EFFECT OF COMBINED APPLICATION OF ORGANIC AND INORGANIC FERTILIZER ON GROWTH AND YIELD OF MUNGBEAN

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CERTIFICATE

This is to certify that the thesis entitled **“EFFECT OF COMBINED APPLICATION OF ORGANIC AND INORGANIC FERTILIZER ON GROWTH AND YIELD OF MUNGBEAN”** submitted to the Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements of **the degree of MASTER OF SCIENCE in SOIL SCIENCE,** embodies the result of piece of bona fide research work carried out by **MD.HARUN-UR-RASHID,** Registration No. **18-09241** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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DEDICATED TO

MY BELOVED PARENTS

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LIST OF SYMBOLS AND ABBRIVIATIONS

ABBREVIATION	FULL WORD
@	At the rate
Cm	Centimeter
i.e	That is
AEZ	Agro-Ecological Zone
CEC	Cation Exchange Capacity
$CuSO_4.5H_2O$	Green vitriol
cv.	Cultivar(s)
CV%	Percentage of Coeffecient of Variance
DMRT	Duncan's Multiple Range Test
e.g.	example
et al	and others
FYM	Farm Yard Manure
g	Gram
H_3BO_3	Boric acid
$HClO_4$	perchloric acid
HNO_3	Nitric acid
H_2O_2	Hydrogen per oxide
H_2SO_4	Sulphuric acid
K	Potassium
Kg	Kilogram
Kg ha^{-1}	Kg per hectare
K_2SO_4	Potassium Sulfate
LSD	Least Significant Difference
TSP	Triple Super Phosphate
M	Meter
ml	Milliliter
mm	Millimeter
MP	Muriate of Potash
N	Nitrogen
NaOH	Sodium hydroxide
NPK	Nitrogen , Phosphate and Potassium
NS	Not Significant
OM	Organic matter
P^H	Hydrogen ion concentration
^oC	Degree Celsius
No.	Number
SAU	Sher – E-Bangla Agricultural University
RCBD	Randomized Complete Block Design.

EFFECT OF COMBINED APPLICATION OF ORGANIC AND INORGANIC FETILIZER ON GROWTH AND YIELD OF MUNGBEAN

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ABSTRACT

A field experiment was conducted at the Sher-e-Bangla Agricultural University farm, Dhaka 1207 during the Kharif-1 season from June 2019 to August 2019 to study the effect of organic and inorganic fertilizers on the growth and yield of mungbean . The experimental soil was silty clay loam in texture having p^H 6.1.The experiment was laid out in Rendomized Complete Block Design (RCBD) with 3 replication .There were 7 treatment where , T_1 = 100% Recommended chemical fertilizer + 0 t/ha vermicompost , T_2=75% Recommended chemical fertilizer + 2 t/ha vermicompost, T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost, T_4= 75% Recommended chemical fertilizer + 4 t/ha vermicomost, T_5= 50% Recommended chemical fertilizer +2 t/ha vermicompost, T_6 =50% Recommended chemical fertilizer + 3 t/ha Vermicompost, T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost . In case of inorganic fertilizer levels are contained 50% level of NPK= (10-10-14 kg/ha) , 75% level of NPK=(15-15-21 kg/ha) , 100% level of NPK =(20-20-28 kg /ha) .Different plant growth and yield parameters were significantly influenced by different organic and inorganic level of fertilizer . Application of 75% recommended inorganic fertilizer and 4 t/ha vermicompost in case of T_4 treatment was recorded the maximum plant height (58.26 cm) , number of branches /plant (1.72) , pod length (9.49) , grain yield (1.54t/ha) , and straw yield (2.63 t/ha) and the minimum plant height(51.50 cm) , number of branches /plant (0.95) , number of pods /plant (13.16) , number of seeds /pod (10.23) , grain yield (0.78 t/ha) and straw yield (1.66 t/ha) was recorded from the T_1 treatment where only 100% recommendation chemical fertilizer was used.. The maximum significant grain and straw yields were obtained with the treatment combination T_4(where, 75% recommended chemical fertilizer + 4 t/ha vermicompost). The minimum yield of grain and straw yield were obtained with the treatment combination T_1 (100% recommended chemical fertilizer + 0 t/ha vermicompost).

CHAPTER 1

INTRODUCTION

Mungbean (*Vignaradiata*) is one of the most important pulses in Bangladesh. Mungbean (*Vignaradiata* (L.), commonly known as green gram, is an important conventional pulse crop of Bangladesh. It has an edge over other pulses because of its high nutritive value, digestibility and non-flatulent behavior. It is grown principally for its protein rich edible seeds (Haq, 1989). Its seed contains 24.7% protein, 0.6% fat, 0.9% fiber and 3.7% ash (Potter and Hotchkiss, 1997).

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 (Mahmoodand Athar, 2008; Mandal et al.,2009).

Mungbean being drought tolerant and short duration can grow well under varied conditions (irrigated and rainfed). Mungbean has the potential of producing higher seed yield from 1295 to 2961 kg ha^{-1} depending on the genotypes studied (Ullahet al., 2011; Bilal, 1994).

Average yields to mungbean in Bangladesh is very low, which is primarily due to substandard methods of cultivation, poor crop stand, imbalanced nutrition, poor plant protection measures and lack of high yielding varieties. The low yield of mungbean besides other factors may partly be due to lack of knowledge about nutrition and modern production technology. Moreover, lack of attention on fertilizer used is also hampered by the lowering of mungbean yields. Mungbean yields and quality can be improved by the balanced use of fertilizers and by managing the organic manures properly. Mungbean is highly responsive to fertilizers and manures. Being leguminous in nature, mungbean needs low nitrogen but need best doses of other major nutrients as recommended. Soil organic matter could affect the soil microbial community and increase the crop growth and yield. Organic materials hold great promises as a source of multiple nutrients and ability to improve soil characteristics. This may not only improve the efficiency of chemical fertilizers along with their minimal use of crop production besides of increasing the crop yield and improving available major and minor nutrients.

Organic farming preserves the ecosystem. Symbiotic life forms are cultured ensuring weed and pest control and optimum soil biological activity, which maintain fertility. Organic farming neither demands the use of synthetic fertilizers nor the harmful chemicals (pesticides & fungicides) for controlling weeds, insects and pests. The synthetic fertilizers are harmful for soil and aerial environment, because the inorganic fertilizers mainly contain major nutrients NPK in large quantities and are neglecting the use of organic manures and biofertilizers and hence have paved the way for deterioration of soil health and in turn ill-effects on plants, human being and livestock (Choudhry, 2005). Most of the soil applied fertilizers (nitrogenous), leach down below the root zone or into the ground water, which pollute the ground water causing diseases mainly “Methemoglobinemia” (Choudhry, 2005). Organic farming relies on large-scale application of animal or farm yard manure (FYM), compost, crop rotation, residues, green manuring, vermicompost, bio-fertilizers and bio-pesticides. Improved cultivars are an important input, which geared revolution in many countries of the world. Like other factors such as quality seed, proper use of fertilizer and irrigation, cultivar with higher yield potential is of prime importance. The present paper aims at finding the effect of seed inoculation, organic manures and inorganic fertilizers on growth and yield of two mungbean cultivars under conditions in Faisalabad.

Mungbean is one of the major rainy (kharif) season pulse crop of Bangladesh. The yield and nutritional quality of mungbean is greatly influenced by application of nutrient element along with organic manures and inoculation of seed with PSB. The crop responds favorably to application of fertilizer phosphorus. The rate of PSB in increasing crop yield, nutrient availability and uptake has been demonstrated under some soil of Bangladesh but such information on these aspects in mungbean layout been investigated . Like other legume crops mungbean*Vignaradiata* (L.) has potential to fix atmospheric nitrogen through its root nodules, which requires phosphorus for their proper growth and development. Besides phosphorus, pulses are require nitrogen as a starter dose along with organic manures and seed inoculation with effective strain of PSB for cultivation. Therefore, the present study was made to workout the optimum dose of phosphorus and organic manures with PSB inoculation in mungbean.

Considering the above facts, the present experiment has been under taken to study the following objectives:

1. To study the effect of organic and inorganic fertilizer on the growth and yield of mungbean.
2. To observe the combined effect of organic and inorganic fertilizers on growth and yield mungbean .

CHAPTER 2

REVIEW OF LITERATURE

Some of the published reports relevant to research topic are reviewed under the following heading:

2.1 Effect of organic and inorganic fertilizer on mungbean and legume crops

Rao et al. (1993) and Ali et al. (2000) conducted an experiment and revealed that Fertilizer levels had significant effect on the pod number. Application of NPK @ 50-100-0 kg ha^{-1} produced 10.95% more pods plant^{-1} than control treatment (17.07). The number of pods per plant varied significantly among different cultivars. NM-46-7-2 produced 7 and 5% more number of pods plant^{-1} than NM98 and NM-36-13-1-2, respectively. The interaction between cultivars and fertilizer levels showed significant results. NM-46-7-2 fertilized @ 50-100-0 kg NPK ha^{-1} produced the highest (20.43) number of pods plant^{-1}, whereas the lowest (16.67) were observed in NM-98 at control (0-0-0 kg N).

Malik et al. (1990) studied the field experiment on effect of differtent fertilizer on mungbean and revealed that the fertilizer levels had non-significant effect on 1000-grain weight of mungbean. However, 1000-grain weight varied from 54.32 to 55.8 g for fertilizer treatments. On the other hand mungbean cultivars exhibited significantly different 1000-grain weight. Mungbean cultivar NM-46-7-2 produced the highest 1000-grain weight (61-95 g) while NM-98 produced the lowest grain weight (46.72 g). The variation in 1000-grain weight among different mungbean cultivars occurred due to varying genetic potential for this parameter. The interaction between both the factors under study was significant. NM-46-7-2 fertilized @ 50-100-50 kg NPK ha^{-1} produced larger 1000-grain weight (63.54 g) than when fertilized @ 50-100-0 kg NPK ha^{-1}. NM-98 produced significantly the lowest (45.99 g), 1000-grain weight with the application of 50-0-0 kg NPK ha^{-1}.

Hussain et al.(1996) conducted an experiment of mungbean and revealed that Straw weight was significantly influenced by the fertilizer treatments. The crop grown without fertilizer application (0-0-0 kg NPK ha^{-1}) produced lower straw weight. Straw weight increased in a linear order when fertilizer rates were increased. The highest straw yield 2428.0 kg ha^{-1} was observed with 50-100-50 kg NPK ha^{-1} which was at par with 50-100-0 kg NPK ha^{-1}. The cultivars showed significant differences in their straw weight. NM46-7-2 produced 10.34 and 7.47% more straw weight than NM-98 and NM-36-13-1-2, respectively. Interaction between cultivars and fertilizers showed significant effect for this trait. NM-46-7-2 produced the highest straw weight (2809-1 kg ha^{-1}) when fertilized @ 50-100-0 kg NPK ha^{-1}.

Mostofa et al .(2008) conducted an experiment and revealed that pods plant (21.43) and 1000-seed weight(39.13g) were who reported that mung 5 variety with no fertilization but in case of number inoculation significantly increased seed and Stover of seeds pod the maximum was produced by BARI yield of mungbean. In case of biological yield maximum 1 Mung 5(12.48) in inoculated plants by Bradyrhizobium was gained from treatment VF (BARI mung 6 × with chemical fertilizers N, P and K followed by BARI Biofertilizer together with N, P and K) and these value mung 6 × biofertilizer with P+K and there was no were 5.90 t ha^{-1} and these view also similar with significant difference between above two treatments for Mostofa et al. production of seeds plant. Statistically lowest was 1 found (11.17) in BARI Mung 5 with control fertilizer conclusion treatment. Significantly highest seed yield/ha was 1 obtained from BARI mung 6 (2.057 t ha^{-1}) in inoculate.

Bhuiyan et al., (2008) conducted an experiment on four levels of phosphorus (P) (0, 20, 40, 60 $kgha^{-1}$) and 2 levels of molybdenum (Mo) (1.0 and 1.5 kg ha^{-1}) having a common Rhizobium inoculant, one control with no Rhizobium or fertilization and a Rhizobium inoculation only were applied. Rhizobium inoculation along with P and Mo significantly increased the growth of plants, number of nodules, dry matter production as well as grain yield of Mungbean significantly compared to uninoculated control.

Norman. (2006) conducted a study and reported that a factorial combination of three levels of nitrogen and three levels of phosphate fertilizer on Mung bean. Mung showed independent responses to phosphate. Mean phosphorus contents increased with increasing level of applied phosphate and decreasing level of applied nitrogen; the changes were largely independent between fertilizers and total phosphorus yield increased with increasing level of applied phosphate.

