INFLUENCES OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON GROWTH, YIELD & NUTRIENT CONTENT OF MUNGBEAN (BARI Mung 5)

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CERTIFICATE

This is to certify that the thesis entitled "INFLUENCES OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON GROWTH, YIELD & NUTRIENT CONTENT OF MUNGBEAN (BARI Mung 5)" submitted to the DEPARTMENT OF AGRICULTURAL CHEMISTRY, FACULTY OF AGRICULTURE Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE (M.S.) in AGRICULTURAL CHEMISTRY, embodies the results of a piece of bona fide research work carried out by WOMMA SALMA RUPA, Registration. No. 05-01659, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

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

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DEDICATED TO MY BELOVED PARENTS AND MY HUSBAND

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ABSTRACT

An experiment was conducted during the period from February to April of 2012 at the experimental field of Sher-e-Bangla Agricultural University to study the effect of organic and inorganic fertilizers on growth ,yield and nutrient content of mungbean (BARI Mung 5) using RCBD (Randomized Completely Block Design) with three replications. During the experiment, following treatments were incorporated .Treatments : T_0 –Control, T_1 - Cowdung 10 t ha^{-1} (Recommended dose), T_2 – Cowdung @ 6 t ha^{-1} + 25 % of optimum dose of inorganic fertilizers, T_3 – Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers, T_4 – Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers, T_5 -Vermicompost 7 t ha^{-1} (Recommended dose), T_6 - Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers, T_7 - Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers, T_8 - Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers, T_9 - 100 % Inorganic Fertilizers were tested. At harvest the highest plant height, number of leaves $plant^{-1}$ and branches $plant^{-1}$ were found from the Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers which was statistically similar or closely followed by Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers. Maximum numbers of pods $plant^{-1}$, seeds pod^{-1} and seeds $plant^{-1}$ were also recorded in Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers and it was statistically similar with or closely followed by Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers. The highest seed yield $plant^{-1}$, 1000-seed weight and seed yield ha^{-1} were also recorded in Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers and it was statistically similar with the treatment of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers. It was observed that, for the above parameters; even Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers and Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers showed better results than sole 100% inorganic fertilizers. The lowest values for all of the growth and yield parameters were obtained from the treatment using no fertilizers. The highest N, P and K contents in seed were recorded in Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers and it was statistically similar with or closely followed by Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers. The lowest N, P and K contents of mungbean seed were found from the treatment using no fertilizers that is control treatment.

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LIST OF ABBREVIATIONS

%	=	Percent
@	=	At the rate
°C	=	Degree Celsius
AEZ	=	Agro Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
cv.	=	Cultivar (s)
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
EC	=	Emulsifiable Concentrate
et al.	=	And Others
FAO	=	Food and Agriculture Organization
g	=	Gram
IRRI	=	International Rice Research Institute
LSD	=	Least Significant Difference
MoP		Muriate of Potash
ppm	=	Parts per million
RCBD	=	Randomized Complete Block Design
SAU	=	Sher-e-Bangla Agricultural University
t/ha	=	Ton per Hectare
Tk./ha	=	Taka per Hectare
TSP	=	Triple Super Phosphate

CHAPTER 1

INTRODUCTION

Mungbean (*Vigna radiata* L.) is one of the important pulse crops of Bangladesh. It ranks fifth considering both acreage and production. The area under pulse crop in Bangladesh is .406 million hectares with a production of 0.322 million tones where mungbean is cultivated in the area of 0.108 million hectares with the production of 0.03 million tons (BBS, 2005). It is considered as a quality pulse in the country, but production per unit area is very low (736 kg per ha.) as compared to other countries of the world (BBS ,2007).

In Bangladesh, total production of pulses is only 0.65 million ton against 2.7 million tons requirement. This means the shortage is almost 80% of the total requirement (Rahman & Ali, 2007). This is mostly due to low yield (MoA, 2005). The reasons for low yield are manifold: some are varietals and some are agronomic management. Due to the shortage of land, the scope of its extensive cultivation is very limited. Therefore, attempts must be made to increase the yield per unit area by applying improved technology and management practices.

Mungbean is cultivated on an area of 261.4 thousand hectares with total grain production of 134.4 thousand tonnes and average yield of 482.63 kg ha^{-1} (Anonymous, 2003). It has the potential of producing higher grain yield of about 1295 kg ha^{-1} (Bilal, 1994). Average yield of 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.

Mungbean yield and quality can be improved by the balanced use of fertilizers and also by managing the organic manures properly. Soil and fertilizer management is very complex and dynamic in nature. We are increasingly forced to meet up growing food needs from increase in yield from existing or even shrinking land areas. In this process, we are moving away from the traditional and rather static "soil dependent" agriculture to dynamic "fertilizer dependent" agriculture (BARC, 2005).

Environmental degradation is a major threat confronting the world, and the use of chemical fertilizers contributes largely to the deterioration of the environment through depletion of fossil fuels, generation of carbon dioxide (CO_2) and contamination of water resources. It leads to loss of soil fertility due to imbalanced use of fertilizers that has adversely impacted agricultural productivity and causes soil degradation. Now there is a growing realization that the adoption of ecological and sustainable farming practices can only reverse the declining trend in the global productivity and environment protection (Aveyard ,1988, Wani and Lee ,1992, Wani *et al.*,1995). On one hand tropical soils are deficient in all necessary plant nutrients and on the other hand large quantities of such nutrients contained in domestic wastes and agricultural byproducts are wasted. Such large quantities of organic wastes generated also pose a problem for safe disposal. Most of these organic residues are burnt currently or used as land fillings. In nature's laboratory there are a number of organisms (micro and macro) that have the ability to convert organic waste into valuable resources containing plant nutrients and organic matter, which are critical for maintaining soil productivity. Microorganisms and earthworms are important biological organisms helping nature to maintain nutrient flows from one system to another and also minimize environmental degradation.

Bending *et al.,* (2002) concluded that crop residues and soil organic matter both could affect the diversity of soil microbial community and increase the crop growth and yield. Integrated use of nutrient may be one of the solutions to increase mungbean production as well as reducing cost of production and make the best use of locally available resources like animal dung, urine, crop residues etc. The use of organic matter as a low cost supplement to the artificial fertilizers may help decreasing the cost of production. Integrated management of chemical fertilizers and organic wastes may be an important strategy for sustainable production of crops. This may not only improve the efficiency of chemical fertilizers along with their minimal use in crop production besides increasing crop yield and improving available major and minor nutrients (Rautaray *et al.*, 2003). Recently, the use of organic materials as fertilizers for crop production has received attention for sustainable crop productivity (Tejada *et al.*, 2009). Organic materials hold great promise as a source of multiple nutrients and ability to improve soil characteristics (Moller, 2009). Organic farming preserves the ecosystem. Symbiotic life forms are cultured ensuring weed and pest control and optimum soil biological activity which maintain soil fertility. The synthetic fertilizers are harmful for soil and aerial environment; a threat to entire globe, because the inorganic fertilizers mainly contain major nutrients NPK in large quantities and are neglecting the use of organic manures and bio-fertilizers and hence have paved the way for deterioration of soil health and in turn of ill-effects on plants, human being and livestock (Choudhry, 2005).

Management of soil organic matter has now become a major issue in dealing with the problems of soil fertility and productivity in Bangladesh. Depletion of soil fertility has arisen principally due to increasing cropping intensity (presently about 190%), increasing use of modern varieties, soil erosion, sandy soils, and higher decomposition of organic matter due to sub-tropical humid climate. Soil organic matter is a key factor in maintaining long-term soil fertility since it is the reservoir of metabolic energy, which drives soil biological processes involved in nutrient availability. A good soil should have at least 2.5% organic matter, but in Bangladesh most of the soils have less than 1.5%, and some soils even less than 1% organic matter (BARC, 2005). Organic matter content of top soils particularly under high land and medium high land situations has declined over time. Organic matter is known as 'storehouse of plant nutrients' and 'life force of a soil'. 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. As we consider the economic side, organic fertilizers are cheap also. But it may not be possible to obtain desired yield from sole use of organic fertilizers. For that reason, balance use of organic and inorganic fertilizers are important to obtain maximum yield.

Based on above conditions, the following objectives were considered to conduct the experiment -

a) To study the growth, yield and nutrient content in mungbean as influenced by combined use of organic manures and inorganic fertilizers.

c) To find out the best optimum doses of NPK fertilizers in combination with cowdung and vermicompost for higher yield of mungbean.

CHAPTER 2

REVIEW OF LITERATURE

The literature pertaining to influence of different organic manures and inorganic fertilizers on growth, seed yield and quality attributes and influence of seed treatment with chemicals and botanicals on seed storability of mungbean are presented in this chapter. However, relative information on effect of organic fertilizers on mungbean is not adequate, analogies from other crops have also been included to emphasize certain point of view.

2.1 Effect of inorganic fertilizers

Patel *et al.* (2003) conducted a field experiment in Gujrat, India during the summer seasons of 1995 to 1998 on sandy loam soils to determine the suitable sowing date, and nitrogen and phosphorus requirements of summer mungbean (cv. GM3). Treatments comprised: all the 27 combinations of three sowing dates: 15 February, 1 March and 15 March; three nitrogen rates: 10, 20 and 30 kg N ha^{-1}; and three phosphorus rates: 20, 40 and 60 P ha^{-1}. Results indicated that sowing mungbean on 1 March recorded significantly higher grain yields, 37 and 16% higher than those of early (15 February) or late-sown crops (15 March), respectively. Application of 10 kg N ha^{-1} recorded significantly higher grain yield over the control. Treatment with 40 kg P ha^{-1} produced 15 and 18% higher grain yields than treatments with 20 and 60 kg P ha^{-1}, respectively. The highest net return of Rs. 18,240 ha^{-1} was recorded from mungbean sown on 1 March and treated with 20 kg N ha^{-1} and 40 kg P ha^{-1}.

Malik *et al.* (2003) carried out a field experiment on mungbean (*Vigna radiata* L.) in Pakistan to determine the effect of varying levels of nitrogen (0, 25 and 50 kg ha^{-1}) and phosphorus (0, 50, 75 and 100 kg ha^{-1}) on the yield and quality of mungbean (*Vigna radiata*) cv. NM-98. Although plant population was not affected significantly, various growth and yield components were significantly affected by varying levels of nitrogen and phosphorus. A fertilizer combination of 25 kg N + 75 kg P ha^{-1} resulted in the maximum seed yield (1,113 kg ha^{-1}). Protein content (25.6%) was maximum in plots treated with 50 kg N + 75 kg P ha^{-1}, followed by 25.1% protein content in plots treated at 25 kg N + 75 kg P ha^{-1}. The highest net income (Rs. 21,375) was obtained by applying 25 kg N + 75 kg P ha^{-1}.

Srinivas and Shaik (2002) conducted field experiment during the kharif seasons to study the effects of N (0, 20, 40 and 60 kg ha^{-1}) and P (0, 25, 50 and 75 kg ha^{-1}) along with seed inoculation with *Rhizobium* culture on the growth and yield components of greengram. Plant height generally increased with increasing rates of P and with increasing rates of N up to 40 kg ha^{-1} followed by decrease with further increase in N. Number of seeds pod^{-1}, 1000-seed weight, seed and haulm yields generally increased. Seed inoculation with *Rhizobium* resulted in higher values for the parameters measured relative to the control. The interaction effects between N and P were not significant for the number of pods plant^{-1}, pod length, seed and haulm yield.

Sharma *et al.* (2001) carried out a field experiment on mungbean cv. Pusa Baisakhi which was fertilized with various levels of nitrogen (0, 10 and 20 kg N ha^{-1}) and phosphorus (0, 30 and 60 kg P_2O_5 ha^{-1}) under mid-hill conditions in Himachal Pradesh, India during the kharif seasons of 1998 and 1999. The highest levels of N and P_2O_5 applications resulted in the average maximum test weight, biological and grain yields, harvest index and seed protein content.

Ashraf *et al.* (2003) conducted a field experiment at Faisalabad in Pakistan to observe the effects of seed inoculation of a biofertilizer and NPK application on the performance mungbean cv. NM-98. The treatments consisted of the seed inoculation of *Rhizobium phaseoli* singly or in combination with 20:50:0, 40:50:0 or 50:50:50 NPK kg ha^{-1} (urea), P (single super phosphate) and K (potassium sulphate) were applied during sowing. The tallest plants (69.9 cm) were obtained with seed inoculation + 50:50:0 kg NPK ha^{-1}. Seed inoculation + 50:50:0 or 50:50:50 kg ha^{-1} resulted in the highest number of pods plant^{-1} (29.0, 56.0, 63.9 and 32.6, respectively) and seed yield (1,053, 1,066, 1,075 and 1,072 kg ha^{-1}). Harvest index was the highest with seed inoculation in combination with NPK and 40:50:0 (25.23), 50:50:0 (24.70) or 50:50:50 (27.5). Seed inoculation along with NPK at 30:50:0 kg ha^{-1} was optimum for the production of high seed yield by mungbean cv. NM-98.

Sangakhara (2003) carried out a field experiment in Sri Lanka in 1999 to determine the impact of effective microorganisms (EM) on N dynamics in a cereal (maize cv. Ruwan)-legume (mungbean) cropping system, using ^{15}N labeled maize or mungbean residues. EM increased the ^{15}N concentrations of maize at the V8 growth stage indicating better use of applied nutrients from organic matter. The uptake of ^{15}N was greater from mungbean residues rather than from maize. EM also increased biological N fixation. The synergistic effects of EM in organic systems were evident from this field study.

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

Hayat *et al.* (2004) conducted a field experiment during kharif 2000 in Rawalpindi, Pakistan to find out the effect of N and *Rhizobium* sp. inoculation on the yield, N uptake and economics of mungbean (cultivars NM 92 and NCM 209). The treatments were: control; 500 g *Rhizobium* inoculum, 30, 60 and 90 kg N ha^{-1} and inoculum combined with N at 30, 60 and 90 kg ha^{-1}. N content was higher in nodules of NM 92 than NCM 209. The highest N content in nodules (2.80%) was obtained with inoculation + 30 kg N ha^{-1}. NCM 209 had higher N shoot content (2.13%) than NM 92 (1.87%). The highest shoot N content was obtained with inoculation + 30 kg N ha^{-1}. The highest soil N content was obtained with inoculation + 90 kg N ha^{-1}. NCM 209 produced higher yield than NM 92. The maximum economic yield for NM 92 and NCM 209 (768 and 910 kg ha^{-1}, respectively) was obtained with inoculation + 90 kg N ha^{-1}. The maximum biological yield (4,889 kg ha^{-1}) was obtained in NCM 209 with inoculation + 30 kg N ha^{-1}. NCM 209 showed higher biological yield than NM 92. The highest harvest index of 18.45% was obtained with inoculation + 30 kg N ha^{-1}. The maximum net income (Rs. 18,329 and Rs. 13,003 ha^{-1}) in NCM 209 and NM 92 was obtained with inoculation alone and inoculation + 30 kg N ha^{-1}, respectively. The highest benefit: cost ratio was obtained in NCM 209 with the inoculation treatment alone.

A field experiment was laid out by Oad and Buriro (2005) to determine the effect of different NPK levels (0-0-0, 10-20-20, 10-30-30, 10-30-40 and 10-40-40 kg ha^{-1}) on the growth and yield of mungbean cv. AEM 96 in Tandojam, Pakistan during the spring season of 2004. The different NPK levels significantly affected the crop parameters. The

10-30-30 kg NPK ha^{-1} was the best treatment, recording plant height of 56.3 cm, germination of 90.5%, satisfactory plant population of 162, prolonged days taken to maturity of 55.5, long pods of 5.02 cm, seed weight per plant of 10.5 g, seed index of 3.52 g and the highest seed yield of 1,205 kg ha^{-1}. There was no significant change in the crop parameters beyond this level.

Rana and Choudhary (2006) conducted a field experiment during 2000 and 2001 in New Delhi, India to evaluate the relative moisture utilization by maize grown as sole crop or in maize-mungbean intercropping system. Total grain production in terms of maize equivalent was higher in maize (75 cm) + two rows of mungbean. Total N uptake and water use efficiency were also highest in maize (75 cm) + two rows of mungbean. All parameters increased with increasing concentration of N up to 120 kg ha^{-1}.

