EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF SOYBEAN (*Glycine max* L.)

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*This is to certify that thesis entitled, "**EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF SOYBEAN (Glycine max L.)**" submitted to the Department of Soil science, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE (MS) in SOIL SCIENCE**, embodies the result of a piece of bona-fide research work carried out by **NASRIN SULTANA**, **Registration no. 15-06675** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledge.

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DEDICATED TO
MY
BELOVED FATHER

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EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF SOYBEAN (*Glycine max* L.)

ABSTRACT

An experiment was conducted at Sher-e-Bangla Agricultural University Farm Dhaka, Bangladesh to study the effect of organic and inorganic fertilizers on growth and yield of soybean (*Glycine max* L.) during the period from November 2021 to March 2022 (Rabi season). The experiment was laid out in randomized complete block design (RCBD) with seven organic and inorganic fertilizer treatments *i.e*. T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost. For the purpose of evaluating the experimental outcomes, data on various parameters were statistically analyzed for evaluation of the different treatment effects. Experimental result revealed that the highest number of branches $plant^{-1}$ (3.46), fresh weight $plant^{-1}$ (10.60 g), number of pods $plant^{-1}$ (27.53), pod length (4.21 cm), seeds pod^{-1} (3.97), 1000-seed weight (115.67 g), seed yield (1.86 t ha^{-1}), stover yield (2.17 t ha^{-1}), biological yield (4.03 t ha^{-1}) and harvest index (46.15 %). were found in T_4 treatment. On the other hand, the lowest value of these properties were obtained in T_1 (100% RCF) treatment. Soil pH, organic matter content, N, P, K, S of post harvest soil at surface (0-15 cm) layer, varied significantly amon different treatments. The highest pH in post harvest soil of soybean (6.27), organic matter content (1.86 %), total nitrogen content (0.069 %), available phosphorus (30.07 ppm), available potassium (0.171 meq/100 g soil) and available sulphur (17.66 ppm) were recorded with T_4 (75% RCF + 4 t ha^{-1} vermicompost) treatment whereas the lowest value were found in T_1 treatment. Therefore, based on the above findings, it could be conclude that the use of vermicompost not only reduce the recommended doses of inorganic fertilizer but also improves the soil physico chemical properties and availability of nutrients in soil in the long run sustaining the soil productivity and improve growth and yield of soybean.

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LIST OF ABBREVIATION AND ACRONYMS

Abbreviations	Full word
AEZ	Agro-Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
FAO	Food and Agricultural Organization
N	Nitrogen
et al.	And others
TSP	Triple Super Phosphate
MOP	Muriate of Potash
RCBD	Randomized Complete Block Design
ha^{-1}	Per hectare
g	gram (s)
kg	Kilogram
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources and Development Institute
wt	Weight
LSD	Least Significant Difference
^0C	Degree Celsius
NS	Not significant
Max	Maximum
Min	Minimum
%	Percent
NPK	Nitrogen, Phosphorus and Potassium
CV%	Percentage of Coefficient of Variance
Vc	Vermicompost

CHAPTER I

INTRODUCTION

Soybean (*Glycine max* L.) is the most widely cultivated legume around the world because of its versatile uses and economic importance (Liu *et al.,* 2020). It is a prominent source of proteins and edible oil, it has valuable uses as food, feed and oil seed crop (Liu *et al*., 2020). Soybean seed contains about 18 to 22% oil and 38 to 56% vegetable protein with favorable amino acid (USDA, 2018). Globally, soybean is responsible for about 61% of total international oilseed production and occupied 6% of the world's cultivable area (SoyStat, 2019). According to USDA (2021), about 391.40 million tons of soybean produced around the world from the cultivated area of 121.69 million hectares with an average yield of 2.76 ton ha^{-1}. The United States, Brazil and Argentina are the leading soybean producing countries in the world and responsible for 81% of the total production.

In Bangladesh, 0.986 million tons of soybean produced in 59,445 hectares land area (USDA, 2021). Whereas according to BBS (2021) the total soybean cultivated area was 57646.26 hectares and total production was 91176.59 M. tons in Bangladesh. The demand for soybean as poultry feed was 1.8-2 million tons in 2021 (BBS, 2021). In Bangladesh, there are 80 oil refineries with a total production capacity of 2.9 million tons. But only 48% of production capacity is utilized, so there is a huge demand for soybean in these industries (USDA, 2017).

The soybean yield is restricted due to the lack of developed varieties and proper soil and crop management practices. Organic fertilizers not only improve the soil physical and biological properties, it also improves the efficacy of chemical fertilizers (Alam *et al.,* 2010). Continuous use of chemical fertilizer has adverse effect on soil fertility and its health. It leads to reduction in crop yield and resulted in imbalance of nutrient in soil (Pahalvi *et al*., 2021).

Organic farming does not require the incur use of expensive agrichemicals that are not permitted. Organic fertilizers are either created in situ by green manuring and leguminous crop rotation or on-farm via composting and worm farming.

Organic manures act not only as a source of nutrient and organic matter, but also increase size, biodiversity and activity of microbial population in soil and many other changes related to physical, chemical and biological parameters of soil (Yadav *et al*., 2022). Organic matter provide good subtrate for growth of micro-organism, maintain soil fertility and its physical properties. Nutrient in organic manure are released slowly and stored for longer time in soil. It ensure longer residual effect and persistence of nutrient availability (Shaji *et al*., 2021).

One of the best organic materials for increasing crops yield is vermicompost. It is highly efficient organic manure, which is made from the farm waste and involves the advantages of increase in production and improve the quality of agricultural produce. It increases the value of land by increasing the NPK content, water holding capacity and productivity (Cao *et al*., 2021). It contains substances which help in building soil structure, stimulate plant growth (Theunissen *et al*., 2010). It helps to suppress plant disease and insect pest attack. It also provides macro and micronutrients to the soil and enhances soil aeration for growth and development of crop (Lamichhane, 2017).

The organic carbon in vermicompost releases the nutrients slowly and steadily into the system and enables the plant to absorb these nutrients. The soil enriched with vermicompost provides additional substances that are not found in chemical fertilizers (Ramnarain *et al.* 2019). Although various reports claim that using organic fertilizer increases plant stability in soil, maintains the nutrient cycle, reduces pollution, and modifies the physico-chemical properties of soil, its use is less common today for a variety of reasons.

The effects of organic fertilizers in this regard are greater than those of pure chemical fertilizers (Behera *et al.*, 2022). Therefore, emphasis is to be given on growing legume, oilseed, pulse supplied with organic inputs to improve physical, chemical, biological characteristics of soil and thereby increasing the soil productivity for maintaining the sustainable crop yield.

Recently the use of organic material as fertilizer along with chemical fertilizer for crop production have received attention for sustainable crop productivity. Considering the above facts the present investigation entitled “Effect of organic

and inorganic fertilizers on growth and yield of Soybean (*Glycine max*, L.)" is undertaken with following objectives.

Objectives:

i. To study the effect of vermicompost and inorganic fertilizer on growth and yield performance of soybean.
ii. To find out suitable combined organic and inorganic fertilizer dose for maximum growth and yield of soybean.

CHAPTER II

REVIEW OF LITERATURE

Several researchers worked to study the effect of different organic manures on growth and yield. Their findings are used as base for present investigation entitled as "Effect of organic and inorganic fertilizers on growth and yield of Soybean (*Glycine max* L.)". The previous research findings are reviewed and presented under following heads.

2.1 Effect of organic manures on growth and yield of soybean

2.2 Effect of inorganic fertilizers and vermicompost on growth and yield of soybean

2.3 Effect of organic and inorganic fertilizers on available NPK status in soil

2.1 Effect of organic manures on growth and yield of soybean

Aritonang and Sidauruk (2020) conducted an experiment to investigate the effect of vermicompost on soybean growth. The vermicompost had four levels: K_0 = no vermicompost, K_1 = 60 g, K_2 = 90 g, and K_3 = 120 g, with each treatment replicated three times. The results revealed that the amount of vermicompost applied had a significant impact on the number of branches, number of pods, and seed weight of soybean.

Awasthi *et al.* (2020) discovered that vermicompost, along with three sprays of vermiwash, significantly influenced soybean plant height (cm), number of leaves, number of branches at various growth stages.

Ingle *et al.* (2018) showed that the application of FYM @ 5.0 t ha^{-1} (M_1) produced significantly highest number of pods $plant^{-1}$ (64.50), number of seeds pod^{-1} (2.71), seed yield $plant^{-1}$ (12.90 g), 1000 seeds weight (15.50 g), seed yield (1700 kg ha^{-1}) and stover yield (2000 kg ha^{-1}), which was higher over control (M_0) and also application of vermicompost @ 0.25 t ha^{-1} (M_2) found statistically equivalent to FYM @ 5 t ha^{-1} in respect of seed yield $plant^{-1}$, test weight, seed yield (kg ha^{-1}) and stover yield (kg ha^{-1}).

Morya *et al.* (2018) in an field experiments revealed that application of 50 percent recommended dose of fertilizer (10:30:20 kg NPK ha^{-1}) + 50 percent Vermicompost (2.5 t ha^{-1}) recorded significantly increased the growth characters of soybean *viz.*, plant height, number of branches, dry matter production, number of nodules and dry weight of nodules.

Shariff *et al.* (2017) observed the effect of soil amendments and organic foliar sprays on crop growth, seed yield and quality of green gram. Application of FYM + Vermicompost + glyricidia leaf manure equivalent to 100% RDP and foliar spray of panchagavya (3%) at flower initiation stage and 15 days after flowering (DAF) recorded significantly higher number of pods per plant, pod length, number of seeds per pod , seed yield.

Khare *et al.* (2016) observed that the applications of organic manure (50 per cent farmyard manure + 50 percent vermicompost) maximized the soybean growth and yield under subabul trees. Therefore, it may be concluded that 50 percent farmyard manure + 50 percent vermicompost can be recommended for growing soybean under subabul based agroforestry system for obtaining better growth and yield.

Patil and Udmale (2016) reported that application of Farm Yard Manure (50 %) + Vermicompost (50 %) + Jeevamrut 2 times recorded significantly higher values of plant height, number of branches, number of leaves, leaf area, root nodules, grain and straw yield of soybean.

Kaur *et al.* (2015) in their study reported that the vermicompost has an effective role in improving growth and yield of different field crops, including vegetables, cereals and fruit crops.

Moghadam *et al.* (2014) conducted investigation to evaluated the effect of different level of vermicompost on soybean. Result showed that highest quantity of seed yield obtained with the application of vermicompost at the rate of 10 tons $acre^{-1}$.