Emsley.(2000) conducted a study and reported that phosphatic fertilization have increasing influence in relation to growth and yield. Higher yields of mungbean have been reported by application of phosphorous @ 90 kg ha^{-1} under field conditions.

Malik et al.,(2002) conducted a study and reported that the effect of seed inoculation and phosphorus levels viz., 0, 30, 50, 90 and 110 kg ha^{-1} on growth, seed yield and quality of Mungbean cv. NM-98. Maximal 1000-grain weight, grain yield and protein contents were obtained from the plots where inoculated seed was grown with phosphorus applied @ 50 kg ha^{-1}

Shen et al. (1994) conducted a study and reported that N application decreased the shoot Na content and increased the K content in mungbean under saline conditions. It is possible that the increase of N absorption by the leaves of mungbean, in the plants treated with a high level of N, led to a relatively high photosynthetic activity, as there was a positive correlation between the two parameters (Sinclair and Hone, 1989). The photosynthetic activity was positively correlated with the soluble protein content of leaves (Hesketh et al. 1981; Boon-Long et al. 1983), leading to a high biomass (both shoots and roots) production. In the process, mungbean plants treated with higher levels of N might have an advantage, because of their improved root growth, as described previously, that enabled them to take up more nutrient elements from the soil than the plants treated with low N. The higher level of N might have also improved the selectivity of the roots in the uptake of essential elements and exclusion ability of harmful Na^+ from leaf tissues. This, however, remains to be elucidated in further systematic studies.

Mohanty et al. (1999) conducted a study and reported that an enhanced mungbean production due to a higher rate of N application under saline conditions. The results obtained in the present study indicate that the better water relations, the reduction in Na uptake and improvement in the uptake of different essential elements, due to the application of a high level of N, may have contributed to the lower reduction in grain yield in mungbean under saline conditions. However, grain yield is the product of a large number of physiological and biochemical processes, such as assimilate production and distribution, nutrient uptake process, water balance, etc. The higher levels of N might have activated these processes, which were inhibited, to some extent, by salinity.

Thenmozhi et.al, (2010) conducted an experiment and disclosed that the effect of soil amendments on all measured traits on *Vignaradiata* had significant differences at 0.5% probability level. The results showed that, in all the soil amendment combinations, the best performance was observed in combination C_5 (OF, BF and VC) followed by C_3, C_8 and C_1 respectively with little variation. However, the lowest seed germination was noticed in control. It may be observed that the combinations that were prepared with bio-fertilizers along with all or some of the organic fertilizer, vermicompost and fly ash induced better growth in most of the cases. This is most likely because of the fact that microorganisms that are used as bio-fertilizers stimulate plant growth by providing necessary nutrients as a result of their colonization at their rhizosphere or by symbiotic association.

Chowdhury et al.,(1998) conducted a study and reported that phosphorus application at the rate of 60 kg P_2O_5/ha significantly increased nodulation. Individual effect of P application was pronounced in this study. Among the phosphorus levels, P at the rate of 40 and 60 kg/ha along with 1.0 kg Mo/ha produced significant number of nodules 13.50 and 13.00/plant respectively at flowering stage. Plant received Rhizobium inoculation alone or with different levels of P and Mo produced higher number of nodules over uninoculated treatment (control).

Chowdhury et al. (1998) found that 50 kg P_2O_5/ha with other fertilizers increased 245% nodule number over control. Khanam et al. (1993) also found the similar results.

Muhammad et al. (2004) and Malik et at. (2002 & 2003) conducted a study and reported that the number of pods per plant of mungbean increased with Rhizobuim inoculants in association with P application. There was a positive correlation between the number of pods and the number of nodules and mature seeds yield of the crop.

Landge et al. (2002) conducted an experiment and disclosed that rhizobium, P and Mo influenced significantly on the formation of seeds per pod. Number of seeds/ pod increased P level upto 40 kg/ha along with Mo 1.5 kg/ha. No variation was observed between Mo level 1.0 and 1.5 kg/ha. The highest number of seeds per pod (11.71) was found with T_5 but statistically identical with the T_6, T_9 and T_{10}. The lowest number of seeds per pod (8.68) was obtained with uninoculated plot (control). It was observed that Rhizobium inoculant in association with P and Mo led to increase the number of seeds per pod of mungbean.

Wu et al. (1994) conducted an study and reported that plant dry weight and the dry weight of different organs in mungbean were positively correlated with Mo concentration. The lowest mungbean yield (20.75g) was recorded with control treatment. Considering interaction effect between phosphorus and molybdenum, the highest mungbean yield was recorded with 40 kg P and 1.0 kg Mo/ha , which was 28.53% increased than control.

Chowdhury (1996) conducted a study and reported that P content increased due to inoculation with Rhizobium. The influence of phosphorus, molybdenum and Rhizobium inoculant, on P uptake by mungbean shoot was found significant at harvest. Both the P content and weight of shoot directly influenced P uptake. Therefore, the values of P uptake increased with the increase of shoot weight and rate of P application. Phosphorus uptake at harvest was higher with the addition of Rhizobium inoculant with P and Mo. The highest P uptake (91.88 mg/plant) was found with the T_6, which was statistically significant with other treatments but identical with T_6 and T_{10}. Rhizobium inoculant alone led to uptake 34% higher P over control.

Rajkhowa et al. (2002); Das et al. (2002) and Kumar et al. (2003) conducted a study and reported that the application of vermicompost and FYM showed significant positive effect on yield attributes, yield and dry matter production of mungbean . All the yield attributes like plant height (46.20 cm), dry weight/plant (13.73 g), branches/plant (4.70), pods/plant (15.63), seed/pod (11.34), seed weight/plant (5.90 g) and test weight (41.92 g) were significantly higher in T_7 . The highest grain yield of 1325 kg/ha was achieved in T_7 followed by T_5 (1252 kg/ha). T_7 produced 820 kg/ha (162.38%) higher grains yield over the control. It might be due to use of vermicompost and FYM improve the physical and chemical properties of soil. They help to augment the growth and development of the crop in two ways firstly, they supply plant nutrients and secondly, improved the availability of native nutrients in the soil through increased microbial activity and secretion of organic acids. The nutrient content in vermicompost is higher (1.60% N + 5.04% P_2O_5 + 0.80% K_2O) than FYM (0.75% N + 0.17% P_2O_5 + 0.55% K_2O) thus it gave better yield attributes, dry matter production and that resulted in higher grain yield.

Chatterjee and Bhattacharjee (2002) carried out an experiment to study the effect of inoculation with Rhizobium sp. and phosphate solubilizing bacteria (PSB) on the nodulation and seed yield of mungbean cv. B-l at West Bengal, India and reported that plants inoculated with Rhizobium strains and PSB showed increased rate of nodulation, N content and seed yield over control. Bhattacharyya and Pal (2001) conducted a field experiment in West Bengal, India during the pre-kharif season of 1998 to study the effect of Rhizobium inoculation on mungbean and reported that inoculation significantly influenced the number of nodules plant^{-1}, dry matter accumulation in the shoot, crop growth rate and plant height. Similarly, Pahujaet al. (1975) reported that weeding had a significant influence on plant height, number of pods plant^{-1} seed yield.

Sreemannaryana and Raju (1993), Mondal et al., (2002) carried out an field experiment and reported that seed yield of mungbean was higher in second year (0.67 t ha $^{-1}$) than that of first year (0.53 t ha^{-1}). When average seed yield of mungbean of two years was compared among different manurial treatments applied to preceding mungbean crop, an increment of yield by 54% was observed with the application of $N_{80}P_{40}K_{40}$ + S_{40} as gypsum along with 5 t FYM ha $^{-1}$ (0.77 t ha^{-1}) over that of $N_{80}P_{40}K_{40}$ along with 5t FYM ha^{-1} (0.50 t ha^{-1}). Under similar condition when rapeseed crop received $N_{80}P_{40}K_{40}$ and S_{40} as ammonium sulphate or elemental sulphur along with 5 t FYM ha^{-1} the increment of seed yield of mungbean were 32% and 40%, respectively.

Dost et al. (2004), Malik et al. (2006), Nadeem et al. (2004) carried out a field experiment and reported that the maximum number of pods $plant^{-1}$ (20.87) was recorded in T_{14}, which was statistically similar with T_{13}, T_{12}, T_{11} and T_{10}. Probably Rhizobium coupled with recommended doses of fertilizer triggired the vegetative and reproductive growth of mungbean that resulted in higher number of nodules.

Duary et al. (2004) conducted a study and reported that the maximum pod length (8.71 cm) was also recorded in T_{14}, which was statistically similar with T_{13}, T_{10} and T_7. On the other hand, the minimum pod length (4.36 cm) was recorded from control. The increase in pod length due to Rhizobium inoculation coupled with recommended doses of fertilizer.

Gowda and Kaul, (1982) conducted a study an reported that Mungbean is a warm season crop. It is grown mainly in semi-arid to sub humid low lands with 600 to 1000 mm annual rainfall, 200 to 300^0 C mean temperatureduring the period of crop production and at elevation not exceeding 1,800 to 2,000 m (Poehlman, 1991). It can also tolerate high temperatures up to 400^0 C but does well at 30– 350^0 C, on a wide range of soil types but are best in deep, well drained loam or sandy loam soil .

Bhavyaet al,(2018) conducted a study and reported that Rhizobium is a genus of gram-negative soil bacteria that fix nitrogen. Rhizobium species form an endosymbioticnitrogenfixing association with roots of legumes. The bacteria colonize plant cells within rootnodules, Rhizobium will fix atmospheric nitrogen by living symbiotically to the soil.

Meena et al., (2016) conducted a study a reported that the plant, in turn, provides the bacteria with organic compounds made by photosynthesis. This mutually beneficial relationship is true of all of the rhizobia, of which the genus Rhizobium is a typical example. The largest contribution of biological nitrogen fixation to agriculture is derived from the symbiosis between legumes and Rhizobium species.

Kirchhoff, (2002) conducted a study and revealed that the interaction effects of mungbean, Rhizobium and VAM inoculation on protein content of the greengram was significant. The maximum protein content was recorded 25.33%.in $T_8(NC_2B_2)$ @ neemcake@500kgha-1+rhizobium @100% ha^{-1} and minimum protein content was recorded was 21.2 in T_0 (NC_0B_0) @ 0% Neem cake @ ha^{-1} + @0% Rhizobium ha^{-1} + @ 0%VAM inoculation.it was concluded from the results that combination of neemcake @500 kg ha^{-1}+ rhizobium inoculation can be used to increase the protein content of the mungbean. Mung beans contain higher amounts of protein with globulin and albumin as main storage proteins in the seeds.

Choudhary et al (2011) and Tiwari et al (2011) conducted a study and reported that beneficial effect of fertility levels and biofertilizer + micronutrient on growth and development of mungbean has been clearly brought out in this investigation. Perusal of the data revealed that application of RDF+VC 5.0 t/ ha recorded maximum plant height, number of branches/plant, dry weight, nodule number and nodule dry weight and significantly superior to RDF. The RDF+VC 2.5 t/ha was next best treatment in these respect. The higher values of these growth parameters with this fertility level might be due to supply of all the essential mineral nutrients in a balanced amount.

Jena et al (1994) conducted a study and reported that the seed inoculation with biofertilizers helped in increasing all the growth characters recorded over control, which might be due the beneficial effect of the Rhizobium and PSB in enhancing the nutrient supply to the plant. Combined application of micronutrients and biofertilizers was found synergistic in enhancing the growth attributing characters. The significant variations created by the addition of Mo are attributed to higher availability and absorption of nutrients and, Co application improving the nodulation and high population of Rhizobia in the rhizosphere .

Singh et al (2010) and Choudhary et al (2011) conducted a study and reported that the yield attributing characters namely number of pods/plant, pod length, number of grains/pod and 1000 grain weight increased with addition of VC in RDF and recorded maximum with RDF+VC 5 t/ha. This might be due to combination of organic and inorganic nutrition provides better soil environment for root growth, nodule formation, availability and absorption of nutrient from soil. Seed inoculation resulted in greater number of pods/plant, pod length, number of grains/pod and 1000 grain weight. This may be attributed to increased nodulation and nitrogen fixation, more solublization of native P and production of secondary metabolites by the bacteria. Combined application of biofertilizers along with micronutrients (Mo+Co) resulted in significant improvement in yield attributes. Application of these micronutrients along with the inoculations might have a synergistic effect, which enhanced the activity of nitrogenase, in turn supplied more nitrogen by fixation for better growth and yield attributes.

Singh et al (2010), Tiwari et al (2011), Choudhary et al (2011) and Meena et al (2016) conducted a study and reported that grain yield of mungbean crop is a function of cumulative effect of various yield components, which are influenced by genetic make-up of variety, various agronomic practices and environmental conditions. The application of RDF+ VC 5 t/ha produced higher seed and yield over RDF and RDF+VC 2.5 t/ha. An enhancement in seed yield is attributed to cumulative effect of number of pods/plant, pod length, number of grain/pod and seed weight.

