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

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CERTIFICATE

This is to certify that the thesis entitled **"ROLE OF INORGANIC AND ORGANIC (COMPOST) FERTILIZERS ON THE 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 fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (MS)** in **SOIL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **A. K. M. SHOHAG MIA**, Registration No. 15-06836 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

June, 2022

Dhaka, Bangladesh

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Dedicated to

My

Beloved Parents

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The Author

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ABSTRACT

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University, Bangladesh to find out the role of inorganic and organic (compost) fertilizers on the growth and yield of soybean (*Glycine max* L.) during the period from November 2021 to March 2022. Two factors experiment was laid out in RCBD (Randomized Complete Block Design) with three replications. Four different organic (compost) fertilizer levels *viz*. C_0 (control; no compost), C_1 (compost 6 t ha^{-1}), C_2 (compost 8 t ha^{-1}) and C_3 (compost 10 t ha^{-1}) in association with two treatments of inorganic fertilizers *viz*. F_0 (control; no chemical fertilizer) and F_1 (Recommended fertilizer dose) were considered for the present study. Regarding the treatments combinations of organic (compost) and inorganic fertilizers, C_2F_1 (compost 10 t ha^{-1} × recommended fertilizer dose) showed the best yield contributing parameters and yield of soybean and gave the maximum number pods $plant^{-1}$ (48.20), pod length (3.60 cm), number of seeds pod^{-1} (2.96), 1000 seed weight (124.20 g), seed yield (1.51 t ha^{-1}), stover yield (1.71 t ha^{-1}), biological yield (3.22 t ha^{-1}) and harvest index (46.93%) followed by C_3F_1 whereas C_0F_0 (no compost and no chemical fertilizer) showed least performance. Regarding the quality parameters of post harvest soil, the treatment combination C_3F_1 (compost 10 t ha^{-1} × recommended fertilizer dose) exhibited the best value on organic matter content, available phosphorus and sulphur content while particle density and organic carbon content of post harvest soil did not vary significantly among the treatment combinations. So, it can be concluded that the treatment combination of C_2F_1 (compost 8 t ha^{-1} × recommended fertilizer dose) can be considered as the best to achieve higher soybean yield followed.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan’s Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
ml	=	MiliLitre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Miligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
µg	=	Microgram
USA	=	United States of America
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Soybean (*Glycine max* L.) is a member of Leguminosae family, rich in nutrients, and it is regarded as a nutrient storage. Soybean is not only seen as an oil plant but also used for various purposes (Arslan *et al*., 1983; Vera *et al*., 2002; Murthy *et al*., 2017). Among grain legumes, soybean is an economically important crop that is grown in diverse environments throughout the world. In Bangladesh, soybean is called the Golden bean. It is considered as miracle crop of 20^{th} Century on account of having high protein and oil content. It contains lysine comparable with cow milk. Soybean oil is either directly used as edible oil or for manufacturing of vanaspati ghee. It is widely used in variety of foods and also in production of different antibiotics. Tripsin inhibitor is a major antinutritional factor in soybean. The seeds of soybean contain 42-45% protein as well as 22% edible oil (Mondal *et al*., 2002) and 24-26% carbohydrate (Gowda and Kaul, 1982), nutritional superiority on account of containing essential amino acids, unsaturated fatty acids and carbohydrates (Pawar *et al*., 2011).The soybean oil is cholesterol free and is an easily acceptable diet. Soybean accounts for approximately 50 % of the total production of oilseed crops in the world (FAO, 2007). As a grain legume, it is gaining important position in the agriculture of tropical countries including Bangladesh. In Bangladesh, the area coverage of soybean is 151407 acres and the annual production is 104761 tons with an average yield of 1.71 t ha^{-1} (BBS, 2020).

To use land continuously for crop cultivation, incorporating organic and inorganic fertilizers to soil would provide multiple benefits for improving the chemical and physical status of the soil which results in improved crop yield (Basso and Ritchie, 2005; Pasha *et al*., 2015). Nitrogen, phosphorus, and potassium have great effects in plant growth and development. Their deficiencies or excesses result in marked effects on the growth and yield of crops. Nitrogen is a chlorophyll component, and it promotes vegetative growth and green colouration of foliage (Jones, 1983).

Phosphorus plays a major role in photosynthesis, respiration, energy storage, cell division, and maturation. Potassium is important in plant metabolism, protein synthesis, and chlorophyll development (Remison, 2005; Khan *et al*., 2016). The most important crop nutrients in agricultural systems are nitrogen (N), phosphorus (P), and potassium (K) (Chude *et al*., 2004). Most compound fertilizers will contain three elements essential for plant growth: NPK which stands for nitrogen (promotes leaf growth), phosphorus (root, flower, and fruit), and potassium (stem and root growth and protein analysis).

Soybean nitrogen (N) requirements are met in a complex manner, as this crop is capable of utilizing both soil N (mostly in the form of nitrate) and atmospheric N (through symbiotic nitrogen fixation) (Vera *et al*., 2002). The use of fertilizer is considered to be one of the most important factors to increase crop yield. As the global population continues to increase, there is a need to increase soybean production to meet the growing demand for food. One approach to achieving this goal is the use of fertilizers to improve plant growth and yield. However, the type of fertilizer used can have significant impacts on soil quality, plant growth, and yield. Organic fertilizers include compost, farm yard manure (FYM), vermicompost, cowdung etc. (Haynes and Naidu, 1998) whereas inorganic fertilizers include sodium nitrate, rock phosphate, limestone, ammonium nitrate, potassium nitrate, NPK fertilizers, muriate of potash (MOP), and supper phosphates (Taylor, 1997). Both organic and inorganic fertilizers are sources of mineral elements, which plants require for effective growth and development. Essential mineral elements are required in optimum amounts and are classified into micro and macro.

Organic compost and inorganic fertilizers are the two most commonly used fertilizers in soybean cultivation. Organic compost is a source of nutrients that can improve soil health, increase water-holding capacity, and enhance the microbial population in the soil. In contrast, inorganic fertilizers are synthetic sources of nutrients that are typically more concentrated than organic fertilizers and provide a readily available source of nutrients to plants.

Several studies have investigated the effects of organic compost and inorganic fertilizers on soybean growth and yield. For instance, Ghasemi *et al*. (2020) found that the use of organic compost increased the yield and quality of soybean. Similarly, other studies have shown that the use of inorganic fertilizers can also increase soybean yield (Alizadeh *et al*., 2019; Chen *et al*., 2020). However, excessive use of inorganic fertilizers can have negative impacts on soil quality, including soil acidification and nutrient depletion (Gao *et al*., 2018). Zhen *et al*. (2019) found that the use of organic compost significantly increased soybean yield compared to the use of inorganic fertilizers. Similarly, Jiang *et al*. (2018) reported that the use of organic compost resulted in higher soybean yield and better soil quality than the use of inorganic fertilizers.