Rana and Badiyala (2014) studied the effect of integrated nutrient management on seed yield, quality and nutrient uptake of soybean (*Glycine max* L.) under mid hill conditions at C.S.K Himachal Pradesh Krishi Vishwavidyalya, Palampur. They

reported that use of FYM at the rate of 2.5 t ha^{-1} + V.C at the rate of 1.25 t ha^{-1} recorded significantly higher plant height (76 cm) at harvest, leaf area index (5.7) at 60 DAS, pods $plant^{-1}$ (63.1), seeds $pods^{-1}$ (2.56), seed yield (18.20 q ha^{-1}) and straw yield (32.50 q ha^{-1}).

Devi *et al.* (2013) showed that integration of 75 per cent recommended dose of fertilizer with vermicompost @ 1 ton ha^{-1} and Phosphate Solubilizing Bacteria recorded higher plant height, number of nodules $plant^{-1}$, number of pods $plant^{-1}$ in soybean.

Laharia *et al.* (2013) conducted a field experiment to study the effect of organic sources on soil fertility, nutrient uptake and yield of soybean (*Glycine max* L.) soybean at P.D.K.V, Akola (M.S) and reported that application of 100% RDN through V.C.+ jeevamrut recorded highest seed yield (16.70 q ha^{-1}) and straw yield (30.27 q ha^{-1}).

Patil *et al.* (2012) observed that the highest yield of soybean seed (16.70 q ha^{-1}), haulm (30.27 q ha^{-1}) and highest test weight (17.47 g) were recorded by the treatment application of 100 percent (Recommended dose of nitrogen) RDN through vermicompost + jeevamrut and which was statistically at par with the treatment 100 percent RDN through vermicompost and 100 percent RDN through FYM + jeevamrut. The increase in yield might be due to application of organic sources. These organic sources may create maximum nutrient availability to plant.

Mahendra and Narendra (2012) revealed that treatment having FYM @ 5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} + Vermiwash @ 10 per cent + 50 per cent NPK recorded maximum nodule number (49 and 53 $plant^{-1}$) and plant dry weights (30.33 and 40.33 g $plant^{-1}$) at 60 DAS, seed yields (3,210 and 3,231 kg ha^{-1}) respectively in the year 2006 and 2007.

Azarpour *et al.* (2012) worked on the effects of vermicompost application and seed inoculation with biological nitrogen fertilizer under different plant densities in soybean. They found that the interaction effect of nitroxin inoculation, vermicompost application and plant density management on seed yield, 100 seeds weight and number of pods per plant showed significance differences at 1% probability level and on other traits was non- significant. The highest seed yield

was obtained from treatment of seeds inoculation with nitroxin, 10 t ha^{-1} vermicompost application and 65 plants per m^2 with 3831 kg ha^{-1}.

Ramesh *et al.* (2009) conducted a field experiment to study the production potential, nutrient uptake, soil fertility and economics of soybean (*Glycine max* L.) based cropping systems under organic, chemical and integrated nutrient management practices at IISS, Bhopal (M.P) and reported that application of organic manures recorded highest pods $plant^{-1}$ (28.3), seeds pod^{-1} (2.7) and seed yield (1114 kg ha^{-1}).

Parthasarathi *et al*. (2008) showed that yield and quality (protein and sugar content in seed) of blackgram was enhanced in soils, particularly clay loam soil by the application of vermicompost.

Singh and Prasad (2008) at Kanpur, UP found that application of vermicompst @ 2 t ha^{-1} resulted in higher dry matter (35.57 g/plant), dry weight of nodules per plant (55.4 mg), number of pods per plant (51.79), seed weight per plant (14.05 g) and grain (19.09 q/ha) and straw yield (22.99 q/ha) of chickpea.

Dhawan *et al.* (2006) reported that application of vermicompost @ 5 t/ha resulted in significantly higher grain and straw yield of soybean.

Edwards *et al.* (2004) stated that vermicompost, which are stabilized organic materials produced by interactions between earthworms and microorganisms in a non thermophilic process, are the best to enhance plant growth and yields in greenhouse crops.

Jat and Ahlawat (2004) reported that the application of vermicompost @ 3 t ha^{-1} produced significantly higher dry matter (19.78 g/plant), leaf area index (1.57), number of pods per plant (27.38), seed (2.35 t/ha) and straw yield (3.81 t/ha) of chickpea.

Atiyeh *et al.* (2002) reported that vermicompost contain plant growth-regulating materials, such as plant growth hormones and humic acids, which are probably responsible, at least in part, for the increased germination, growth, and yields of plants in response to vermicompost application or substitution.

2.2 Effect of inorganic fertilizers and vermicompost on growth and yield of soybean

Purna *et al*. (2020) conducted a pot experiment to evaluate the effects of zinc and vermicompost on the growth, yield and nutrient content of soybean (*Glycine max* L.). The treatment variables were control (Zn and VC), VC 5 ton/ha, Zn 1 kg/ha, Zn 2 kg/ha, Zn 3 kg/ha, Zn 1 kg/ha + VC 5 ton/ha, Zn 2 kg/ha + VC 5 ton/ha and Zn 3 kg/ha + VC 5 ton/ha. Application of zinc and vermicompost showed a significant effect on the growth parameters and macro-and micronutrients uptake by the plant. The highest average plant height (164 cm), leaf number (80 nos./plant), leaf area (3360 cm^2 /plant), fresh weight (49.03 gm/plant), dry weight (24.54 gm/plant), fruit length (9.4 cm), fruit number per plant (5 nos. /plant) at harvest were recorded for Zn 1 kg/ha + VC 5 ton/ha treatment while the lowest values were observed in control at harvest.

Desai *et al.* (2019) conducted experiment during 2014-15 at tribal research cum training centre, Anand agricultural university, Gujrat. The result indicates that highest seed yield of soybean with application of vermicompost @ 2.5 t ha^{-1}, 60 kg ha^{-1} P_2O_5 and seed treatment Rhizobium + Phosphate Solubilizing Bacteria.

Mamia *et al.* (2018) recorded that application of fertilizer at recommended dose, vermicompost + 75 percent recommended fertilizer dose and poultry litter + 75 percent recommended fertilizer dose produced higher seed yield of soybean 2053, 2073 and 2166 kg ha^{-1}, respectively over control. It was also observed that considering the sustainable yield and environment friendly nutrient source, poultry litter + 75 percent recommended fertilizer dose (T_9) and vermicompost + 75 percent recommended fertilizer dose (T_7) could be promising for soybean cultivation.

Morya *et al.* (2018) conducted a field experiments at Zonal Agricultural Research Station, Jhabua (RVSKVV, Gwalior) during the kharif season in 2013, 2014 and 2015 to study the effect of organic, inorganic manures and biofertilizers on growth, yield and nutrient uptake by soybean. Results revealed that application of 50% RDF (10:30:20 kg NPK/ha) + 50% vermicompost (2.5 t/ha) recorded significantly higher growth characters *viz.*, plant height (55.88 cm), number of

branches (4.72), dry matter production (19.21 g/plant), no. of nodules (19.21/plant) and dry weight of nodules (65.43 mg/plant). Similarly, the maximum pods/plant (72.40), seeds/pod (3.25) and 1000 seed weight (137.63 g) also recorded with the application of 50% RDF + 50% vermicompost. The highest seed yield (2262 and 2143 kg/ha) and straw yield (2386 and 2330 kg/ha) was produced under 50% RDF + 50% vermicompost and 100% RDF (20:60:40 kg NPK/ha) respectively. The same treatment also recorded higher N, P and K uptake (190.21, 23.45 and 121.06 kg/ha, respectively) followed by 100% RDF.

Ashraful *et al*. (2017) reported the result on growth and yields (20.8 t ha^{-1}) in tomato were higher in the IPNS treatment. A higher number of fruits per plant (73.7) and plant height (73.5 cm) were obtained from mixed fertilizers (organic 2/3 + inorganic 1/3) or IPNS (integrated plant nutrient system) in Roma VF than other treatments. Fruit yield and diameter were found statistically significant.

A field experiment was conducted by Godavari *et al.* (2017) at Oilseeds Research Unit Dr. P. D. K.V. Akola, during 2015-2016 using a Randomized Block Design with three replications along with seven treatments. The study was conducted with the specific goals of higher moisture retention and slow release to mitigate the effects of intermittent drought on sunflower growth and yield during the Kharif season. Two levels of farm yard manure (FYM) @ (2.5 t ha^{-1}, 5 t ha^{-1}), Vermicompost (VC) @ 2.5 t ha^{-1}, Fly ash @ 2.5 t ha^{-1}, hydrogel @ 2.5 kg ha^{-1}, humic acid @ 2.5 kg ha^{-1} and RDF (80:60:30). Those were used with RDF and RDF alone. The result showed that growth parameters *viz.* plant height, head diameter, seed yield and 100 seed weight varied significantly due to use of moisture retentive material on sunflower. Application of 100 percent RDF with vermicompost @ 2.5 t ha^{-1} recorded highest plant height, head diameter, 100 seed weight, seed yield and oil yield except oil content.

Mahendra *et al.* (2017) found that application of FYM @ 5 t ha^{-1}+ vermicompost @ 2.5 t ha^{-1} + vermiwash @ 10 per cent + 50 per cent NPK produced maximum seed yield (3209.87 and 3230.88 kg ha^{-1} respectively) in both years. The maximum 100-seed weight was obtained with treatment having FYM @ 5 t ha^{-1} + vermicompost @ 2.5 t ha^{-1} + vermiwash @ 10 per cent + 50 per cent NPK in both years.

Mondal *et al.* (2017) reported that 25% reduced dose of chemical fertilizer and its combination with vermicompost significantly influenced growth, yield and yield contributing characters of mustard.

Zerihun *et al.* (2017) reported the yield of soybean variety (Boshe 19) increased by 100-200% using combined application of organic and inorganic fertilizers when compared to the control on acidic soil of Bako, Western Ethiopia.

Falodun *et al.* (2015) showed that plant height, number of branches and number of leaves per plant were enhanced by organic and inorganic fertilizers. Similarly, combined application of organic and inorganic fertilizer increased the pod weight/plant, 1000 seed weight compared to the sole application of organic and inorganic fertilizer.

Sushil *et al.* (2015) conducted a field experiment at Allahabad (U.P.) they observed that the application of 100% RDF + vermicompost @ 1.25 t ha^{-1}+ Azotobacter @ 375 ha^{-1} recorded significantly higher plant height (44.17 cm), number of pods $plant^{-1}$ (24.77), number of seeds pod^{-1} (14.77), number of seeds $plant^{-1}$ (342.74), seed yield $plant^{-1}$ (14.80 g), seed yield ha^{-1} (1139.46 kg ha^{-1}), thousand seed weight (42.52 g), Number of pods $plant^{-1}$ (24.77) of green gram as compared to others treatments.