Biswas et al (2009) conducted a study and reported that seed and yield was enhanced by seed inoculation with biofertilizer and micronutrient application. Combined application of micronutrient and seed inoculation resulted higher seed and yield over control and alone application of Mo and Co. This might be due to molybdenum have a synergistic effect, which enhances the activity of nitrogenase in turn supplied more nitrogen by fixation for better growth and finally increased yield .

Khan et al (2002) and Jain et al (2007) conducted a study and reported that protein content and protein yield was significantly influenced by different fertility levels. Maximum protein content (25.2%) and protein yield (107.6 kg/ha) was recorded under RDF+VC 5 t/ha. This was mainly due to higher biological production under these treatments which increase the nutrient uptake. Application of Mo + Co along with biofertilizer recorded maximum protein content and protein yield. The minimum protein content and protein yield was recorded under control.

Bhattacharyja and pal.(2001) conducted a study and reported that nitrogen, phosphorus, potassium uptake by crop was also relatively higher with RDF+ VC 5 t/ha . This was mainly due to higher biological production under these fertility levels. Nutrient uptake increased significantly with biofertilizer + Mo + Co treatment. The increased uptake with the application of biofertilizers and micronutrients might be due to enhanced effect of Rhizobium in nitrogen supply.

Sunil Kumar (2011) carried out a field experiment was conducted at agriculture farm of Sri Karan Narendra Agriculture University, Jobner during kharif, 2014. The treatment consisted 20 combinations of phosphorus (0, 20, 40 and 60 kg ha^{-1}) and bio-organics (Control, PSB,VAM, vermicompost at 2t ha^{-1} and vermicompost at 2t ha^{-1} + VAM). Results showed that every increase in level of phosphorus up to 40 kg ha^{-1} significantly increased the growth and yield attributing characters viz., plant height, no. of branches $plant^{-1}$, dry matter accumulation, number and weight of root nodules $plant^{-1}$, number of pods $plant^{-1}$, number of grains pod^{-1} and test weight and grain, straw and biological yield and nutrient content in grain and straw of mungbean . However, it was found at par with 60 kg P_2O_5 ha^{-1}, wherein the maximum values were obtained. Application of bio-organics as vermicompost at 2t ha^{-1} + VAM significantly increased the observed growth and yield attributing characters viz. plant height, no. of branches $plant^{-1}$, dry matter accumulation, number and weight of root nodules $plant^{-1}$, number of pods $plant^{-1}$, number of grains pod^{-1} and test weight and yields and nutrient content in grain and straw of mungbean as compared to vermicompost, VAM, PSB and control.

Ram and Dixit (2001), Biswas and Patra (2007), Choudhary (2008) conducted an experiment and reported that different levels of phosphorus (P) fertilization as well as use of various bioorganics could not bring variation in plant stand and RGR of mungbean up to the level of significance. Results of the experiment were revealed that growth parameters of mungbean showed marked variation due to P levels. Results revealed that application of P at 40 kg ha^{-1} significantly enhanced the plant height at 25, 50 DAS and at harvest, Branches $plant^{-1}$ at 50 DAS and at harvest, dry matter accumulation at 25, 50 DAS and at harvest, no. of total and effective nodules $plant^{-1}$, fresh and dry weight of nodules and crop growth rate at 0-25, 25- 50 DAS and 50- at harvest stages of mungbean over control and 20 kg P_2O_5 ha^{-1}. However, it was found at par with 60 kg P_2O_5 ha^{-1}, wherein the maximum values of growth parameters were obtained. It is associated with the better nutritional environment in the root zone for growth and development of the crop as well as in plant system. Phosphorus not only plays important role in root development and proliferation but also improves nodulation and N fixation by supplying assimilates to the roots. Increased availability of phosphorus owing to its application in soluble form to the soil which was otherwise deficient in P content might have led to significant improvement in the concentration and uptake of this nutrient which in turn helped in early root development and ramification, thereby leading to better growth in terms of plant height, branches plant^{-1} and dry matter accumulation.

Biswas and Patra (2007), Mathur (2000), Rajkhowa et al. (2002), Das et al. conducted an experiment and results indicated that application of vermicompost at 2 t ha^{-1} + VAM recorded the significantly highest value of plant growth parameters as plant height at 25, 50 DAS and at harvest, Branches plant^{-1} at 50 DAS and at harvest, dry matter accumulation at 25, 50 DAS and at harvest, no. of total and effective nodules plant^{-1} , fresh and dry weight of nodules, crop growth rate at 0-25, 25-50 DAS and 50 at harvest stages of mungbean over control, PSB, Vesicular ArbuscularMycorrhiza (VAM) and vermicompost @ 2 t ha^{-1} , respectively. Using vermicompost@ 2 t/ha^{-1}, PSB and Vesicular ArbuscularMycorrhiza (VAM) alone were obtained as the next better bio-organics over control, respectively. The organic manures play an important role in root development and proliferation resulting in better, nodules formation and nitrogen fixation by supplying assimilates to the root. They also increase water holding capacity and phosphate availability in soil thus provide better environment in rhizosphere for growth and development. The vermicompost enhanced the release of nutrients early in the crop period. Such beneficial effects of vermicompost along with better edaphic environment available to the crop might have improved all the growth attributes. VAM inoculation also plays significant and unique role in phosphate mobilization and uptake of phosphorus, zinc, sulphur and water by plant. The relatively higher availability of phosphorus in rhizosphere might have helped in rhizobium activity and resulted in more number of nodules plant.

Rajkhowa et al. (2002), Mathur et al. (2003), Meena and Sharma (2013), Chaudhary et al. (2004) carried out on mungbean and disclosed the results showed that application of vermicompost @ 2 t ha^{-1} + VAM recorded the significantly highest number of pods plant^{-1} (41.18), number of grains pod^{-1} (9.73), test weight (40), grain yield (1269 kg ha^{-1}), straw yield (2602 kg ha^{-1}) and biological yield (3871 kgha^{-1}) over vermicompost at 2 t ha^{-1}, PSB, VAM and control, respectively. Enhanced vegetative growth in terms of number of branches plant^{-1} provided more sites for the translocation of photosynthates and ultimately resulted in increased number of yield attributes. The beneficial effect of vermicompost in terms of availability and optimum supply of macro as well as micronutrients during entire growing season which led to higher yield attributes.VAM inoculation in soil significantly plays an important role in P cycling, mobilization and uptake by plants i.e. earlier P availability, greater root extension, higher nutrient uptake, higher photosynthesis and balanced portioning as discussed in previous section are the main factors of significant increase in yield attributes and yield.

Das et al. (2002), Meena et al. (2013) carried out an experiment on mungbean results showed that application of vermicompost @ 2 t ha^{-1} + VAM recorded the significantly highest nitrogen (4.04 and 1.97%), phosphorus (0.50 and 0.25%), and potassium (1.02 and 2.36%) in grain and straw and their total uptake nitrogen (104.7 kg ha^{-1}), phosphorus (9.71 kg ha^{-1}), and potassium (75.39 kg ha^{-1}) and protein content (25.25%), respectively over vermicompost at 2 t ha^{-1} , PSB, VAM and control, respectively. Reason for higher nitrogen content might be due to increased activity of nitrate reductase in synthesis of protein in seeds because it is a primary component of amino acids which are the building blocks of protein molecules. Since uptake of nutrient is a function of their content and yield, increase in seed and straw yield along with higher content of N, P and K might have resulted in higher uptake of these nutrients in the crop.

Mst. NusratJahan (2011) conducted a study and reported that a field experiment was conducted comprising two varieties of mungbean, BARI Mung-5 (V_1) and BARI Mung-6 (V_2), and five levels of phosphorus fertilizer: triple super phosphate [$Ca(H_2PO_4)$] viz. T_1 (control), T_2 (42.5 kg P ha^{-1}), T_3 (85 kg P ha^{-1}), T_4 (127.5 kg P ha^{-1}), and T_5 (170 kg P ha^{-1}). The experiment was organized in a randomized complete block design with three replications. V_1 produced the highest number of pods per plant (7.65), whereas the maximum 1,000-seed weight (49 g) was produced by V_2. The maximum plant height (30.89 cm), number of branches per plant (8.55), number of leaves per plant (19.05), number of pods per plant (10.25), pod length (8.95 cm), number of seeds per pod (9.11), 1,000-seed weight (48.17 g), and yield (1.05 t ha^{-1})

were obtained from the T_4 treatment. The interaction of phosphorus levels and varieties had a considerable effect on the growth, yield, and yield attributes of mungbean. The highest number of leaves (20.44) and number of pods (10.39) were obtained from V_1 when 127.5 kg P ha^{-1} (T_4) was applied, whereas the maximum number of seeds per pod (9.25) and maximum pod length (9.09 cm) were obtained when 85 kg P ha^{-1} and 42.5 kg P ha^{-1}, respectively, were used. The highest number of branches per plant (8.87), 1,000-seed weight (52.83 g), and the maximum seed yield (1.14 t ha^{-1}) were achieved from the treatment V_2T_4 owing to the interactive effect of phosphorus dose and mungbean variety.

Sehrawat et al,. (2015) conducted a study and reported that mungbean can respond efficiently to phosphorus fertilization (G. R. Rao et al., 1993); however, this impact may depend on the plant variety. We demonstrated the effect of phosphorus fertilization on two varieties of mungbean (BARI Mung-5 – V_1 and BARI Mung-6 – V_2) in aagroecological zone (salinity prone area of the subtropics). The V_1 variety responded better to increased phosphorus fertilization than did V_2 for number of pods per plant and pod length under the phosphorus treatments used. The V_2 variety was superior in relation to the phosphorus treatment for seed yield and 1,000-seed weight. The study reveals that both varieties responded best to the T_4 treatment in comparison to other treatments.

Arulbalachandran et al., (2009) Wahid et al., (2004) conducted an experiment and revealed that Salinity stress causes swelling of membranes in chloroplasts of sensitive plants causing reduced chlorophyll content, or it can occur owing to excessive accumulation of ions (Na^+ and Cl^-) in leaves which induces loss of chlorophyll .

Kabir et al. (2005) conducted a study and reported that the application of high concentration of nitrogen fertilizer can improve the water status and nutrient absorption of plants under salinity stress and improves the yield in subtropical conditions.

Abdul quddus (2005) studied an experiment and revealed that Zinc (Zn), boron (B) and molybdenum (Mo) are essential to increase the productivity of mungbean (*Vignaradiata* L.) and help to maintain the soil fertility but mostly ignored. Hence, an experiment was conducted during the years of 2016 and 2017 to know the impact of Zn, B and Mo on mungbean yield, nutrient uptake, economics and soil fertility improvement. The experiments were planned in randomized complete block design including of eight treatments with three replications. The treatments were T_1 = Control, T_2 = Zn 2 kg ha^{-1}, T_3 = B 1.5 kg ha^{-1}, T_4 = Mo 1 kg ha^{-1}, T_5 = $Zn_2B_{1.5}$, T_6 = Zn_2Mo_1, T_7 = B1.5Mo1 and T_8 = Zn_2B1.5Mo_1. The other fertilizers, N, P, K and S at 20, 20, 30 and 10 kg ha^{-1}, respectively were used in all treatments. The results indicate that the highest seed yield (1522 kg ha^{-1}) was obtained from T_8 treatment followed by T_7. The highest percent seed yield increment (51.6%) over control was achieved in T_8 treatment. Most of the growth and yield contributing characters of mungbean were recorded highest in T_8 treatment. The maximum nodulation (37.6) and highest amount of protein (24.3%) was also obtained from T_8 treatment. The T_8 treatment contributed positively to attain higher total uptake of N, P, K, S, Zn and B by mungbean. The combination of Zn, B and Mo is showed more productive compare to sole or couple use of these micronutrients. The T_8 (Zn_2B1.5Mo1 kg ha^{-1}) treatment exhibited helpful effects on soil organic matter, total N, available P, Zn and B. This treatment also showed economically better on the basis of net return. Results of the present study suggest that the combination of Zn, B and Mo applied at 2, 1.5 and 1 kg ha^{-1}, respectively could be recommended for mungbean cultivation.

