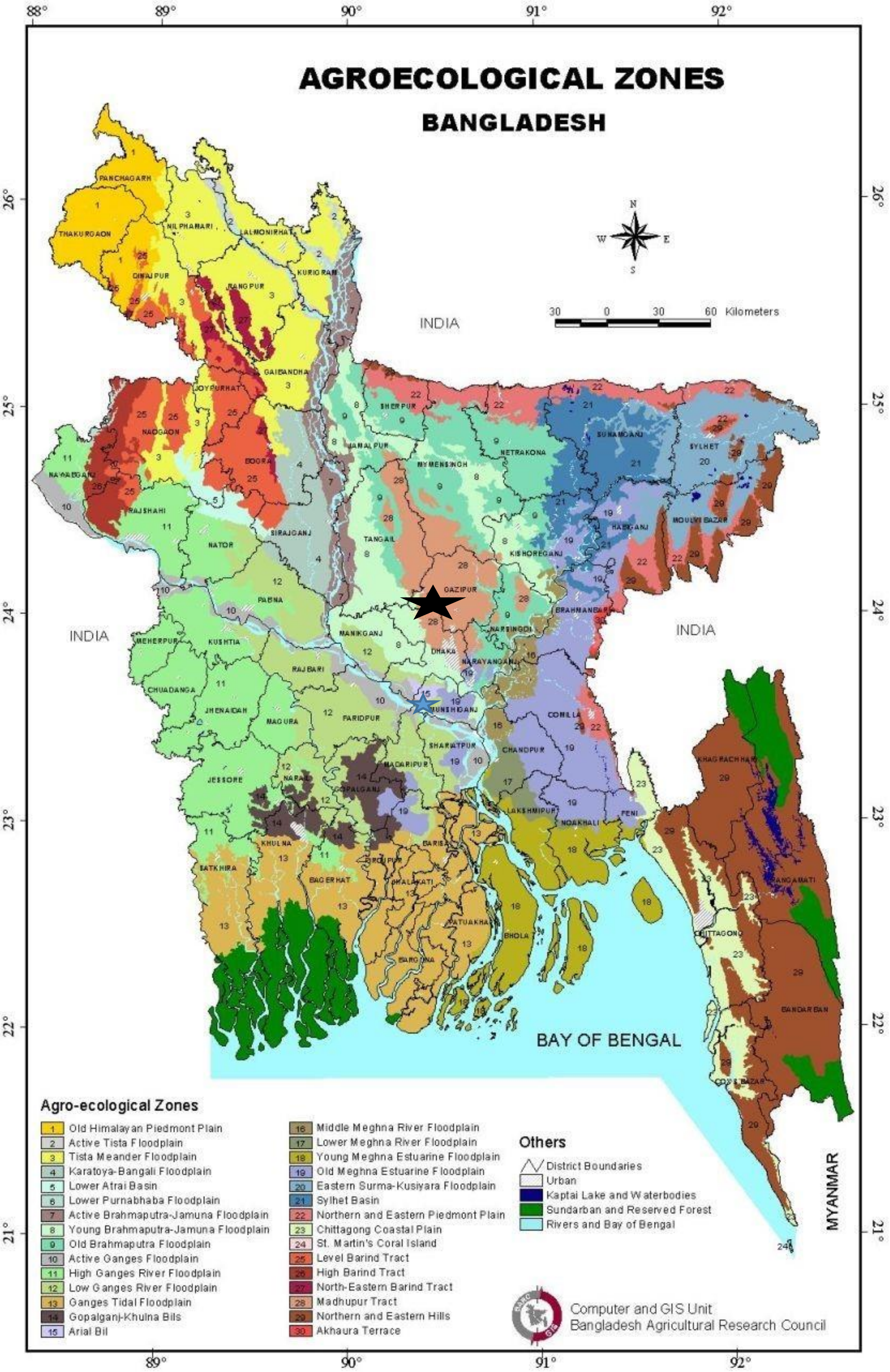
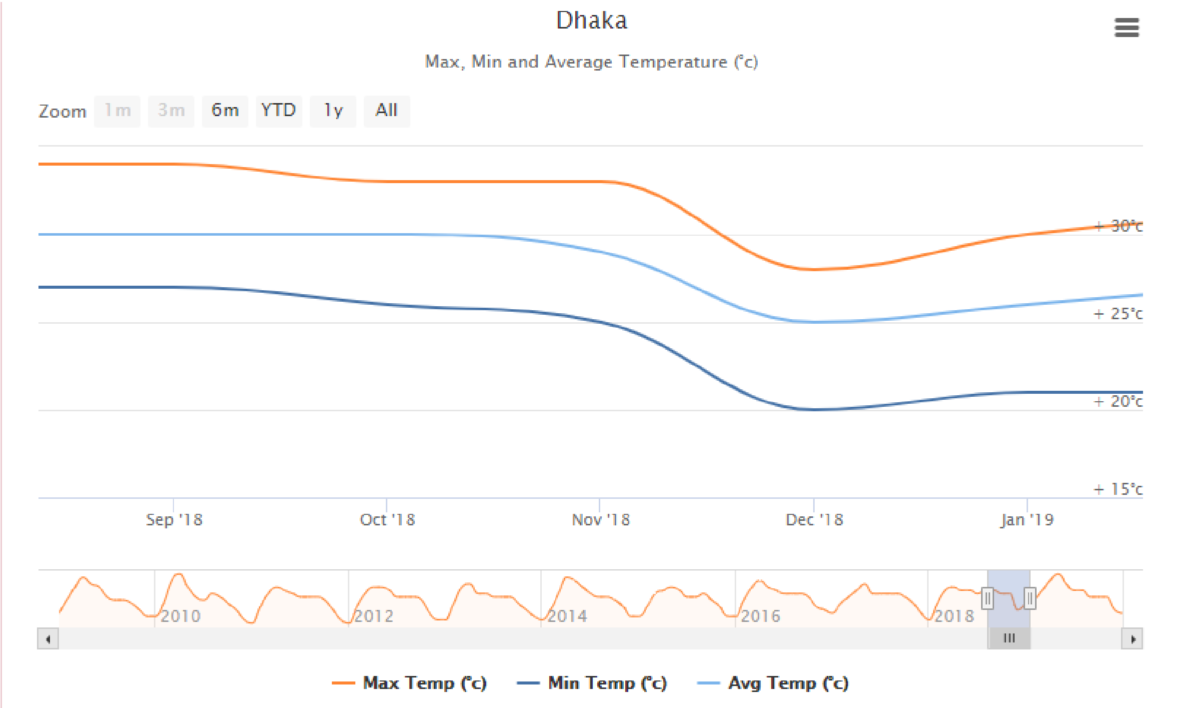