Kanwar and Sharma (2014) studied the effect of organic and inorganic nutrition on fertility status of soil and yield of vegetable cowpea. The treatment consist of four organic manure (control, FYM @ 10 t ha^{-1}, vermicompost @ 5 t ha^{-1} and poultry manure @ 5 t ha^{-1}). The results revealed that the application of vermicompost @ 5 t ha^{-1} and combined application of S+Mo+Fe were found significantly superior in increasing the green pod yield of cowpea over control.

Awasarmal *et al.* (2013) found highest seed, straw and biological yields of soybean with the treatment of 100 percent recommended dose of fertilizer + Rhizobium + Phosphate Solubilizing Bacteria (PSB) + sulphur @ 25 kg ha^{-1} + vermicompost @ 3 t ha^{-1} (T_7) and it was at par with 100 percent recommended dose of fertilizer + Rhizobium + PSB + sulphur @ 25 kg ha^{-1} + FYM @ 5 t ha^{-1} (T_4) treatments.

Devi *et al.* (2013) observed the effect of inorganic, biological and organic manures on nodulation and yield of soybean and soil properties. The results revealed that integration of 75% RDF with vermicompost @ 1 t ha^{-1} and Phosphate Solubilizing Bacteria (PSB) produced significantly higher plant height, number of nodules $plant^{-1}$, dry weight of nodules $plant^{-1}$, pods $plant^{-1}$ and harvest index over the other treatments. Similarly, significantly higher grain and stover yield were obtained from the application of 75% RDF in combination with vermicompost @ 1 t ha^{-1} followed by seed inoculation of PSB.

Joshi *et al.* (2013) reported that application of VC and recommended dose of NPK recorded the maximum yield. All the growth and yield parameters were found superior with vermicompost treatment over control.

Shwetha *et al.* (2012) reported that application of 63:100:75 kg NPK + 6 t vermicompost per ha^{-1} recorded significantly highest plant height and number of pods per plant (41.80) of French bean.

Prativa and Bhattarai (2011) studied the effect of Integrated Nutrient Management (INM) on the growth and yield of tomato (*Lycopersicon lycopersicum* (L.).The result showed that the integration of organic manures in combination with inorganic fertilizers was found significant for improving the overall plant growth, yield. Maximum plant height, highest no. of plant clusters, maximum fruit weight, fruit yield and number of leaves per plant were observed with treatment 16.66 mt/ha FYM + 8.33 mt/ha Vermicompost + NPK. Treatment 20 mt/ha FYM had the earliest days to 50% flowering. The pH value was found near to neutral in treatment 10 mt/ha vermicompost. Similarly, the maximum organic matter percentage was also recorded in treatment 10 mt/ha vermicompost.

Reddy *et al.* (2010) conducted a field experiment to study the effect of different organic sources of nitrogen with inorganic fertilizers on quality, yield, and yield attributes of soybean. Higher soybean yields 13.3 q ha^{-1} and 12.50 q ha^{-1} were obtained with the application of 75% of recommended dose of nitrogen and 100% recommended dose of P and K through inorganic fertilizers + 25% of recommended dose of nitrogen is through vermicompost.

Sharma *et al.* (2009) reported that application of Wellgro-soil (an organic product) @ 200 kg ha^{-1} along with 50 or 75% recommended dose of fertilizer enhanced the nodulation in soybean.

Singh *et al.* (2011) reported that application of $N:P_2O_5:K_2O$ @ 8:13:10 kg ha^{-1} + vermicompost 3.75 t ha^{-1} improved the plant height of French bean.

By combining inorganic (NPK) and organic (vermicompost) fertilizers, Kumar *et al.* (2009) studied five fertility levels and found that l00 percent NPK+50 percent organic resulted in a significant improvement in the number of branches $plants^{-1}$, leaves $plants^{-1}$, pods $plants^{-1}$, seeds $pods^{-1}$, and 1000 seed weight of French bean.

Dikshit and Khatik (2008) observed that application of organic and inorganic fertilizers increased the stover yield of soybean.

Ullah *et al.* (2008) evaluated the effect of manures and fertilizers on the yield of brinjal. Consisting of organic and inorganic combined sources of nutrient showed significantly increased numbers of branches $plant^{-1}$.

Walia and Kler (2007) conducted field experiment by keeping organic (pure), integrated (partial) and chemical farming system. In soybean-wheat sequence, the full and partial organic farming treatments showed discernible edge in the periodic photosynthetically active radiation interception, plant height, dry matter accumulation, leaf area index over alone chemical fertilizer treatment. The nodule count and their dry weight, and root density was significantly more whereas the soil and canopy temperature was less in sole and partial organic farming treatments as compared to chemical fertilizer application.

Baradhan *et al.* (2006) revealed that in sunflower application of 50 percent recommended dose of nitrogen fertilizer as urea along with 50 percent N as vermicompost recorded the highest seed yield (1140 kg ha^{-1}) followed by FYM and bone sludge (995 and 930 kg ha^{-1}) respectively.

Kalange (2006) observed that the application of 75 percent RDF + Vermicompost @ 1.5 t per ha significantly increased the height of French bean.

Manjunath *et al.* (2006) observed that application of rock phosphate + Vermicompost + PSB resulted in the greatest plant height at 40 days after sowing (36.88 cm) and at harvest (56.43 cm) in French bean.

Sharma *et al.* (2005) recorded the highest grain, straw and biological yields of wheat and maximum nutrient uptake when lantana Vermicompost along with 67% and 100% recommended dose of fertilizers (120, 60 and 30 kg ha^{-1} NPK) was applied. Hence, 67% of recommended dose of NPK along with lantana vermicompost at 10 tones/ha was considered to be best treatment for the highest grain, straw and biological yields production of wheat.

Jat and Ahlwat (2004) carried out experiment at the JNKVV, College of Agriculture, Indore (M.P.) and found that soil test crop response based $N_{27}P_{69}K_{40}$+ 2.5 t vermicompost ha^{-1} + S_{30} was found most effective in raising soybean productivity.

Paradkar and Deshmukh (2004) carried out an investigation to find out the effect of macro and micronutrients and organic manures on soybean cv. JS-335. Application of recommended dose of fertilizer + vermicompost 5 t/ha resulted in 19% highest seed yield (1240 kg/ha) than control. This may be due to superiority in growth parameters (plant height, branches per plant, number of pods per plant, 100 seed weight) and root characters (length of root, root weight, number of nodules per plant, root nodules per plant and nodule weight per plant).

2.3 Effect of organic and inorganic fertilizers on available NPK status in soil

The result obtained from the investigation conducted by Dwivedi *et al.* (2020) showed that changes in chemical properties pH and EC in surface soil under different treatments were statistically non-significant. However, the treatments of combined application of chemical fertilizers with and without organic fertilizer (FYM) have significant effect on organic carbon content, available nitrogen, phosphorus and potassium content in surface soil of soybean under soybean-wheat cropping system.

Aher *et al.* (2019) conducted a field experiment at the Research Farm of ICAR-Indian Institute of Soil Science, Bhopal, India to study the effect of different combinations of organic inputs on performance of soybean (*Glycine max* L.). The

application of organic manures significantly improved the available nutrient status of soil N and P respectively higher than RDF.

Suryavanshi *et al.* (2015) carried out a field experiment during 1999-2011, on fixed site at Latur, to assess the nutrient requirement of soybean (*Glycine max* L.)-sunflower (*Helianthus annuus* L.) cropping system with different combinations of organic and inorganic nutrient management in Vertisols. Application of FYM 5 t ha^{-1} continuously over the period of 13 years along with 100 per cent NPK to *Kharif* soybean and 100 per cent NPK to *Rabi* sunflower in sequence improved the soil fertility in terms of organic carbon, available nitrogen, phosphorus and potassium.

Rana and Badiyala (2014) recorded significantly highest oil content (18.9 per cent), oil yield (343.9 kg ha^{-1}), available nutrients and NPK uptake with the application of FYM @ 2.5 t ha^{-1} + vermicompost @ 1.25 t ha^{-1} compared to sole application of vermicompost @ 2.5 t ha^{-1}, FYM @ 5 t ha^{-1} and the control.

Chatterjee and Thrudasu (2014) observed that the application of 4 tonnes vermicompost per hectare supplemented with 75 % of recommended inorganic fertilizer inoculated with Azophos improve the soil status of N, P and K. Integrated application of diverse source of nutrients not only increased the uptake of plant nutrients but also improved the post harvest soil fertility and subsequently helped for achieving the much desired crop production with sustainable soil health.

Kanwar and Sharma (2014) studied the effect of organic and inorganic nutrition on soil fertility status and yield of cowpea and reported that application of organic manure significantly influenced the available N, P, K, S, Mo, Fe and Zn in the soil at crop harvest. The nutrient availability was maximum in treatment P_5 (poultry manure @ 5 t ha^{-1}) and at par with the treatment V_5 (vermicompost@ 5 t ha^{-1}).

Devi *et al.* (2013) conducted a field experiments to study the effect of inorganic, biological and organic manures on nodulation and yield of soybean and soil properties during rainy seasons of 2008 and 2009 in India (Manipur). The available N, P and K of soil after the harvest of soybean were improved significantly due to the integration of inorganic fertilizers with organic manures.

Materechera (2012) reported that vermicompost (VC) and wood ash were increased the pH of acid soils and improve soil fertility by supplying essential plant nutrients.

Vidyavathi *et al.* (2012) worked on nutrient status of soil under different nutrient and crop management practices in soybean-wheat cropping system. The result showed that application of organic manure recorded significantly higher available N (278.4 kg ha^{-1}), P_2O_5 (23.4 kg ha^{-1}), K_2O (355.0 kg ha^{-1}) and S (18.7 kg ha^{-1}) when compared to chemical nutrient management practice. Similarly, DTPA extractable Zn, Fe, Mn and Cu were significantly influenced by the integrated nutrient management practice (1.46, 7.96, 9.67 and 0.89 mg kg^{-1} respectively).

Munji *et al.* (2010) investigated the impact of organics and fermented organic liquid on sesame yield and reported that the highest levels of soil-available N, P, and K were found in FYM (1/3) + VC (1/3) + GM (1/3) after harvesting sesame, which is equivalent to RDN + FYM over RDF alone.

Prativa and Bhattarai (2011) reported the effect of Integrated Nutrient Management (INM) on the soil nutrient status of tomato and revealed that the integration of organic manures with inorganic fertilizers was found significant in improving the overall soil macro nutrient status than the sole application of nutrients. The highest available nitrogen, phosphorus and potassium were found in treatment 50% recommended dose of NPK + 15 mt ha^{-1} vermicompost.