Chude et al (2004) carried out an experiment and revealed that the seed yield of mungbean was affected significantly by the application of Zn, B and Mo during the 1st year and 2nd year . The highest seed yield (1485 kg ha^{-1}) was recorded from the treatment T_8 which was significantly higher over the other treatments, but statistically at per T_7 treatment in 1st year while in 2nd year, the seed yield was highest (1558 kg ha^{-1}) in the same T_8 treatment which showed statistically identical to T_7, T_6, T_5, and T_4 treatment. The lowest seed yield was in control (T_1) treatment. The mean seed yield ranged from 1005 to 1522 kg ha^{-1} across the treatments. In the experiment, increment of percent mean seed yield of mungbean over control was varied from 26.5 to 51.6% across the treatments, where the highest percent seed yield increment was calculated from the treatment T_8 and the lowest was from T_2 treatment. Results of the trial indicated that every micronutrient (Zn, B and Mo) contributed individually to help yield benefit over control. Micronutrients deficient soil is leading to low crops yield.

Baily & Laidlaw, (1999) conducted a study and reported that molybdenum plays a significant role for achieving higher productivity of legume compared to non-legume crops.

Rahman et al. (2008) conducted a study and reported that application of molybdenum which is encouraged nodule formation and N_2 fixation. Molybdenum is also involved in various metabolic processes, i.e., chlorophyll synthesis and leads to yield reduction of Mo deficiency (Liu, 2001). In this experiment, Mo significantly contributed to achieve 34.6% seed yield increment of mungbean over control.

Khan et al. (2019) conducted a study and reported that Mo application significantly influenced to get higher biological yield of mungbean over control. On the other hand, application of double and triple micronutrients was performed better over single micronutrient although the combination of triple micronutrient which was played superior activities over paired micronutrient. Present experimental result is supported to the above explanation that triple micronutrient treatment T_8 (Zn2.0B1.5Mo1.0 kg ha^{-1}) was contributed higher yield increment 10.6% over double micronutrient treatment T_5 = Zn2.0B1.5 kg ha^{-1}, 11.1% over treatment T_6 = Zn2.0Mo1.0 kg ha^{-1} and 6.06% over treatment T_7 = B1.5Mo1.0 kg ha^{-1}, respectively.

Islam et al. (2017), and Alam and Islam (2016) conducted a study and reported that combined application of Zn and B showed superior effect on the yield of mungbean than their single application.

Yang et al. (2009) carried out a study on the combined application of B with Mo or Zn resulted in higher seed yield than that of application of B, Mo, or Zn alone, while the combined application of B, Mo, and Zn increased the seed yield of rapeseed by 68.1% compared to control treatment.

O'Hara, (2001) carried out a study on the number f nodules $plant^{-1}$ of mungbean responded significantly by the application of Zn, B and Mo. In the experiment, application of Zn, B and Mo either single or in combination significantly gradually augmented the number of nodules $plant^{-1}$ over control. The percent increment of nodules $plant^{-1}$ was ranged from 17.5 to 40.3% across the treatment. The highest increment of nodulation (40.3%) was occurred in T_8 treatment. Nodulation result of the exhibited that the highest number of nodules $plant^{-1}$ (37.6) was documented from

T_8 treatment which was significantly different with the other treatments but statistically alike to T_7 (36.3), T_6 (36.9), T_5 (36.7) and T_4 (35.4) treatment. The lowest nodulation was found in control (T_1) treatment. The results also indicated that every micronutrient has an important role in nodule formation and N_2 fixation.

JyotiSoni and HS Kushwaha (2008) conducted a field experiment found that a field experiment was conducted during kharif season of 2018 at Mahatma Gandhi ChitrakootGramodayaVishwavidyalaya, ChitrakootSatna (M.P.) to evaluate the performance of mungbean with foliar spray of zinc and iron. The experiment was laid out in a randomized block design with three replication. Treatments consisted absolute control, 0.5% $ZnSO_4$ Spray at FI, 0.5% $ZnSO_4$ Spray at FI and PI, 0.5% $FeSO_4$ spray at FI, 0.5% $FeSO_4$ spray at FI and PI, 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI, 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI and PI and 25 Kg $ZnSO_4$ Soil application. Plant height nodules/plant and branches/plant were not influenced significantly by foliar spray of zinc and iron treatment. Yield attributes viz pods per plant was significantly improved with 0.5% $FeSO_4$ spray at FI. Significantly maximum seed yield (571 kg/ha) and pod length (6.30 cm) was recorded under 0.5% $ZnSO_4$ Spray at FI and PI. Foliar applicaton 0.5% $ZnSO_4$ Spray at FI, 0.5% $ZnSO_4$ Spray at FI and PI, 0.5% $FeSO_4$ spray at FI, 0.5% $FeSO_4$ spray at FI, 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI, 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI and PI and T_8: 25 Kg $ZnSO_4$ Soil application enhanced seed yield of mungbean by 36.85%, 47.16%, 14.69%, 27.31%, 32.98%, 18.04% and 43.04% over control, respectively. However Gross returns (48676/ha) net returns (28537/ha) and B:C ratio (2.41) was earned significantly higher under 0.5% $ZnSO_4$ Spray at FI and PI.

Khalil RahmanBarakzai (2011) conducted a field experiment and disclosed that a field experiment was conducted during spring-summer seasons of 2017 at Tarnak Research Farm, ANASTU, Kandahar, Afghanistan to investigate the effect of sources of nutrient and biofertilizers on growth, yield and economics of Mungbean. The experiment laid out in Split Plot Design (SPD) with by assigning 4 levels of nutrients sources (control, 30:60:40 kg N:P:K ha^{-1} , 10 t FYM ha^{-1} and 15:30:20 kg N:P:K ha^{-1} + 5t FYM ha^{-1}) in main plot and 4 levels of biofertilizers [No Biofertilizer, Rhizobium, Phosphate solubilizing bacteria (PSB) + Vesicular ArbuscularMycorrhiza (VAM), and Rhizobium + PSB + VAM] in subplot, thus sixteen treatment combinations were tested in three replications. Results of the study revealed that significantly superior plant growth parameters like plant height, number of branches, trifoliate leaves, leaf area and dry matter accumulation were recorded from RDF 0.5+ FYM 5 t ha^{-1}. Similarly, these parameters were superior with the application of Rhizobium+ PSB+VAM at most of the growing stages. Among different nutrient sources and biofertilizer the interaction effect was significant at different stages and found best with the combination of RDF 0.5+ FYM 5 t ha^{-1} and Rhizobium +PSB+ VAM for most of the growth parameters. Root parameters like root length and root nodules (7.7 $plant^{-1}$) were significantly higher with the application of RDF0.5+FYM 5 t ha^{-1} and Rhizobium+ PSB+ VAM over control at 25, 50 and at harvest stages. Highest growth and yield can be obtained with the application of 15:30:20 kg N: P: K ha^{-1}+ 5 t FYM ha^{-1} along with Rhizobium + PSB + VAM in the Kandahar province of Afghanistan Jiaping Liang (2013) carried out an experiment and disclosed that It is still a long-term challenge to improve crop production and economic benefits in arid area of northwest China. The objective of this study was therefore to propose a new and promising mungbean intercropping (CMBI) system to cope with the challenge based on the traditional monocroppingsystem. A two-year field experiment was conducted to evaluate crop production and economic benefits between the CMBI and MC systems by analyzing the total land output (TLO), aboveground dry matter, nitrogen uptake, water use efficiency (WUE), nitrogen use efficiency (NUE), partial factor productivity (PFP) of nitrogen, and economic benefits. Experiment treatments consisted of two cropping systems (MC and CMBI systems) and a combination of the CMBI system with different N-fertilizer rates [160 (N_{160}), 315 (N_{315}), 390 (N_{390}), and 475 (N_{475}) kg ha^{-1} in 2016, and 160 (N_{160}), 315 (N_{315}), and 390 (N_{390}) kg ha^{-1} in 2017], respectively. All treatments were designed using a randomized complete block with three replications. The results indicated that no significant differences in growth parameters [PH (plant height), SD (stem diameter), and LAI (leaf area index)] of cotton were found between the MC and CMBI systems in 2016 and 2017. Compared with the MC system, however, the CMBI system significantly increased TLO, aboveground dry matter, total N uptake, WUE, NUE, PFP for nitrogen, and economic benefits in 2016 and 2017. The result suggested the CMBI system had greater production advantages and economic benefits than the MC system. In addition, compared to the N_{160} treatment, other N treatments (N_{315}, N_{390}, and N_{475}) in the CMBI system significantly enhanced crop growth, TLO, total aboveground dry matter, total

N uptake, WUE, and economic benefits. However, PFP for nitrogen and NUE significantly decreased with the increase of application N rates. According to analyzing the production functions of different application N treatments, we found that 390 kg ha^{-1} in the CMBI system might be recommended as an appropriate application N rate to improve crop production and economic benefits in the arid area of northwest China.

Pooja rani (2008) conducted an experiment and disclosed that the present study emphasis on the synthesis of zinc oxide (ZnO) and magnesium oxide (MgO) nanoparticles (NPs) via a simple, eco-friendly and low-cost approach. The leaf extract was employed as a source of capping and reducing agents for the synthesis of ZnO and MgO NPs. The synthesized ZnO and MgO NPs were confirmed by various techniques such as UV–Visible, scanning electron microscopy, tunneling electron microscopy and X-ray diffraction. TG/DTA analysis deciphers the thermal decomposition and weight loss of synthesized metal oxides NPs. Further, the influence of as-synthesized NPs on seed germination, root, and shoot, fresh and dry biomass parameters of *Vignaradiata* (mung bean) and *Cajanuscajan* (red gram) seeds was assessed. A significant increment in the germination rate of MgO and ZnO NPs treated seeds was observed relative to water treated seeds (control). Moreover, chlorophyll content was also examined to validate the seed germination potential of synthesized NPs. Therefore, this study provides a positive step towards the development of inorganic nanomaterials via the green approach and their applications as green agrochemicals.

Andre A. Diatta (2009) conducted an experiment and disclosed mungbeanVignaradiata (L.), a short-duration and relatively drought-tolerant legume crop, is capable of improving soil fertility and productivity of associated crops. Our study evaluated the effects and mungbean intercropping on crop yields in the semi-arid regions of Senegal. Field experiments were conducted during the 2017 and 2018 growing seasons at Bambey and Nioro sites located within Senegal’s west-central and Saloum agricultural regions, respectively. Experimental treatments: monocropped millet (T_1), monocroppedmungbean (T_2, 100%), and 23% (T_3), 43% (T_4), 47% (T_5), 62% (T_6), 125% (T_7), and 164% (T_8) of mungbean intercropped with millet were laid out in a randomized complete block design and replicated four times. In addition to yield, canopy cover and normalized difference vegetation index (NDVI) were measured and yield advantage was assessed with the land equivalent ratio (LER). Combined millet and mungbean seed yields were up to 60 and 85% higher under intercropping systems compared to millet monocropping at Bambey and Nioro, respectively. Similarly, LER was always greater than unity (> 1) under millet–mungbean intercropping compared to millet monocropping. Mean canopy cover estimates and NDVI values increased by up to 60 and 30% in millet–mungbean intercropping over millet grown alone, respectively. These combined yield gains obtained without fertilizer applications suggested that optimizing mungbean density (62–125%) in pearl millet-based systems can increase the combined yields in a low-input and/or high-risk environment in Senegal.

2.2 Effect of organic fertilizer on other crops

Julia Cooper et al (2011) carried out an experiment on wheat and result that the effects of organic versus conventional crop management practices (crop rotation, crop protection, and fertility management strategies) on wheat yields and grain metal (Al, Cd, Cu, Ni, Pb, and Zn) concentrations were investigated in a longterm field trial. The interactions between crop management practices and the season that the crop was grown were investigated using univariate and redundancy analysis approaches. Grain yields were highest where conventional fertility management and crop protection practices were used, but growing wheat after a previous crop of grass/clover was shown to partially compensate for yield reductions due to the use of organic fertility management. All metals except for Pb were significantly affected by crop management practices and the year that the wheat was grown. Grain Cd and Cu levels were higher on average when conventional fertility management practices were used. Al and Cu were higher on average when conventional crop protection practices were used. The results demonstrate that there is potential to manage metal concentrations in the diet by adopting specific crop management practices shown to affect crop uptake of metals.