Tickoo *et al.* (2006) carried out a field experiment in Delhi, India during the kharif season of 2000 with mungbean cultivars Pusa 105 and Pusa Vishal which were sown at 22.5 and 30 m spacing and supplied with 36-46 and 58-46 kg NP ha^{-1}. Cultivar Pusa Vishal recorded higher biological and grain yield (3.66 and 1.63 t ha^{-1}, respectively) compared to cv. Pusa 105. Differences in the values of the parameters examined. NP rates had no significant effects on both the biological and grain yield of the crop. Row spacing at 22.5 cm resulted in higher grain yields in both crops.

Sultana *et al.* (2009) conducted a field experiment during the period from March 2007 to June 2007 at Sher-e-Bangla Agricultural University, Dhaka with nitrogen and weed management in mungbean where nitrogen (0, 20 kg ha^{-1} at vegetative, 20 kg N ha^{-1} at vegetative and flowering) and weeding (no weeding, one weeding at vegetative, two weeding at vegetative and flowering) was done. Result showed that application of 20 kg N ha basal showed significantly higher values of all growth parameters like number of leaflet (24.3 at 20 DAS and 24.3 at 40 DAS), leaf area (23.3 cm^2 at 20 DAS and 102.2 cm^2 at 40 DAS), Leaf dry weight (0.30, 6.99 and 10.61 g at 10, 17 and 24 DAS, respectively) and shoot dry weight (2.76 and 4.69 g at 17 and 24 DAS, respectively). This treatment also produced significantly more number of branches (1.67), pods $plant^{-1}$ (17.8) and seed yield (1,982 kg ha^{-1}).

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

Kayani *et al.* (2010) conducted experiment to investigate the impact of legume on the oncoming wheat crop. Mungbean (NM92) was planted during Kharif 2007. The wheat variety Inqalab-91 was sown before and after the mungbean plantation during Rabi 2006-07 and 2007-08. Twelve different treatments were applied having different doses of N and P but Farm Yard Manure (FYM) remained constant. Six parameters were selected to investigate the potential effects of the legume viz., soil physico-chemical properties, plant height, spike length, number of grains spike^{-1}, 1000 grains weight and yield plot^{-1}. The results showed significant increase in plant height, spike length, number of grains/spike, 1000-grains weight and yield/plot after cropping mungbean. The yield was obtained at an increase of 26.90% after mungbean application. Based on results, cereal legume crop rotation is highly recommended.

A field experiment was conducted by Mohammad *et al.* (2010) to study the effect of crop residues and tillage practices on BNF, WUE and yield of mungbean (*Vigna radiata* (L.) Wilczek) under semi-arid rainfed conditions at the Livestock Research Station, Surezai, Peshawar in North West Frontier Province (NWFP) of Pakistan. The experiment comprised of two tillage i) conventional tillage (T1) and ii) no-tillage (T0) and two residues i) wheat crop residues retained (+) and ii) wheat crop residues removed

(-) treatments. Basal doses of N @ 20: P @ 60 kg ha^{-1} was applied to mungbean at sowing time in the form of urea and single super phosphate respectively. Labeled urea having 5% N-15 atom excess was applied @ 20 kg N ha^{-1} as aqueous solution in micro plots (1m^2) in each treatment plot to assess BNF by mungbean. Similarly, maize and sorghum were grown as reference crops and were fertilized with N-15 labeled urea as aqueous solution having 1% N-15 atom excess @ 90 kg N ha^{-1}. The results obtained showed that mungbean yield (grain/straw) and WUE were improved in no-tillage treatment as compared to tillage treatment. Maximum mungbean grain yield (1224 kg ha^{-1}) and WUE (6.61 kg ha^{-1} mm^{-1}) were obtained in no-tillage (+ residues) treatment. The N concentration in mungbean straw and grain was not significantly influenced by tillage or crop residue treatments. The amount of fertilizer-N taken up by straw and grain of mungbean was higher under no-tillage with residues-retained treatment but the differences were not significant. The major proportion of N (60.03 to 76.51%) was derived by mungbean crop from atmospheric N-2 fixation, the remaining (19.6 to 35.91%) was taken up from the soil and a small proportion (3.89 to 5.89%) was derived from the applied fertilizer in different treatments. The maximum amount of N fixed by mungbean (82.59 kg ha^{-1}) was derived in no-tillage with wheat residue-retained treatment. By using sorghum as reference crop, the biological nitrogen fixed by mungbean ranged from 37.00 to 82.59 kg ha^{-1} whereas with maize as a reference crop, it ranged from 34.74 to 70.78 kg ha^{-1} under different treatments. In comparison, non-fixing (reference) crops of sorghum and maize derived upto 16.6 and 15.5% of their nitrogen from the labeled fertilizer, respectively. These results suggested that crop productivity, BNF and WUE in the rainfed environment can be improved with minimum tillage and crop residues retention.

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

2.2 Effect of organic fertilizers

A field experiment was conducted by Raundal and Sabale (2000) during 1997-98 in Maharashtra, in India showed that application of vermicompost to mungbean gave highest nitrogen content and protein in grain.

Jain and Tiwari (1995) reported that the application of FYM @ 5 t per ha + sugar cane press mud @ 5 t per ha recorded significantly higher seed yield (1508.67 kg/ha) and straw yield (3492.20 kg/ha) compared to the application of FYM @ 4 t per ha (107.17 kg/ha, 2899.30 kg/ha, respectively) in soybean.

Appavu and Saravanan (1999) observed that the application of farmyard manure had significantly recorded higher seed yield (738 kg/ha) than control (500 kg/ha) in soybean.

Kathireshan *et al.* (1999) observed in soybean that the application of enriched FYM recorded significantly higher mean number of pods per plant (164), number of seeds per pod (2.30) with test weight of 8.40 g. The maximum mean soybean seed yield of 2031 kg per ha was obtained by application of enriched FYM, which was 32 per cent higher over control.

Karmegam and Daniel (2000) reported that application of vermicompost resulted in significant increase in growth and yield of cowpea.

A field trial was conducted by Reddy *et al.* (1998) during kharif season of 1997-98 showed that application of 60 kg P_2O_5 per hectare through phospho-vermicompost significantly increased the growth, dry matter and yield of pea.

An experiment was carried out by Bhuiyan *et al.* (2003) at the Bangladesh Agricultural University (BAU) Farm, Mymensingh from *rabi* season of 1999 to *kharif-II* season of 2002 in the Old Brahmaputra Floodplain Soils (AEZ 9) of Bangladesh to investigate the effect of integrated use of organic and inorganic fertilizers on yield and nutrient uptake of T. Aus rice and mungbean in the Wheat-T. Aus/ Mungbean-T. Aman cropping pattern. The results showed that application of organic manure along with chemical fertilizers resulted in markedly higher uptake of nutrients. The application of

NPKS (HYG) fertilizers remarkably increased the crop yield. The lowest grain yield and the lowest nutrient uptake were noted in control plots receiving no fertilizer or manure.

A field experiment was conducted by Shukla and Tyagi (2009) during 2004–07 in summer season to ascertain the effect of 2 organic inputs, viz enriched compost and vermicompost applied @ 2 tonnes/ha, on selected soil parameters for soil health, growth and nodulation of 'PusaRatna' mungbean [*Vigna radiata* (L.) Wilczek]. The beneficial effects were compared not only to soils but also the growth of the crop without organic inputs. Organic matters, like vermicompost and enriched compost enhanced soil physical properties and plant nutrients (N, P and K) at the time of crop establishment and early growth. Incorporation of vermicompost and enriched compost before sowing had a greater beneficial impact, especially on physical properties of soil. The added organic materials, like vermicompost and enriched compost increased germination growth of shoots, roots and enhanced nodulation, the slightly greater benefits were derived with vermicompost as compared to enriched compost. The selected microorganisms used were Rhizobium, a symbiotic nitrogen fixer and phosphate-solubilizing bacteria which helps in solubilization of fixed phosphorus.

Appavu *et al* (2000) reported that the application of poultry manure @ 5 t per ha had significantly recorded higher seed yield (1039 kg/ha) fallowed by the application of FYM @ 12.50 t per ha (899 kg/ha) over control (638 kg/ha) in soybean.

Channabasavanna *et al.* (2001) observed in rice that the application of poultry manure @ 2 t per ha recorded significantly higher seed yield (4883 kg/ha) fallowed by FYM @ 7 t per ha (4459 kg/ha) and press mud @ 2 t per ha (4545 kg/ha) and control (4124 kg/ha). The application of poultry manure and FYM increased the seed yield by 18.40 per cent and 11.30 per cent respectively.

Ghosh *et al.* (2001) reported that the application of FYM @ 10 t per ha along with recommended dose of NPK to soybean recorded significantly higher seed yield (2.65 t /ha) compared to NPK alone (1.45 t /ha).

Reddy *et al.* (2004) reported that the application of FYM @ 10 t per ha recorded significantly higher seed yield in sorghum (2623 kg/ha), pigeon pea (474 kg/ha), castor (1056 kg/ha) and sunflower (969 kg/ha) over application of RDF (1988 kg/ha, 232 kg/ha, 653 kg/ha and 750 kg/ha, respectively). Application of FYM, on an average increased the seed yield of sorghum, sunflower, castor and pigeon pea by 27, 23, 36 and 30 per cent respectively, compared to the recommended dose of chemical fertilizers.

Vinay (2006) reported that the application of FYM @ 10 t per ha alone significantly increased the seed yield (26.85 q/ha) of wheat compared to control (22.72 q/ha).

Ramamurthy and Shivashankar (1996) reported that the application of FYM @ 10 t per ha recorded significantly higher protein content (38.54%), oil content (19.38%), protein yield (1103.60 kg/ha) and oil yield (522.70 kg/ha) compared to control (37.25%, 18.84%, 857.38 kg/ha and 433.23 kg/ha, respectively) in mungbean.

Vermicomposting is a process of recycling of organic wastes in an environmentally safe method. Vermicompost is a mixture of worm casts, which is rich source of micro and macronutrients. The worm casts apart from increasing the density of microbes also provide the required nutrients to plants. It contains plant growth promoting substances such as NAA, cytokinins, gibberellins, etc. It also increases the efficacy of added fertilizers in the soil. On an average, vermicompost contains 0.80 to 1.10% N, 0.40 to 0.80% P_2O_5 and 0.80 to 0.98% K_2O while 10 to 52 ppm Cu, 186.60 ppm Zn and 930.00 ppm Fe (Giraddi, 2001 and Giraddi *et al.*, 2006).

A field experiment was conducted by Kumar *et al.* (2002) during 2001-02 on the sandy loam soil of Haryana, India to investigate the effect of *Rhizobium* sp. seed inoculation, FYM (farmyard manure) at 5 t ha^{-1}, vermicompost at 2.5 and 5 t ha^{-1}, and 4 levels of fertilizers (control, no chemical fertilizer; 75% recommended dose of fertilizer, RDF; 100% RDF. N:P at 20:40 kg ha^{-1}; and 125% RDF) on the performance of mungbean cv. Asha. *Rhizobium* sp. inoculation significantly increased the grain yield. Increasing RDF levels up to 100% also increased grain yield. Vermicompost at 5 t ha^{-1} produced 16.5 and 9.5% higher grain yield compared to FYM at 5 t ha^{-1} and vermicompost at 2.5 t ha^{-1}, respectively, in 2002. However, the organic amendment did not affect the grain pod^{-1} in 2001 and the 1000-grain weight in both years. The interaction of the different treatments was significant in 2002. Vermicompost application at both levels resulted in higher yield compared to FYM. Yield increased with increasing fertilizer rate up to 125% RDF, when applied with FYM, but yield was higher under the treatment 100% RDF + vermicompost (both rates).

Chinnamuthu and Venkatakrishnan (2001) reported that the application of vermicompost @ 2 t per ha recorded significantly higher plant height (147.80 cm) and 100 seed weight (4.14 g) compared to application of FYM @ 5 t per ha (140.80 cm and 4.06 g, respectively) to sunflower.

Govindan and Thirumurugan (2005) observed that the application of vermicompost (75%) had significantly recorded higher plant height (84.70 cm), leaf area index (3.40) over press mud (100%N) (78.20 cm and 2.70, respectively) in soybean.

Aruna and Narsa Reddy (1999) reported that the application of vermicompost @ 15 t per ha to soybean recorded significantly higher number of pods per plant (59.00), 100 seed weight (15.80 g), seed yield (1143 kg/ha), seed protein content (41.80 %) and seed oil content (24.30%) over the application of FYM @ 5 t per ha + 50 kg N per ha (29.70, 13.9 g, 782 kg/ha, 38.70% and 23.00%, respectively).

A field experiment was conducted by Sangakkara *et al.* (2005)over a minor (dry) season to ascertain the impact of two organic materials (Gliricidia leaves and rice straw) applied as a surface mulch or incorporated into the root zone, on selected soil parameters, growth, nodulation and yields of mung bean (*Vigna radiata* L. R. Wilcz). The beneficial effects were compared to soils and the growth of the crop without organic matter. Organic matter, especially Gliricidia leaves, enhanced soil physical properties and plant nutrients (N, P and K) at the time of crop establishment and early growth. Incorporation had a greater beneficial impact, especially on physical properties of soil. While the organic materials increased germination, the method of addition had no significant impact. Growth of shoots, roots and nodulation were enhanced by incorporation of organic matter, again, the greater benefits were derived with Gliricidia leaves. Root growth measured in terms of root length densities was stimulated by organic matter incorporation. In contrast, surface application of the organic matter, especially rice straw, reduced weed growth. The benefits of the organic matter were also evident in seed yields and harvest indices, although incorporation did not increase seed yields to the same magnitude observed in vegetative growth or harvest indices and relative crop yields.

Roy and Singh (2006) reported in malt barley that the application of vermicompost @10 t per ha recorded higher ears per meter row length (75.40), test weight (47.70 g), seed yield (44 q per ha) protein content (8.30%) and starch content (60.90%) over control (70.10,45.30 g, 40 q/ha, 7.70 % and 60.05%, respectively).

2.3 Combined effect of organic and inorganic fertilizers

A field investigation was carried out by Aslam *et al.* (2010) in Pakistan to evaluate the effect of organic and inorganic sources of phosphorous on the growth and yield of mungbean (*Vigna radiata* L.). FYM, poultry manure and chemical fertilizer were accumulated at various concentrations to formulate different treatments. Analysis of data revealed significant differences with respect to plant height, number of plants m^{-2}, leaf area (cm^2), root length (cm), number of pod bearing branches plant $^{-1}$, number of pods plant^{-1}, number of seeds pod^{-1}, pod size (cm), number of seeds plant $^{-1}$, 1000 seed weight (g), biological yield (Kg ha^{-1}), seed yield (Kg ha^{-1}), harvest index (%) and grain protein contents (%) indicating primacy of integration of the two sources in having improved mungbean productivity.

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

Rajkhowa *et al.* (2002) reported that the application of 100 per cent RDF along withvermicompost @ 2.5 t per ha recorded significantly higher plant height (52.7 cm), number ofpods per plant (12.67), seeds per pod (12.00), 100 seed weight (4.6 g), seed yield (5.35 q ha^{-1}), seed yield (5.4 q ha^{-1}) and it was on par with the application of 75% or 50% RDF + vermicompost (2.5 t/ha) over control in mungbean.

Malligawad *et al.* (2000) in groundnut revealed that application of RDF (25:75:25 kgNPK kg/ha) + vermicompost @ 1 t/ha recorded significantly higher pod yield (3389 kg/ha) compared to FYM @ 4 t/ha + 50% RDF (3232 kg/ha), RDF alone (3148 kg/ha) and no NPK application (2742 kg/ha).

Kale *et al.* (1994) observed that the application of vermicompost @ 5 t per ha + 50%RDF recorded significantly higher value of growth yield components and yield of sunflower compared to FYM @ 5 t per ha + RDF.

Channaveerswami (2005) reported that combined application of vermicompost @ 2.5 t per ha + RDF (25:50:50 kg NPK per ha) + copper ore tailing recorded higher plant height (43.94 cm), number of branches (6.92), and less number of days to 50% flowering (35.15), number of matured pods (17.06), pod yield (3337 kg/ha) and kernel yield (2362 kg/ha) 100 seed weight (35.26 g). This seed obtained with this treatment also recorded higher seed quality parameters like, germination (94.31%), seedling length (23.85cm), seedling dry weight (4.60 g), seedling vigour index (2249) and lower electrical conductivity (0.186 dSm^{-1}) in groundnut.