In conclusion, both organic compost and inorganic fertilizers can improve soybean growth and yield, but the choice of fertilizer should depend on several factors, including soil quality, plant requirements, and environmental sustainability. Keeping all the points in mind mentioned above, the present piece of research work was under taken with the following objectives:

1. To observed the maximum growth and yield of soybean by the influence of organic (compost) and inorganic fertilizer
2. To determine suitable combination of organic and inorganic fertilizers on growth and seed yield of soybean

CHAPTER II

REVIEW OF LITERATURE

Soybean is one of the leading oil and protein containing crops of the world. The present study emphasis the importance of proper nutrient management, including the use of organic and inorganic fertilizers, in improving soybean growth and yield. However, it is important to note that excessive fertilizer application can lead to environmental problems such as nutrient pollution and greenhouse gas emissions. Therefore, farmers and agronomists should consider a balanced approach to nutrient management that considers soil and crop nutrient status, and integrates different nutrient sources such as organic amendments, cover crops, and biological nitrogen fixation to ensure sustainable crop production. Some of the important and informative works and research findings related to the integrated nutrient management so far been done at home and abroad have been reviewed in this chapter under the following headings-

2.1 Effect of organic manure on growth and seed yield of soybean

Soybean (*Glycine max* L.) is an important legume crop, widely cultivated for its high protein content and oil. However, the productivity of soybean is often limited by soil fertility and inadequate nutrient supply. Organic fertilizers (cowdung, compost, poultry manure, vermicompost, FYM etc.) are the most commonly used organic amendments to improve soil fertility, and its application has been reported to enhance the growth and yield of soybean.

Pati and Udmale (2016) conducted an experiment with FYM and vermicompost on growth and yield of soybean. The application of FYM + vermicomopst (50 % each) + Jeevamrut 2 times (30 and 45 DAS) to soybean recorded significantly higher values for growth parameters (plant height, leaf number), yield attributes (number of pods/plant, seeds/pod, pod length, 1000 seed weight, seed weight/plant) and yield of soybean. The application of FYM + vermicomopst

(50% each) + Jeevamrut 2 times (30 and 45 DAS) showed higher protein and oil content in soybean grain than rest of the treatments used.

Ashrafuzzaman *et al*. (2015) conducted a field experiment to evaluate the effect of organic compost on soybean growth and yield. They found that the application of organic compost significantly increased the plant height, number of branches, number of pods, and yield of soybean. Similarly, Zhao *et al*. (2017) reported that organic compost had a greater positive effect on soybean growth and yield compared to inorganic fertilizers.

Khaosaad *et al*. (2018) investigated the effect of a combination of organic compost and mycorrhizal fungi on soybean growth and yield. They found that the treatment resulted in the highest growth and yield of soybean compared to other treatments. Singh *et al*. (2018) also reported that the use of vermicompost and biofertilizers significantly increased the growth, yield, and quality of soybean.

Sanaei-Moghadam *et al*. (2020) investigated the effect of organic compost on soybean growth and yield under different irrigation regimes. They found that the application of organic compost increased the growth and yield of soybean under different irrigation regimes. Kumar *et al*. (2017) also reported that the use of organic compost improved soybean growth, yield, and quality under different cropping systems.

Dusane *et al*. (2018) investigated the effect of organic compost and phosphorus fertilization on soybean growth, yield, and nutrient uptake. They found that the application of organic compost and phosphorus fertilization significantly increased the nutrient uptake and yield of soybean.

Deshmukh *et al*. (2018) also reported that the use of organic compost improved the nutrient uptake and growth of soybean. In summary, the literature suggests that the application of organic compost is a promising strategy to enhance soybean growth and yield. The positive effects of organic compost on soybean growth and yield have been observed under different environmental conditions and cropping systems. Additionally, the combination of organic compost with other organic amendments, such as mycorrhizal fungi and vermicompost, has been found to further enhance soybean growth and yield.

Jat and Garg (2017) conducted a study aimed to investigate the impact of vermicompost and cowdung manure on the growth and yield of soybean under rainfed conditions. The experiment was conducted in a randomized block design with four treatments: control (no manure), cow dung manure, vermicompost, and cowdung + vermicompost. Results showed that the application of both vermicompost and cowdung manure significantly increased plant height, number of branches, number of pods per plant, seed yield, and straw yield of soybean. The highest seed yield was observed in the cowdung + vermicompost treatment. The study concluded that the application of vermicompost and cow dung manure is beneficial for soybean production in rainfed areas.

Kumar *et al*. (2019) carried out a study to evaluate the effect of organic manures on soybean yield, nutrient uptake, and economics under rainfed conditions. The experiment was conducted in a randomized block design with five treatments: control (no manure), vermicompost, cow dung, poultry manure, and vermicompost + cow dung. Results showed that the application of organic manures significantly increased soybean yield, nutrient uptake, and economic returns. The highest yield and nutrient uptake were observed in the vermicompost + cow dung treatment, while the highest economic returns were observed in the cow dung treatment. The study concluded that the application of organic manures is beneficial for soybean production in rainfed areas.

Singh *et al*. (2017) conducted an experiment to investigate the impact of vermicompost and cow dung on the growth and yield of soybean. The experiment was conducted in a randomized block design with five treatments: control (no manure), vermicompost, cow dung, vermicompost + cowdung, and chemical fertilizer. Results showed that the application of both vermicompost and cowdung significantly increased plant height, number of branches, number of pods per plant, seed/pod and seed yield of soybean. The highest seed yield was observed in the vermicompost + cow dung treatment, followed by the chemical fertilizer treatment. The study concluded that the application of vermicompost and cow dung is an effective alternative to chemical fertilizers for soybean production.

Verma *et al*. (2018) conducted an experiment to examine the effect of organic manures, including vermicompost and compost on soybean growth, yield, and economics in acid soil. Results indicated that the application of organic manures significantly improved soybean yield and economic returns.

Tawar and Chandrakar (2020) conducted a study to evaluate the effect of organic manures, including vermicompost and compost, on soybean growth, yield, and quality in the rainfed ecosystem. Results showed that the application of organic manures significantly increased plant height, number of branches, number of pods per plant, seed yield, and protein content of soybean.

2.2 Effect of inorganic fertilizer on growth and seed yield of soybean

Chen *et al*. (2020) studied the effect of zinc and nitrogen fertilizers on soybean yield and seed quality in China, finding that combined application of zinc and nitrogen fertilizers significantly improved yield, protein content, and oil content compared to individual fertilizers. The authors suggest that balanced zinc and nitrogen fertilization can enhance soybean productivity and quality in zinc-deficient soils.

Kang *et al*. (2019) studied the impact of integrated nutrient management on yield and nitrogen use efficiency in maize-soybean relay intercropping, finding that a combination of organic and inorganic fertilizers improved yield and nutrient use efficiency compared to either fertilizer type alone. This study highlights the potential benefits of integrated nutrient management, which combines the use of different fertilizer sources to improve soil health and crop productivity. The authors note that organic amendments can improve soil structure and water holding capacity, while inorganic fertilizers can provide a quick source of essential nutrients.

Liu *et al*. (2019) studied the effect of nitrogen, phosphorus, and potassium fertilizers on soybean yield and quality in Northeast China. Results showed that higher rates of nitrogen and potassium fertilizers gave higher plant height, number of leaves/plant, number of pods/plant and seeds/pod and also seed yield, protein content, and oil content compared to control or individual application, while higher rates of phosphorus fertilizers had no significant effect on yield and quality parameters. This study highlights the importance of considering the specific nutrient needs of soybean crops in fertilizer management to optimize productivity and quality.