Min Zhang et al. (2018) carried out an experiment and told that In China, the current high reliance on chemical nitrogen (N) in agriculture has resulted in low N use efficiency and high N loss. Reducing N fertilizer input is necessary for environmental protection, but it has not been attractive to Chinese farmers because of insufficient increase in net income. Reduced use of N fertilizer might be attractive if reduced N combined with organic fertilizer could increase rice yield. Therefore, a three-year field trial and a 15N micro-plot experiment were conducted to study the effect of organic fertilizer combined with chemical N on rice yield, NH_3 loss and the fate of 15N in an intensive rice cropping system in Taihu Lake region. Six treatments were used: control (0 N, zero N application), organic N alone (Org N, 41 kg N ha^{-1}), local farmers' N practice (FN, 300 kg N ha^{-1}), reduced N (RN, 225 kg N ha^{-1}), organic fertilizer combined with FN (FN + Org N) and organic fertilizer combined with RN (RN + Org N). Compared to chemical N, organic fertilizer markedly increased soil organic matter content, promoted grain N accumulation, and improved rice production. Organic fertilizer treatments showed 11%–13% higher yield and 4%–5% higher net economic benefit over FN for three years. Organic fertilizer produced high NH_4 + in the floodwater and increased NH_3 loss. Although FN + Org N had significantly higher 15N-NH_3 loss than FN, it increased soil residual 15N and decreased 15N loss by 29%. There was no significant difference of yield and NEB between FN + Org N and RN + Org N, while RN + Org N was superior to FN + Org N because of the lower NH_3 loss and higher N recovery efficiency (NRE). Therefore organic fertilizer is an economically attractive practice to increase NRE and rice yield without increasing chemical N input .

Helda Morales et al. (2000) conducted an experiment on traditional fertilization and told that Cakchiquel farmers in Patzún, Guatemala stated that pest populations have increased in corn crops since they abandoned organic fertilization and adopted synthetic fertilizers. Given the dearth of scientific information about the effects of fertilization practices on pests, a controlled experiment was performed to elucidate these interactions. Pests, their natural enemies, and nutritional status were compared among corn plots with synthetic and organic fertilizers, and a control without fertilizer. Corn in fields treated with organic fertilizer applied for at least 2 years hosted fewer aphids (*Rhopalosiphummaidis*) than corn treated with synthetic fertilizer. This difference seems attributable to high concentration and total content of foliar nitrogen in corn in the synthetic fertilizer plots, although numbers of Spodopterafrugiperda showed a weak negative correlation with increased nitrogen levels. Coccinellidae populations were higher in plots with high aphid populations, but only where organic fertilizer was applied. There were no significant yield differences among treatments .

S. EiKinany et al. (2019) carried out an experiment on date palm. Date palm is an important crop in Morocco, Tunisia and many other drylands of the world, but its growth is often limited due to the low soil fertility and harsh environmental conditions of oases ecosystems, which can hardly be compensated by the sole application of high dosages of chemical fertilizers. For the first time, we investigated the effects of compost application and inoculation with a commercial strain of the arbuscularmycorrhizal fungus (AMF), *Glomus iranicum*, on the growth of micropropagated date palm plantlets (cv. Feggous). After twelve months of growth, plantlets transplanted into compost amended substrate inoculated with AMF showed increased biomass production (root and shoot biomass), chlorophyll and mineral nutrient contents than plantlets transplanted into compost amended substrate or without compost addition. Thus, this inoculum reinforced the promoting effect of compost and was successful in colonizing the root system. According to our results, sandy substrate enriched with compost and inoculated with *G. iranicum* can be recommended for improving the growth and nutrition of micropropagated date palm plantlets.

Dan o. chellem et al. (2002) carried out a field experiment on wheat and told that field experiments were conducted to measure the yield response of Cantaloupe (*Cucumismelo*), pepper (*Capsicum annuum*), and tomato (*Lycopersiconesculentum*) to an organic fertilizer derived from hydrolyzed feather, meat, bone, and blood meal, sulfate of potash and langeinite (Nature Safe 10-2-8). The effects on soilborne pests, soil nutrient concentrations, and soil microorganism populations were also determined. The field site had been previously cropped to tomato using conventional production practices and was judged to have low soil fertility. Application of 560 N, 110 P, 440 K (kg·ha^{-1}) resulted in an increase in soil pH, ammonia concentrations and counts of total soil fungi, but not total soil bacteria. Based on observations of growth, necrosis and mortality an application rate of 440 N, 88 P, 352 K (kg·ha^{-1}) was phytotoxic to pepper. Phytotoxicity on tomato was observed at an application rate of 1120 N, 220 P, 880 K (kg·ha^{-1}). A quadratic effect of application rate was observed for yield of pepper (R_2 = 0.83) and tomato (R_2 = 0.98). Optimum yields were projected to occur at 310 N, 62 P, 248 K (kg·ha^{-1}) for pepper and 400 N, 80 P, 320 K

$kg{\cdot}ha^{-1}$ for tomato. A second location that had been previously cropped to vegetables under certified organic production guidelines and had moderate levels of soil fertility, was used to test the effect on cantaloupe yields. An application rate of 110 N, 22 P, 88 K ($kg{\cdot}ha^{-1}$) of Nature Safe increased early yields as compared to a formulation of dried poultry manure (NOPI 5-4-5) applied at 112 N, 90 P, 112 K ($kg{\cdot}ha^{-1}$) or an unfertilized control. However, final total yields of cantaloupe were similar among the three treatments. The effect of fertilizer rates on emergence of yellow (*Cyperusesculuntus*) and purple nutsedge (*C. rotundus*) was erratic with suppression observed at rates phytotoxic to pepper. Reductions in the incidence of southern blight, caused by *Sclerotiumrolfsii*, occurred on tomato and pepper at application rates below the rates required for optimum yields. This study demonstrates that organic fertilizers can provide multiple benefits for Florida vegetable production systems including improving fertility, increasing soil microbial populations, and reducing the incidence of a soilborne disease.

2.3 Nutrient status of organic manure

Alexandra Maltas et al. (2012) carried out a field experiment and told that The combined effects of the nature of fertilizers (chemical and/or organic), splitting of manure inputs and tillage intensity (reduced or conventional) on soil properties, crop production and crop response to nitrogen (N) fertilization were studied in Changins, Switzerland between 1997 and 2009. Five maintreatments were tested in a split-plot design: (i) mineral fertilizer with reduced-tillage (MinRT), (ii) manure every year plus mineral fertilizer with reduced-tillage (Ma_1RT), (iii) manure every year plus mineral fertilizer with conventional-tillage (Ma_1CT), (iv)manure every three years plus mineral fertilizer with reduced-tillage (Ma_3RT) and (v) slurry every year plus mineral fertilizer with reducedtillage (Slu_1RT). Sub-treatments included two levels of N-fertilization: an optimal dose (according to the Swiss fertilization guidelines) and a sub-fertilization (60% of the optimal dose). The soil was a CalcaricCambisol with, in 1997, 20.5 g kg^{-1} of soil organic matter (SOM) in the first twenty centimeters. After twelve years of experimentation, SOM contents were 19.8, 20.3, 21.3, 21.5, and 22.8 g kg^{-1} under respectively Ma_1CT, MinRT, Ma_1RT, Slu_1RT and Ma_3RT treatments. The main-treatments do not have a significant effect on SOM contents and chemical soil properties. When N-fertilization was non-limited (optimal dose) and manure was applied, tillage intensity had not significant effect on grain yield. When N-fertilization was non-limited with reduced tillage (RT), the crops in the treatments with organic fertilizers yielded 2–13% more grains (0.2, 0.3, 0.4 and 0.5 t ha^{-1} more for respectively rapeseed, spring cereal, maize and winter wheat) than those in treatments with mineral fertilizers only. The subfertilization (60% of the optimal dose) decreased the grain yields by 9, 13, 15, 7 and 16%, respectively, in MinRT, Ma_3RT, Ma_1RT, Ma_1CT, Slu_1RT. In conclusion, organic fertilizers and reduced tillage provide effective means to conserve soil fertility and crop production in the studied soil, although both enhance N fertilizer needs. Splitting manure applications into lower amounts annually did not bring any benefits to soil properties or crop production.

J. A. Olfati et al. (2012) carried out an experiment on french dwarf bea. Conventional agriculture can lead to loss of organic matter. Organic agriculture employs closed cycles of energy and materials, maximizes reuse, employs rotation systems, and uses nutrients of organic origin. The use of municipal solid waste compost and spent mushroom compost as additions to soils is increasing. A study that was carried out in spring 2009 with 0, 100, 200, and 300 Mt·ha^{-1} of municipal solid waste compost, spent mushroom compost, and cow manure applied to soil in which French dwarf bean (*Phaseolus vulgaris* L.) was planted. Organic fertilizer type affected total yield, number of pods per plant, pod dry matter, pod weight, number of branches, and leaf ash percentage. Municipal solid waste compost and spent mushroom compost increased total yield over the control and can be used as a substitute for cow manure in French dwarf bean production.

Francesco Montemurro et al. (2015) carried out an experiment and told that an inadequate replacement of organic matter in agricultural lands progressively leads to soil fertility reduction and therefore, soil application of organic fertilizers and amendments should be promoted. The objectives of this 3-year research project on organic lettuce were to investigate the agronomic performance of experimental organic amendments obtained by using agro-industrial wastes in comparison with a commercial organic fertilizer, and to evaluate their short-term effects on soil mineral-N and soil organic carbon changes. Two types of olive pomace mixtures, with different initial C/N ratios, were composted and either stopped at the active phase (A_1 and B_1) or processed until maturation (A_2 and B_2). Also an anaerobic digestate (DA) and the B_2 in combination with mineral fertilizer (B_2-MIN) were studied. The four composts, DA and B_2-MIN were compared with a commercial organic fertilizer

(Org), and an unfertilized control (N_0). Results suggested that the best compromise for organic lettuce yield and soil fertility could be obtained with the B_2 compost, thus highlighting the need for choosing a good stage of maturity of the compost, along with an appropriate C/N ratio of composting mixture, to improve the fertilizing efficiency of agro-food residues in organic farming. Furthermore, the application of immature amendments did not increase (B_1) or significantly reduce (A_1) marketable lettuce yield, indicating that the choice of organic fertilizer is an important concern in sustainable agriculture, especially in organic vegetable production.

Janainabraga et al. (2012) conducted an experiment and result were bioethanol from sugarcane is becoming an increasingly important alternative energy source worldwide as it is considered to be both economically and environmentally sustainable. Besides being produced from a tropical perennial grass with high photosynthetic efficiency, sugarcane ethanol is commonly associated with low N fertilizer use because sugarcane from Brazil, the world's largest sugarcane producer, has a low N demand. In recent years, several models have predicted that the use of sugarcane ethanol in replacement to fossil fuel could lead to high greenhouse gas (GHG) emission savings. However, empirical data that can be used to validate model predictions and estimates from indirect methodologies are scarce, especially with regard to emissions associated with different fertilization methods and agricultural management practices commonly used in sugarcane agriculture in Brazil. In this study, we provide in situ data on emissions of three GHG (CO_2, N_2O, and CH_4) from sugarcane soils in Brazil and assess how they vary with fertilization methods and management practices. We measured emissions during the two main phases of the sugarcane crop cycle (plant and ratoon cane), which include different fertilization methods and field conditions. Our results show that N_2O and CO_2 emissions in plant cane varied significantly depending on the fertilization method and that waste products from ethanol production used as organic fertilizers with mineral fertilizer, as it is the common practice in Brazil, increase emission rates significantly. Cumulatively, the highest emissions were observed for ratoon cane treated with vinasse (liquid waste from ethanol production) especially as the amount of crop trash on the soil surface increased. Emissions of CO_2 and N_2O were 6.9 kg ha^{-1} yr^{-1} and 7.5 kg ha^{-1} yr^{-1}, respectively, totaling about 3000 kg in CO_2 equivalent ha^{-1} yr^{-1}.

2.4 Importance of organic manure

J.W.C. Wong et al. (1998) conducted an experiment and told that a manure compost has been identified as an alternative to fertilizer to increase soil fertility and crop production in organic farming. The aim of the present study was to evaluate the effects of manure compost on soilproperties and crop quality as well as to determine the optimum application rate. A field experiment was carried out to evaluate the growth of *Brassica chinensis* and *Zea mays* L. on loamy soil amended with 0, 10, 25, 50 and 75 tonnes ha^{-1} of manure compost. Addition of manure compost increased total organic matter, macro-nutrients (N, P, Mg, Na, Ca and K) and micro-nutrients (Cu, Zn and Mn) in the amended soils according to the rate of compost application. It also improved soil physical properties with a significant increase in soil porosity and hydraulic conductivity, but a decrease in bulk density. The dry weight yields of both plant species were higher in soils receiving manure compost amendment and plots with 50 and 25 tonnes ha^{-1} compost had the highest yields of *Z. mays* L. and *B. chinensis*, respectively. An increase in dry weight yields indicated a better nutrient status in compost-amended soil which was supported by the higher tissue nutrient contents of N, P and K of plants grown in soil with manure compost amendment. However, there was also a higher accumulation of Cu and Zn in plants growing in compost-amended soil. Nevertheless, the accumulated Cd contents were all within the concentrations recommended for vegetables by the National Health and Medical Research Council, Australia. It can be concluded that the manure compost produced locally could be a suitable organic fertilizer for organic farming in Hong Kong and an application rate of 25–50 tons ha^{-1} would give the highest crop yield.