Pawar *et al.* (1995) reported that the application of vermicompost @ 2.50 t per ha along with 100 per cent RDF recorded significantly higher seed yield (74.80 q/ha).

However, *in situ* vermiculture and application of 50 per cent RDF recorded a yield equivalent to that with 100 per cent RDF. They further observed that the application of vermicompost @ 2.50 t per ha along with 50 per cent RDF recorded seed yield on par with 100 per cent RDF in maize.

Patil (1998) reported that in groundnut the maximum pod yield (30.04 q/ha) was recorded with the application of vermicompost @ 2.50 t per ha + fly ash @ 30 t per ha + RDF. Whereas, the lowest pod yield (20.66 q/ha) was recorded with the application of RDF alone.

CHAPTER 3

MATERIALS AND METHODS

Details of the experimental materials and methods followed in the study are presented in this chapter. The experiment was carried out during the period from February to April of 2012 for finding out the effect of different combinations of organic and inorganic fertilizers on growth and yield and nutrient contents of a selected mungbean cultivar.

3.1 Experimental site

The experiment was carried out at the Sher-e-Bangla Agricultural University (SAU) Farm, Dhaka. The experimental site is situated at 23°77' North Latitude and 90°30' East Longitude. The elevation of the experimental site is 1.0 m above the sea level. The area belongs to the Agro-ecological Zone (AEZ- 28): Madhupur Tract.

3.2 Soil

The experiment was conducted on silty clay loam soil of the Order Inceptisols. The soil of SAU farm is high land having irrigation facilities. The morphological, physical and chemical characteristics of the experimental soil are presented in Tables 3.1 and 3.2.

3.3 Climate

The climate of the experimental site is sub-tropical, wet and humid. Heavy rainfall occurs in the monsoon (mid-April to mid-August) and scanty during rest of the year.

Table 3.1. Morphological characteristics of the experiment field

Characters	SAU farm
Locality	SAU, Dhaka
Geographic position	23°77'North Latitude 90°30'East Longitude 1.0 m height above the mean sea level
Agro-ecological zone	Madhupur Tract (AEZ-28)
General soil type	Deep Red Brown Terrace Soil
Soil Series	Tejgaon
Parent material	Madhupur Terrace
Topography	Fairly level
Drainage	Well drained
Land type	High land

Table 3.2. Physical and chemical characteristics of the soils

Characteristics	SAU farm
Mechanical fractions:	
%Sand (0.2-0.02 mm)	29.93
%Silt (0.02-0.002 mm)	40.27
%Clay (< 0.002 mm)	29.80
Textural class	Clay loam
Soil pH	6.9
Organic C (%)	0.61
Organic matter (%)	1.05
Total N (%)	0.08
Available P (ppm)	12.78
Available K (ppm)	43.29
Available S (ppm)	23.74
Available B (ppm)	0.36

3.4 Crop: Mungbean

BARI Mung 5 was used in the study. The salient characteristics of this variety are presented below:

BARI Mung 5

BARI released BARI Mung 5 in 2001. Plant height of this variety ranges from 50 to 78 cm and seeds are deep green in colour. One thousand seed weight is about 41 to 46 g. The variety requires 55 to 60 days to mature, and average yield is 1,300 kg ha^{-1}. It is also resistant to *Cercospora* leaf spot and tolerant to yellow mosaic virus (BARI, 2008).

3.5 Year: Kharif-I, 2012

3.6 Treatments and experimental design

The experiment was laid out in a randomized complete block design with three replications. Each plot was measured 3 m x 2 m.

Organic and Inorganic Fertilizers and Doses :

1. Organic Fertilizers

a) Cowdung (Recommended dose - 10 t ha^{-1})

b) Vermicompost (Recommended dose -7 t ha^{-1})

These rates of the different organic fertilizers are almost equal in consideration of essential nutrient contents. Vermicompost were found in SAU farm.

2. Inorganic Fertilizer

a) Urea for nitrogen @ 25 kg ha^{-1}

b) TSP for phosphorous@ 50 kg ha^{-1}

c) MoP for potassium at @ 20 kg ha^{-1}

d) Gypsum for sulphur @30 kg ha^{-1}

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

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

Different treatments:

T_0 –Control

T_1 - Cowdung 10 t ha^{-1} (Recommended dose)

T_2 - Cowdung @ 6 t ha^{-1} + 25 % of optimum dose of inorganic fertilizers

T_3 - Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers

T_4 – Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers

T_5 -Vermicompost 7 t ha^{-1} (Recommended dose)

T_6 - Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers

T_7 - Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers

T_8 - Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers

T_9 - 100 % Inorganic Fertilizers

3.7 Land preparation

The experimental lands were opened with a power tiller on 11th February 2012 and subsequently ploughed twice followed by laddering. Weed stubble and crop residues were removed. The lands were finally prepared on 17th February 2012.

3.8 Fertilizer application

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

3.9 Sowing

Sowing of Mungbean was done on 21st February 2012. Healthy seeds of mungbean @ 35 kg ha^{-1} were sown by hand as uniformly as possible in furrows. Seeds were sown in the afternoon and immediately covered with soil to avoid sunlight. Line to line distance was 30 cm.

3.10 Intercultural operation

Weeding was done at 12 and 35 days after sowing. Thinning was done on the same date of 1st weeding to maintain optimum plant density. Plant to plant distance was maintained at 10 cm. A light irrigation was given after sowing for germination of seed. Pest did not infest the mungbean crop at the early stage. The insecticide Sumithion 57 EC was sprayed @ 0.02% at the time of pod formation to control pod borer. No disease was observed in the experimental field.

3.11 Harvesting and sampling

The crops were harvested at a time due to synchronous maturity of pods. At first 50% of early matured pods were harvested by hand picking at 55 days after sowing. Finally 4 days after first harvesting all plants were harvested plot-wise by uprooting and were bundled separately, tagged and brought to the threshing floor of the SAU farm. All of the harvested pods were kept separately in properly tagged gunny bags. Ten plants were randomly selected prior to maturity from each plot for data recording.

3.12 Threshing, drying, cleaning and weighing

The crop bundles were sun dried for two days on threshing floor. Seeds were separated from the plants by beating the bundles with bamboo sticks. The collected seeds were dried in sun to lower the moisture content to 12% level. The dried and cleaned seed and stover were weighed plot-wise.

3.13 Data collection

i) Plant height

The plant height was measured from base of the plant to the tip of the main shoot for ten randomly tagged plants with the help of scale at harvest. The average of ten plants was computed and expressed as the plant height in centimeters.

ii) Number of leaves per plant

The numbers of green trifoliate leaves present on each plant were counted manually from the ten tagged plants at harvest. The mean number of leaves per plant was calculated and expressed in number per plant.

iii) Number of branches per plant

The total number of branches originating from the main stem was counted at harvest from ten earlier tagged plants. Average was worked out and expressed as number of branches per plant.

iv) Days to 50 per cent flowering

Plants were observed daily for flowering. The day on which 50 per cent of the plants showed flowers in the plot was considered as 50 per cent flowering. The number of days taken from the date of sowing to flowering was calculated and expressed as days taken for 50 per cent flowering.

v) Number of pods per plant

The total number of pods from ten randomly selected plants was counted manually from each treatment. Average was worked out and recorded as number of pods per plant.

vi) Number of seeds pod^{-1} and seeds plant^{-1}

Ten pods were selected at random from the total number of pods harvested from tagged ten plants. The seeds from each pod were separated, counted and average was worked out and expressed as number of seeds pod^{-1}.The total numbers of seeds from ten randomly selected plants were counted manually from each treatment. Average was calculated and recorded as number of seeds plant^{-1}.

vii) Weight of thousand seed

One hundred seeds were counted from the seed sample of each plot separately and then their weight was recorded with the help of an electrical balance. These values were multiplied by ten to determine the weight of thousand seed.

viii) Seed yield

The seed yield obtained from the net plot area of each treatment was added with the yield obtained for ten tagged and harvested plants. The seeds were cleaned and dried in shade for five days. After size grading seed weight per plant was recorded in gram. The seed yield per hectare was computed and expressed in kg per hectare.

3.14 Determination of N, P and K

3.14.1 Preparation of plant sample for N

The plant material (seed) were dried in an oven at 60^0 C at 72 hours after sun drying and finely ground in a grinder machine for chemical analysis. Then the prepared samples were put into paper bags.

3.14.1.1 Determination of Nitrogen

The total nitrogen was determined from the seed sample by macro Kjeldahl method. The samples were digested by commercial H_2SO_4 in presence of catalyst mixture K_2SO_4, $CuSO_4$ and selenium powder. The formed $(NH_4)_2$ SO_4 was mixed with NaOH during distillation. The liberated ammonia was received in 4% boric acid (H_3BO_3) solution and 5 drops of mixed indicator of bromocresol green ($C_2H_{14}O_5BO_4S$) and methyl red ($C_{10}H_{10}N_3O_2$) solution. Finally the distillate was titrated with standard (0.05N) H_2SO_4until the color changed to pink (Jackson, 1973).

The %N in plant was calculated by the following formula:

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

Where,

T = Titration value for sample (ml.), B = Titration value for blank (ml)

N = Normality of H_2SO_4, S = Weight of the sample (g),

1 mL N $H_2SO_4 \equiv 0.014$ g N

3.14.2 Preparation of plant extract for P and K

Exactly 0.5 g plant sample was taken in a 250 ml conical flask and 10 ml of di-acid mixture ($HNO_3 : HClO_4 = 2 : 1$) was added to each conical flask. The flask was then placed on an electric hot plate and heated until white fumes were evolved. Then the flask was removed from the hot plate and allowed to cool. After cooling, the digest was filtered and transferred to a 100 ml volumetric flask and the final volume was made up to 100 ml with distilled water (Singh, 1999). From the digest, phosphorus, potassium and sulphur were analyzed by following standard method. BCSIR lablatory was used for this chemical analysis.

3.14.2.1 Determination of phosphorus

Phosphorus in the digest was determined colorimetrically using $SnCl_2$ as reducing agent. The intensity of color read at 660 nm wave length with a spectrophotometer (Jackson, 1973).

3.14.2.2 Determination of potassium

Potassium of the plant sample was determined with the help of flame emission spectrophotometer. The samples were aspirated into a gas flame. The air pressure was fixed at 10 PSI. Percent emission was recorded following the method described by Ghosh *et al.* (1983).

3.16 Statistical analysis

The collected data on different growth and yield parameters and nutrient contents of mungbean were statistically analyzed. The means for all treatments were calculated and the analyses of variances for all the characters were performed by 'F' variance test using MSTAT-C computer package program. The significance of difference between pair of means was performed by the Dancan's Multiple Range Test (DMRT) (Russel, 1986).

CHAPTER 4

RESULTS AND DISCUSSION

The present experiment was conducted at the farm of Sher-e-Bangla Agricultural University. The results have been presented and discussed, and possible interpretations have been given under the following headings:

4.1 Plant height

The data on plant height of mungbean at harvest as influenced by different combinations of organic and inorganic fertilizers are presented in Figure 4.1 and Appendix II.

The plant height at harvest differed significantly due to different treatments. Significantly higher plant height (53.79 cm) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer) and it was statistically similar with the application of Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer (T_7 : 52.85 cm) and followed by T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizer) (49.70 cm) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer) (46.05 cm). Better results were also showed by T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizer) (47.23 cm) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer) (46.05 cm) which gave statistically equal plant height.The lowest plant height at harvest was found from the treatment using no fertilizer (T_0 : 32.68 cm), whereas 100% inorganic fertilizer gave a plant height of 44.54 cm (Figure

4.1), which was statistically similar with the treatments T_2 , T_0 , T_6 . (Appendix-II).

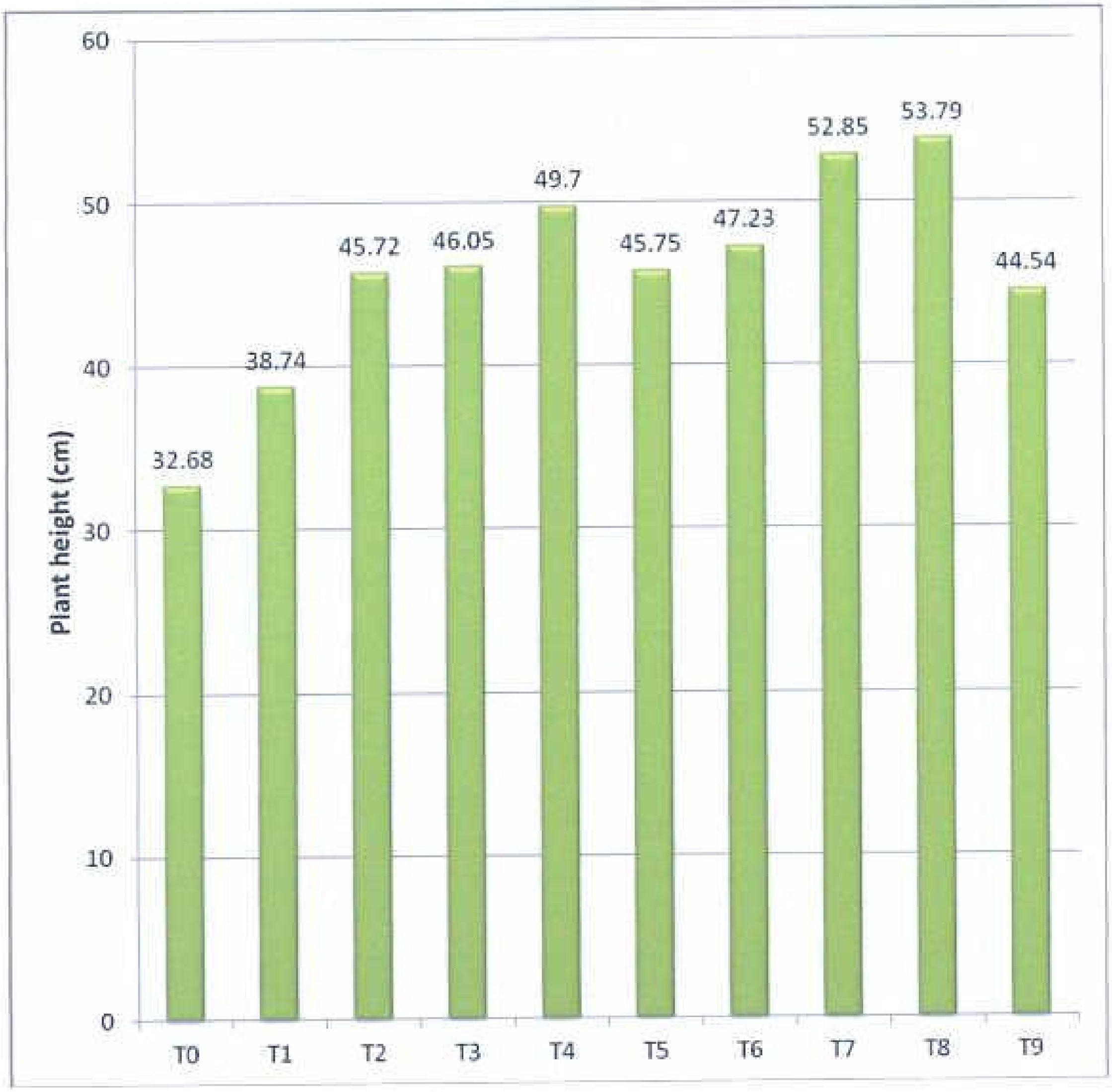


Figure 4.1: Effect of various combinations of organic and inorganic fertilizers on plant height of mungbean (BARI Mung 5) at harvest

It seems from the results that combination of organic and inorganic fertilizers increased the plant height than sole use of inorganic fertilizers but not significant. Actually organic fertilizers help to increase the organic matter content of soil, thus reducing the bulk density and decreasing compaction. Thus plants get a suitable growing environment which promotes better growth and development. Similar sort of findings were found by many scientists while experimenting with various crops. Combination of organic and inorganic fertilizers was found better by Channaveerswami (2005) in groundnut and Rajkhowa *et al.* (2002) in green gram than only inorganic fertilizers.