CHAPTER III

MATERIALS AND METHODS

An experiment was conducted at Sher-e-Bangla Agricultural University farm Dhaka, Bangladesh to study the effect of organic and inorganic fertilizers on growth and yield of Soybean (*Glycine max*, L.). Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Experimental period

The experiment was conducted in rabi season during the period of November 2021 to March 2022.

3.2 Description of the experimental site

3.2.1 Geographical location

The experiment was conducted in the research field of Sher-e-Bangla Agricultural University (SAU). The experimental site, is geographically situated at 23°77′ N latitude and 90°33′ E longitude at an altitude of 8.6 meters above sea level.

3.2.2 Agro-Ecological Zone

The experimental field belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28. This was a region of complex relief and soils developed over the Modhupur clay, where floodplain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils surrounded by floodplain. For a better understanding of the experimental site Map of AEZ of Bangladesh has been shown in the in Appendix-I.

3.2.3 Soil

The soil texture was silty clay with pH 5.56. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix-II.

3.2.4 Climate condition

The climate at the experimental site is subtropical, with three distinct seasons and a winter season from November to February, a pre-monsoon or hot season from March to April, and a monsoon or rainy season from May to October. The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix III.

3.3 Planting material

BARI Soybean-6 variety was used as planting materials for this experiment.

BARI Soybean-6 was developed by Bangladesh Agriculture Research Institute (BARI), Gazipur, Bangladesh through Exotic germplasm collected from AVRDC, Taiwan and released in 2009. The plant height is between 50-55 cm, capsules/plant 50-55, length of capsule 3-3.5 cm, maximum seed/capsule 2-3, seed coat cream color medium size, 100 seed weight 10-12g, crop duration 100-110 days are the main characteristics of this variety. This variety is cultivated throughout the country in rabi and kharif season. In rabi season mid December to mid-January and in kharif season july is suitable time for sowing. BARI Soybean-6 is tolerant to yellow mosaic virus (YMV). It can produce seed yield of 1.80-2.40 t ha^{-1} and content 20-21% oil and 42-44% protein.

3.4 Land preparation

The field preparation was done with a power tiller. After giving one deep ploughing the experimental field was cross harrowed and leveled properly to break the clods and bring the soil to the desired tilth. The plots were prepared manually for sowing seeds. Land preparation was done at 22 November 2021.

3.5 Experimental treatment

The single factor experiment consisting of the following treatments:

T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost
T_2 : 75% RCF + 2 t ha^{-1} vermicompost
T_3 : 75% RCF + 3 t ha^{-1} vermicompost
T_4 : 75% RCF + 4 t ha^{-1} vermicompost
T_5 : 50% RCF + 2 t ha^{-1} vermicompost
T_6 : 50% RCF + 3 t ha^{-1} vermicompost
T_7 : 50% RCF + 4 t ha^{-1} vermicompost

3.6 Experimental design and layout

The present experiment was laid out by using Randomized block design with three replications. The layout consisted of 21 experimental units in three replications with 7 experimental units in each replication. The unit plot size was 5.4 m^2 (2.7 m × 2 m). The blocks and unit plots were separated by 1.0 m and 0.50 m spacing, respectively.The layout of the experimental field was done at 25 November 2021 and shown in Appendix -IV.

3.7 Seed collection

For conducting the present experiment the seeds of the test crop *i.e*., BARI Soybean-6 was collected from Bangladesh Agriculture Research Institute (BARI), Gazipur.

3.8 Chemical fertilizer management

Nitrogen, Phosphorus, Potassium and sulphur were required @ 50, 150, 100and 80 kg ha^{-1} (BARI, 2019). All the fertilizer were applied as basal application during the final land preparation according to the treatment requirement except nitrogen fertilizer. One third of whole amount of nitrogen was applied at the time of final land preparation. The remaining nitrogen was top dressed in two equal installments - at 20 days after sowing (DAS) and 50 DAS respectively.

3.9 Organic manure

In this experiment, different levels of vermicompost, was used as organic manure. The nutrient content (*viz*: NPK) of vermicompost, was given below-

Sources of Manure	Nitrogen content (N %)	Phosphorous content (P_2O_5 %)	Potassium content (K_2O %)	References
Vermicompost (VC)	1.6	0.6	0.8	(Bhatta, 2022)

3.10 Application of organic manure

Organic manure i.e., vermicompost was applied according to the treatment requirement during final land preparation

3.11 Seed sowing

The seeds of soybean were sown on 26 November, 2021 in solid rows in the furrows having a depth of 2-3 cm , row to row distance was 30 cm and plant to plant 5-6 cm.

3.12 Germination of seeds

After the sixth day of seed sowing, the seed began to germinate. More than 85% of seeds germinated on the 7^{th} day, and nearly all young plants emerged from the soil on the 15^{th} days after sowing.

3.13 Gap filling

Gap filling was done at 20 DAS by sowing the seeds wherever the previous sowing seeds did not germinate in order to achieve the required plant population in experimental plot.

3.14 Intercultural operations

3.14.1 Thinning

For appropriate development and to avoid a crowded environment, only healthy seedling were preserved per plot. When necessary, thinning was carried out for this.

3.14.2 Weeding

Two hand weedings were given during the growth period of soybean for control of weeds and better aeration in the soil.

3.14.3 Plant protection measures

At early stage of growth few worms (*Agrotis ipsilon*) infested the young plants and at later stage of growth pod borer (*Maruca testulalis*) attacked the plant. Ripcord 10 EC was applied at the rate of 1 mL with 1 litre water for two times at 15 days interval after seedlings germination.

3.14.4 Irrigation

Two irrigation was given. First irrigation was given at 25 DAS whereas the second irrigation was given at 55 DAS.

3.15 Harvesting

Harvesting was done when 90% of the pods became brown in color. The matured pods were collected by hand picking from the area of 5.4 m^2 of each plot. After complete drying of biomass, threshing was done manually and after winnowing clean seeds were collected separately and their weights were recorded in kg $plot^{-1}$ along with biomass. It was done at 6 March, 2022.

3.16 Data collection

The data were recorded on the following parameters.

i. Plant height (cm)
ii. Number of branches $plant^{-1}$
iii. Fresh weight $plant^{-1}$
iv. Number of pods $plant^{-1}$
v. Pod length $plant^{-1}$
vi. Number of seeds pod^{-1}
vii. Weight of 1000-seed (g)
viii. Seed yield (t ha^{-1})
ix. Stover yield (t ha^{-1})
x. Biological yield (t ha^{-1})

xi. Harvest index (%)

3.17 Procedure of recording data

i. Plant height (cm)

The height of the selected plant was measured from the ground level to the tip of the plant at 20, 40 and 60 days after sowing. Mean plant height of soybean plant were calculated and expressed in cm.

ii. Number of branches plant^{-1}

The primary branch was counted from five selected sampled plants. It was done by counting the total number of branches of all sampled plants then the average data were recorded.

iii. Fresh weight plant^{-1} (g)

After harvest five plants were collected randomly from each plot. The sample plants were cleaned, and the weight was calculated and expressed in grams (g) for data collection using an electrical weight measuring balance.

iv. Number of pods plant^{-1}

Pods were counted from the 5 selected plant sample and then the average pod number was calculated.

v. Pod length plant^{-1}

Pod length is measured by scale on five tagged plants and averaged to pod length.

vi. Number of seeds pod^{-1}

The number of seeds were counted randomly from selected pods at the time of harvest. Data were recorded as the average of 10 pods from each plot.

vii. Weight of 1000-seed

One thousand cleaned, dried seeds were counted from each harvest sample and weighed by using a digital electric balance and weight was expressed in gram (g).

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

The mean seed weight was taken by threshing the plants of each sample area and then converted to t ha^{-1} in dry weight basis.

ix. Stover yield

After separation of seeds from plant, the straw and shell from harvested area was sun dried and the weight was recorded and then converted into t ha^{-1}.

x. Biological yield

Seed yield and stover yield together were regarded as biological yield. The biological yield was calculated with the following formula:
Biological yield = Seed yield + Stover yield.

xi. Harvest index

Harvest index was calculated from the seed yield and stover yield of soybean for each plot and expressed in percentage.

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

3.18 Soil analysis

The soil samples were collected from each plot at various growth stages and at harvest of the crop from surface layer (0-15 cm) of each plot of the layout. Soils were air dried, ground with wooden mortar and pestle and passed through 2 mm sieve. The sieved samples were stored in polythene bags with proper labeling for further analysis. These soil samples were subjected to various chemical estimations as per standard methods.

i. Soil reaction (pH)

It was determined in (1:2.5) soil water suspension using digital pH meter (Jackson, 1973).

ii. Soil organic matter

Organic carbon in soil sample was determined by walkey and black wet oxidation method. The underlying principle was used to oxidize the organic carbon with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and conc. H_3PO_4 and to titrate the excess $K_2Cr_2O_7$ solution with 1N $FeSO_4$. Organic matter was calculated by

multiplying the percent organic carbon by 1.73 (Van Bemmelen factor) and the results were expressed in percentage (Jackson, 1967).

iii. Total nitrogen content (%)

Total nitrogen of soil was determined by Micro-Kjeldahl method where soil was digested with H_2SO_4 and catalyst mixture (K_2SO_4: $CuSO_4.5H_2O$: Se powder in the ratio of 100:10:1). Nitrogen in the digest was estimated by distillation with 40% NaOH followed by titration of the distillate trapped in H_3BO_3 with 0.01N H_2SO_4 (Bremner and Mulvaney, 1982).

iv. Available phosphorous

Available phosphorus in the soil samples was extracted with 0.5 M $NaHCO_3$ solution at a nearly constant pH of 8.5 following the method (Olsen‟s method) described by Olsen *et al*. (1954). Spectrophotometer was used to measure the intensity of the color developed by ascorbic acid reagent.

v. Available potassium

Available potassium was determined using neutral normal ammonium acetate as an extractant using flame photometer (Piper, 1966).

vi. Available sulphur

Available sulphur in soil was determined by the $CaCl_2.H_2O$ (0.15% Solution) by turbidemetric method (Williams and Steinbergs, 1959).

3.19 Data analysis technique

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program named Statistix 10 data analysis software and the mean differences were adjusted by Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

This section contains a presentation and discussion of the study's findings on the effect of organic and inorganic fertilizers on growth and yield of Soybean (*Glycine max* L.). The information was presented in various tables and figures. The findings had been discussed and possible interpretations were provided under the headings listed below.