Ewulo et al (2008) carried out an experiment and told that In order to study the effect of poultry manure additions on nutrient availability, soil physical and chemical properties and yield of tomato, five levels of the manure, namely 0, 10, 25, 40 and 50 t ha^{-1} were applied at Akure, Southwest Nigeria. The soil at the two experimental sites were slightly acidic, low in organic matter, N, P, and Ca. Poultry manure increased soil organic matter, N and P. Soil bulk density were reduced and moisture content increased with levels of manure. Manure applications increased leaf N, P, K, Ca and Mg concentrations of tomato, plant height, number of branches, root length, number and weight of fruits. The 25 t ha^{-1} poultry manure gave highest leaf P, K, Ca and Mg and yield relative to control. The 10, 25, 40 and 50 t ha $^{-1}$ manure levels increased average fruit weight by 58, 102, 37 and 31% respectively.

S.O. Ojeniyi et al. (2007) conducted an field experiment and told that combined use of crop and animal wastes is necessary in order to obtain adequate amount of organic manure for use in crop production. Hence field experiments were conducted at two sites in Akure, Southwest Nigeria to compare effect of NPK (15-5-15) fertilizer (200 kg ha^{-1}) and each of Spent Grain (SG) and ground 1 Cocoa Husk (CH) amended with Cattle Dung (CD), Poultry Manure (PM) and Goat Manure (GM) at equal rates (12.5 t ha^{-1} :12.5 t ha^{-1}). The effects of treatments on leaf N, P and K concentrations, growth and fruit yield 1 1 of tomato were studied. Compared with control, NPKF and animal manure amended SG and CH increased leaf N and K, plant height, number of branches, leaf area, number and weight of fruits significantly ($p>0.05$). Fruit yields given by CD, PM and GM amended CH and PM and GM amended SG were similar. Among eight treatments compared, CH and SG amended with PM gave highest fruit yields. Compared with control, NPKF, amended SG and CH increased fruit yield by 268,342 and 397%, respectively.

NavRatenPanwar (2010) conducted an expreriment and told that soil organic carbon (SOC), macro- and micronutrient status, and nitrogen (N) mineralization were studied in a soil profile managed with organic (OMP), chemical (CMP), and integrated (IMP) management practices for 3 years (2004–7) under a soybean–durum wheat cropping sequence. The most significant buildup of SOC and nutrients was in OMP, followed by IMP and then CMP. The OMP had 15.8 and 7.3% more SOC content than the CMP and IMP, respectively. The concentration of nitrate N was significantly greater in the OMP and IMP than in the CMP. The amount of ammonium N was less than nitrate N in OMP and IMP, indicating the high nitrification ability of the soil. A buildup of the micronutrient cation content was also noticed in the surface layer in the OMP and IMP plots. The OMP and IMP had a significantly greater mineralization rate of N than did CMP, and it was greatest in the top 0- to 15-cm soil layer. .

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CHAPTER 3

MATERIALS AND METHODS

This chapter includes a brief description of the experimental soil, mungbean variety, land preparation, experimental design, treatments, cultural operations, collection of soil and plant samples etc. and analytical methods followed in the experiment to study the effect of vermicompost and chemical fertilizers on the yield of mungbean.

3.1 Experimental site

The field work is combined use of organic and inorganic fertilizer in the growth and yield of mungbean worked at the Sher-e-Bangla Agricultural University farm, Dhaka -1207 during kharif season of 2019. The map (Figure 1) related experimental site is given below.

3.2 Description of soil

The working place is under Tejgaon series to Agroecologicalzone ,Modhupur Tract (AEZ – 28) and soil type is Deep Red Brown Terrace Soils .

3.3 Description of the mungbean variety

BARI Mungbean5 was used as the test crop in this experiment. This variety is released by Bangladesh Agricultural Research Institute, Joydebpur, Gazipur .Its life cycle limit from 60 to 65 days. It is resistant to disease, insects and pest.

3.4 Climate

The experiment was driven out during kharif-1 season, 2019.

3.5 preparation of the field

The field was disclosed by power tillar on the 10thJune 2019; then the land was ploughed many times then laddering was done for mungbean seed sowing . Weeds and stubbles were separate from the field and big size clods were broken down for desirable size .Finally, working field was equal in size and the field was divided into unite plot.

3.6 treatments

The experiment consists 7 treatment combination are given below:

Treatment combinations

T_1 = 100% Recommended chemical fertilizer + 0 t/ha vermicompost .

T_2=75% Recommended chemical fertilizer + 2 t/ha vermicompost

T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost

T_4= 75% Recommended chemical fertilizer + 4 t/ha vermicomost

T_5= 50% Recommended chemical fertilizer +2 t/ha vermicompost

T_6 =50% Recommended chemical fertilizer + 3 t/ha Vermicompost

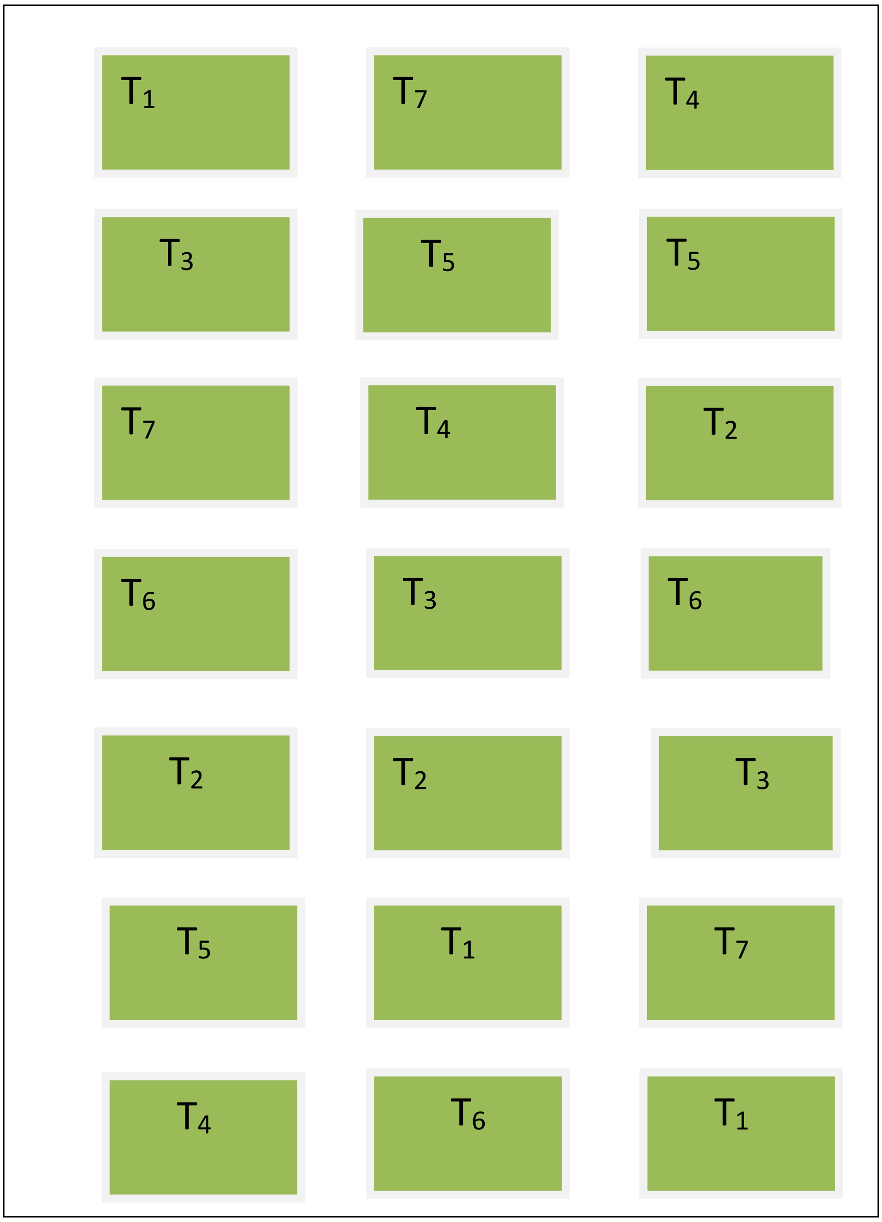
T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost

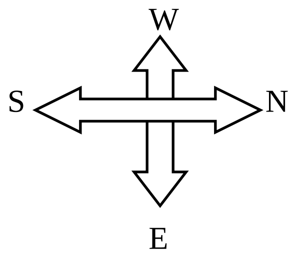
3.7 Nutrient status of vermicompost:

An ideal vermicompost contain 1% nitrogen, 1% phosphorus, 1% potassium , 18%carbon and 15-25% moisture.

3.8 layout of the experiment

The working field was two factor and RCBD design with 3 replication. The amount of plots was 21, each measuring 6.25 m^2 .In the field contained 3 replication with each at 7 plots. The distance maintained between two plots was 50 cm and between blocks was 50cm. The layout of the experiment is shown in figure no 1





Plot size: 3m×2.67m (8.01) m^2

Plot to plot distance 50 cm

Block to block distance 50 cm

Figure1. Layout of the experimental field

3.9Aplication of organic and inorganic fertilizers:

At the time of final land preparation urea, triple super phosphate, muriate of potash and boric acid was applied. At the time of sowing of mungbean seed the organic fertilizer was applied. Sulpher from gypsum, Zinc from zinc oxide and boron from boric oxide.

3.10Seed sowing :

Mungbean seeds were sown on the 13^{th}june 2019 in lines following the recommended line to line distance of 24 cm and plant to plant distance of 6 cm.

3.11 Cultural and management practices:

Various cultural practicesuch as thinning of plants, Weeding and insecticide application were done whenever it required. After 15 days of sowing when they attaked by cutworm , When was taken proper steps against the insect applied malathion in the required amount .To protect the insect different preventive measure such as purching was ensured at the time of germination .The field was irrigated twice -one at 16 days and the other at 35 days after sowing .

3.12 Harvesting:

Harvesting time of the mungbean crops was 13^{th} august 2019. After harvest the crop they are bundled at a plotwise.The grain and straw yields was notedown plot wise because for ststistical analysis those data are recquired .

3.13 Collection of samples

3.13.1 Soil sample:

Before cultivation the land about 0-15 cm depth of the land was collected soil for analysis the data, Then when the land mixed well then soil are collected for composite sample. After harvest the crop some soil are collected, on 18^{th} august 2019 around 0 - 15 cm depth. The samples were dried in the air, and then sieved with 2 mm(10 meshes) sieve for next analysis.

3.13.2 Plant sample:

At the time of maturity plant samples were taken consciously for further analysis. After cutting above ground level they were put for further analysis. Then they are washed by tap water and then with distilled water. The plant samples were dried in the electric oven at 72^0c for 47 hours.

Then the samplewere taken in an electric grinding machine and put those for further analysis. Plant samples were not collected from border area.

3.14 Collection of data

Data collection were done on the following paramerers –

3.14.1 Plant height:

For the analysis from the ground level to the top of the canopy of 8 plants from each plot and for mean value. It was done at the maturity stage of the crop .

3.14.2 Number of leaves / plant:

From each plot around 8 plants leaves were counted and averaged.

3.14.3 Number of branches / plant:

From each plot around 8 plants branches were counted and averaged.

3.14.4 Number of pods / plant:

From each plot around 8 plants pods were counted and averaged .

3.14.5 Pod length (cm) :

From each plot around 8 plants Pods were counted and averaged.

3.14.6 Number of seeds / pod:

From each plot around 8 pod seeds were counted and averaged.

3.14.7 Thousand seed weight:

Thousand seeds of mungbean were counted randomly and then weighed plot wise .

3.14.8 Grain yield:

Grain yield was measured carefully, carefully air-dried and then they are converted into t ha^{-1}

3.14.9 Straw yield:

Straw yield was measured carefully , carefully air -dried and then they are converted into t ha^{-1}

3.15 Chemical analysis of the plant, soil and organic fertilizer samples

3.15.1 Plant sample analysis

The grounded plant samples were digested with come. HNO_3 and $HClO_4$ mixture for the determination on P and K.

3.15.1. a Nitrogen

For the determination of nitrogen an amount of 0.5 g oven dry, Ground sample were taken in a micro kheldahl flask . 1.1 g catalyst mixture (K_2SO_4:$CuSO_4.5H_2O$: Se in the ratio of 100:10:1), and 7 ml conc. H_2SO_4 were added. The flasks were heated at 160^0 C and added 2 ml 30% H_2O_2 then heating was continued at 360^0C until the digests become clear and colorless. After cooling, the content was taken into a 50 ml volumertic flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by sistilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4 .