4.2 Number of leaves

The data on number of leaves plant^{-1} of mungbean at harvest as influenced by organic and inorganic fertilizers are presented in Figure 4.2 and Appendix II.

The number of leaves plant^{-1} at harvest differed significantly due to different treatments. Highest number of leaves plant^{-1} (18.78) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was statistically similar with T_7 *i.e.* Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers (18.67). T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) (16.86), T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (16.58) and T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) (16.47) gave statistically same results and also showed better performances in comparison to sole 100 % Inorganic Fertilizers (T_9) which gave 15.00 leaves plant^{-1}. On the other hand, T_0 (No fertilizer) treatment showed the lowest number of leaves plant^{-1} (14.80) (Figure 4.2).

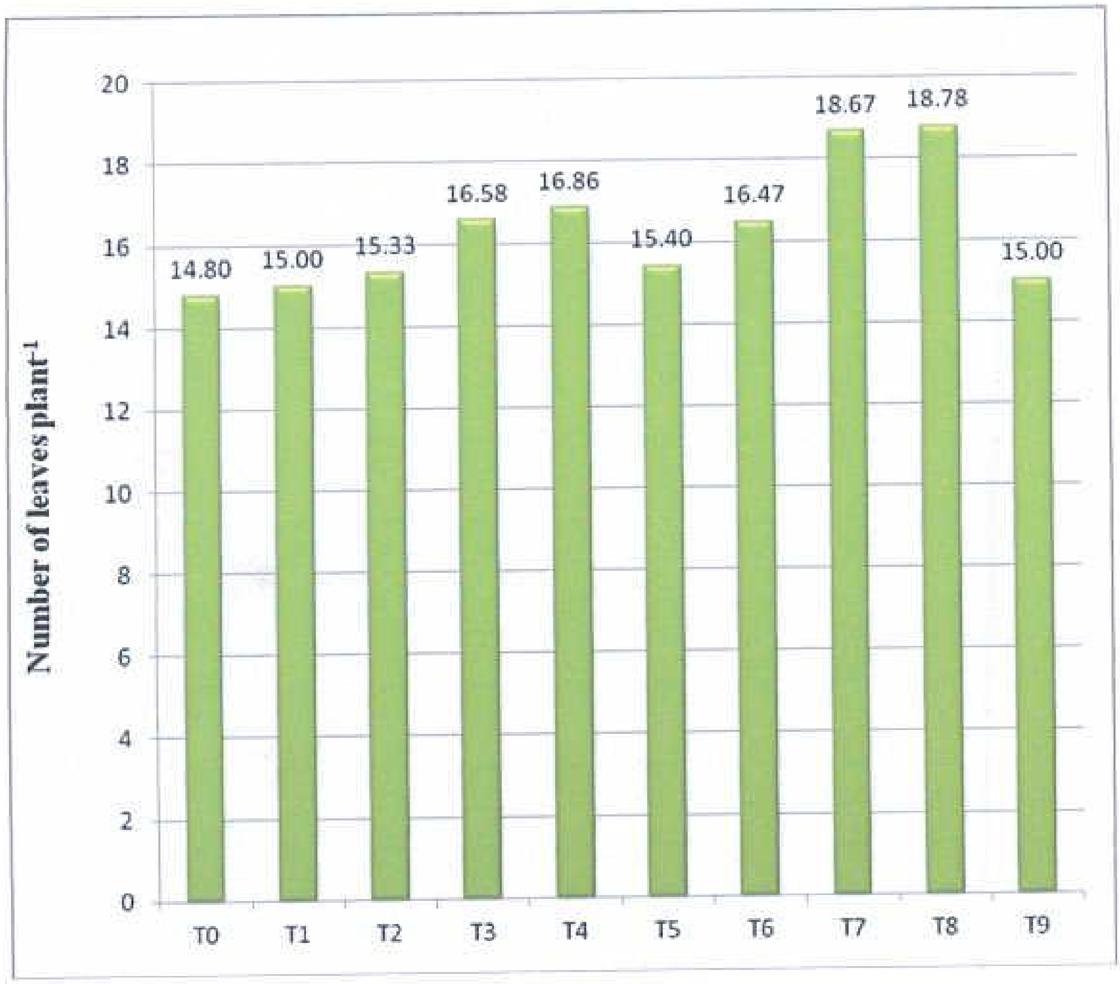


Figure 4.2 : Effect of various combinations of organic and inorganic fertilizers on number of leaves plant^{-1} of mungbean (BARI Mung 5) at harvest

Results showed that the combination of organic and inorganic fertilizers significantly increased the number of leaves plant^{-1} than sole use of inorganic fertilizer. As organic fertilizers help to improve the soil condition and inorganic fertilizers assure quick availability of essential nutrients, the combination of two proved better than single use of the each. Channaveerswami (2005) and Rajkhowa *et al*. (2002) found better growth by using combination of organic and inorganic fertilizers than only inorganic fertilizers in groundnut and in green gram respectively.

4.3 Number of branches plant^{-1}

The data on number of branches plant^{-1} of mungbean at different growth stages as influenced by organic and inorganic fertilizers are presented in Figure 4.3 and Appendix II.

The number of branches plant^{-1} at harvest also differed significantly due to different treatments. Significantly higher number of branches plant^{-1} (3.85) was recorded in T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizer) which was statistically similar with T_8 *i.e.* Vermicompost @ 4 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (3.83) and T_7 (Vermicompost @ 4 t ha^{-1} + 50% of optimum dose of inorganic fertilizers) (3.79). T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (3.69), T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) (3.69) and T_5 (Vermicompost 7 t ha^{-1}) (3.60) also showed better performances from the rest of the treatments especially from 100% inorganic fertilizers (3.54). On the other hand, among all the treatments, T_0 (No fertilizer) treatment showed lowest number of branches plant^{-1} (3.19) at harvest (Figure 4.3).

Combination of organic and inorganic fertilizers significantly increased the number of branches plant^{-1} than sole use of inorganic fertilizer. As organic fertilizers help to improve the soil condition and inorganic fertilizers assure quick availability of essential nutrients, the combination of two proved better than single use of the each. Channaveerswami (2005) reported that combined application of vermicompost @ 2.5 t per ha + RDF (25:50:50 kg NPK per ha) + copper ore tailing recorded higher number of branches (6.92) in groundnut.

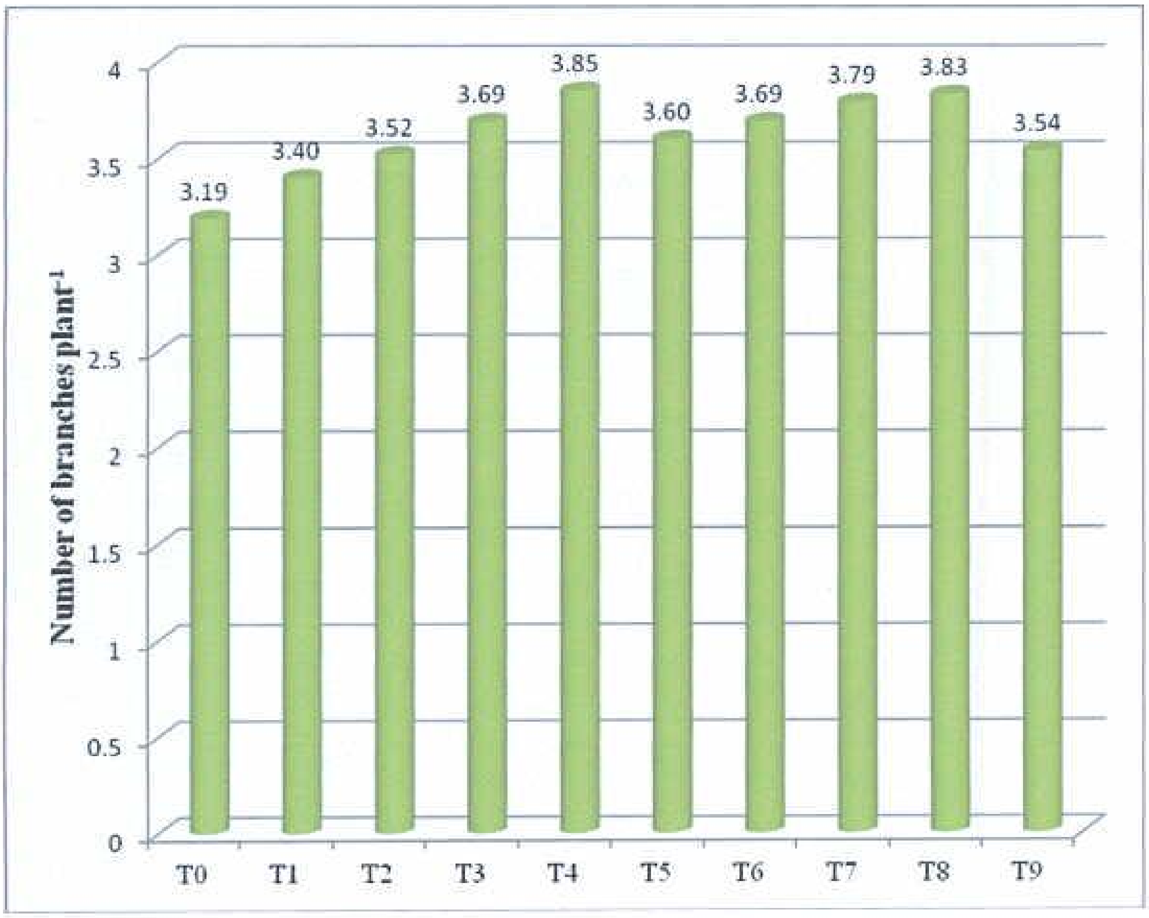


Figure 4.3: Effect of various combinations of organic and inorganic fertilizers on number of branches plant^{-1} of mungbean (BARI Mung 5) at harvest

4.4 Days to 50% flowering

The data on days to 50% flowering of mungbean as influenced by organic and inorganic fertilizers are presented in Table 4.1.

Days to 50% flowering showed significant variation due to the different combinations of organic and inorganic fertilizer doses. Minimum days to 50% flowering (39.67) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer) and it was statistically similar with T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer) and was closely followed by T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizer) (40.00). Better results were also showed by T_2 , T_3 T_6 ,T_9 treatments ,while maximum days to 50% flowering was found from the treatment no fertilizer (T_0 :43.20).

Table 4.1 : Effect of organic and inorganic fertilizers on days to 50% flowering of mungbean (BARI Mung 5)

Treatments	Days to 50% flowering
T_0	43.20 a
T_1	41.67 a-c
T_2	41.33 b-d
T_3	40.23 b-d
T_4	40.00 cd
T_5	42.00 ab
T_6	40.85 b-d
T_7	39.87 d
T_8	39.67 d
T_9	40.71 b-d
LSD	1.772
CV (%)	8.31
Level of Significance	*

* = Significant at 5% level

T_0 –Control, T_1 - Cowdung 10 t ha^{-1} (Recommended dose), T_2 - Cowdung @ 6 t ha^{-1} + 25 % of optimum dose of inorganic fertilizer, T_3 - Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer, T_4 – Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizer, T_5 -Vermicompost 7 t ha^{-1} (Recommended dose), T_6 - Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizer, T_7 - Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer, T_8 - Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer, T_9 - 100 % Inorganic Fertilizer

Similar results were reported by Channaveerswami (2005) in groundnut and Rajkhowa *et al*. (2002) in greengram.

4.5 Number of pods plant^{-1}

The data on number of pods plant^{-1} of mungbean as influenced by different combinations of organic and inorganic fertilizers are presented in Figure 4.4 and Appendix- III.

Number of pods plant^{-1} showed significant variation due to the different combinations of organic and inorganic fertilizer doses. Maximum number of pods plant^{-1} (25.64) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer) which was statistically similar with the application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizer (T_4: 25.51) and closely followed by T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer) (25.11) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer) (24.31). Better results were also showed by T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizer) (23.17) among rest of the treatments while 100 % Inorganic Fertilizer (T_9) gave 22.64 pods plant^{-1}. Minimum number of pods plant^{-1} was found from the treatment using no fertilizer (T_0 : 15.28) (Appendix- III).

Combination of organic and inorganic fertilizers increased the number of pods plant^{-1} than use of inorganic fertilizer alone. This may be because combination of organic and inorganic fertilizers improves soil physical properties, which provide health and favourable soil conditions to enhance nutrient use efficiency. Similar results were reported by Channaveerswami (2005) in groundnut and Rajkhowa *et al.* (2002) in green gram. Patil (1998) reported that in groundnut the maximum pod yield (30.04 q/ha) was recorded with the application of vermicompost @ 2.50 t per ha + fly ash @ 30 t per ha + RDF, whereas, the lowest pod yield (20.66 q/ha) was recorded with the application of RDF alone. Abbas *et al.* (2011) found that application of DAP at 124 kg along with 10 tons ha^{-1} of poultry litter yielded maximum number of pods $plant^{-1}$.

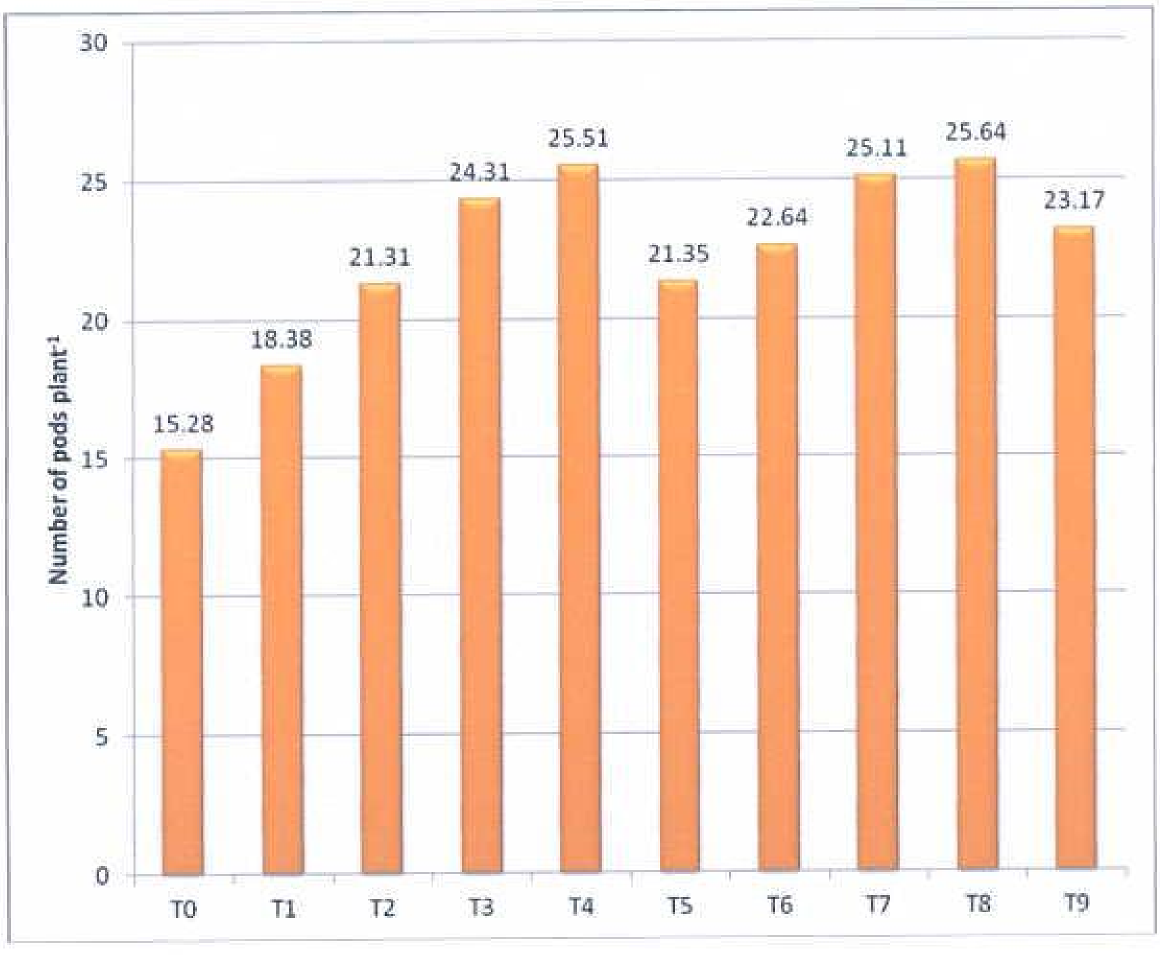


Figure 4.4: Effect of various combinations of organic and inorganic fertilizers on number of pods plant^{-1}

4.6 Number of seeds pod^{-1}

The data on number of seeds pod^{-1} of mungbean as influenced by organic and inorganic fertilizers are presented in Figure 4.5 and Appendix -III.