Hu *et al*. (2019) investigated the effect of nitrogen and zinc fertilizers on soybean yield and quality in China. Results revealed that combined application of nitrogen and zinc fertilizers significantly improved plant height, leaf number, pods/plant, pod length, seeds/pod, yield, protein content, and oil content compared to individual fertilizers. The authors suggest that optimal nitrogen and zinc fertilization is crucial for improving soybean productivity and quality in zinc-deficient soils.

Yao *et al*. (2019) studied the effect of phosphorus fertilization on soybean yield and quality in Northeast China. They found that higher rates of phosphorus fertilizers improved yield and seed quality parameters such as protein content, oil content, and fatty acid composition. However, excessive phosphorus fertilization also reduced soil pH and increased the risk of phosphorus runoff and pollution, emphasizing the importance of optimal phosphorus management in soybean production.

Fageria (2018) discusses the importance of proper nutrient management in crop production, including the use of inorganic fertilizers to supplement soil nutrients as needed. The author notes that soybean is a relatively low nutrient-demanding crop, but still requires sufficient levels of nitrogen, phosphorus, and potassium for optimal growth and yield. Proper fertilizer management can help maximize nutrient use efficiency resulted higher seed yield and reduce environmental risks associated with excessive fertilizer application.

Das *et al*. (2018) studied the effect of different levels of nitrogen, phosphorus, potassium, sulfur, and zinc fertilizers on soybean growth, yield and nutrient uptake in India. The finding indicated that combined application of NPKSZn fertilizers significantly improved leaf number, photosynthesis rate, pod number, pod length, seeds per pod, 100 seed weight, yield and nutrient uptake compared to individual fertilizers. The authors suggest that integrated nutrient management with balanced application of NPKSZn fertilizers can improve soybean productivity and nutrient use efficiency in nutrient-deficient soils.

Zhang *et al*. (2018) studied the effect of nitrogen and potassium fertilization on soybean yield and quality in Northeast China, finding that a combination of nitrogen and potassium fertilizers improved pod and seed yield and quality parameters such as protein content and oil content. This study highlights the importance of balanced nutrient management, which considers not only the use of inorganic fertilizers but also the appropriate ratios of different nutrients to optimize crop productivity and quality. The authors note that proper fertilizer management can also reduce environmental risks associated with excessive fertilizer application.

Manna *et al*. (2018) investigated the effect of different levels of nitrogen and sulfur fertilizers on soybean yield and nutrient uptake in India. Finding revealed that higher rates of nitrogen and sulfur fertilizers improved yield contributing characters (such as pod length, seeds per pod, 1000 seed weight) and yield and nutrient uptake compared to control or sole application. This study emphasizes the importance of sulfur fertilization, which is often neglected in soybean production, to improve crop productivity and quality in sulfur-deficient soils.

Wang *et al*. (2018) investigated the effect of different ratios of nitrogen, phosphorus, and potassium fertilizers with and without zinc and sulfur fertilizers on soybean yield and nutrient uptake in China, finding that the optimal fertilizer ratio varied among different soybean varieties. The authors suggest that soybean variety-specific fertilizer management is crucial for improving soybean productivity and nutrient use efficiency.

Munir *et al*. (2017) investigated the effect of nitrogen and phosphorus fertilizers on soybean yield and quality in Pakistan. Results indicated that higher rates of nitrogen and phosphorus fertilizers improved plant height, pod yield per plant, seed yield and protein content. However, excessive fertilizer application also increased soil salinity and reduced soil microbial biomass, highlighting the importance of balanced nutrient management to avoid environmental problems.

Kumar *et al*. (2017) studied the effect of nitrogen, phosphorus, potassium, sulfur, and zinc fertilizers on soybean yield and nutrient uptake in India, finding that combined application of NPKSZn fertilizers significantly improved growth (plant height, leaf number), yield contributing parameters and yield (pods per plant, pod length, seeds per pod, 1000 seed weight, pod and seed yield) and nutrient uptake compared to individual fertilizers. The authors suggest that the combined use of NPKSZn fertilizers can enhance soybean productivity and nutrient use efficiency in nutrient-deficient soils.

Singh (2011) studied the effect of weed and nutrient management on nutrient dynamic, productivity and quality of soybean in Vertisols. Nutrient application at 100% and 125% significantly improved weed dry weight and nutrient (N, P and K) uptake by weeds, but simultaneously enhanced crop nutrient uptake, yield attributes, protein content and oil content and seed yield (17.52 q/ha) as compared to 75% of RDF (1569 kg/ha).

Brar *et al*. (2010) conducted a field experiment to study the response of soybean to different levels of phosphorus (P) and sulphur (S). Phosphorus application resulted in additional grain yield to the tune of 1.8 and 4.2 q ha^{-1} at research farm and farmers' field, respectively. Addition of S further improved grain yield of soybean. Phosphorus and sulphur uptake and apparent recovery efficiency increased significantly with P and S application. Response of soybean to P and S application was higher when sulphated phosphate was applied.

Tewari and Pal (2005) studied the effect of graded P_2O_5 (0, 30, 60 and 90 kg/ha) and K_2O (0, 30, 60 and 90 kg/ha) on yield and uptake of secondary and micronutrients by soybean. P_2O_5 significantly increased the grain and straw yield and uptake of N, P, K and S but decreased the uptake of Ca, Mg, Fe, Zn, Cu and Mn. K_2O significantly increased the grain and straw yield and the uptake of major, secondary and micronutrients.

2.3 Organic and inorganic fertilizers on growth and yield of soybean

Kuntyastuti *et al*. (2022) conducted an experiment to evaluate the optimization use of organic and inorganic NPK fertilizers on soil and soybean (*Glycine max* L.) productivity on dry land. The treatments evaluated were 12 dosage combinations of ZA (ammonium sulphate), SP-18 (super phosphate-18), KCl (potassium chloride), and chicken manure. The study was conducted on dry land without and with 5,000 kg cow manure/ha. The results showed that (1) application of 5,000 kg cow manure/ha increased the yield of Argomulyo soybean variety by 0.21 t/ha (9%), (2) application of 100 kg KCl/ha + 50 kg ZA/ha + 100 kg SP-18/ha + 5,000 kg cow manure/ha, and 50 kg ZA/ha + 2,500 kg chicken manure/ha + 5,000 kg cow manure/ha increased soybean yield by 0.95-1.38 t/ha (50-74%), (3) application of 100 kg KCl/ha increased P uptake by 68%, Ca uptake by 60%, and Mg uptake by 54% compared to without fertilizer, (4) application of 50 kg KCl/ha + 2,500 kg chicken manure/ha increased N uptake by 48%, application of 50 kg ZA/ha + 100 kg SP-18/ha increased K uptake by 117%, and application of 50 kg ZA/ha increased Ca uptake by 60% compared without fertilizer, and (5) application of 5,000 kg cow manure/ha improved the physical properties of the soil by reducing soil bulk density by 7% and soil penetration by 37% and increasing soil permeability of 2.20 cm/hour from 1.78 cm/hour to 3.98 cm/hour. Soybean cultivation of the Argomulyo variety on dry land in Gresik requires the addition of organic cow manure 5000 kg/ha plus ZA fertilizer 50 kg/ha + chicken manure 2500 kg/ha or ZA fertilizer 50 kg/ha + SP-18 100 kg/ha + KCl 100 kg/ha to increase yield 0.95–1.38 t/ha and improve soil physical fertility.