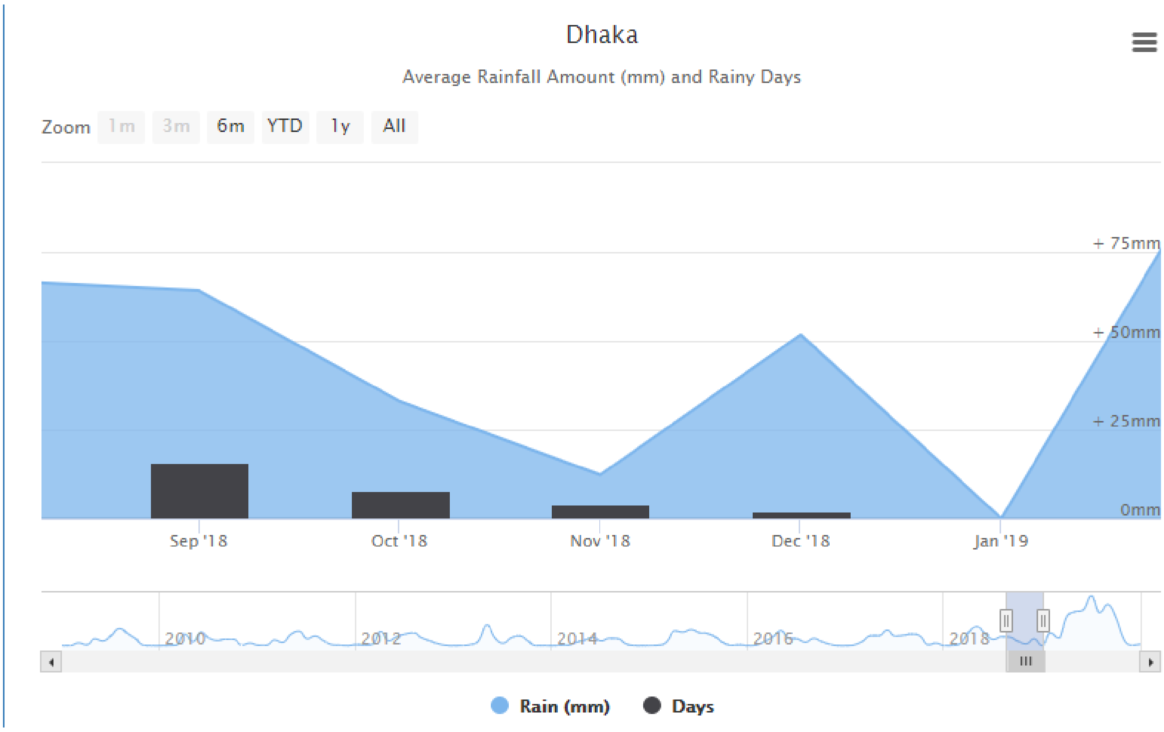
APPENDICES