Number of seeds pod^{-1} showed significant variation due to the different combinations of organic and inorganic fertilizer doses. Maximum number of seeds pod^{-1} (12.07) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) which was statistically similar with T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) (12.05) and was closely followed by T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (11.52). Better results were also found in T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) (11.09) which was statistically similar with T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (11.06). T_9 (100 % Inorganic Fertilizers) gave 10.39 seeds pod^{-1}. Minimum number of seeds pod^{-1} was found from the treatment using no fertilizers (T_0 : 10.05) (Figure 4.5).

Combination of organic and inorganic fertilizers increased the number of seeds pod^{-1} than use of inorganic fertilizer alone. This may be because combination of organic and inorganic fertilizers improves soil physical properties, which provide health and favourable soil conditions to enhance nutrient use efficiency. Similar results were reported by Channaveerswami (2005) in groundnut and Rajkhowa *et al.* (2002) in green gram. Patil (1998) reported that in groundnut the maximum number of seeds pod^{-1} was recorded with the application of vermicompost @ 2.50 t per ha + fly ash @ 30 t per ha + RDF, whereas, the lowest number of seeds pod^{-1} was recorded with the application of RDF alone. Abbas *et al.* (2011) found that application of DAP at 124 Kg along with 10 tons ha^{-1} of poultry litter yielded maximum number of seeds pod^{-1}.

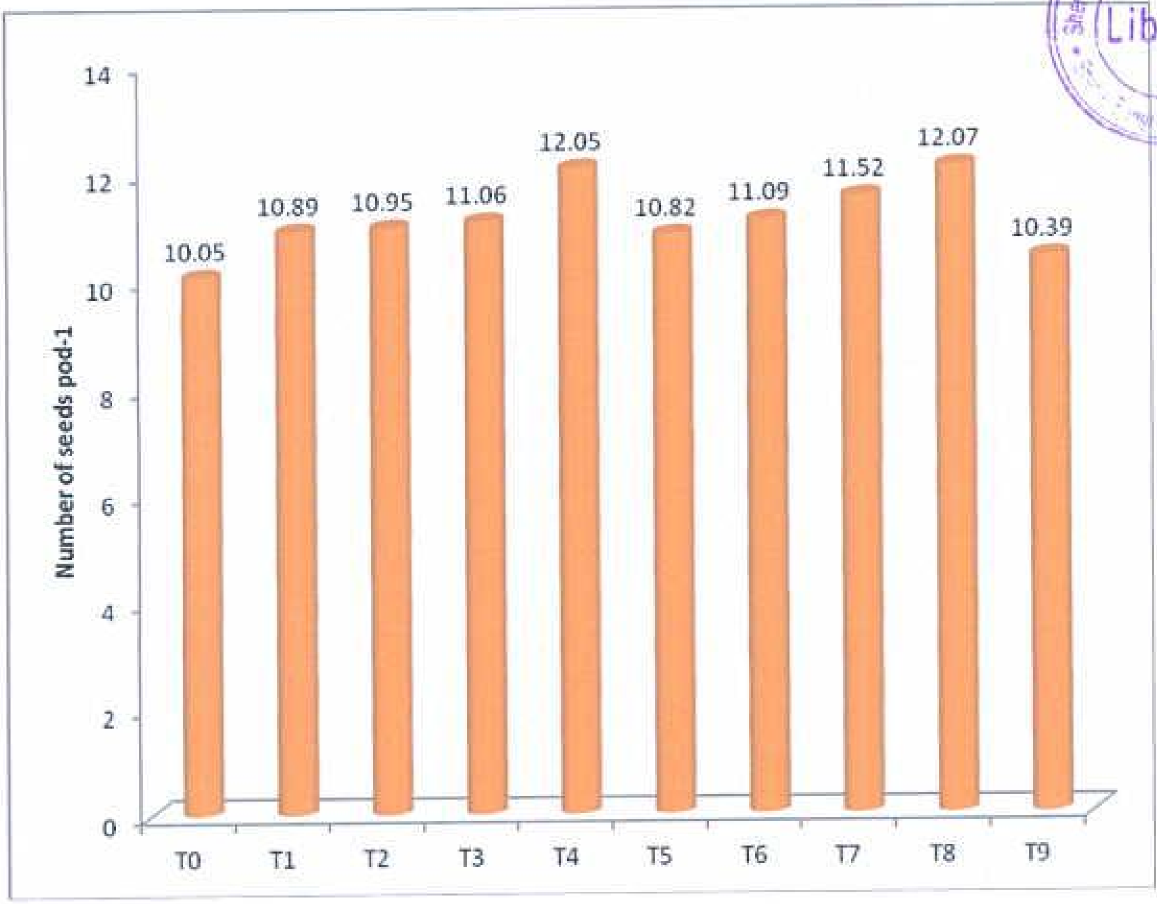


Figure 4.5 : Effect of various combinations of organic and inorganic fertilizers on number of seeds pod^{-1} of BARI Mung 5

4.7 Number of seeds plant^{-1}

The data on number of seeds plant^{-1} of mungbean as influenced by organic and inorganic fertilizers are presented in Figure 4.6 and Appendix- III.

Number of seeds plant^{-1} showed significant variation due to the different combinations of organic and inorganic fertilizers doses. Maximum number of seeds plant^{-1} (312.56) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was followed by T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) (299.27) and T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (295.17). Among the remaining treatments better results were also showed by T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (269.64) and T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) (270.84) while 100 % Inorganic Fertilizers (T_9) gave 267.25 seeds plant^{-1}. Minimum number of seeds plant^{-1} was found from the treatment using no fertilizers (T_0 : 188.13) (Figure 4.6).

It is revealed from the result that combination of organic and inorganic fertilizers increased the number of seeds plant^{-1} than use of inorganic fertilizers alone. This may be due to increase in the number of pods plant^{-1} and seeds pod^{-1}. Similar results were reported by Channaveerswami (2005) in groundnut and Rajkhowa *et al.* (2002) in green gram. Patil (1998) reported that in groundnut the maximum number of seeds pod^{-1} was recorded with the application of vermicompost @ 2.50 t per ha + fly ash @ 30 t per ha + RDF, whereas, the lowest number of seeds pod^{-1} was recorded with the application of RDF alone. Abbas *et al.* (2011) found that application of DAP at 124 Kg along with 10 tons ha^{-1} of poultry litter yielded maximum number of seeds pod^{-1}.

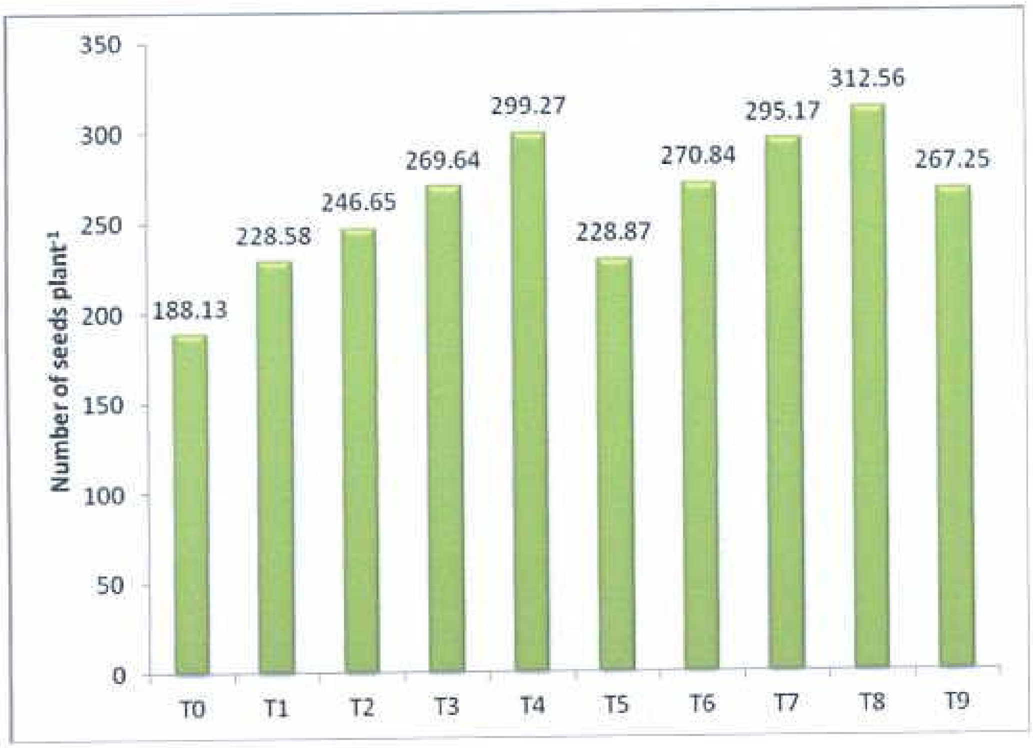


Figure 4.6 : Effect of various combinations of organic and inorganic fertilizers on number of seeds plant^{-1}

4.8 Seed yield plant^{-1}

The data on seed yield plant^{-1} of mungbean as influenced by organic and inorganic fertilizers are presented in Figure 4.7 and Appendix IV.

Seed yield plant^{-1} showed significant variation due to the different combinations of organic and inorganic fertilizers doses. Among all the treatments, the highest seed yield plant^{-1} (14.63 g) was recorded in T_8

(Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was statistically similar with application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (T_4:14.13 g) and followed by T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (12.57 g) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (12.07 g). 100 % Inorganic Fertilizers (T_9) gave a yield of 11.05 g plant^{-1}. The lowest seed yield plant^{-1} was found from T_0 among all the treatments which was 7.94 g plant^{-1} (Figure 4.7).

It was revealed from the result that combination of organic and inorganic fertilizers increased the seed yield plant^{-1} than use of inorganic fertilizers alone. This may be due to higher pods plant^{-1}, seeds pod^{-1} and seeds plant^{-1}. Similar results were reported by Channaveerswami (2005) in groundnut and Rajkhowa *et al.* (2002) in green gram. Patil (1998) reported that in groundnut the maximum seed yield plant^{-1} was recorded with the application of vermicompost @ 2.50 t per ha + fly ash @ 30 t per ha + RDF, whereas, the lowest seed yield plant^{-1} was recorded with the application of RDF alone. Abbas *et al.* (2011) found that application of DAP at 124 Kg along with 10 tons ha^{-1} of poultry litter yielded maximum seed yield plant^{-1}.

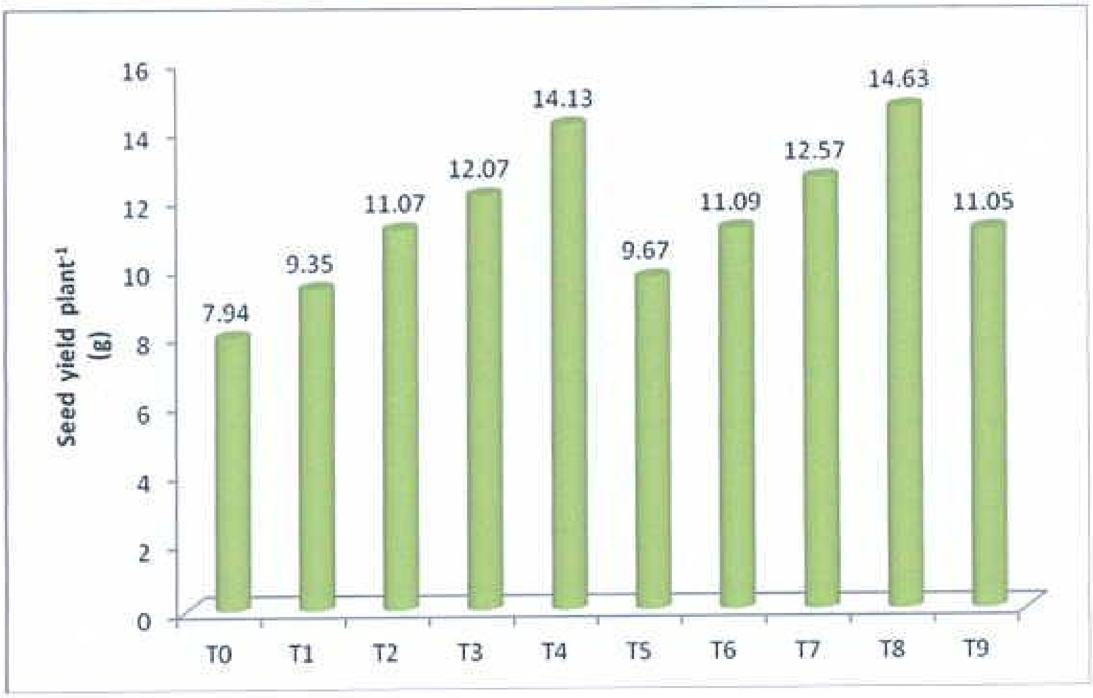


Figure 4.7 : Effect of various combinations of organic and inorganic fertilizers on seed yield plant^{-1} of BARI Mung 5

4.9 1000-seed weight

The data of 1000-seed weight (g) of mungbean as influenced by organic and inorganic fertilizers are presented in Figure 4.8 and Appendix IV.

1000-seed weight showed significant variation due to the different combinations of organic and inorganic fertilizers doses. The highest 1000-seed weight (35.56 g) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was closely followed by the treatment of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (T_4: 35.08 g), T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (34.22 g) and T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (33.26 g). Among the remaining treatments better results were also showed by T_2 (Cowdung @ 6 t ha^{-1} + 25 %

of optimum dose of inorganic fertilizers) (33.19 g) while 100 % Inorganic Fertilizers (T_9) gave a value of 30.67 g for 1000-seed weight. Among all the treatments, the lowest 1000-seed weight was found from the treatment using no fertilizers (T_0 : 29.45 g) (Figure 4.8).

It is revealed from the result that combination of organic and inorganic fertilizers increased the 1000-seed weight than use of inorganic fertilizers alone. This may be because organic fertilizers are known to contain plant nutrients, growth promoting substances and beneficial microflora which in combination with inorganic fertilizers provide favourable soil conditions to enhance nutrient use efficiency. Similar results were reported by Channaveerswami (2005) in groundnut and Rajkhowa *et al.* (2002) in green gram. Patil (1998) reported that in groundnut the maximum 1000-seed weight was recorded with the application of vermicompost @ 2.50 t per ha + fly ash @ 30 t per ha + RDF, whereas, the lowest 1000-seed weight was recorded with the application of RDF alone.