Mamia *et al*. (2018) executed an experiment to study the effects of fertilizer management of different combinations of inorganic and organic fertilizers on growth, yield attributes and yield of soybean (var. BARI Soybean 6). The treatment combinations were T_0= Control, T_1= fertilization at recommended fertilizer dose (RFD - urea 50 kg ha^{-1}, TSP 150 kg ha^{-1}, MoP 100 kg ha^{-1}, gypsum 80 kg ha^{-1} and boron 500 kg ha^{-1}), T_2= Bio-fertilizer + 50% RFD, T_3= Bio1fertilizer + 75% RFD, T_4= Mixed fertilizer + 50% RFD, T_5= Mixed fertilizer + 75% RFD, T_6= Vermicompost + 50% RFD, T_7= Vermicompost + 75% RFD, T_8= Poultry litter + 50% RFD and T_9= Poultry litter + 75% RFD. Results indicated that application of fertilizer at recommended dose, vermicompost + 75% RFD and poultry litter + 75% RFD produced higher grain yield 2053, 2073 and 2166 kg ha^{-1}, respectively over control. It was also observed thatconsidering the sustainable yield and environment friendly, poultry litter + 75% RFD (T_9) and vermicompost + 75% RFD (T_7) could be promising for soybean cultivation.

Yagoub *et al*. (2012) conducted a field experiment to study the effect of some fertilizers on growth and yield of soybean (Glycine max L. merril). The fertilizers treatments consisted of three types of fertilizers: urea (180 kg/ha), NPK (361 kg/ha), compost (%) and the control. The results showed that fertilizers treatments in first season had significant difference on number of pods/plant, 100 seed weight, economic yield and harvest index. Mean while, highly significant difference on green, biological and straw yield. In second season fertilizers treatments had significant difference on plant height at 30 days, leaf number and leaf area at 45 and 60 days, green yield, biological yield and straw yield.

Sandrakirana and Arifin (2021) conducted an experiment to evaluate the effectiveness of organic fertilizer treatment to reduce the amount of urea as chemical fertilizer needed in soybean cultivation. The treatment 2,000 kg ha^{-1} compost + 50 kg ha^{-1} urea resulted the highest dry yield in soybean and had significant differences with urea-only treatment. A mixture of chemical and organic fertilizers had no significant result over the yield compared to the use of chemical fertilizer only. Compost application of 1,000-2,000 kg ha^{-1} with urea 50-100 kg ha^{-1} showed an increase in seed yield of 35-38% with a profit reaching 333-340 USD ha^{-1} compared to standard treatment using urea 50 kg ha^{-1} + SP-36 and 50 kg ha^{-1} + 50 KCl kg ha^{-1}.

Morya *et al*. (2018) conducted field experiments 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), leaf number (18.60), 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), pod length (3.52 cm), seeds/pod (3.25) and test weight (137.63 g) were 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.

Murthy *et al*. (2017) conducted a study aimed to investigate the effect of different organic and inorganic fertilizers on the growth and yield of soybean under rainfed conditions. The results showed that the combination of organic and inorganic fertilizers resulted in higher yields compared to using either of the fertilizers alone. The study also found that the combination of vermicompost and recommended doses of inorganic fertilizers significantly increased the yield of soybean.

Naik *et al*. (2019) carried out a study to study the effect of different organic and inorganic fertilizers on growth, yield and quality of soybean (*Glycine max* L.). This study compared the effects of different organic and inorganic fertilizers on the growth, yield, and quality of soybean. The results showed that the combination of vermicompost and recommended doses of inorganic fertilizers resulted in the highest yield and quality of soybean.

Naeem *et al*. (2018) investigated the integrated effect of organic and inorganic fertilizers on the growth, yield, and nutrient uptake of soybean. The results showed that the combination of organic and inorganic fertilizers significantly increased the growth, yield, and nutrient uptake of soybean. The study recommended the use of poultry manure and recommended doses of inorganic fertilizers for better yield and nutrient uptake of soybean.

Khan *et al*. (2016) carried out a study aimed to evaluate the influence of integrated nutrient management on the growth, yield, and quality of soybean. The results showed that the combination of organic and inorganic fertilizers significantly increased the yield and quality of soybean. The study also found that the use of vermicompost along with recommended doses of inorganic fertilizers was the most effective treatment.

Pasha *et al*. (2015) conducted an experiment to study the effect of organic and inorganic fertilizers on growth, yield and nutrient uptake of soybean (Glycine max L.). This study compared the effects of different organic and inorganic fertilizers on the growth, yield, and nutrient uptake of soybean. The results showed that the combination of poultry manure and recommended doses of inorganic fertilizers resulted in the highest yield and nutrient uptake of soybean. The study recommended the use of poultry manure along with inorganic fertilizers for better yield and nutrient uptake of soybean.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the Sher-e-Bangla Agricultural University farm, Dhaka, Bangladesh during the period from November 2021 to March 2022 to study the role of inorganic and organic (compost) fertilizer on the growth and yield of soybean (*Glycine max* L.). The details of the materials and methods have been presented below:

3.1 Experimental location

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

3.2 Climate

The climate of experimental site was subtropical, characterized by three distinct seasons, the winter from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al*., 1979). Details on the meteorological data of air temperature, relative humidity, rainfall and sunshine hour during the period of the experiment was collected from the Weather Station of Bangladesh, Sher-e-Bangla Nagar, presented in Appendix II.

3.3 Soil

The soil of the experimental area belongs to the Madhupur Tract (UNDP, 1988) under AEZ No. 28 and was dark grey terrace soil. The selected plot was medium high land and the soil series was Tejgaon (FAO, 1988). The characteristics of the soil under the experimental plot were analyzed in the Soil Testing Laboratory, SRDI, Khamarbari, Dhaka. The details of morphological and chemical properties of initial soil of the experiment plot were presented in Appendix III.

3.4 Test crop

BARI Soybean 5, was collected from Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur which was used as plant materials for the present study.

3.5 Treatments of the experiment

Factor A: Organic fertilizers (compost)