4.1 Plant height (cm)

Plant height is an essential character of the vegetative stage of the crop plant and indirectly impacts on yield of crop. Application of different doses of organic and inorganic fertilizers significantly influenced on plant height of soybean at different days after sowing (DAS). It was seen that height increased gradually with the age of the crop. Experimental result revealed that the highest plant height (24.40, 29.28 and 47.06 cm at 20, 40 and 60 DAS, respectively) was observed in T_4 (75% RCF + 4 t ha^{-1} vermicompost) treatment which was statistically similar with T_3 (44.36 cm) treatment at 60 DAS (Figure 1). Whereas, the lowest plant height (17.60, 21.42 and 37.10 cm at 20, 40 and 60 DAS, respectively) was observed in T_1 (100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost) treatment which was statistically similar with T_7 (23.10 cm) treatment at 40 DAS. The significant increase in plant height due to different doses of organic and inorganic fertilizers application might be attributed to increase in the availability of cytokinine to shoot which in turn play a role in cell elongation process either through cell division or cell elongation (Falodun *et al.*, 2015). Morya *et al.* (2018) reported that applying the recommended dose of fertilizer in conjunction with vermicompost application resulted in significantly higher growth characteristics of soybean.

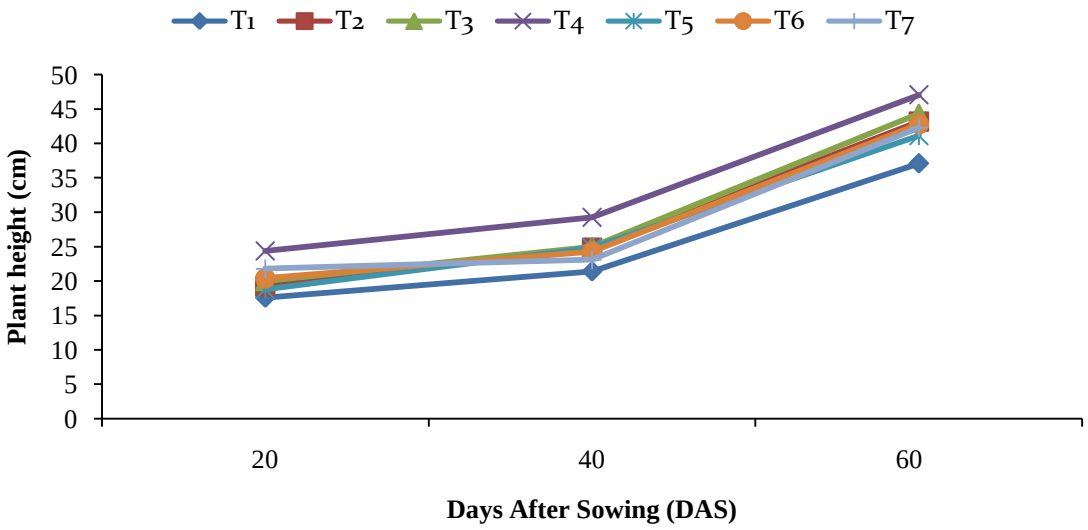

Figure 1. Effect of different doses of organic and inorganic fertilizer application on plant height of soybean at different days after sowing.

Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost.

4.2 Number of branches $plant^{-1}$

Different doses of organic and inorganic fertilizers application significantly affect the number of branches $plant^{-1}$ of soybean at harvest (Figure 2). According to the experimental results, the T_4 (75% RCF + 4 t ha^{-1} vermicompost) treatment had the highest number of branches $plant^{-1}$ (3.46) at harvest. While the lowest number of branches $plant^{-1}$ (1.53) at harvest was found in T_1 treatment. The variation of number of branches $plant^{-1}$ might be attributed to the availability of nutrients from organic and inorganic sources, which aid in improved nutrient absorption, eventually promoting cell division and therefore increasing all growth features. Falodun *et al.* (2015) showed that in soybean number of branches and number of leaves $plant^{-1}$ of soybean was enhanced by organic and inorganic fertilizers.

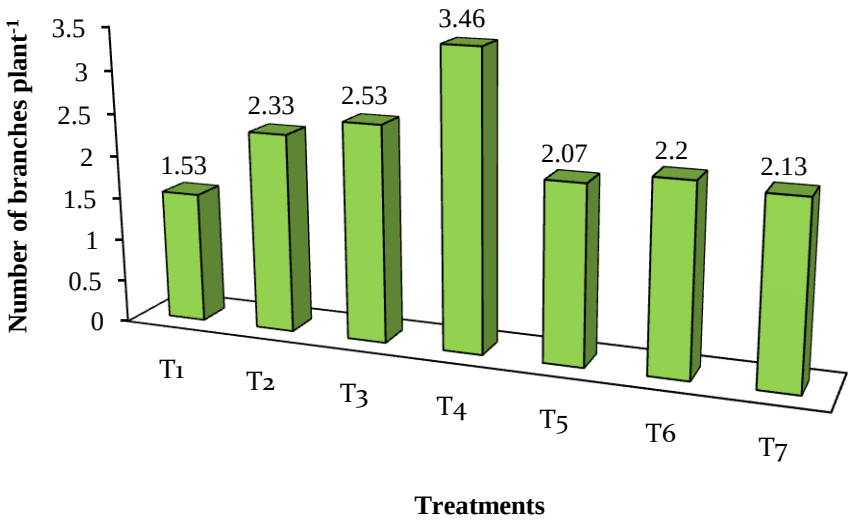

Figure 2. Effect of different doses of organic and inorganic fertilizer application on no. of branches plant^{-1} of soybean at harvest.

Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost.

4.3 Fresh weight plant^{-1} (g)

The experimental results revealed that fresh weight plant^{-1} of soybean was significantly influenced by different doses of organic and inorganic fertilizers application (Figure 3). The highest fresh weight plant^{-1} of soybean (10.60 g) was observed in T_4 treatment which was statistically similar with T_3 (10.10 g) treatment. Whereas the lowest fresh weight plant^{-1} of soybean (7.46 g) was observed in T_1 treatment. The balanced use of inorganic and organic sources of nutrients-maintained the fertility and physical behaviour of soil resulting in higher fresh weight plant^{-1} soybean. Purna *et al.* (2020) reported that applying inorganic fertilizer and vermicompost to the soil increases organic carbon, total nitrogen and total phosphorous content, which are key determinants affecting soil microbial community, resulting in increased uptake of macro-and micronutrients by the plant. In general, it improves photosynthesis and thus increased fresh weight plant^{-1} of soybean.

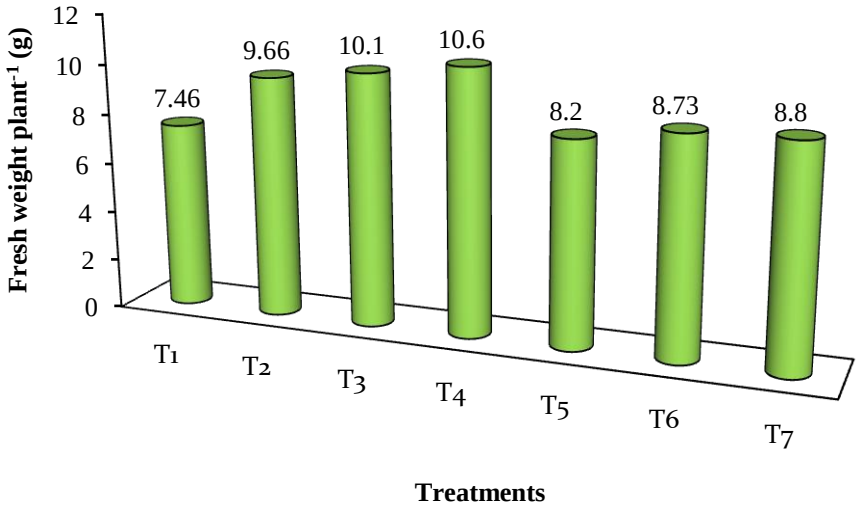

Figure 3. Effect of different doses of organic and inorganic fertilizer application on fresh weight plant^{-1} of soybean at harvest.

Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost.

4.4 Number of pods plant^{-1}

The number of pods plant^{-1} of soybean was significantly influenced by different doses of organic and inorganic fertilizers (Figure 4). Experimental result revealed that the highest number of pods plant^{-1} of soybean (27.53) was found in T_4 whereas the T_1 treatment had the lowest number of pods plant^{-1} (16.93). The variation of number of pods plant^{-1} of soybean might be due to greater availability of micronutrients, form of organic and inorganic sources which assisted in acceleration of various metabolic processes of N, P and K which help in better absorption of nutrients. The results of this study is in agreement with Morya *et al.* (2018) who reported that application of inorganic fertilizer and organic vermicompost recorded significantly increased number of pods plant^{-1} of soybean.

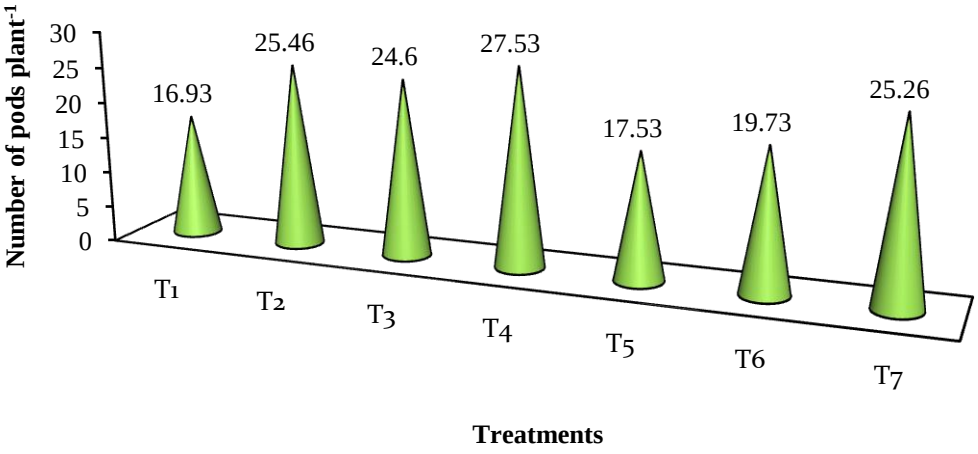

Figure 4. Effect of different doses of organic and inorganic fertilizer application on number of pods plant^{-1} of soybean at harvest.

Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost.

4.5 Pod length (cm)

Different doses of organic and inorganic fertilizers application significantly influenced pod length of soybean (Figure 5). Experimental result showed that the highest pod length (4.21 cm) was observed in T_4 treatment which was statistically similar with T_3 (4.01 cm) treatment. On the other hand the shortest pod length (3.58 cm) was found in T_1 treatment. The results indicates that the synergistic effect of the chemical fertilizers and mineralization of organic manures throughout the growing period did not put the plants nutrient stress at any stage resulting in enhancing pod length of soybean. Also the increased in pod length might be related to various enzymatic activities which controlled flowering, pod formation, growth and development (Awasthi *et al.*,2020). This results corroborates with the study of Mondal *et al.* (2017) who reported that 25% reduced dose of chemical fertilizer and its combination with vermicompost significantly influenced growth, yield and yield contributing characters of mustard.