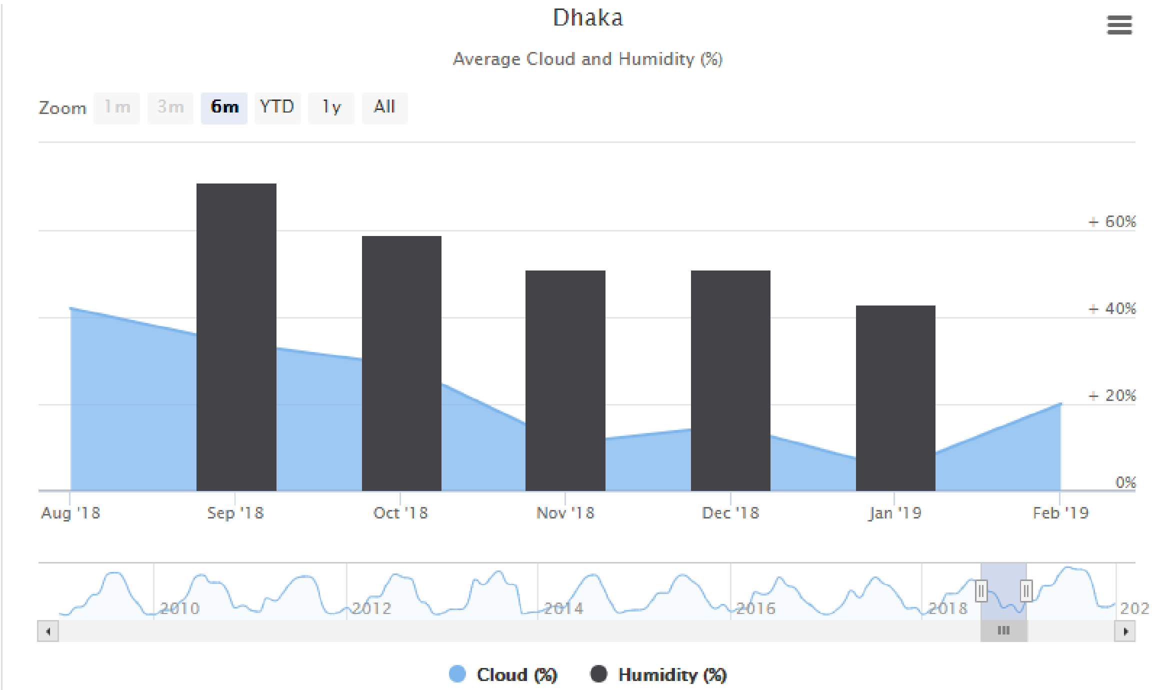
Appendix I. Map showing the experimental site (AEZ-28) Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka-1207 under study