1. C_0 = Control (no compost)
2. C_1 = Compost 6 t ha^{-1}
3. C_2 = Compost 8 t ha^{-1}
4. C_3 = Compost 10 t ha^{-1}

Factor B: Inorganic fertilizer

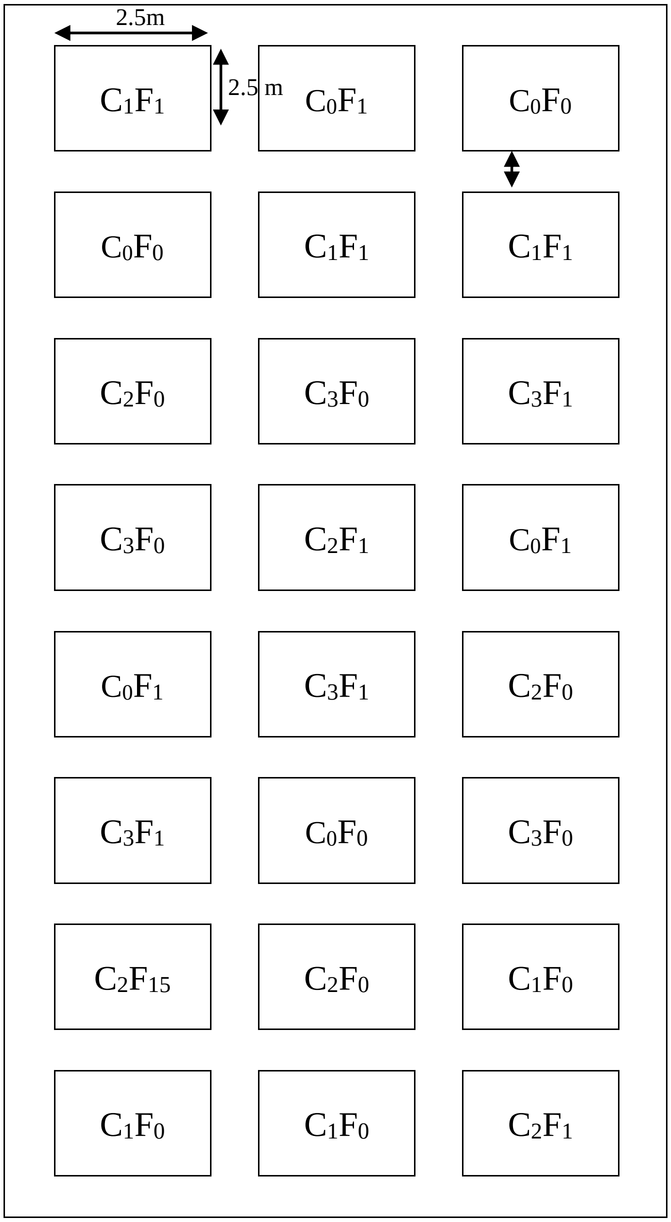
1. F_0 = Control (no chemical fertilizer)
2. F_1 = Recommended fertilizer dose

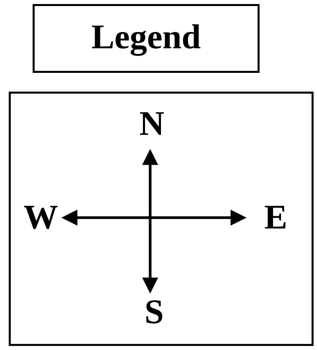
Treatment combinations: 8 (4×2=8) treatment combinations as follows:

$T_1 = C_0F_0$, $T_2 = C_0F_1$, $T_3 = C_1F_0$, $T_4 = C_1F_1$, $T_5 = C_2F_0$, $T_6 = C_2F_1$, $T_7 = C_3F_0$ and $T_8 = C_3F_1$.

3.6 Experimental design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the combinations of organic compost manure and inorganic fertilizer doses. The 8 treatment combinations of the experiment were assigned at random into 24 plots. The size of each unit plot was 2.5 m × 2.5 m. The distance between block to block and plot to plot were 0.5 m and 0.5 m respectively. The layout of the experiment field is presented in Figure 1.





Treatments

Factor A: Organic fertilizers (compost)

1. C_0 = Control (no compost)
2. C_1 = Compost 6 t ha^{-1}
3. C_2 = Compost 8 t ha^{-1}
4. C_3 = Compost 10 t ha^{-1}

Factor B: Inorganic fertilizer

1. F_0 = Control (no chemical fertilizer)
2. F_1 = Recommended fertilizer dose

Fig. 1. Layout of the experimental plot

3.7 Preparation of the main field

The plot selected for the experiment was opened in the 13 November, 2021 with a power tiller, and was exposed to the sun for a few days, after, which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubble were removed and finally obtained a desirable tilth of soil for transplanting. The land operation was completed on 20 November 2021. The individual plots were made by making ridges (20 cm high) around each plot to restrict lateral runoff of irrigation water.

3.8 Fertilizers and manure application

The N, P, K, S, Zn and B nutrients were applied through urea, Triple super phosphate (TSP), Muriate of potash (MoP) Gypsum, $ZnSO_4$ and Boric acid, respectively were applied according to Krishi Projukti Hat Boi, BARI, 2019. Compost manure was applied as per treatment. Name and recommended doses of nutrients were as follows:

Plant nutrients	Manure and fertilizer	Doses ha^{-1}
N	Urea	60 kg
P	TSP	175kg
K	MoP	120 kg
S	Gypsum	115 kg
Zn	$ZnSO_4$	3 kg
B	Boric acid	1 kg

One third of whole amount of Urea and full amount of TSP, MoP, Gypsum, $ZnSO_4$ and boric acid were applied at the time of final land preparation. The remaining Urea was top dressed in two equal installments - at 20 days after transplanting (DAT) and 50 DAT respectively.

3.9 Sowing of seeds

The seeds of soybean were sown on November 21, 2021 in solid rows in the furrows having a depth of 2-3 cm and row to row distance was 30 cm and plant to plant 5-6 cm.

3.10 Intercultural operation

After establishment of seedlings, various intercultural operations were accomplished for better growth and development of the soybean.

3.10.1 Thinning

Seeds started germination within four days after sowing (DAS). Thinning was at 23 DAS to maintain optimum plant population in each plot.

3.10.2 Irrigation and weeding

Irrigation was provided two times at 25 DAS and 55 DAS for all experimental plots equally. The crop field was weeded at 23 DAS and 52 DAS.

3.10.3 Protection against insect and pest

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 sprayed at the rate of 1 ml with 1 litre water for two times at 15 days interval after seedlings germination to control the insects.

3.11 Crop sampling and data collection

Five plants from each treatment were randomly selected and marked with sample card. Plant height and number of branches plant-1 were recorded from selected plants at an interval of 10 days started from 30 DAS to 60 DAS and at harvest.

3.12 Harvest and post harvest operations

Harvesting was done when 90% of the pods became brown in color. The matured pods were collected by hand picking from the area of 6 m^2 of each plot.

3.13 Data Collection and Recording

Five plants were selected randomly from each unit plot for recording data on crop parameters and the yield was taken plot wise. The following parameters were recorded during the study:

3.13.1 Growth parameters

1. Plant height (cm)
2. Number of leaves plant^{-1}

3.13.2 Yield contributing parameters

1. Pod length (cm)
2. Number of pod plant^{-1}
3. Number of seeds pod^{-1}
4. 1000 seed weight (g)

3.13.3 Yield parameters

1. Seed yield (kg ha^{-1})
2. Stover yield (kg ha^{-1})
3. Biological yield (kg ha^{-1})
4. Harvest index (%)

3.13.4 Soil analysis

1. Particle density
2. Soil Organic carbon content
3. Available phosphorus
4. Available sulphur

3.14 Procedure of recording data

3.14.1 Plant height

The plant height was measured at 30, 50, 70 DAS and at harvest with a meter scale from the ground level to the top of the plants and the mean height was expressed in cm.

3.14.2 Number of leaves plant^{-1}

The total number of leaves plant-1 was counted from each selected plant. Data were recorded as the average of 5 plants selected at random of each plot at 30, 50, 70 DAS.

3.14.3 Pod length (cm)

Pod length was taken of randomly selected ten pods and the mean length was expressed on pod-1 basis.

3.14.4 Number of pods plant^{-1}

Numbers of total pods of selected plants from each plot were counted and the mean numbers were expressed as plant-1 basis. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot.