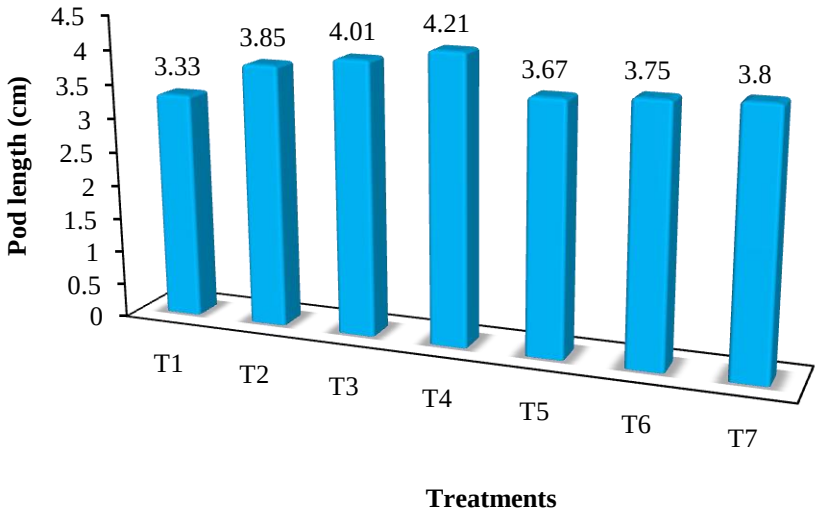

Figure 5. Effect of different doses of organic and inorganic fertilizer application on pod length of soybean at harvest.

Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost.

4.6 Number of seeds pod^{-1}

The number of seed pod^{-1} of soybean was significantly influenced by various doses of organic and inorganic fertilizers application (Table 1). According to the results of the experiment, T_4 treatment had the highest number of seeds pod^{-1} (3.97). On the other hand, T_1 treatment had the lowest number of seeds pod^{-1} (2.22). The supply of adequate nutrients through combined application of vermicompost and inorganic fertilizers might have facilitated the higher plant height, primary branches and number of pods $plant^{-1}$ which might in turn contributed to the production of higher number of seeds pod^{-1} (Morya *et al.*, 2018) The result corroborates with the findings of Sushil *et al.* (2015) who reported that the application of 100% RDF + vermicompost @ 1.25 t ha^{-1}+ Azotobacter @ 375 ha^{-1} recorded significantly higher number of seeds pod^{-1} of green gram as compared to other treatments.

4.7 1000-seed weight (g)

The weight of 1000 soybean seeds varies significantly depending on the doses of organic and inorganic fertilizer (Table 1). The T_4 treatment had the highest 1000-seed weight (115.67 g) which was statistically comparable to T_3 (109.33 g). On the other hand, T_1 treatment had the lowest 1000-seed weight (96.00 g). The advantage of application of organic manure and fertilizer is quite obvious, as these provide a steady supply of nutrients leading better growth of plants. Moreover, the increased availability of P and K in addition to other plant nutrients released by the organic manures might have contributed in enhancing the yield-attributes. The positive impact of availability of individual plant nutrients and humic substances from manure and balanced supplement of nutrients through inorganic fertilizers might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and regulation of water intake into the cells, resulting in the enhancement of yield parameters (Khare *et al.,* 2016). Falodun *et al.* (2015) showed that combined application of organic and inorganic fertilizer increased the 1000 seed weight of soybean compared to the sole application of organic and inorganic fertilizer.

Table 1. Effect of different organic and inorganic fertilizer doses on no. of seeds pod^{-1} and 1000-seed weight of soybean

Treatments	No. of seeds pod^{-1}	1000-seed weight
T_1	2.22 d	96.00 d
T_2	2.53 c	106.67 b
T_3	3.53 b	109.33 ab
T_4	3.97 a	115.67 a
T_5	2.37 cd	98.33 cd
T_6	2.42 c	103.00 bc
T_7	2.44 c	105.33 b
$LSD_{(0.05)}$	0.19	6.88
CV(%)	3.93	3.69

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost.

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

Due to the different doses of organic and inorganic fertilizer application the seed yield of soybean was significantly influenced (Figure 6). Experimental result showed that the highest seed yield (1.86 t ha^{-1}) was observed in T_4 treatment. Whereas the lowest seed yield (0.79 t ha^{-1}) was observed in T_1 treatment. The differences of yield among different treatments might be attributed to fresh weight plant^{-1}, number of pods plant^{-1}, seeds plant^{-1} and 1000-seed weight. This might be due to adequate supply of nutrient element at the right time from organic and inorganic sources which helped optimum dry matter partitioning from the source to sink during reproductive stage of plant, consequently increase the seed yield of soybean. Morya *et al.* (2018) reported that combined application of organic and inorganic fertilizer significantly affected seed yield of soybean. Joshi *et al.* (2013) reported that application of VC and recommended dose of NPK recorded the maximum yield. Shwetha *et al.* (2012) reported that application of 63:100:75 kg NPK + 6 t vermicompost per ha^{-1} recorded significantly highest plant height and number of pods per plant (41.80) of French bean.

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

Different doses of organic and inorganic fertilizers application had shown significant effect on the soybean's stover yield (Figure 6). The experimental findings showed that the T_4 treatment recorded the highest stover yield of soybean (2.17 t ha^{-1}). On the other hand the T_1 treatment recorded the lowest stover yield (1.46 t ha^{-1}) of soybean which was statistically similar with T_5 (1.48 t ha^{-1}) treatment. Patil and Udmale (2016) reported that soybean stover yield was found to be higher at various doses of organic and inorganic fertilizers comparable to sole treatment of inorganic fertilizer. The high concentration of P and S nutrients found in applied fertilizers (organic and inorganic) may be playing a role in metabolism, chlorophyll formation, and photosynthesis activities of the plant, which in turn increases stover yield. This results corroborates with the study of Dikshit and Khatik (2008) who reported that application of organic and inorganic fertilizers increased the stover yield of soybean.

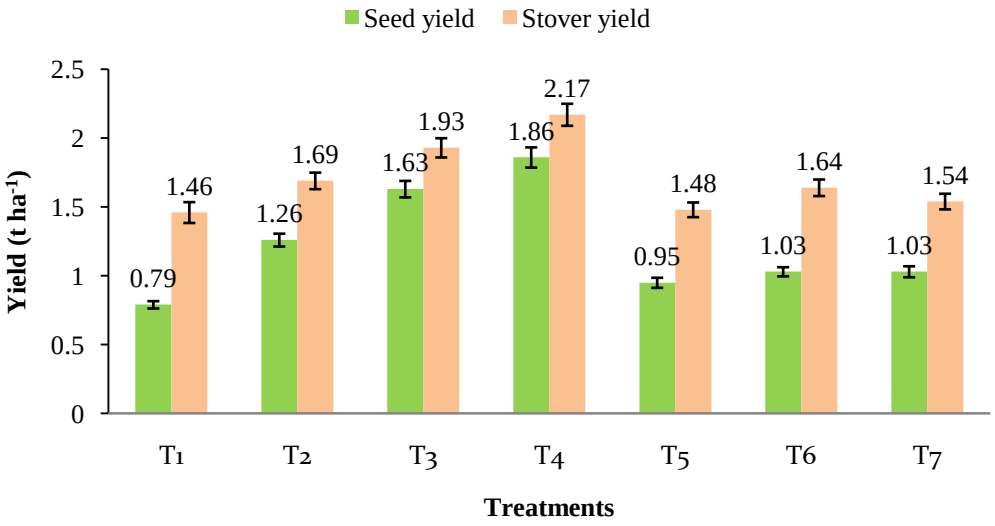

Figure 6. Effect of different doses of organic and inorganic fertilizer application on seed and stover yield of soybean at harvest.

Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost.

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

The biological yield of soybean varies significantly depending on the organic and inorganic fertilizer doses (Table 2). According to the experimental findings the T_4 treatment had the highest biological yield (4.03 t ha^{-1}) of soybean. While the T_1 treatment had the lowest biological yield (2.25 t ha^{-1}). The combined application of vermicompost and inorganic fertilizer might have resulted in the better availability of nutrients throughout the crop growth. The result found in this study is in agreement with the results of Awasarmal *et al.* (2013) who reported that biological yield of soybean was significantly influenced by the uses of organic and inorganic fertilizer in soybean.

4.11 Harvest index (%)

Various doses of organic and inorganic fertilizer application had shown significant effect on the soybean harvest index (Table 2). The T_4 treatment had the highest harvest index of soybean (46.15 %), which was statistically similar to the T_3 (45.79 %). While the T_1 treatment had the lowest soybean harvest index (35.11 %). The increased harvest index per plant with increased inorganic fertilizer and

vermicompost treatment compared to sole inorganic fertilizer treatment could be attributed to the availability of P and S, which has a greater influence on pod and seed setting than above ground biomass yield (Desai *et al.*, 2019). Similar result was observed by Devi *et al.* (2013) who stated that the integration of 75% RDF with vermicompost @ 1 t ha^{-1} and PSB produced significantly higher harvest index over the other treatments.

Table 2. Effect of different organic and inorganic fertilizer doses on biological yield and harvest index of soybean

Treatments	Biological yield (t ha^{-1})	Harvest index (%)
T_1	2.25 f	35.11 d
T_2	2.95 c	42.71 b
T_3	3.56 b	45.79 a
T_4	4.03 a	46.15 a
T_5	2.43 e	39.09 c
T_6	2.67 d	38.57 c
T_7	2.57 de	40.08 c
$LSD_{(0.05)}$	0.16	1.98
CV(%)	3.18	2.71

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost

4.12 pH

In terms of pH in post-harvest soil, different doses of organic and inorganic fertilizer applications showed statistically significant variation (Table 3). Experimental result showed that the highest pH in post harvest soil (6.27) was observed from T_4 (75% RCF + 4 t ha^{-1} vermicompost) treatment which was statistically similar with T_3 (6.15) treatment. While the lowest pH (5.48) was found from T_1 (100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost) treatment (Table 11). Addition of vermicompost along with inorganic fertilizer has a significant impact on soil properties. The soil pH increased due to the increased electrical conductivity as a result of different doses

of organic and inorganic fertilizer applications. Materechera (2012) reported that vermicompost (VC) and wood ash were increased the pH of acid soils and improve soil fertility by supplying essential plant nutrients.