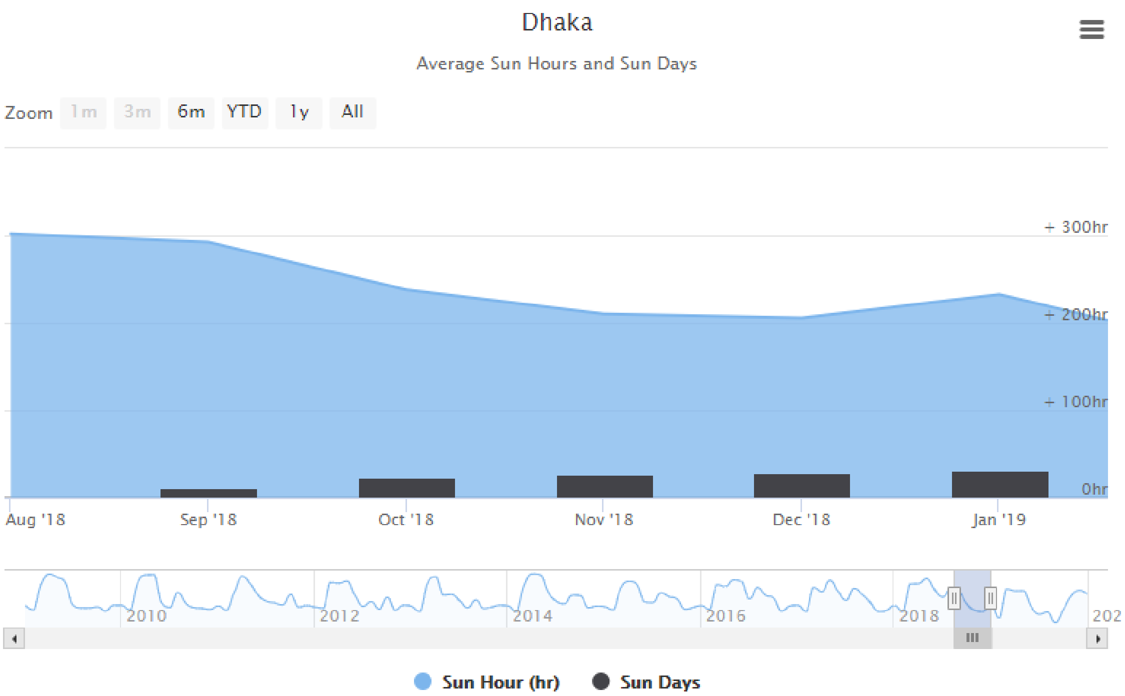


Appendix II. Monthly weather data of Dhaka during experiment (from Oct'2018 to Dec'2018)