3.14.5 Number of seeds pod^{-1}

The number of seeds pods-1 was recorded from randomly selected 10 pods at the time of harvest. Data were recorded as the average of 10 pods from each plot.

3.14.6 Weight of 1000 seeds (g)

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.

3.14.7 Seed yield (kg ha^{-1})

The seeds collected from 6 (3 m ×2 m) square meter of each plot were cleaned. The weight of seeds was taken and converted the yield in kg ha^{-1}.

3.14.8 Stover yield (kg ha^{-1})

Stover obtained from each unit plot was sun-dried and weighed carefully. The dry weight of stover of central 1 m^2 area and five sample plants were added to the respective stover yield m^{-2} and finally converted to kg ha^{-1}.

3.14.9 Biological yield (kg ha^{-1})

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.

3.14.10 Harvest index (%)

It denotes the ratio of grain yield to biological yield and was calculated with the following formula.

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

3.14.11 Soil analysis

The soil samples were analyzed by the following standard methods as follows:

3.14.11.1 Particle size analysis

Particle size analysis of soil sample was done by hydrometer method as outline by day. The textural classes were ascertained using Marshall's Textural Triangular coordinate as designated by USDA, 1993.

3.14.11.2 Soil organic carbon content

Organic carbon in the soil sample was determined by the 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_3 and titrate the excess $K_2Cr_2O_7$ solution with 1N $FeSO_4$. To obtain the content of Organic carbon was calculated by multiplying the percent organic carbon by 1.73 (Van Bemmelen factor) and the results were expressed in percentage

3.14.11.3 Available phosphorus

Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen *et al.,* 1954). Phosphorus in the extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity was measured calorimetrically at 660 ηm wavelength and readings were calibrated with the standard P curve (Akul *et al.,* 1982)

3.14.11.4 Available sulphur

Available sulphur was extracted from the soil with Ca $(H_2PO_4)_2.H_2O$ (Fox *et al.,* 1964). Sulphur in the extract was determined by the turhidimetric method as described by hunt (1980) using a Spectrophotometer (LKB Novaspce 4049).

3.15 Statistical analysis

The data obtained for different characters were statistically analyzed to observe the significant difference among the treatment by using the MSTAT-C computer package program. The mean values of all the characters were calculated and analysis of variance was performed. The significance of the difference among the treatments means was estimated by the Least Significant Difference Test (LSD) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

This study was conducted to explore the role of inorganic and organic (compost) fertilizer on the growth and yield of soybean (*Glycine max* L.). Data were collected on different growth, yield and yield contributing parameters and present in this chapter through different Tables and Graphs. The results and discussions and also possible interpretations have been given under the following headings:

4.1 Growth parameters

4.1.1 Plant height (cm)

Effect of organic (compost) fertilizers

Plant height of soybean significantly influenced by different organic (compost) fertilizer levels at different growth stages (Figure 2 and Appendix IV). Results revealed that at 30 DAS, the highest plant height (35.40 cm) was recorded from the treatment C_3 (compost 10 t ha^{-1}) that was statistically similar with C_2 (compost 8 t ha^{-1}) and C_1 (compost 6 t ha^{-1}) whereas the lowest plant height (31.09 cm) was recorded from the control treatment C_0 (no compost). At 50 DAS, the treatment C_3 (compost 10 t ha^{-1}) gave the highest plant height (49.91 cm) that was statistically similar with C_2 (compost 8 t ha^{-1}) and C_1 (compost 6 t ha^{-1}) whereas the lowest plant height (46.53 cm) was recorded from the control treatment C_0 (no compost). Similarly, at 70 DAS, the highest plant height (52.02 cm) was recorded from the treatment C_3 (compost 10 t ha^{-1}) that was statistically similar with the treatment C_2 (compost 8 t ha^{-1}) and C_1 (compost 6 t ha^{-1}) whereas the lowest plant height (47.73 cm) was recorded from the control treatment C_0 (no compost). Similar result was also observed by the findings of Ashrafuzzaman *et al*. (2015), Pati and Udmale (2016) and Jat and Garg (2017); they reported significantly higher plant height from organic manure compared to control treatment.

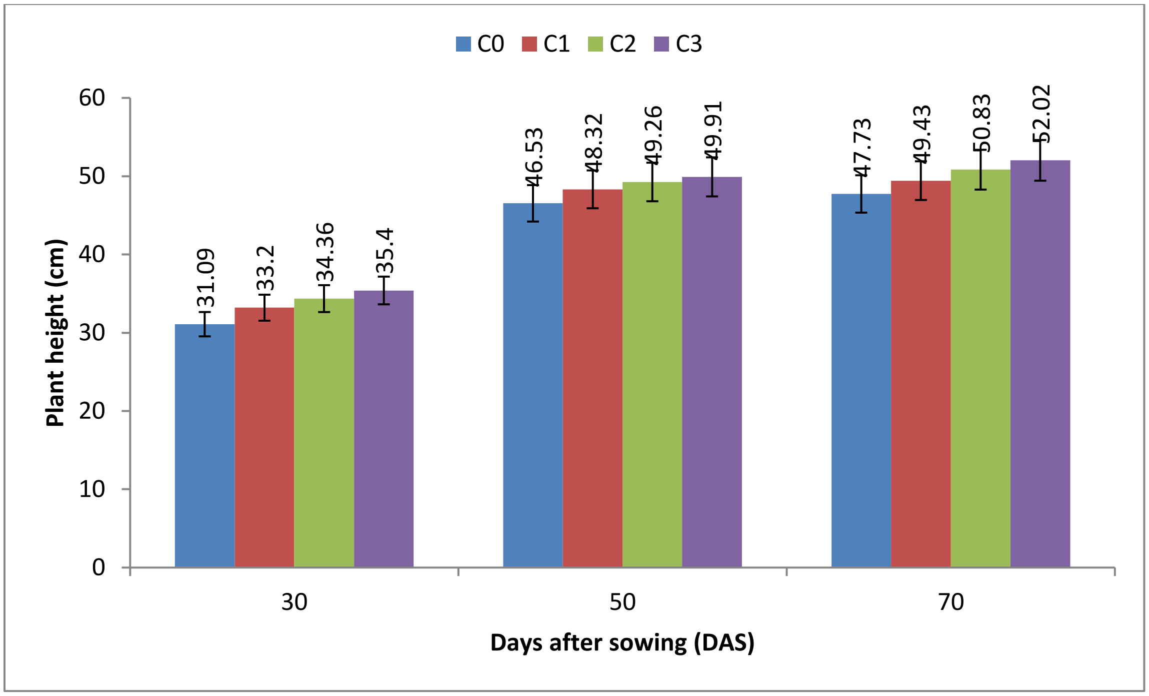


Fig. 2. Plant height of soybean as influenced by organic (compost) fertilizer ($LSD_{0.05}$ = 3.051, 2.377 and 3.053 at 30, 50 and 70 DAS, respectively)

C_0 = Control (no compost), C_1 = Compost 6 t ha^{-1}. C_2 = Compost 8 t ha^{-1}, C_3 = Compost 10 t ha^{-1}

Effect of inorganic fertilizer

There was significant difference between the two different levels of inorganic fertilizer in respect to plant height of soybean at different growth stages (Figure 3 and Appendix IV). Results indicated that the treatment F_1 (Recommended fertilizer dose) showed the higher plant height (36.50 cm) at 30 DAS whereas the control treatment F_0 (no chemical fertilizer) exhibited the lower plant height (30.53 cm). At 50 DAS, the highest plant height (51.14 cm) was recorded from the treatment F_1 (Recommended fertilizer dose) whereas the lowest plant height (45.87 cm) was recorded from the control treatment F_0 (no chemical fertilizer). Likewise, at 70 DAS, the highest plant height (52.66 cm) was given by the treatment F_1 (Recommended fertilizer dose) whereas the lowest plant height (47.34 cm) was recorded from the control treatment F_0 (no chemical fertilizer). Liu *et al*. (2019) and Hu *et al*. (2019) found significant effect on plant height of soybean due to inorganic fertilizers compared to control which supported the present study.