4.13 Organic matter content (%)

The data on organic matter content (%) of post harvest soil of soybean was significantly influenced by the application of different doses of organic and inorganic fertilizer inputs and are narrated in Table 3. The organic matter content (%) in soil clearly indicated that there was build up of organic matter content (%) over initial values due to application of organic and inorganic fertilizer at different doses. The highest build up of organic matter content in soil was recorded in T_4 (75% RCF + 4 t ha^{-1} vermicompost) treatment having values of (1.86 %) which was statistically similar with T_3 (1.65 %) treatment. Whereas lowest value (1.23 %) was noted in treatment T_1 which was statistically similar with T_6 (1.43 %) treatment. Organic matter content varied among different treatment might be due to the addition of organic and inorganic fertilizer have created environment conducive for formation of humic acid, stimulating the activity of soil microorganism and increasing mineralization of vermicompost on surface soil layer resulting in an increase in the organic carbon content of the soil (Mamia *et al.*, 2018). Prativa and Bhattarai (2011) reported that the soil organic matter content increased only where plots treated with vermicompost as compared to inorganic fertilizer treated plot. Increased soil organic carbon due to organic inputs and vermicompost sustains soil health for a longer period than chemical fertilization.

4.14 Total nitrogen content (%)

Total nitrogen content (%) in post-harvest soil of soybean varied significantly due to the different doses of organic and inorganic fertilizer applications (Table 3). The initial total nitrogen content in soil was (0.05%). It was found that availability of nitrogen varied from 0.061 % to 0.069 % at harvest of soybean. The maximum total nitrogen content in post-harvest soil of soybean was recorded with T_4 (0.069 %) treatment. While the lowest total nitrogen content in post-harvest soil of soybean was found in T_1 (0.061%) treatment. The increased of total nitrogen content in soil could be attributed to greater multiplication of microbes due to addition of organic and inorganic fertilizer which helped in mineralization

of soil N leading to higher available and quickly released nitrogen into the soil (Rana and Badiyala, 2014). Devi *et al.* (2013) reported that the available N of soil after the harvest of soybean was improved significantly due to the integration of inorganic fertilizers with organic manures.

4.15 Available P (ppm)

Experimental data presented in table 3 indicate that the available phosphorus in post harvest soil varies significantly among different treatments (Table 3). The highest available phosphorus in post-harvest soil of soybean was recorded with T_4 (30.07 ppm) treatment. While the lowest available phosphorus in post-harvest soil of soybean was found in T_1 (29.35 ppm) treatment which was statistically similar with T_5 (29.55 ppm). Prativa and Bhattarai (2011) revealed that the integration of organic manures in combination with inorganic fertilizers was found significant in improving the overall soil macro nutrient status than the sole application of nutrients.

4.16 Available K (meq/100 g soil)

Available potassium in post harvest soil varied significantly due to the application of different doses of organic and inorganic fertilizer. According to the experimental result the highest available potassium in post harvest soil (0.171 meq/100 g soil) was recorded from T_4 treatment which was statistically similar with T_3 (0.169 eq/100 g soil) treatment. Whereas the lowest available potassium in post harvest soil (0.161 eq/100 g soil) was observed from T_1 treatment (Table 3).

4.17 Available S (ppm)

Sulphur availability in soybean post-harvest soil varied significantly due to different doses of organic and inorganic fertilizer applications (Table 3). The soil's initial available sulphur was 22 ppm. At soybean harvest, the availability of sulphur present in soil ranged from 17.66 ppm to 16.69 ppm. The maximum available sulphur in post-harvest soil was recorded with T_4 (17.66 ppm) treatment. While the lowest available sulphur in post-harvest soil was found in T_1 (16.69 ppm) treatment which was statistically similar with T_5 (16.89 ppm) treatment.

Table 3. Effect of different doses of organic and inorganic fertilizer application on nutrient status of post harvest soil of soybean

Treatments	pH	Organic matter (%)	Total nitrogen content (%)	Available P (ppm)	Available K (meq/100 g soil)	Available S (ppm)
T_1	5.48 d	1.23 c	0.061 d	29.35 d	0.161 d	16.69 d
T_2	6.02 bc	1.62 b	0.067 b	29.77 b	0.168 bc	17.08 c
T_3	6.15 ab	1.65 ab	0.067 b	29.79 b	0.169 ab	17.42 b
T_4	6.27 a	1.86 a	0.069 a	30.07 a	0.171 a	17.66 a
T_5	5.61 d	1.48 b	0.066 c	29.55 cd	0.167 bc	16.89 cd
T_6	5.97 c	1.43 bc	0.066 c	29.75 bc	0.167 bc	16.99 c
T_7	5.98 c	1.54 b	0.067 b	29.77 b	0.166 c	16.95 c
$LSD_{(0.05)}$	0.15	0.22	0.0009	0.21	0.002	0.20
CV(%)	1.46	4.24	1.10	3.29	1.04	0.66

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost

CHAPTER V

SUMMERY AND CONCLUSION

An experiment was conducted at Sher-e-Bangla Agricultural University, Farm Dhaka, Bangladesh to study the effect of organic and inorganic fertilizers on growth and yield of Soybean (*Glycine max* L.) during the period from November 2021 to March 2022 (Rabi season). The experiment was laid out in randomized complete block design (RCBD) with seven organic and inorganic fertilizers treatments i.e. T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost. For the purpose of evaluating the experimental outcomes, data on various parameters were statistically analyzed based on different treatments..

The experimental result showed that different doses of organic and inorganic fertilizers application exhibited in significant variations in soybean growth, yield contributing characters, and yield. The highest plant height (24.40, 29.28 and 47.06 cm at 20, 40 and 60 DAS) was observed in T_4 (75% RCF + 4 t ha^{-1} vermicompost). Whereas, the lowest plant height (17.60, 21.42 and 37.10 cm at 20, 40 and 60 DAS) was observed in T_1 (100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost) treatment. The use of different doses of organic and inorganic fertilizers caused a significant change in the number of branches $plant^{-1}$ and fresh weight $plant^{-1}$ at harvest. The T_1 treatment had the lowest number of branches $plant^{-1}$ (1.53) and fresh weight $plant^{-1}$ of soybean (7.46 g) at harvest. While the highest number of branches $plant^{-1}$ (3.46) and fresh weight $plant^{-1}$ of soybean (10.60 g) at harvest was observed in T_4 treatment. The influence of different doses of organic and inorganic fertilizers application on yield contributing characters was also found significant. The highest number of pods $plant^{-1}$ (27.53), pod length (4.21 cm), seeds pod^{-1} (3.97) and 1000-seed weight (115.67 g) were found in T_4 treatment. On the other hand, the T_1 treatment had the lowest pods $plant^{-1}$ (16.93), pod length (3.58 cm), seeds pod^{-1} (2.22) and 1000-seed weight (96.00 g).

The yield of soybean was significantly influenced by different doses of organic and inorganic fertilizers application. The lowest seed yield (0.79 t ha^{-1}), stover yield (1.46 t ha^{-1}), biological yield (2.25 t ha^{-1}) and harvest index (35.11 %) of soybean was observed in T_1 treatment. While application of vermicompost along with inorganic fertilizer influenced seed yield of soybean and the highest seed yield (1.86 t ha^{-1}), stover yield (2.17 t ha^{-1}), biological yield (4.03 t ha^{-1}) and harvest index (46.15 %) of soybean was observed in T_4 treatment.

Chemical analysis (soil pH, organic matter content, N, P, K, S) of post harvest soil in surface (0-15 cm) layer showed significant variation under different treatments. Experimental result showed that the highest pH in post harvest soil of soybean (6.27), organic matter content (1.86 %), total nitrogen content (0.069 %), available phosphorus (30.07 ppm), available potassium (0.171 meq/100 g soil) and available sulphur (17.66 ppm) were recorded with T_4 (75% RCF + 4 t ha^{-1} vermicompost) treatment. On the other hand, the lowest value of these properties were obtained in T_1 (100% RCF) treatment.

Conclusion

Based on the data above, our experimental results demonstrated that application of different doses of organic and inorganic fertilizers resulted in substantial differences in growth, yield contributing characters, soybean yield, and nutritional status of post harvest soil of soybean. The use of vermicompost not only reduce the recommended doses of inorganic fertilizer but also improves the soil physicochemical properties and availability of nutrients in soil in the long run sustaining the soil productivity and improved growth and yield of plant.

Recommendation

i. Such study in needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performances.
ii. The results are required to substantiate further with different varieties of soybean.

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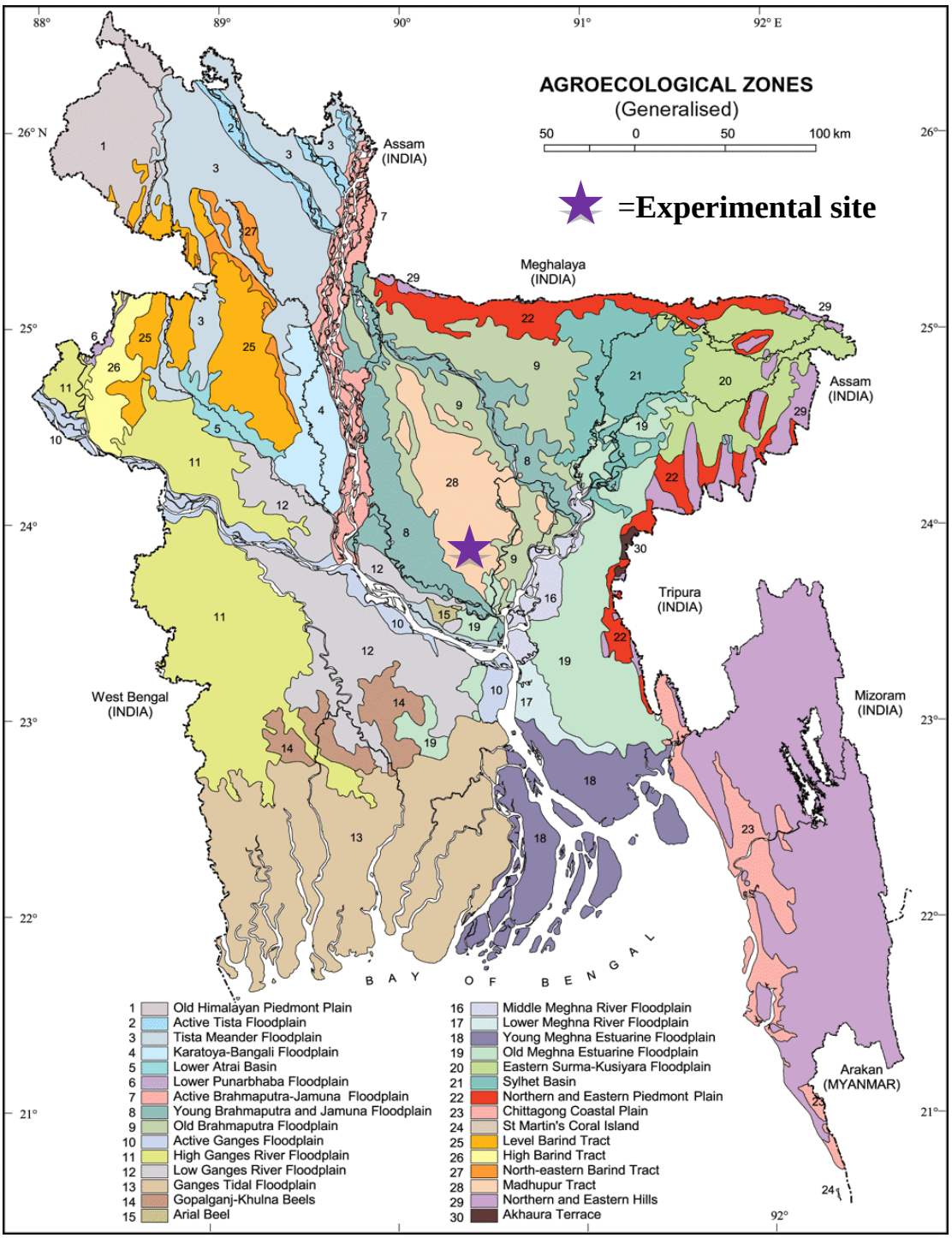
APPENDICES