3.15.1.b Phosphorous

Plant samples (stover) were digested by diacid (Nitric acid and Perchloric acid) mixture and P content in the digest was measured by blue color development (Olsen et al., 1954). Phosphorus in the digest was determined by using 5 ml for stover sample from 50 ml digest by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were showed the standard curve (age et al., 1982) .

3.15.1.c Potassium

One mili-liter of digest sample for the stover was taken and diluted 20 ml volume to make desired concentration so that the flame photometer reading of samples were measure within the range of standard solutions. The concentrations were measured by using standard curves.

3.15.2 Soil sample analysis

3.15.2.a Organic carbon

Soil organic carbon was determined by walkley and black's wet oxidation method as outlined by Jackson (1973) from the soil samples collected before sowing and also after harvesting the crop.

3.15.2 .b Total nitrogen

Total N content of soil were determined followed by the Micro Kjeldahl method. One gram of oven dry ground soil sample was taken into micro kheldahl flask to which 1.1 gm catalyst mixture (K_2SO_4:$CuSO_4.5H_2O$:se in the ration of 100:10:1) , and 7 ml H_2SO_4 were added . The flasks were swirled and heated 160^0C was continued until the digest was clear and colorless. After cooling, the content was taken into 50 ml volumetric flastk and the volume was made up to lthe mark with distillled water. A reagent blank was prepared in a similar manner. These digests were used for nitrogen determination (page et al.,1982).

Then 20 ml digest solution was transferred into the distillation flask , Then 10 ml of H_3BO_3 indicator solution was taken into a 250 ml conical flask which its marked to indicate a volume of 50 ml and placed the flask under the condenser outlet of the distillation apparatus so that the delivery end dipped in the acid. Add sufficient amount of 10NNaOH solutions in the container connecting with distillation apparatus. Water runs through the condenser of distillation apparatus collected the distillate. The conical flask was removed by washing the delivery outlet of the distillation apparatus with distilled water. Finally the distillates were titrated with standard 0.01 N H_2SO_4 until the color changes from to pink. The amount of N was calculated using the following formula:

$$\%\ N = \frac{(T-B)\times N\times 0.014\times 100}{S}$$

where, T=Sample titration (ml) value of standard H_2SO_4

B= Blank titration(ml) value of standard H_2SO_4

N=Strength of H_2SO_4S=Sample weight in gram

3.15.2. c Available phosphorous

Available phosphorous was extracted from the soil by bray -1 method (bray and Kurtz, 1945). phosphorous in the extract was determined by ascorbic acid blue color method (Murphy and riley , 1962) with the help of a spectrophotometer .

3.15.2.d Exchangeable potassium

Exchangeable potassium in the soil sample was extracted with 1N neutral ammonium acetate and the potassium content was determined by flame photometer.

3.15.3 Organic fertilizer

Organic fertilizer was analyzed for organic matter, total N, available P and K contents following the methods used for plant and soil analysis. Organic fertilizer contained 11.04% organic matter, 0.6208% total N, 0.02349% available P and 0.0762% available K.

3.15.4 Statistical analysis

The data obtained from the experiment were analyzed statistically to find out the significance of the difference among the treatments. The mean values of all the characters were evaluated and analysis of variance was performed by the ~F" (variance ration) test. The significance of the differences among pairs of treatment means was estimated by the least significant difference (LSD) test at 5% and 1% level of probability and DMRT was calculated (Gomez and Gomez. 1984).

CHAPTER 4

RESULT AND DISCUSSION

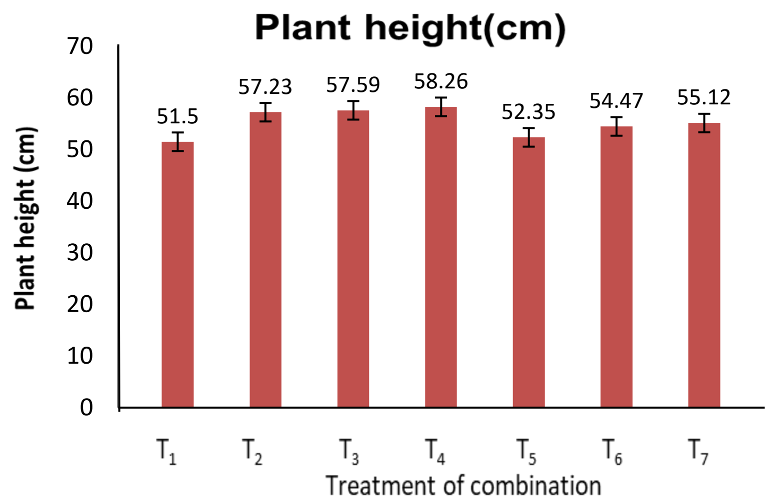
This chapter includes the experimental results along with discussions. Effects of vermicompost and NPK on growth , yield and yield attributes of mungbean presented in below table and graph are discussed characterwise under the following heads.

4.1 Effect of organic and inorganic fertilizer on the plant character of mungbean

4.1.1 Plant height

Interaction between organic as vermicompost and inorganic fertilizers (NPK) had also significant effect on the plant height of mungbean (Figure 1). The minimum plant height was T_1 (51.50 cm) treatment where only 100% recommended chemical fertilizer was used. On the other hand, the maximum plant height (58.26 cm) was recorded with T_4 (75% Recommendation chemical fertilizer dose + 4 t/havermicompost) treatment . It is understand from the data that 75% of inorganic along with 4 t/ha vermicompostas organic fertilizer resulted the highest plant height of mungbean plants. These are in agreement with those of Yadav and Malik (2005), Reddy et al. (1998) and Das et al. (2002) who have reported that different levels of vermicompost significantly increased plant height.

Figure 1: Effect of organic and inorganic fertilizer on plant height (cm) of mungbean



T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost ,T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer + 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost

4.1.2 Number of leaves per plant

Combined use of various doses of vermicompost as organic fertilizer and inorganic fertilizers (NPK) had also significant effect on the number of leaves per plant of mungbean (Table 1). The minimum number of leaves per plant of mungbean was (7.82) T_1 where only 100% recommended chemical fertilizer was used. On the other hand, the maximum the number of leaves per plant of mungbean (10.75) was recorded with T_4 (75% Recommendation dose + 4 t/ha ofvermicompost) treatment. It is understand from the data that 75% of inorganic along with 4 t/ha of organic fertilizer resulted the maximum number of leaves of mungbeanplants .Tomar et al. (1996) found that the highest numbers of leaves were obtained from 60 kg P_2O_5/ha.

Table 1: Effect of organic and inorganic fertilizer on number of leaves /plant of mungbean

Treatment	Number of leaves /plant
T_1	7.817g
T_2	9.597 c
T_3	10.507 b
T_4	10.747 a
T_5	8.370 f
T_6	8.387 e
T_7	8.820 d
LSD $_{(0.05)}$	0.0145
Cv%	0.01

In a column figures having similar letter(s) so not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT.

T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost ,T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer+ 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost

4.1.3 Number of branches per plant

Combined use of various doses of organic fertilizer as vermicompost and inorganic fertilizers (recommended chemical fertilizer dose) had also significant effect on the number of branches per plant of mungbean (Table 2).The minimum number of branches per plant of mungbean was (0.95) in the T_1 treatment where only 100% recommended chemical fertilizer used . On the other hand, the maximum the number of leaves per plant of mungbean in (1.72) was recorded with T_4 (75% Recommendation chemical fertilizer dose+4t/ha vermicompost) treatment. It is understand from the data that 75% of inorganic along with 4t/ha of organic fertilizer resulted the maximum number of branches of mungbean plants .These are in agreement with those of Yadav and Malik (2005) , Reddy et al . (1998).

Table 2: Effect of organic and inorganic fertilizer on No. of branches /plant of mungbean

Treatment	**Number of branches /plant**
T_1	0.9533g
T_2	1.5467 b
T_3	1.5300 c
T_4	1.7167 a
T_5	1.1400 f
T_6	1.1700 e
T_7	1.2733 d
$LSD_{0.05}$	0.35
Cv%	8.38

In a column figures having similar letter(s) so not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT.

T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost ,T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer + 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost

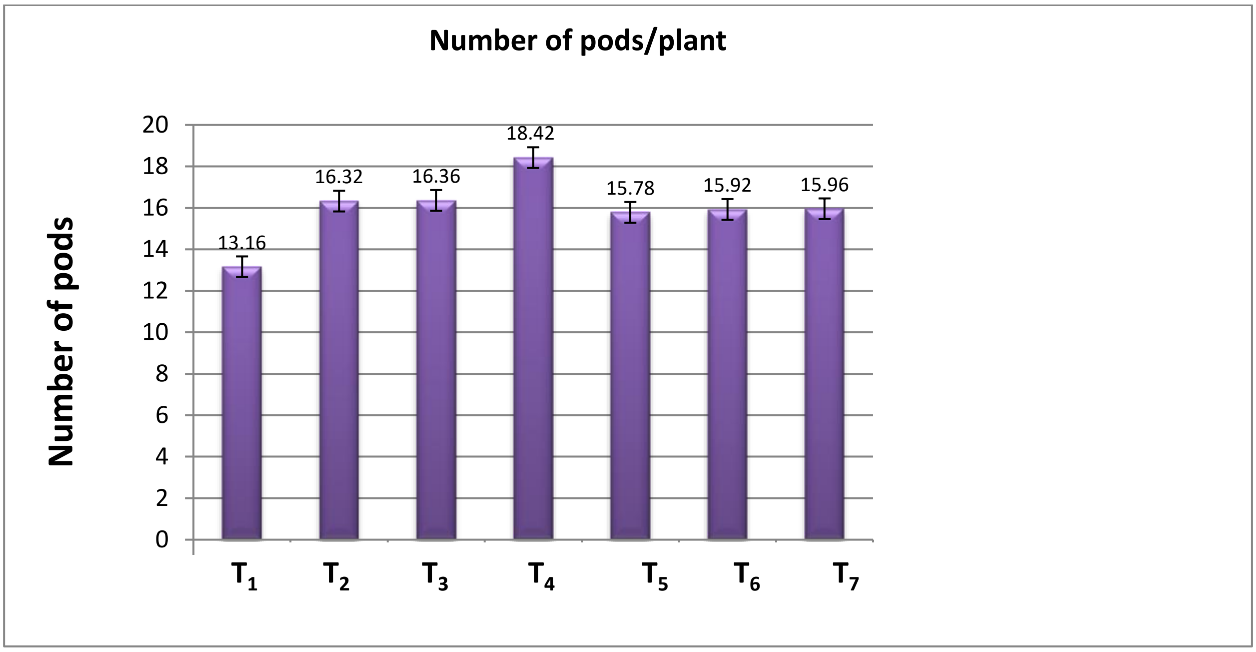
4.2 Effect of organic and inorganic on the yield and yield attributes of mungbean

4.2.1 Number of pods per plant

The effect of different levels of fertilizer on the number of pods per plant was statistically significant (Figure 2).

Combined use of various doses of organic fertilizer as vermicompost and inorganic fertilizers (recommended chemical fertilizer dose or NPK) had also significant effect on the number of pods per plant of mungbean (Figure 2) . The minimum number of pods per plant of mungbean was (13.16) in the T_1 treatment where only 100% of recommended chemical fertilizer was used. On the other hand, the maximum the number of pods per plant of mungbean (18.42) was recorded with T_4 (75% Recommendation dose + 4t/ha vermicompost) treatment . It is understand from the data that 75% of inorganic along with 4t/ha of organic fertilizer resulted the maximum number of pods of mungbean plants .These are in agreement with that of Reddy et al. (1998) who has reported that different levels of vermicompost significantly increased number of pods per plant of mungbean.