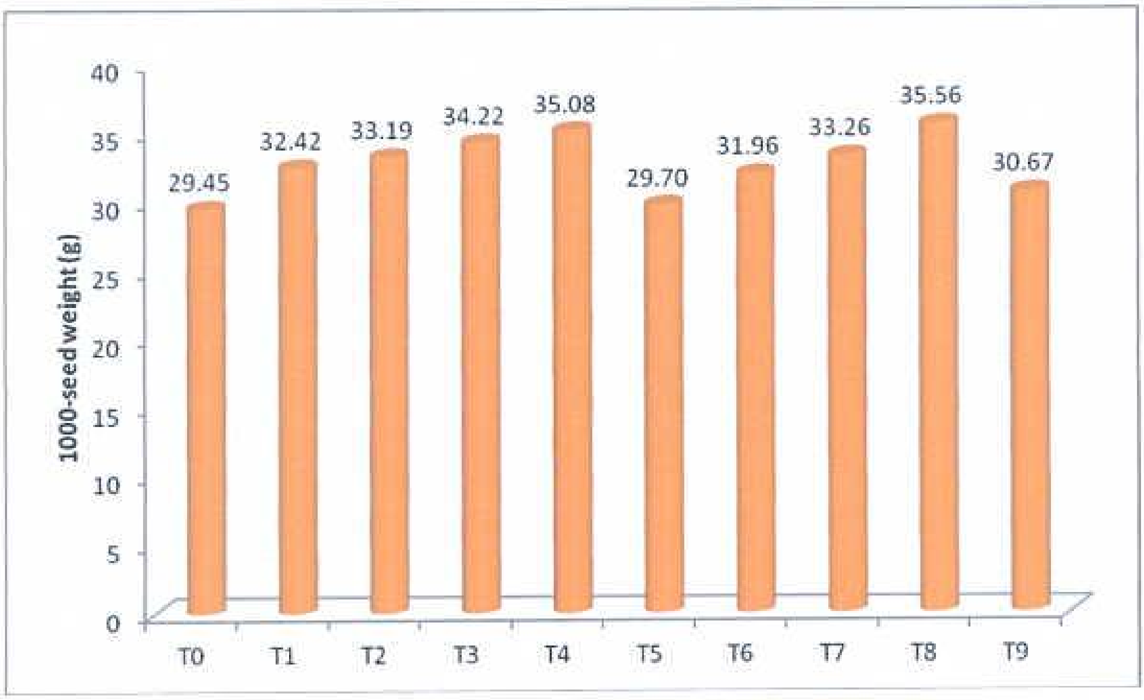


Figure 4.8 : Effect of various combinations of organic and inorganic fertilizers on 1000-seed weight

4.10 Seed yield ha^{-1}

The data on seed yield ha^{-1} of mungbean as influenced by organic and inorganic fertilizers are presented in Figure 4.9 and Appendix IV.

Seed yield ha^{-1} showed significant variation due to the different combinations of organic and inorganic fertilizer doses. Among the treatments, the highest seed yield ha^{-1} (1127.46 kg) was recorded from T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer) and it was statistically identical with the application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizer (T_4: 1104.20 kg) and followed by T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer) (985.55 kg) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer) (975.45

kg). T_2, T_3 , T_5 , T_6 , T_7 and T_9 showed no difference statistically. 100 % Inorganic Fertilizer (T_9) gave seed yield of 909.76 kg ha^{-1}. Lowest seed yield 699.05 kg.ha^{-1} was found from the treatment using no fertilizer .

It is revealed from the result that combination of organic and inorganic fertilizers increased the seed yield ha^{-1} than use of inorganic fertilizer alone. This may be because organic fertilizers are known to contain plant nutrients, growth promoting substances and beneficial microflora which in combination with inorganic fertilizers provide favourable soil conditions to enhance nutrient use efficiency. Similar results were reported by Channaveerswami (2005) in groundnut and Rajkhowa *et al*. (2002) in green gram. Patil (1998) reported that in groundnut the maximum seed yield ha^{-1} was recorded with the application of vermicompost @ 2.50 t per ha + fly ash @ 30 t per ha + RDF,whereas, the lowest seed yield $ha^{-1}$was recorded with the application of RDF alone. Abbas *et al.* (2011) found that application of DAP at 124 Kg along with 10 tons ha^{-1} of poultry litter yielded maximum seed yield ha^{-1}.

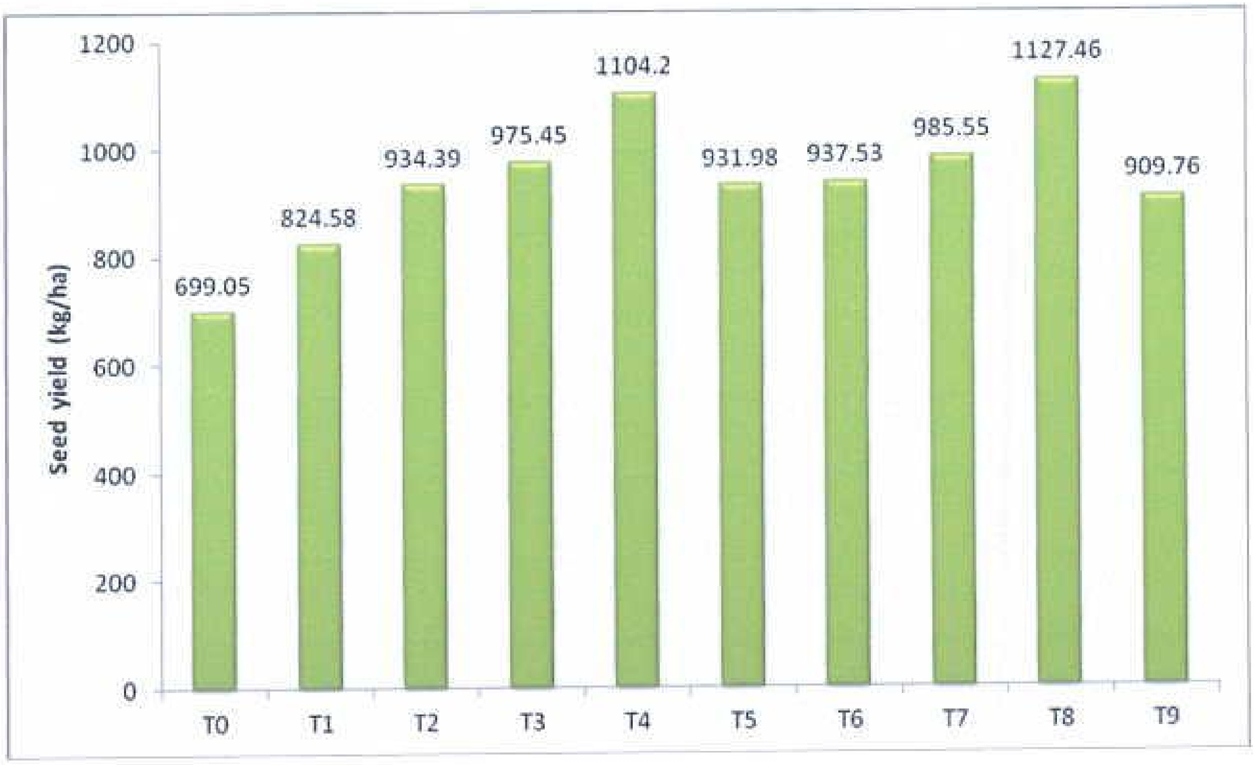


Figure 4.9 : Effect of various combinations of organic and inorganic fertilizers on seed yield ha^{-1} of BARI Mung 5

4.11 Nitrogen content in seeds (%)

The data on nitrogen (N) content in (%) seed of mungbean as influenced by organic and inorganic fertilizers are presented in Figure 4.10 and Appendix V.

N content (%) of mungbean seed was differed significantly due to the different combinations of organic and inorganic fertilizer doses. Highest N content (3.39 %) in seed was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was followed by the application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (T_4: 3.33 %) and T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (3.36 %) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (3.31 %). While 100 % Inorganic Fertilizers (T_9) showed N content of 3.30 %. Among all the treatments, the lowest N content in seed was found from the treatment using no fertilizer (T_0 : 3.19 %).

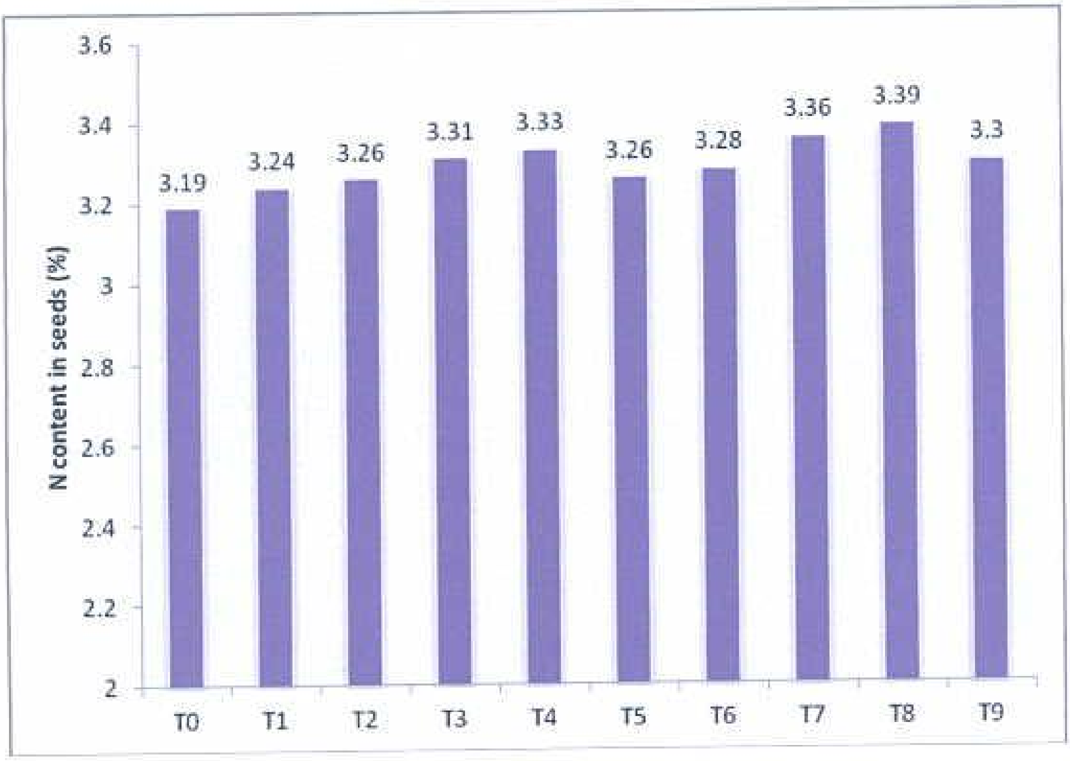


Figure 4.10 : Effect of various combinations of organic and inorganic fertilizers on nitrogen (N) content in seed (%)

4.12 Phosphorus content in seeds (%)

The data of phosphorus (P) content (%) in seed of mungbean as influenced by organic and inorganic fertilizers are presented in Figure 4.11 and Appendix V.

P content of mungbean seed was differed significantly due to the different combinations of organic and inorganic fertilizer doses.The highest P content 0.351 % in seed was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was closely followed by the application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (T_4: 0.345%), and T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (0.339 %). Better results were also showed by T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) (0.333 %) while the lowest P content in seed was found from the treatment using no fertilizer (T_0 : 0.287 %).

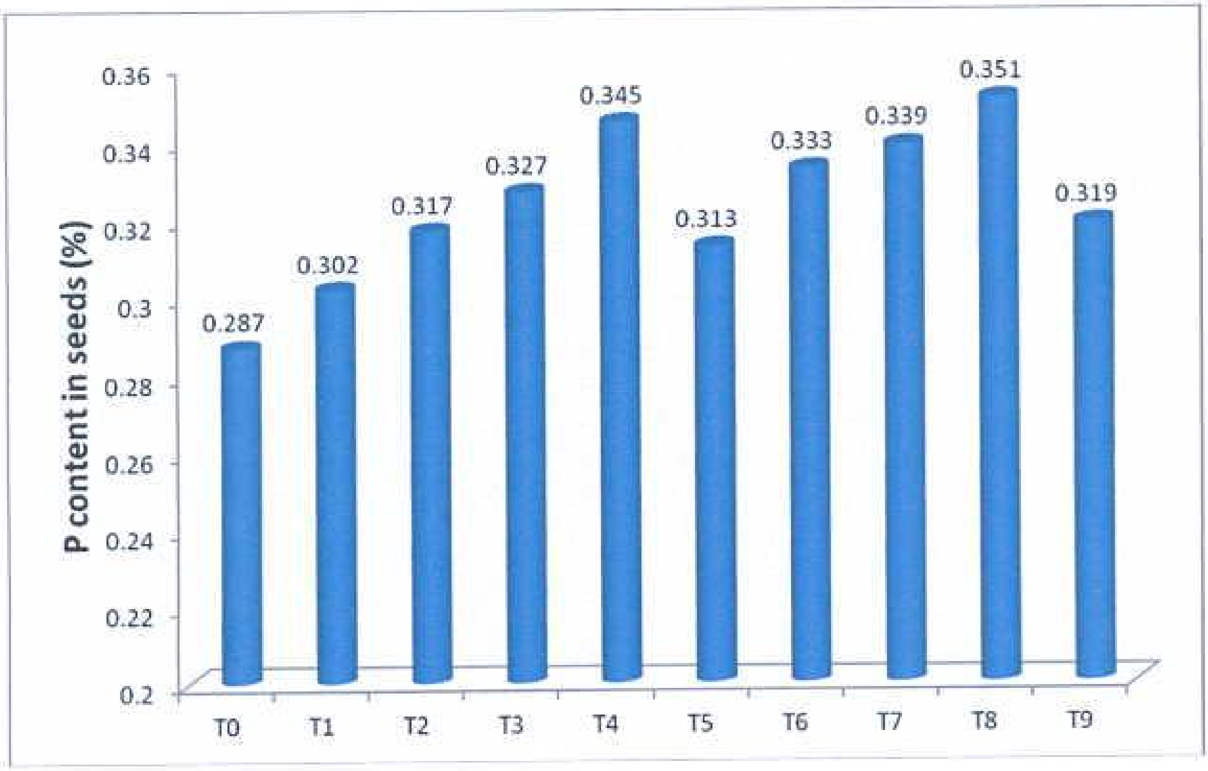


Figure 4.11 : Effect of various combinations of organic and inorganic fertilizers on phosphorus (P) content in seed (%)

4.13 Potassium content in seeds (%)

The data on potassium (K) content (%) in seed of mungbean as influenced by organic and inorganic fertilizers are presented in Figure 4.12 and Appendix V.

K content(%) of mungbean seed was differed significantly also due to the different combinations of organic and inorganic fertilizer doses. The highest K content (2.29 %) in seed was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and which was statistically similar with the application of Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers (T_7: 2.25 %) and followed by T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) (2.19 %), T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) (2.18 %) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (2.12 %) showed statistically same results while 100 % Inorganic Fertilizers(T_9) showed K content of 1.91 %. Among all the treatments, the lowest K content in seed was found from the treatment using no fertilizer (T_0 : 1.06 %).

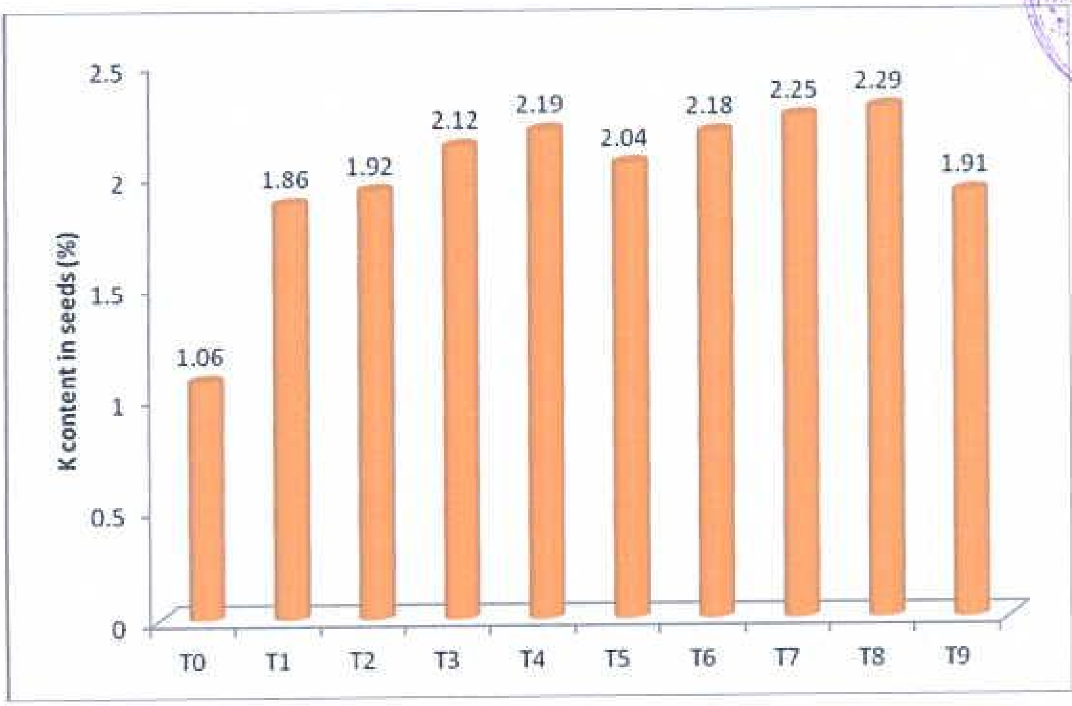


Figure 4.12 : Effect of various combinations of organic and inorganic fertilizers on potassium (K) content in seed (%)

CHAPTER 5

SUMMARY AND CONCLUSION

A field experiment was carried out during Kharif-I season of 2012 at Sher-e-Bangla Agricultural University (SAU) Farm in the Madhupur Tract (AEZ 28, Paleaustult) of Bangladesh with an objective of finding out the effect of different combinations of organic and inorganic fertilizers on growth and yield of one mungbean cultivar. . The experiment was designed with 10 treatments as followed: T_0 –Control, T_1 - Cowdung 10 t ha^{-1} (Recommended dose), T_2 - Cowdung @ 6 t ha^{-1} + 25 % of optimum dose of inorganic fertilizer, T_3 - Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer, T_4 – Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizer, T_5 - Vermicompost 7 t ha^{-1} (Recommended dose), T_6 - Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizer, T_7 - Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer, T_8 - Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer, T_9 - 100 % Inorganic Fertilizer. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each plot size was 3 m x 2 m. BARI Mung 5 was used in the study. A summary and conclusions results of this study are given below.