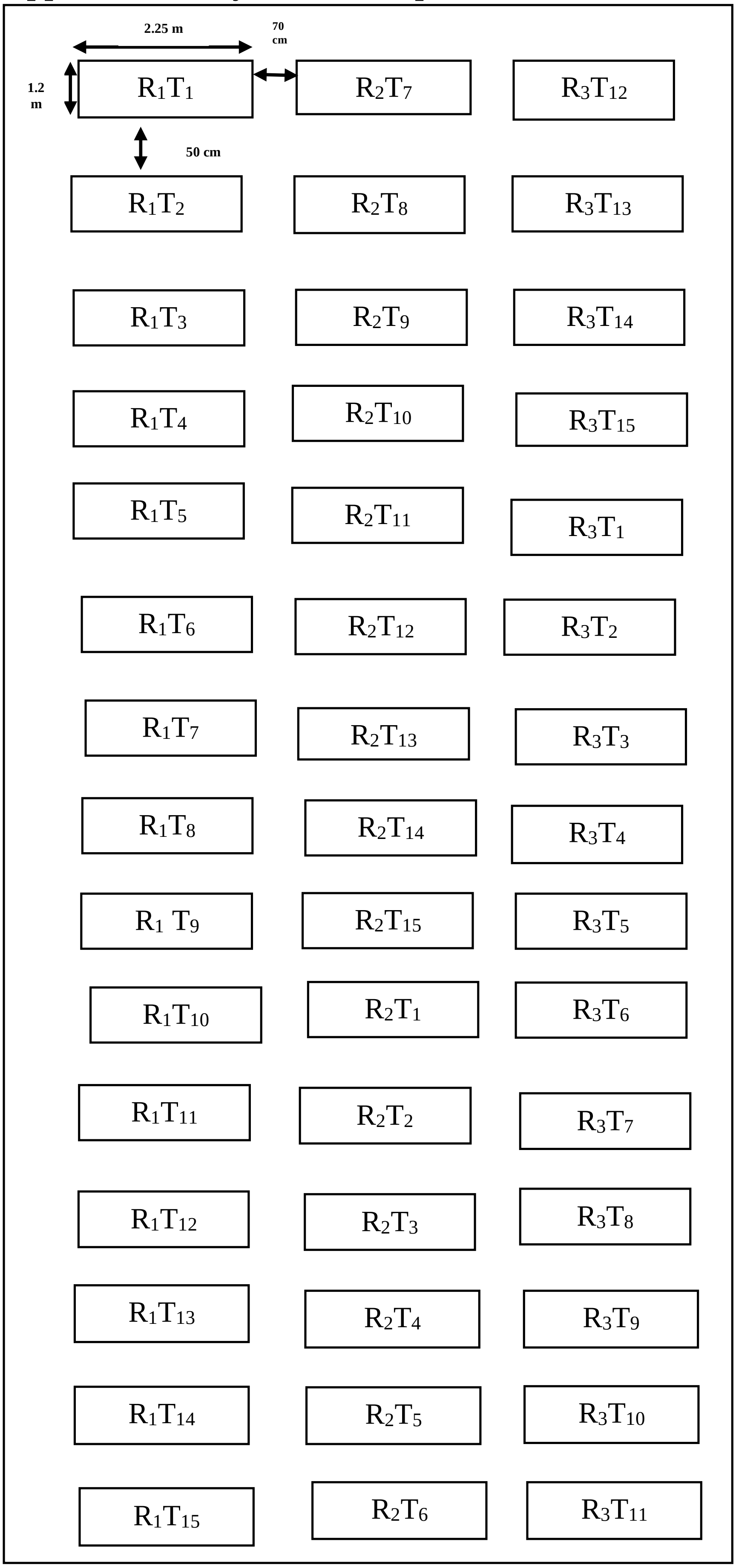


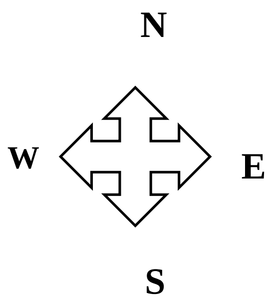




(www.worldweatheronline.com/dhaka-weather-history/bd.aspx)

Appendix III. Layout of the experiment field





Single plot area = 2.7 m^2
Row to row distance= 70 cm
Plot to plot distance = 50 cm

T_1= Recommended dose of fertilizers (RDF),
T_2= Poultry manure (PM),
T_3= Compost,
T_4= PM + RDF,
T_5= Compost + RDF,
T_6= PM + 50% RDF,
T_7= Compost + 50% RDF,
T_8= PM+ NPK,
T_9= Compost + NPK,
T_{10}= PM + NP,
T_{11}= Compost+ NP,
T_{12}= PM + NK,
T_{13}= Compost + NK,
T_{14}= PM + PK,
T_{15}= Compost + PK
R_1= Replication 1
R_2= Replication 2
R_3= Replication 3

Appendix IV. Analysis of variance of the data for the plant height(cm), Brancing plant^{-1} and Number of Leaves at 30 DAS and at harvest at different integrated nutrient management system

Source	df	MS				
		Plant height(cm)		Brancing plant^{-1}		Number of Leaves
		30 DAS	At harvest	30 DAS	At harvest	
Replication	2	17.6194	32.7282	0.02867	0.21025	0.90422
Treatment	14	8.6363	30.2555	0.25990*	0.47843	0.92994
Error	28	6.5692	38.1406	0.00843	0.24691	0.89898

*Significant at 5% level of probability

Appendix V. Analysis of variance of the data for the Nodules plant^{-1}, Number of pods and Length of pod at different integrated nutrient management system

Source	df	MS			
		Nodules plant^{-1}		Number of pods	Length of pod
		30 DAS	At harvest		
Replication	2	4.7429	0.97222	1.99267	1.86054
Treatment	14	13.8214	2.92698	2.31133	0.14062
Error	28	9.1507	9.10913	1.26100	0.71929

*Significant at 5% level of probability

Appendix VI. Analysis of variance of the data for the Number seeds pod^{-1}, 1000 seed weight and seed yield (t ha^{-1}) at different integrated nutrient management system

Source	df	MS		
		Number seeds pod^{-1}	1000 seed weight	seed yield (t ha^{-1})
Replication	2	0.60800	1.4047	0.00991
Treatment	14	1.16048	17.1339	0.18962*
Error	28	1.28705	19.2116	0.02129

*Significant at 5% level of probability

Appendix VII. Analysis of variance of the data for the Stover yield (t ha^{-1}), Biological yield (t ha^{-1}) and Harvest index(%) at different integrated nutrient management system

Source	df	MS		
		Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index(%)
Replication	2	0.15106	0.32401	8.7059
Treatment	14	0.39442*	0.99785*	7.9123
Error	28	0.05575	0.12885	19.9748

*Significant at 5% level of probability

Plates

Plate 1: Layout of experimental field

Plate 2: Seed sowing on crop field

Plate 3: Seedling emergence

Plate 4: Crop field (growing stage)

Plate 5: Data collection

Plate 6: Nodule formation

Plate 7: Flower initiation stage

Plate 8: Fruit formation stage

Plate 9: Fruit maturation stage

Plate 10: Fruit ripening stage

Plate 11: Field before harvesting

Plate 12: Field view of the crop field