Appendix I. Map showing the experimental location under study



Appendix II. Soil characteristics of the experimental field

A. Morphological features of the experimental field

Morphological features	**Characteristics**
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Shallow Red Brown Terrace Soil
Land type	High land
Location	Sher-e-Bangla Agricultural University Agronomy research field, Dhaka
Soil series	Tejgaon
Topography	Fairly leveled

Source: SRDI

B. Physico-chemical properties of composite soil

Sr. No.	**Particulars**	**Value (%)**	**Method used**	**Reference**
I	**Mechanical composition**			
A	Clay	29 %	International pipette method	Piper, 1966
B	Sand	26 %		
C	Silt	45 %		
D	Textural class	Silty clay		
II	**Chemical composition**			
A	Soil pH	5.56	Glass electrode pH meter	Jackson, 1973
B	Organic matter (%)	0.45	Walkey and Black method	Jackson, 1967
C	Total N content (%)	0.05	Micro-Kjeldahl method	Bremner and Mulvaney, 1982
D	Available P (ppm)	26 ppm	Olsen's method	Olsen *et al*., 1954
E	Available K (meq/100g soil)	0.14	Flame photometer	Piper, 1966
F	Available S (ppm)	22.15 (ppm)	Turbidemetric method	Williams and Steinbergs, 1959

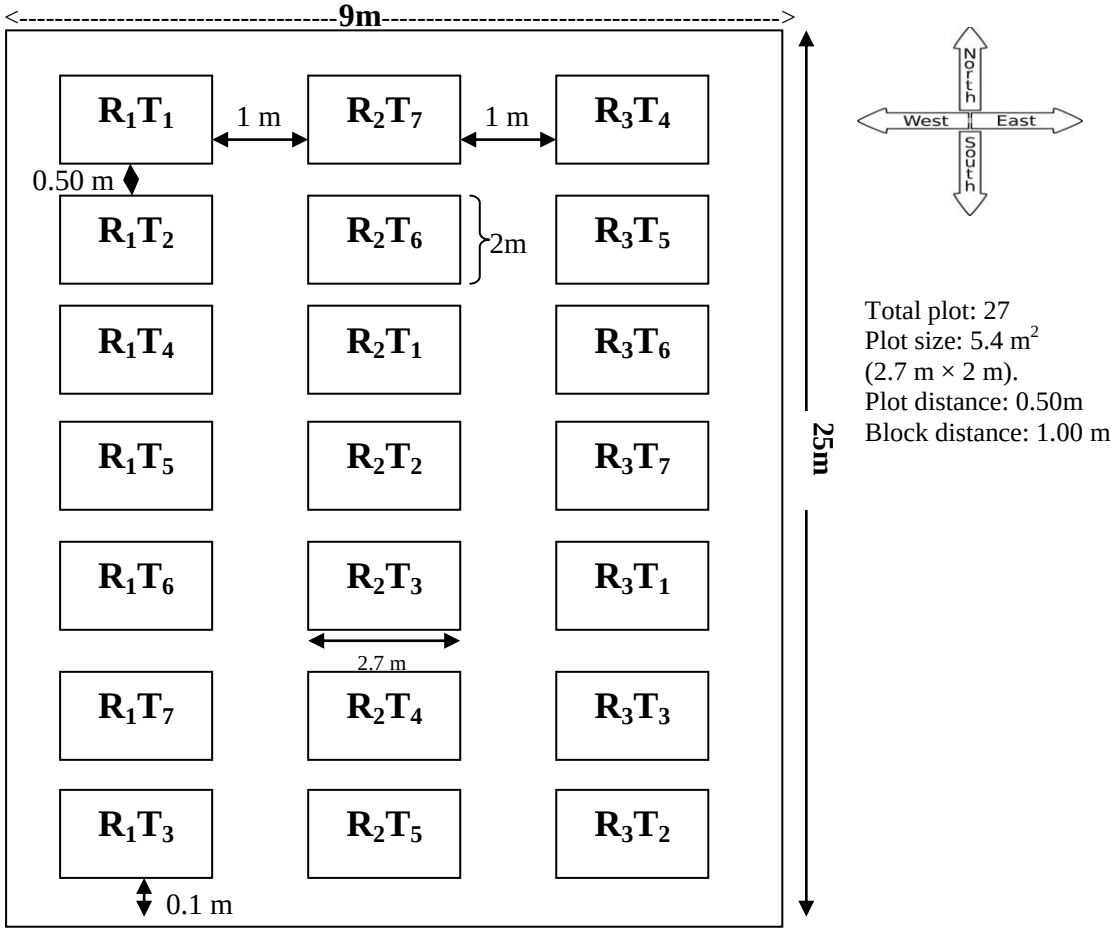
Source: Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Appendix III. Monthly meteorological information during the period from November 2021 to March, 2022.

Year	Month	Air temperature (^{0}C)		Relative humidity (%)	Average rainfall (mm)
		Maximum	Minimum		
2021	November	29.6	19.8	53	00 mm
	December	28.8	19.1	47	00 mm
2022	January	25.5	13.1	41	00 mm
	February	25.9	14	34	7.7 m
	March	31.9	20.1	38	71 mm

Source: Metrological Centre, Agargaon, Dhaka (Climate Division)

Appendix IV**.** Lay out of the experimental plot



R_1T_1	R_2T_7	R_3T_4
R_1T_2	R_2T_6	R_3T_5
R_1T_4	R_2T_1	R_3T_6
R_1T_5	R_2T_2	R_3T_7
R_1T_6	R_2T_3	R_3T_1
R_1T_7	R_2T_4	R_3T_3
R_1T_3	R_2T_5	R_3T_2

1 m, 1 m, 0.50 m, 2m, 2.7 m, 25m, 0.1 m

North, West, East, South

Total plot: 27
Plot size: 5.4 m^2 (2.7 m × 2 m).
Plot distance: 0.50m
Block distance: 1.00 m

Here, T_1 : 100% RCF (Recommended chemical fertilizer) + 0 t ha^{-1} vermicompost, T_2 : 75% RCF + 2 t ha^{-1} vermicompost, T_3 : 75% RCF + 3 t ha^{-1} vermicompost, T_4 : 75% RCF + 4 t ha^{-1} vermicompost, T_5 : 50% RCF + 2 t ha^{-1} vermicompost, T_6 : 50% RCF + 3 t ha^{-1} vermicompost and T_7 : 50% RCF + 4 t ha^{-1} vermicompost

Appendix V. Analysis of variance of the data on plant height of soybean as influenced by different doses of organic and inorganic fertilizer application

Source	**DF**	Mean square of plant height		
		20 DAS	50 DAS	80 DAS
Replication (R)	2	4.3063	4.5028	6.5978
Treatment (T)	6	14.9543*	17.3074*	27.9016*
Error	12	0.4339	0.8991	4.0543

Ns: Non significant

*Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on no. of branches plant^{-1} and fresh weight plant^{-1} (g) of soybean as influenced by different doses of organic and inorganic fertilizer application

Source	**DF**	Mean square	
		No. of branches plant^{-1}	Fresh weight plant^{-1}
Replication (R)	2	0.43750	2.07476
Treatment (T)	6	1.04044*	3.64685*
Error	12	0.00453	0.20373

Ns: Non significant

* Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on no. of pods plant^{-1}, pod length plant^{-1}, seeds pod^{-1} and 1000-seed weight of soybean as influenced by different doses of organic and inorganic fertilizer application

Source	**DF**	Mean square			
		Number of pods plant^{-1}	Pod length	Number of seeds pod^{-1}	1000-seed weight
Replication (R)	2	6.6326	1.36403	0.63519	80.531
Treatment (T)	6	54.7293*	0.22817*	1.38397*	132.460*
Error	12	0.6325	0.02317	0.01195	14.975

Ns: Non significant

*Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on no. of pods plant^{-1}, pod length plant^{-1}, seeds pod^{-1} and 1000-seed weight of soybean as influenced by different doses of organic and inorganic fertilizer application

Source	**DF**	Mean square			
		Seed yield	Stover yield	Biological yield	Harvest index
Replication (R)	2	0.12893	0.26143	0.80670	7.0745
Treatment (T)	6	0.45464*	0.20454*	1.25827*	48.7232*
Error	12	0.00240	0.00186	0.00863	1.2406

Ns: Non significant

*Significant at 0.05 level of probability

Appendix IX. Analysis of variance of the data available nutrient status of post harvest soil of soybean as influenced by different doses of organic and inorganic fertilizer application

Source	**DF**	Mean square					
		pH	Organic matter	Total nitrogen content	Available P	Available K	Available S
Replication (R)	2	0.29	0.0361	4.286E-07	0.01000	9.291E-06	0.01857
Treatment (T)	6	0.24*	0.1152*	1.668E-05*	0.14803*	2.980E-05*	0.36144*
Error	12	0.01	0.0161	2.619E-07	0.01500	2.354E-06	0.03857

Ns: Non significant

*Significant at 0.05 level of probability

PLATES

Plate 1. Layout of the experimental field

Plate 2. Seed sowing

Plate 3. Weeding

Plate 4. Irrigation

Plate 5. Insecticide spray

Plate 6. Supervisor field visit

Plate 7.Field banner

Plate 8. Data collection

Plate 9. Harvesting of soybean