Significant variation was found in plant height, number of leaves and branches $plant^{-1}$ of BARI Mung 5 at harvest due to the various combinations of organic and inorganic fertilizers. Significantly higher plant height (53.79 cm) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was statistically similar with the application of Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer (T_7 : 52.85 cm) and followed by T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) (49.70 cm) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (46.05 cm).The lowest plant height at harvest was found from the treatment using no fertilizers (T_0 : 32.68 cm) and 100% inorganic fertilizers gave a plant height of 44.54 cm.

The highest number of leaves $plant^{-1}$ (18.78) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer) and it was statistically similar with T_7 *i.e.* Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer (18.67). T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) (16.86), T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (16.58) and T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) (16.47) gave statistically same results and also showed better performances in comparison to sole 100 % Inorganic Fertilizers (T_9) which gave 15.00 leaves $plant^{-1}$. On the other hand, T_0 (No fertilizers) treatment showed lowest number of leaves $plant^{-1}$ (14.80).

Significantly higher number of branches $plant^{-1}$ (3.85) was recorded in T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) which was statistically similar with T_8 *i.e.* Vermicompost @ 4 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (3.83) and T_7 (Vermicompost @ 4 t ha^{-1} + 50% of optimum dose of inorganic fertilizers) (3.79). T_0 (No fertilizer) treatment showed lowest number of branches plant^{-1} (3.19) at harvest (Figure 4.3). For the above parameters, T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) and T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) showed better results than sole 100% inorganic fertilizers (T_9).

Minimum days to 50% flowering (39.67) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was statistically similar with T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) and was closely followed by T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) (40.00). Better results were also showed by T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (40.23) while maximum days to 50% flowering was found from the treatment no fertilizers (T_0 :43.20).

Number of pods plant^{-1}, seeds pod^{-1} and seeds plant^{-1} showed significant variation due to the different combinations of organic and inorganic fertilizer doses. Maximum number of pods plant^{-1} (25.64) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) which was statistically similar with the application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (T_4: 25.51) and closely followed by T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (25.11) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (24.31). Maximum number of seeds pod^{-1} (12.07) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer) which was statistically similar with T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizer) (12.05) and was closely followed by T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (11.52). Maximum number of seeds $plant^{-1}$ (312.56) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer) and it was followed by T_4 (Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers) (299.27) and T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (295.17). Minimum numbers of pods $plant^{-1}$, seeds pod^{-1} and seeds $plant^{-1}$ was found from the treatment using no fertilizers (T_0). It was observed that, for the above parameters; T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) and T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) showed better results than sole 100% inorganic fertilizers (T_9).

Seed yield $plant^{-1}$ showed significant variation due to the different combinations of organic and inorganic fertilizer doses. Among all the treatments, the highest seed yield $plant^{-1}$ (14.63 g) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer) and it was statistically similar with application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (T_4:14.13 g) and closely followed by T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (12.57 g) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (12.07 g). Highest 1000-seed weight (35.56 g) was recorded in T_8

(Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was closely followed by the treatment of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers(T_4: 35.08 g), T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (34.22 g) and T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer) (33.26 g). Highest seed yield ha^{-1} was recorded in T_8 T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was statistically identical with the application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (T_4: 1104.20 kg) and followed by T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (985.55 kg) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (975.45 kg). Lowest seed yield plant^{-1}, 1000-seed weight and seed yield ha^{-1} was found from the treatment using no fertilizers(T_0). T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) and T_6 (Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizers) showed better results than sole 100% inorganic fertilizers (T_9). This improvement in seed yield components may be due to improved vegetative growth. The overall improvement in growth and yield components may be due to synergistic effect of combined use of organic and inorganic manures.

N, P and K contents of mungbean seed were differed significantly due to the different combinations of organic and inorganic fertilizer doses.The highest N content (3.39 %) in seed was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was followed by the application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers(T_4: 3.33 %) and T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (3.36 %) and T_3 (Cowdung @ 6 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (3.31 %). Highest P content in seed (0.351 %) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and it was closely followed by the application of Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers (T_4: 0.345%), and T_7 (Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers) (0.339 %). The highest K content in seed (2.29 %) was recorded in T_8 (Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizers) and which was statistically similar with the application of Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizers (T_7: 2.25 %). Lowest N, P and K contents of mungbean seed were found from the treatment using no fertilizer (T_0).

From the above results it can be concluded that combination of organic and inorganic fertilizers is more productive compare to sole use of inorganic fertilizers. We may be able to reduce the doses of inorganic fertilizers by combining the both. It is evident from the results that, in case of BARI Mung 5, Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer gave statistically same yield with Cowdung @ 6 t ha^{-1} + 75% of optimum dose of inorganic fertilizers. So, if we use these combinations, it will allow us to reduce the use of 25% inorganic fertilizers at least.

Recommendations for further researches :

1. Such studies should be conducted under different AEZs.

2. Research works may be initiated on the long term effects of organic fertilizers on soil fertility.

3. Other improved cultivars may be tested under such fertilizer combinations.

REFERENCES

Abbas, G, Abbas, Z, Aslam, M, Malik, A U, Ishaque, M and Hussain, F. 2011. Effects of organic and inorganic fertilizers on mungbean (*Vigna radiata* (L.)) yield under arid climate. *Intl. Res. J. Pl. Sci.* (ISSN: 2141-5447) Vol. 2(4) pp. 094-098.

Anonymous, (2003). *Pakistan Economic Survey.* Government of Pakistan, Economic Advisor's wing, Finance Division, Islamabad.

Appavu, K. and Saravanan, A. (1999). Effect of organic manures and tillage practices on soil physical properties and crop yields under sorghum – soybean cropping sequence. *Madras Agric. J.,* 86(10-12) : 561 – 565.

Appavu, K., Saravanan, A. and Mathan, K. K.(2000). Effect of organics and irrigation levels of soil physical properties and yield of crops under sorghum - soybean cropping system. *Madras Agric. J.,* 37 (1-3) : 50 – 53.

Aruna, P. and Narsa Reddy, S.(1999.) Response of soybean (*Glycine max*) to conjunctive use of organic and inorganic sources of nitrogen. *Indian J. Agric. Sci.*, 69(5) : 382 – 383.

Ashraf M., Mueen-Ud-Din M., and. Warrick., N.H. (2003.) Production efficiency of mungbean (*Vigna radiata* L.) as affected by seed inoculation and NPK application. *Intl. J. Agric. Biol.* 5(2): 179-180.

Aslam, M., Nazim., H; Zubair, M, Hussain, S B and Baloch, M S. (2010.) Integration Of Organic & Inorganic Sources Of PhosphorusFor

Increased Productivity Of Mungbean (*Vigna radiata* L.). *Pak. J. Agri. Sci.*, Vol. 47(2): 111-114.

Aveyard J. 1988. Land degradation: Changing attitudes - why? Journal of Soil Conservation, New South Wales 44:46–51.

BARI (Bangladesh Agricultural Research Institute),(2008.) *Annual Report of 2008-2009*. Bangladesh Agriculture Research Institute, Gazipur-1701, Bangladesh.

BARC (Bangladesh Agricultural Research Council). (2005). Fertilizer Recommendation Guide. BARC Soils Pub. No. 45. Bangladesh Agril. Res. Coun., Dhaka, Bangladesh.

BBS (Bangladesh Bureau of Statistics). (2005). Statistical year book of Bangladesh. Statistical Division, Ministry of planning. Govt. of the Peoples' Republic of Bangladesh, Dhaka. P. 163-172.

BBS (Bangladesh Bureau of Statistics). (2007). Monthly Statistical Bulletin, Bangladesh. June, 2007. Planning Div., Ministry of planning. Government of the peoples' Republic of Bangladesh. Dhaka. P. 57-143.

Bending, G.D., Mary, K.T. and Julie, E.J.(2002). Interaction between crop residues and soil organic matter, quality and functional diversity of soil microbial communities. *Soil Biol. Biochem. J.* 34(8):1073-1083.

Bhuiyan, M. A. H., Mian, M. H., Islam, M. S. and Islam, M. R.(2003). Effects Of Integrated Use Of Fertilizers And Manure On Yield And Nutrient Uptake Of T.Aus Rice And Mungbean In The Wheat-T.Aus Rice/Mungbean-T.Aman Rice Cropping Pattern.*Bangladesh J. Agril.* Res. 36(4): 697-710.

Bilal M. (1994). Effect of sowing dates on growth and yield of three varieties of mungbean (*Vigna radiata* L.). MSc. Thesis. Deptt. Agron. Univ. of Agric. Faisalabad.

Channabasavanna, A. S., Yelamali, S. G. and Biradar, D. P.,(2001) Response of rice (*Oryza sativa*) to sources of organic manures and levels of zinc phosphate in deepblack soils. *Indian J. Agron.,* 46(33) : 458 – 461.

Channaveerswami, A. S.,(2005) Studies on integrated nutrient management and planting methods on seed yield and quality of groundnut. *Ph.D. Thesis,* Univ. Agric. Sci., Dharwad, Karnataka (India).

Chinnamuthu, C. R. and Venkatakrishnan. (2001). Effect of integrating inorganic fertilizer with vermicompost and vescular arbuscular mycorrhizae (VAM) on the productivity of sunflower. *Madras Agric .J.*,88 (7-9) : 424 – 427.

Choudhry A U. (2005). Higher-Value Organics, pp: 35–8. Pakistan and Gulf Economist Potter, N.N. and J.H. Hotchkiss. 1997. Food Science CBS Publishers, New Delhi, India pp: 403.

Ghosh, A.B., Bajaj, J.C., Hasan R., Singh, D.(1983). A Laboratory Manual.Division of Soil Science and Agricultural Chemistry. IARI, New Delhi 110012. pp. 36-45.

Ghosh, B. N., Prakash, V. and Singh, R. D.,(2001). Micronutrient status in soybean (*Glycine max*) wheat (*Triticum aestivum*) Cropping system in Kumaon region of Uttaranchal. *Indian J. Agric. Sci.* 71(2) : 149 – 152.

Giraddi, R. S.,(2001,) *Vermi technology* (in Kannada), CAPART, GOI & University of Agricultural Sciences, Dharwad, pp. 1-60.

Giraddi, R. S., Babalad, H. B. and Chandargi, D. M.(2006) Vermicompost technology. *Technical Bulletin*, University of Agricultural Sciences, Dharwad and DBT, New Delhi, pp. 1-6.

Govindan, K. and Thirumurugan, V., (2005,) Synergistic association of *Rhizobium* with phosphate solubilizing bacteria under different sources of nutrient supply on productivity and soil fertility in soybean (*Glycine max*). *Indian J. Agron.*, **50**(3) : 214 – 217.

Hayat, R.., Ali, S. , and Khan ,F.S., (2004) Effect of nitrogen and *Rhizobium* inoculation on yield, N-uptake and economics of mungbean. Intl. J. Agric. Biol. 6(3): 547-551.

Jackson, M L. 1973. Soil chemical analysis. Prentice-Hall of India, Pvt. Ltd.. pp. 326-338.

Jain, R. C. and Tiwari, R. J. (1995) Influence of farm yard manure and sugar press mud on yield and nutrient content of soybean (*Glycine max* L. Merill) in medium black soils of Madhya Pradesh. *Crop Res., 9*(2) : 215 – 217.

Kale, R. D., Banok, V., Sunitha, N. and Gangadhar, H. J., (1994) Adloc scheme on promotion of vermicomposting for production of organic fertilizers. ICAR, New Delhi. *Tech. Rep.*, 1994, Univ. Agric. Sci., Bangalore, Karnataka.

Karmegam N and Daniel T.(2000)Effect of biodigested slurry and vermicompost on the growth and yield of cowpea [*Vigna unguiculata* (L.)]. *Environment and Ecology* 18(2):367–370.

Kathireshan, G., Manickam, G. and Gyanmurthy, P. (1999) Effect of enriched farm yard manure and time of gypsum application on growth and yield of soybean (*Glycine max*). *J. Oilseed Res.,* 16(2) : 348 – 349.

Kayani, A.K., Qureshi, S., Kayani, W.K., Qureshi, R. ,Waheed, A., Arshad,M,. Gulfraz M.., and Laghari,. M.K.,(2010) Assessment of wheat yield potential after cropping mungbean (*Vigna radiata* (l.) Wilczek). *Pakistan J. Botany.* 42(3): 1535-1541.

Malik, M.F. Saleem,M.F ,Ali.A., and Mahmood I.,(2003.) Effect of nitrogen and phosphorus application on growth, yield and quality of mungbean (*Vigna radiata* L.). *Pakistan J. Agril. Sci.* 40(3/4): 133-136.

Malligawad, L. H., Patil, R. K., Vidyadhar, K. and Giriraj, K., (2000), Effect of fertility management practices in groundnut. *Karnataka J. Agric. Sci.,* 13(2) : 299-305.

Ministry of Agriculture (MoA),(2005). *Hand Book of Agricultural Statistics, December, 2005*, p: 14. Ministry of Agriculture, Government ofPeople's Repub., Bangladesh, Dhaka.

Mohammad,W,. Shehzadi W., Shah S.M and Shah Z..(2010). Effect of tillage and crop residues management on mungbean (*Vigna radiata* (l.) Wilczek) crop yield, nitrogen fixation and water use efficiency in rainfed areas. *Pakistan J. Botany.* 42(3): 1781-1789.

Moller K. (2009). Influence of different manuring systems with and without biogas digestion on soil organic matter and nitrogen inputs, flows and budgets in organic cropping systems. *Nutr. Cycling Agroecosyst.* 84: 179-202.

Oad, F.C. and Buriro. U.A., (2005). Influence of different NPK levels on the growth and yield of mungbean. *Indus J. Plant Sci.* 4(4): 474-478.

Panda,P.K., Sen H., Mukherjee, A., and Satapathy, M.R., (2003.) Studies on the effect of NK fertilization on the performance of yambean-pigeonpea intercropping system and its residual effect on the succeeding mung. *Legume Res.* 26(4): 235-241.

Patel, J.J., Mevada, K.D. and Chotaliya, R.L. (2003). Response of summer mungbean to date of sowing and level of fertilizers. *Indian J. Pulses Res.* 16(2): 122-124.

Patil, B. S.,(1998), Studies on integrated nutrient management in summer groundnut (*Arachis hyphogea* L.). *M. Sc. (Agri). Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).

Pawar, R B, Patil, C, V, Prakash, S, S and Yeledhalli, N, A. 1995. Dynamics of earthworm soil - plant relationship in semiarid tropics. In :*Abstracts : Seminar on Conservation of Natural Resources for Sustainable Production*, 16–17 November 1995. Univ. Agric. Sci., Dharwad, Karnataka. pp. 37.

Rahman, M A. and Ali, M.O. (2007).The Causes of Decrease in Pulse Production and its Remedy, p: 5. Krishi Biplop (A fortnightly magazine in Bengali), Published on 15 November, 2007,. 279 East Hazipara, Rampura, Dhaka-1219, Bangladesh.