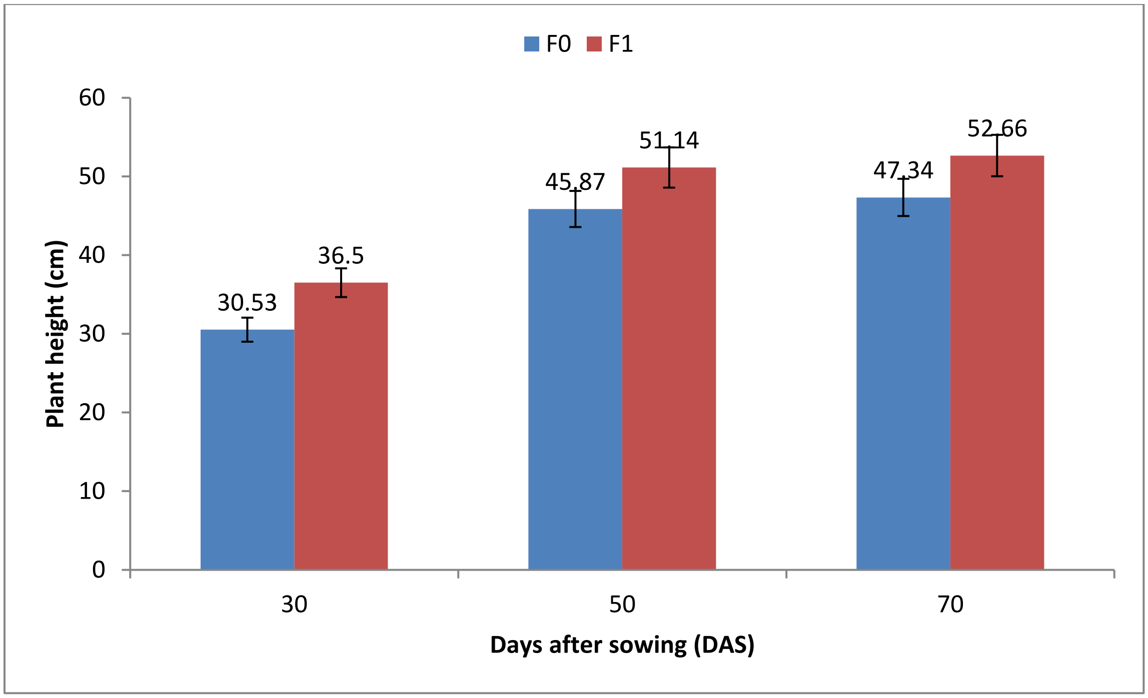


Fig. 3. Plant height of soybean as influenced by inorganic fertilizer ($LSD_{0.05}$ = 1.244, 2.136 and 1.612 at 30, 50 and 70 DAS, respectively)

F_0 = Control (no chemical fertilizer), F_1 = Recommended fertilizer dose

Combined effect organic and inorganic fertilizer

The treatment combinations of organic (compost) and inorganic fertilizers had significant effect on plant height of soybean at different growth stages (Table 1 and Appendix IV). Results exhibited that at 30 DAS, the treatment combination of C_3F_1 registered the highest plant height (38.40 cm) that was statistically identical to the treatment combinations of C_2F_1 whereas the lowest plant height (27.82 cm) was found from the treatment combination of C_0F_0 that was statistically similar to C_1F_0. At 50 DAS, the highest plant height (52.62 cm) was given by the treatment combination of C_3F_1 that was statistically identical to the treatment combinations of C_2F_1 whereas the lowest plant height (43.30 cm) was found from the treatment combination of C_0F_0 that was significantly different with other treatments. Similarly, at 70 DAS, the highest plant height (54.60 cm) was recorded from the treatment combination of C_3F_1 that was statistically identical to the treatment combination of C_2F_1 whereas the lowest plant height (44.25 cm) was recorded from the treatment combination of C_0F_0 that was significantly differed with other treatment combinations. Similar result was also observed by the findings of Yagoub *et al*. (2012) Morya *et al*. (2018); they reported higher plant height from organic and inorganic fertilizer combination compared to control or individual application of organic or inorganic sources of plant nutrients.

Table 1. Plant height of soybean as influenced by inorganic and organic (compost) fertilizer combinations

Treatments	Plant height (cm)		
	30 DAS	50 DAS	70 DAS
C_0F_0	27.82 e	43.30 d	44.25 e
C_0F_1	34.36 bc	49.75 ab	51.20 b
C_1F_0	30.70 de	46.24 cd	47.36 d
C_1F_1	35.70 ab	50.40 a	51.50 b
C_2F_0	31.20 d	46.72 bc	48.32 cd
C_2F_1	37.52 a	51.80 a	53.33 a
C_3F_0	32.40 cd	47.20 bc	49.44 c
C_3F_1	38.40 a	52.62 a	54.60 a
$LSD_{0.05}$	3.051	3.187	1.700
CV(%)	8.371	11.203	10.365

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_0 = Control (no compost), C_1 = Compost 6 t ha^{-1}. C_2 = Compost 8 t ha^{-1}, C_3 = Compost 10 t ha^{-1}
F_0 = Control (no chemical fertilizer), F_1 = Recommended fertilizer dose

4.1.2 Number of leaves plant^{-1}

Effect of organic (compost) fertilizers

Different organic (compost) fertilizer levels at different growth stages showed significant influence on number of leaves plant^{-1} of soybean (Figure 4 and Appendix V). Results indicated that at 30 DAS, the highest number of leaves plant^{-1} (9.10) was recorded from the treatment C_3 (compost 10 t ha^{-1}) that was statistically identical with C_2 (compost 8 t ha^{-1}) whereas the lowest number of leaves plant^{-1} (7.72) was recorded from the control treatment C_0 (no compost). At 50 DAS, the treatment C_3 (compost 10 t ha^{-1}) gave the highest number of leaves plant^{-1} (28.32) that was statistically identical to C_2 (compost 8 t ha^{-1}) whereas the lowest number of leaves plant^{-1} (24.00) was recorded from the control treatment C_0 (no compost). Similarly, at 70 DAS, the highest number of leaves plant^{-1} (14.00) was recorded from the treatment C_3 (compost 10 t ha^{-1}) that was statistically identical with the treatment C_2 (compost 8 t ha^{-1}) whereas the lowest number of leaves plant^{-1} (12.15) was recorded from the control treatment C_0 (no compost). Pati and Udmale (2016) also reported similar result with the present study.