Figure 2: Effect of organic and inorganic fertilizer on number of pods/plant of mungbean



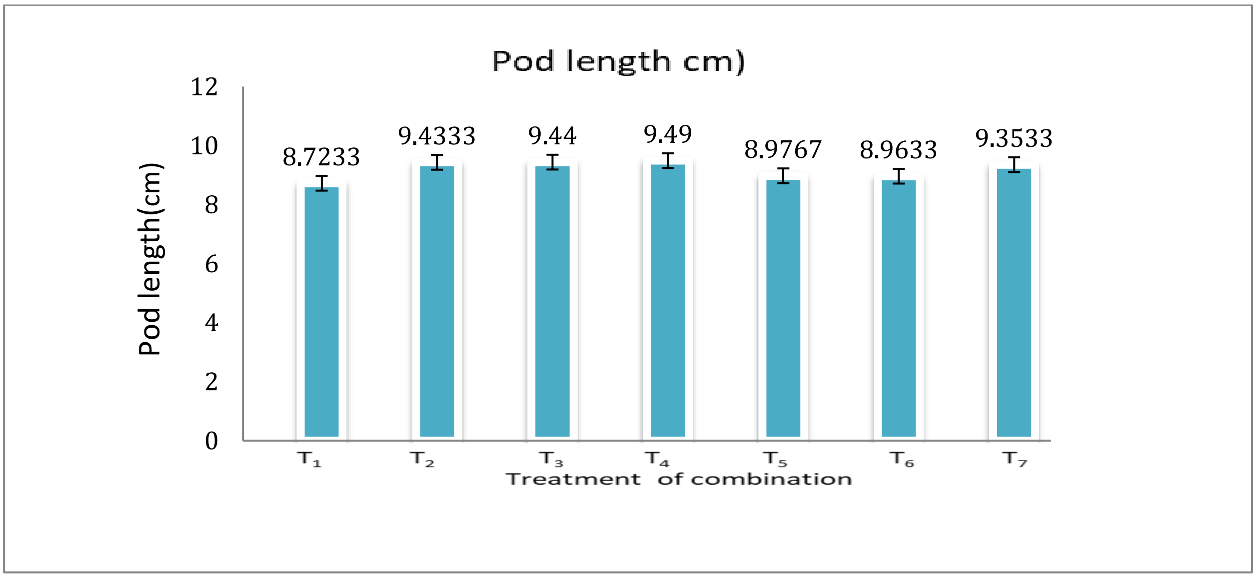
T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost, T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer + 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost

4.2.2 Pod length

There was statistically significant effect of the pod length of mungbean due to different doses of fertilizer (Figure 3).

Combined use of various doses of organic fertilizer as vermicompost and inorganic fertilizers (recommended chemical fertilizer dose or NPK) had also significant effect on the number ofpods per plant of mungbean (Figure.3).The minimum pod length of mungbean was (8.72 cm) in the T_1 treatment where only 100% of recommended chemical fertilizer was used . On the other hand, the maximum pod length of mungbean(9.49 cm) was recorded with T_4 (75% Recommendation dose + 4 t/ha vermicompost) treatment. It is understand from the data that 75% of inorganic along with 4t/ha of organic fertilizer resultedthe maximum pod length of mungbean plants .

Figure 3: Effect of organic and inorganic fertilizer on pod length (cm) of mungbean



T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost ,T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer+ 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost.

4.2.3 Number of seeds per pod

There was significant effect of the number of seeds per pod due to different doses of Fertilizer (Table 3)

Combined use of various doses of organic as vermicompost and inorganic fertilizers (recommendation chemical fertilizer dose or NPK) had also significant effect on the number of seeds per pod (Table 3).The minimum number of seeds per pod (10.23) in the T_1 treatment where only 100% recommendation chemical fertilizer dose was used. On the other hand, the maximum number of seeds per pod (11.80) was recorded with T_4 (75% Recommendation dose + 4 t/ha vermicompost) treatment. It is understand from the data that 75% of inorganic along with 4 t/ha of organic fertilizer resulted the maximum number of seeds per pod.

Table 3:Effect of organic and inorganic fertilizer on number of seeds/pod of mungbean

Treatment	Number of seeds/pod
T_1	10.230 f
T_2	10.950c
T_3	11.153 b
T_4	11.797a
T_5	10.827e
T_6	10.833e
T_7	10.860d
$LSD_{0.05}$	0.0151
CV%	0.08

In a column figures having similar letter(s) so not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT.

T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost,T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer+ 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost

4.2.4 Weight of 1000-grain

There was significant effect in the weight of 1000 grain of mungbean due to different doses of fertilizer (Table 4).

There was significant effect in the weight of 1000 grain of mungbean due to different doses of fertilizer (Table 4).

Combined use of various doses of organic as vermicompost and inorganic fertilizers (recommended chemical fertilizer dose or NPK) had also significant effect on the 1000 grain weight (Table 4) .The minimum 1000 grain weight (43.34 gm) in the T_1 treatment where only 100% recommended chemical fertilizer was used . On the other hand, the maximum 1000 grain weight (48.28gm) was recorded with T_3 (75% Recommended chemical fertilizer dose + 3t/ha vermicompost) treatment. It is understand from the data that 75% of inorganic along with 3 t/ha of organic fertilizer resulted the maximum 1000 grain weight .

Table 4:Effect of organic and inorganic fertilizer on 1000 grain weight (gm) of mungbean

Treatment	**1000 grain weight(gm)**
T_1	43.340g
T_2	47.477 c
T_3	48.277 a
T_4	48.233 b
T_5	46.680 f
T_6	46.710 e
T_7	46.710 d
LSD$_{(0.05)}$	0.0295
cv%	0.04

In a column figures having similar letter(s) so not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT.

T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost ,T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer + 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost .

4.2.5 Grain yield

Combined use of various doses of organic as vermicompost and inorganic fertilizers (recommendation dose or NPK) had also significant effect on the grain yield (Table 5).The minimum grain yield (0.78 t/ha) in the T_1 treatment where only 100% recommendation chemicalfertilizer dose was used. On the other hand, the maximum grain yield (1.54 t/ha) was recorded with T_4 (75% Recommendation dose + 4t/havermicompost) treatment . It is understand from the data that 75% of inorganic along with 4 t/ha of organic fertilizer resulted the maximum grain yield .These are in agreement with those of Tolanur and Badanur (2003) who have reported that combined application of vermicompost NPK fertilizers significantly increased grain yield .

Table 5: Effect of organic and inorganic fertilizer on grain yield (t/ha) of mungbean

Treatment	grain yield(t/ha)
T_1	0.7773f
T_2	0.9400 c
T_3	0.9700 b
T_4	1.5367 a
T_5	0.8200 e
T_6	0.8567 d
T_7	0.8600 d
$LSD_{0.05}$	0.0101
cv%	0.59

In a column figures having similar letter(s) so not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT.

T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost ,T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer + 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost

4.2.6 Straw yield

Combined use of various doses of organic as vermicompost and inorganic fertilizers (recommended chemical fertilizer dose or NPK) had also significant effect on the straw

Table 6: Effect of organic and inorganic fertilizer on straw yield (t/ha) of mungbean

Treatment	straw yield(t/ha)
T_1	1.6567g
T_2	2.3233 c
T_3	2.0367 d
T_4	2.6300 a
T_5	1.6767 f
T_6	1.6967 e
T_7	2.3767 b
$LSD_{0.05}$	0.0139
cv%	0.38

In a column figures having similar letter(s) so not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT.

T_1 =100% Recommended chemical fertilizer + 0 t/ha vermicompost, T_2= 75% Recommended chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommended chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommended chemical fertilizer+ 4 t/ha vermicomost,T_5 = 50% Recommended chemical fertilizer + 2 t/ha vermicompost,T_6 =50% Recommended chemical fertilizer + 3 t/ha Vermicompost,T_7= 50% Recommended chemical fertilizer +4t/ha vermicompost

Yield (Table 6).The minimum straw yield (1.66 t/ha) in the T_1 treatment where 100% recommendation chemical fertilizer dose was applied . On the other hand, the maximum straw yield (2.63 t/ha) was recorded with T_4 (75% Recommendation chemical fertilizer dose +4 t/ha vermicompost) treatment. It is understand from the data that 75% of recommended chemical fertilizer along with 4t/ha of vermicompost as organic fertilizer resulted the maximum straw yield .These are in agreement with those of Yadav and Malik (2005) , Das et l. (2002) and Rao et al. (2000) who have reported that different levels of vermicompost significantly increased straw yield.

CHAPTER 5

SUMMARY AND CONCLUSION

An experiment was conducted at the Sher-e-Bangla Agricultural University Farm (SAU Farm), Dhaka 1207 (Tejgaon series under AEZ No. 28) during the Kharif season of 2019 to study the effect of organic manure and inorganic fertilizer on the yield of mungbean. The soil was silty loam in texture having pH 6.1, organic matter 0.89%. Randomized complete block design was followed with seven treatments having unit plot size of 8.01 m^2 replicated thrice. The treatments were T_1=100% Recommendation chemical fertilizer +0 t/ha vermicompost,T_2=75% Recommendation chemical fertilizer + 2 t/ha vermicompost,T_3= 75% Recommendation chemical fertilizer + 3 t/ha vermicompost,T_4= 75% Recommendation chemical fertilizer + 4 t/ha vermicomost,T_5 = 50% Recommendation chemical fertilizer +2 t/ha vermicompost,T_6 =50% Recommendation chemical fertilizer + 3 t/ha Vermicompost,T_7= 50% Recommendation chemical fertilizer +4t/ha vermicompost . As inorganic fertilizer urea, TSP, MP Gypsum, zinc oxide and boric acid. Full required amounts of urea, TSP and MP were applied at the time of final land preparation and organic manure was applied during sowing. Mungbean seeds cv. Local mung were sown in 13^{th}june 2019,and the crop was harvested in 13^{th} august 2019. Intercultural operations were done when required. The data were collected plot wise for plant height , number of leaves /plant, number of branches/plant , number of pods /plant , pod length, number of seeds /pod , weight of 1000 grains , grain and straw yields .All the data were statistically analyzed following F-test and the mean comparison was made by DMRT at 5% and 1% level. The results of the experiment are stated below.

Different plant and yield parameters were significantly influenced by different organic levels. The maximum plant height(58.26 cm) ,number of leaves /plant (10.75) , number of branches /plant (1.72) , number of pods/plant(18.42) , number of seeds /pod(11.80) , grain yield (1.54 t/ha) and straw yield (2.63 t/ha) produced by T_4 and the lowest plant height (51.50 cm),number of leaves /plant (7.82) , number of branches/plant (0.95) number of pods /plant (13.16) ,number of seeds /pod(10.23) , grain yield (0.78 t/ha) and straw yield (1.66 t/ha) produced by T_1 where only 100% recommendation chemical fertilizer was used.

Grain yield of mungbean responded significantly to the combined application of organic and inorganic fertilizer. The maximum grain yield of (1.54 t/ha) was obtained in T_4 (75% Recommendation chemical fertilizer + 4t/ha Vermicompost). The minimum grain yield (0.78 t/ha) was observed in the T_1 treatment where only 100% recommendation chemilcal fertilizer was applied. The result revealed that when organic is applied with inorganic fertilizers, the effect is better on yield product rather applying organic or inorganic fertilizer alone. Like grain yield the maximum straw yield (2.63 t/ha) was recorded in T_4 (75% Recommendation chemical fertilizer + 4t/ha Vermicompost) , treatment and the minimum (1.66 t/ha) in T_1 treatment where only 100% recommendation chemical fertilizer was applied . The treatment combination T_4 (75% Recommendation chemical fertilizer dose +4t/ha Vermicompost) produced maximum number of leaves /plant (10.75) , number of branches /plant (1.72) , number of pods /plant (18.42) , pod length (9.49) , number of seeds /pod (11.80) , and straw yield (2.63 t/ha) . The T_1 where only 100% recommendation chemical fertilizer was applied produced minimum number of leaves /plant (7.82), number of branches /plant (0.95), number of pods /plant (13.16), pod length (8.72 cm) , number of seeds /pod (10.23) , grain yield 0.78 t/ha) and straw yield (1.66 t/ha) .

CHAPTER 6

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APPENDICES

Appendex I. Monthly records of meteorological observation at the period of experiment (13thjune to 13th august 2019).

Month	Temperature		Humidity (%)	Precipitation(mm)
	(Maximum, ^{0}C	(Minimum, ^{0}C)		
June	33.70	22.8	82.8	67
July	34.80	23.4	83.4	71
August	33.90	24.5	84.6	74

Source : Weather Yard, Bangladesh Meteorological department , Dhaka .

Appendex no II. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate , Dhaka .

A. Morphological characteristics of the experimental field

Morphological Features	Characteristics
Location	Sher-e-Bangla Agricultural University Farm , Bangladesh
AEZ No. and name	AEZ – 28 , Modhupur Tract
General soil type	Deep Red Brown Terrace Soil
Soil Series	Tejgaon
Topography	Fairly leveled
Depth of Inundation	Above flood level
Drainage condition	Well drained
Land type	High land

Source : Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Soil properties	Value
A. Physical properties	
1. Particle size analysis	
of soil.	31.50
% Sand	39.34
% Silt	29.16
% Clay	Silty Clay Loam
2. Soil texture	
B. Chemical properties	5.8
1. Soil pH	0.78
2. Organic carbon (%)	1.34
3. Organic matter (%)	0.08
4. Total N (%)	10:1
5. C:N ration	33.5
6. Available P (ppm)	0.21
7. Exchangeable K (	36.75
me/100g soil)	0.36
8. Available S (ppm)	
9. Available B (ppm)	

Source : Soil Resource Development Institute (SRDI)