Rajkhowa, D. J., Saikia, M. and Rajkhowa, K.M.(2000), Effect of vermicompost with and without fertilizer on Greengram. *Legume Res.*, 25(4) : 295-296.

Ramamurthy, V. and Shivashankar, K.,(1996), Effect of organic matter and phosphorus on growth and yield of soybean (*Glycine max*).*Indian J. Agron.*, 41(1):65 – 68.

Rana, K.S. and Choudhary, R.S., (2006.) Productivity, nitrogen uptake and water use in maize (*Zea mays* L.) + mungbean intercropping system as affected by nitrogen levels under rainfed conditions. *Crop Res. Hisar.* 32(3): 306-308.

Raundal, P. U., and Sabale, R. N., (2000.) Grain quality and economics of greengram-wheat cropping system. Journal of Maharashtra Agricultural Universities 2000 Vol. 25 No. 1 pp. 98-99.

Rautaray, S, Ghoshm B. C .and Mittra, B.N.(2003.) Effect of Fresh , organic wastes and chemical fertilizers on yield, nutrient uptake, heavy metal content and residual fertility in a Rice–Mustard cropping sequence under acid leteritic soils. *Bioresource Tech.* 90(3):275-283.

Reddy.R., Reddy, M.A.N,. Reddy .,Y. T. N, Reddy, N. S., Anjanappa. N, and Reddy ,R. (1998). Effect of organic and inorganic sources of NPK on growth and yield of pea [*Pisum sativum* (L)]. *Legume Research* 21(1):57–60.

Reddy, S. G., Maruthi, V. and Sreerekha, M.,(2004,) Assessing the method of application of farm yard manure in dry land crops. *Indian J. Agron.,* 49(2) : 104 – 107.

Roy, D. K. and Singh,(2006), Effect of level and time of nitrogen application with and without vermicompost on yield, yield attributes and quality of malt barley (*Hordeum vulgare*). *Indian J. Agron.,* 51(1) : 40 – 42.

Russel, D.F. (1986). MSTAT-C Package Programme.Dept. of Crop and Soil Science, Michigan State University, USA.

Sangakhara, U.R.(2003.)Nitrogen dynamics, growth and yield of a cereal legume intercropping system as affected by effective microorganisms and Kyusei nature farming. Seventh Intl. Conf. Kyusei Nature Farming Proc. Conf. held at Christchurch, New Zealand, 15-18-January 2002. pp. 77-81.

Sangakkara,R., Amarasekera ., P. and Stamp. P. (2011). Growth, yields, and nitrogen-use efficiency of maize (*Zea mays* L.) and mungbean (*Vigna radiata* L. Wilczek) as affected by potassium fertilizer in Tropical South Asia.*Communications in Soil Sci. and Plant Analysis.* 42(7): 832-843.

Sangakkara, U. R., Pietsch, G, Gollner M. and Freyer, B.(2005). Impact of Organic Matter and Method of Addition on Selected Soil Parameters, Growth and Yields of Mungbean Grown an a Minor Season in the Humid Tropics. Faculty of Agriculture, University of Peradeniya, Peradeniya 20400, Sri Lanka.

Sharma, S., Daramwal,N.S., Sharma,C.R., and Upadhyay, R.G.,(. 2001). Influence of various doses of nitrogen and phosphorus on protein content, yield and its attributes of mungbean [*Vigna radiata* (L.) Wilczek]. *Res. Crops.* 2(2): 108-111.

Shukla, L., And Tyagi, S. P.,(.2009.)Effect of integrated application of organic manures on soil parameters and growth of mungbean (*Vigna radiata*).*The Indian Journal of Agricultural Sciences.*Vol 79, No 3.

Singh, M. (1999). Soil and plant sample analysis. *Indian* J. *Agric. Sci.,* 69: 379-381.

Srinivas, M. and. Shaik ,M.(2002.) Effect of *Rhizobium* inoculation and different levels of nitrogen and phosphorus on yield and economics of greengram (*Vigna radiata* L. Wil.). *Crop Res*. 24(3): 463-466.

Sultana, S., Ullah, J., Karim ,F., and Asaduzzaman. (2009). Response of mungbean to integrated nitrogen and weed management.*American Eurasian J. Agron*. 2(2): 104-108.

Tejada M, Hernandez MT and Garcia C. (2009). Soil restoration using composted plant residues: Effects on soil properties. *Soil and Tillage Res*. 102: 109-117.

Tickoo, J.L.,. Chandra, N., Gangaiah, B., and Dikshit, H.K., (2006.) Performance of mungbean (*Vigna radiata*) varieties at different row spacing and nitrogen-phosphorus fertilizer levels. *Indian J. Agril. Sci*. 76(9): 564-565.

Vinay S. (2006). Productivity and economics of rice (*Oryzae sativa*) wheat (*Triticum aestivum*) cropping system under integrated nutrient supply system in recently reclaimed sodic soil. *Indian J. Agron*.51(2): 81-84.

Wani, S .P., and Lee ,K. K.,(1992.) Biofertilizers role in upland crops production. Pages 91–112 *in* Fertilizers, organic manures, recyclable wastes and biofertilisers (Tandon HLS, ed.). New Delhi, India: Fertilizer Development and Consultation Organisation.

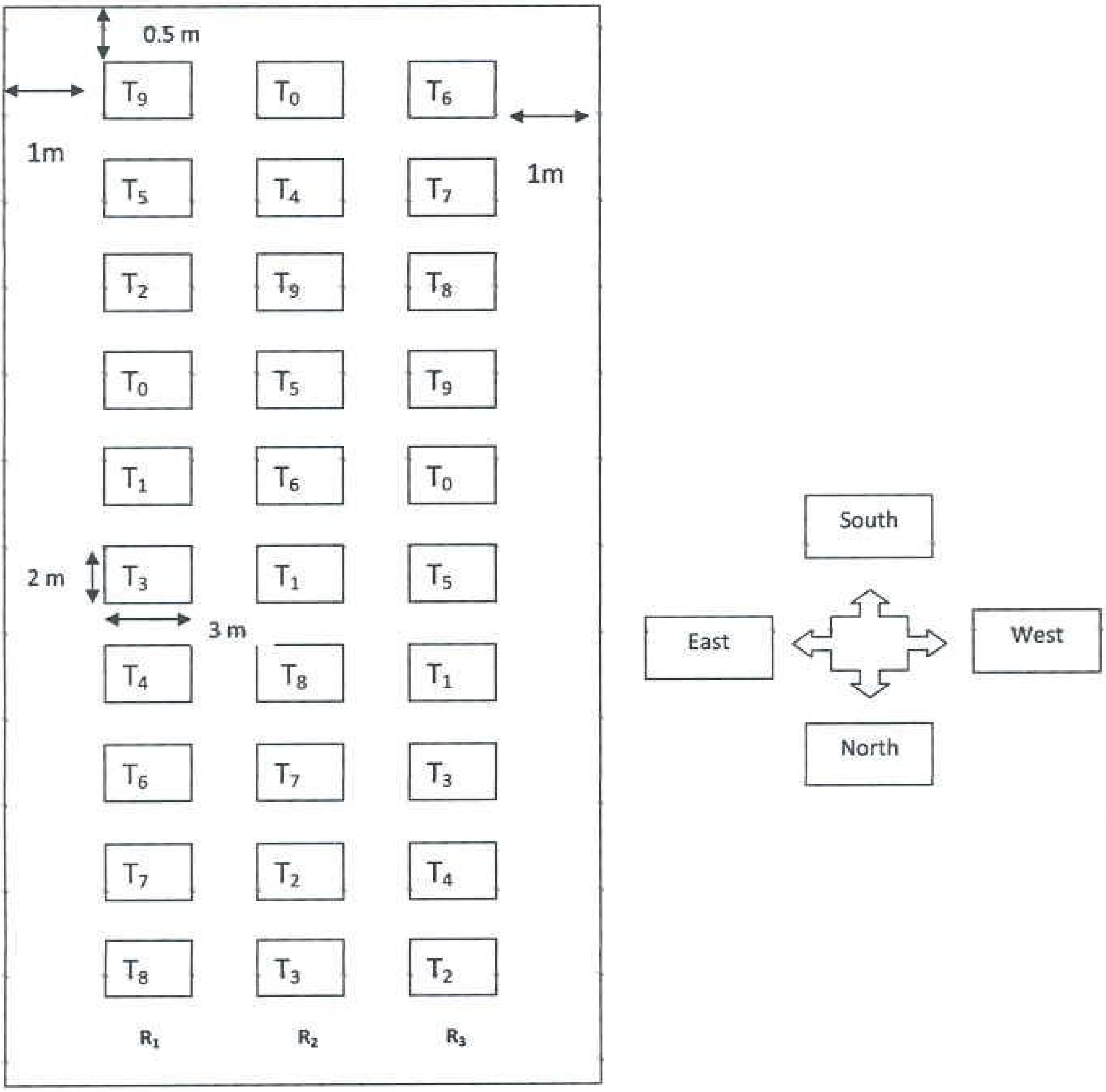
Wani S P, Rupela. O. P. and Lee, K .K. (1995). Sustainable agriculture in the semi-arid tropics through biological nitrogen fixation in grain legumes. *Plant and Soil* 174:29–49.

Wolf, B. (1982.)A comprehensive system of leaf analyses and its use for diagnosing crop nutrient status. *Commun. Soil Sci. Plant Anal.* 13:1035-1059.

Yaqub, M., Mahmood,T.,Akhtar, M., Iqbal, M.M., and Ali. S., (2010). Induction of mungbean [*Vigna radiata* (L.) Wilczek] as a grain legume in the annual rice-wheat double cropping system. *Pakistan J. Botany*. 42(5): 3125-3135.

APPENDICES

Appendix I : Layout of the experiment



Appendix II : Effect of various combinations of organic and inorganic fertilizer on plant height, number of leaves and number of branches plant^{-1} (at harvest)

Treatments	Plant height	Number of leaves plant^{-1}	Number of branches plant^{-1}
T_0	32.68 d	14.80c	3.19 c
T_1	38.74 c	15.00 bc	3.40 bc
T_2	45.72 b	15.33 bc	3.52 a-c
T_3	46.05 b	16.58 a-c	3.69 ab
T_4	49.70 b	16.86 a-c	3.85 a
T_5	45.75 b	15.40 bc	3.60 ab
T_6	47.23 b	16.47 a-c	3.69 ab
T_7	52.85 a	18.67 a	3.79 a
T_8	53.79 a	18.78 a	3.83 a
T_9	44.54 b	15.00 bc	3.54 a-c
LSD	3.6407	2.62	0.3612
CV (%)	2.71	5.80	4.00
Level of Significance	**	*	**

** = Significant at 1% level, * = Significant at 5% level

T_0 –Control,

T_1 - Cowdung 10 t ha^{-1} (Recommended dose)

T_2 - Cowdung @ 5 t ha^{-1} + 25 % of optimum dose of inorganic fertilizer

T_3 - Cowdung @ 5 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer

T_4 – Cowdung @ 5 t ha^{-1} + 75% of optimum dose of inorganic fertilizer

T_5 -Vermicompost 7 t ha^{-1} (Recommended dose)

T_6 - Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizer

T_7 - Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer

T_8 - Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer

T_9 - 100 % Inorganic Fertilizer

Appendix III : Effect of various combinations of organic and inorganic fertilizer on number of pods plant^{-1}, seeds pod^{-1} and seeds plant^{-1}

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	Number of seeds plant^{-1}
T_0	15.28 e	10.05 e	188.13 h
T_1	18.38 d	10.89 c-e	228.58 fg
T_2	21.31 c	10.95 cd	246.65 f
T_3	24.31 ab	11.06 b-d	269.64 c-e
T_4	25.51 a	12.05 a	299.27 ab
T_5	21.35 c	10.82 c-e	228.87 fg
T_6	23.17 a-c	11.09 b-d	270.84 cd
T_7	25.11 ab	11.52 a-c	295.17 ab
T_8	25.64 a	12.07 a	312.56 a
T_9	22.64 bc	10.39 de	267.25 c-e
LSD	2.5216	0.8315	21.4705
CV (%)	6.92	2.51	2.39
Level of Significance	**	**	**

** = Significant at 1% level, * = Significant at 5% level

T_0 -Control,

T_1 - Cowdung 10 t ha^{-1} (Recommended dose)

T_2 - Cowdung @ 5 t ha^{-1} + 25 % of optimum dose of inorganic fertilizer

T_3 - Cowdung @ 5 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer

T_4 – Cowdung @ 5 t ha^{-1} + 75% of optimum dose of inorganic fertilizer

T_5 -Vermicompost 7 t ha^{-1} (Recommended dose)

T_6 - Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizer

T_7 - Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer

T_8 - Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer

T_9 - 100 % Inorganic Fertilizer

Appendix IV : Effect of various combinations of organic and inorganic fertilizer on seed yield $plant^{-1}$, 1000-seed weight and seed yield ha^{-1}

Treatments	Seed yield $plant^{-1}$ (g)	1000-seed weight (g)	Seed yield (kg ha^{-1})
T_0	7.94 f	29.45 f	699.05 c
T_1	9.35 e	32.42 c-e	824.58 bc
T_2	11.07 c	33.19 b-d	934.39 b
T_3	12.07 b	34.22 a-c	975.45 b
T_4	14.13 a	35.08 ab	1104.20 a
T_5	9.67 de	29.70 f	931.98 b
T_6	11.09 c	31.96 de	937.53 b
T_7	12.57 b	33.26 b-d	985.55 b
T_8	14.63 a	35.56 a	1127.46 a
T_9	11.05 c	30.67 ef	909.76 b
LSD	0.79	2.1103	130.702
CV (%)	2.89	11.5	5.17
Level of Significance	**	**	**

** = Significant at 1% level, * = Significant at 5% level

T_0 –Control,

T_1 - Cowdung 10 t ha^{-1} (Recommended dose)

T_2 - Cowdung @ 5 t ha^{-1} + 25 % of optimum dose of inorganic fertilizer

T_3 - Cowdung @ 5 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer

T_4 – Cowdung @ 5 t ha^{-1} + 75% of optimum dose of inorganic fertilizer

T_5 -Vermicompost 7 t ha^{-1} (Recommended dose)

T_6 - Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizer

T_7 - Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer

T_8 - Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer

T_9 - 100 % Inorganic Fertilizer

Appendix V : Effect of various combinations of organic and inorganic fertilizer on N, P, K content in seeds

Treatment	**N content in seeds (%)**	**P content in seeds (%)**	**K content in seeds (%)**
T_0	3.19 g	0.287 g	1.06 d
T_1	3.24 fg	0.302 fg	1.86 c
T_2	3.26 ef	0.317 d-f	1.92 c
T_3	3.31 b-e	0.327 b-e	2.12 ab
T_4	3.33 b-d	0.345 ab	2.19 ab
T_5	3.26 ef	0.313ef	2.04 bc
T_6	3.28 d-f	0.333 a-e	2.18 ab
T_7	3.36 ab	0.339 a-c	2.25 a
T_8	3.39 a	0.351 a	2.29 a
T_9	3.30 c-e	0.319 c-f	1.91 c
LSD	0.0502	0.0185	0.1755
CV (%)	5.23	6.87	3.26
Level of Significance	**	**	**

** = Significant at 1% level, * = Significant at 5% level

T_0 –Control,

T_1 - Cowdung 10 t ha^{-1} (Recommended dose)

T_2 - Cowdung @ 5 t ha^{-1} + 25 % of optimum dose of inorganic fertilizer

T_3 - Cowdung @ 5 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer

T_4 – Cowdung @ 5 t ha^{-1} + 75% of optimum dose of inorganic fertilizer

T_5 -Vermicompost 7 t ha^{-1} (Recommended dose)

T_6 - Vermicompost @ 4 t ha^{-1} + 25% of optimum dose of inorganic fertilizer

T_7 - Vermicompost @ 4 t ha^{-1} + 50 % of optimum dose of inorganic fertilizer

T_8 - Vermicompost @ 4 t ha^{-1} + 75 % of optimum dose of inorganic fertilizer

T_9 - 100 % Inorganic Fertilizer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