Effect of inorganic fertilizer

Number of leaves plant^{-1} of soybean affected significantly due to different levels of inorganic fertilizer at different growth stages (Figure 5 and Appendix V). At 30 DAS, the treatment F_1 (Recommended fertilizer dose) showed the highest number of leaves plant^{-1} (9.68) whereas the control treatment F_0 (no chemical fertilizer) showed the lowest number of leaves plant^{-1} (7.40). At 50 DAS, the highest number of leaves plant^{-1} (29.52) was recorded from the treatment F_1 (Recommended fertilizer dose) whereas the lowest number of leaves plant^{-1} (23.38) was recorded from the control treatment F_0 (no chemical fertilizer). At 70 DAS, the highest number of leaves plant^{-1} (14.92) was given by the treatment F_1 (Recommended fertilizer dose) whereas the lowest number of leaves plant^{-1} (11.65) was recorded from the control treatment F_0 (no chemical fertilizer). Supported result was also observed by Liu *et al*. (2019).

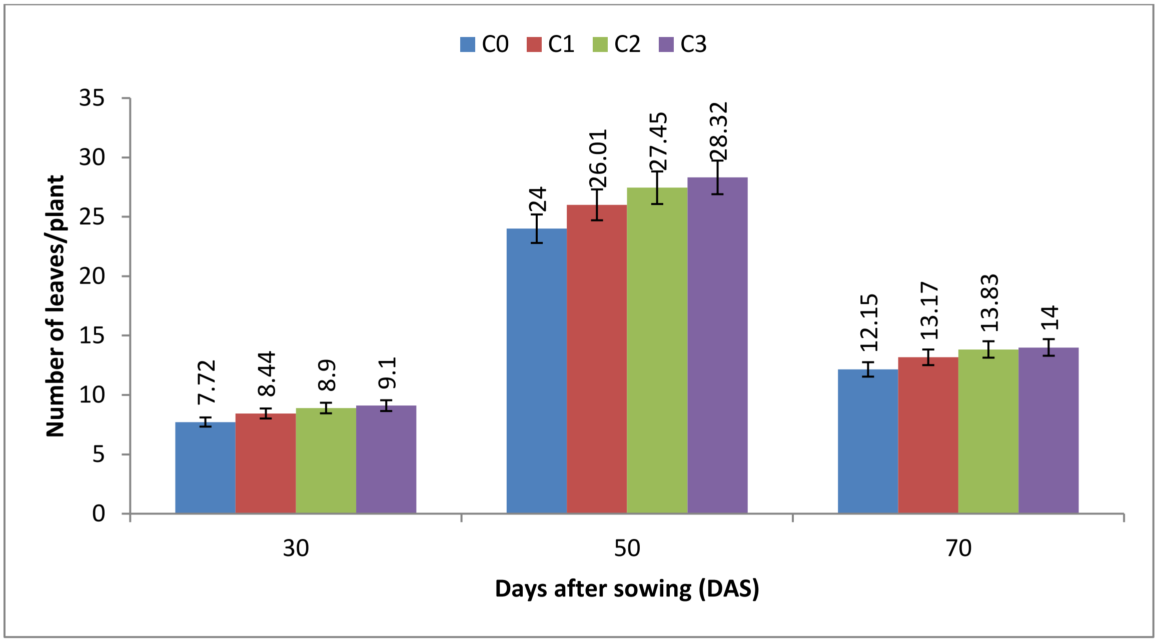


Fig. 4. Number of leaves plant^{-1} of soybean as influenced by organic (compost) fertilizer ($LSD_{0.05}$ = 0.974, 1.37 and 1.151 at 30, 50 and 70 DAS, respectively)

C_0 = Control (no compost), C_1 = Compost 6 t ha^{-1}. C_2 = Compost 8 t ha^{-1}, C_3 = Compost 10 t ha^{-1}

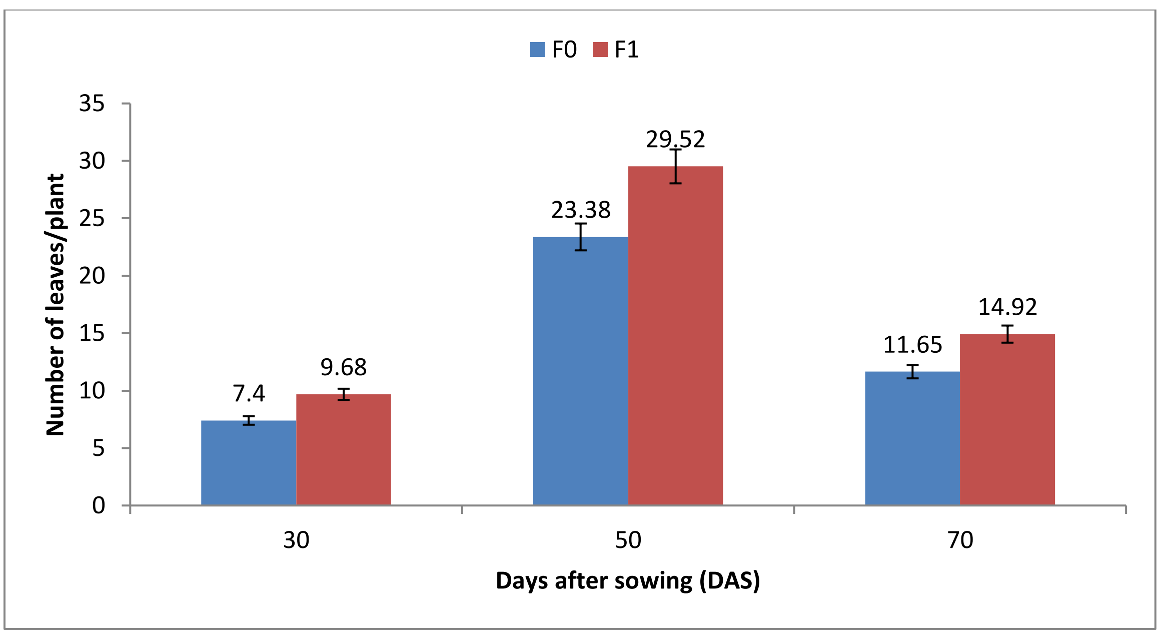


Figure 5. Number of leaves plant^{-1} of soybean as influenced by fertilizer ($LSD_{0.05}$ = 0.471, 2.062 and 1.105 at 30, 50 and 70 DAS, respectively)

F_0 = Control (no chemical fertilizer), F_1 = Recommended fertilizer dose

Table 2. Number of leaves plant^{-1} of soybean as influenced by inorganic and organic (compost) fertilizer combinations

Treatments	Number of leaves plant^{-1}		
	30 DAS	50 DAS	70 DAS
C_0F_0	6.32 d	20.40 e	10.40 d
C_0F_1	9.12 b	27.60 b	13.90 b
C_1F_0	7.40 c	23.50 d	11.63 c
C_1F_1	9.48 ab	28.52 b	14.70 ab
C_2F_0	7.88 c	24.20 cd	12.18 c
C_2F_1	9.92 ab	30.70 a	15.48 a
C_3F_0	8.00 c	25.40 c	12.40 c
C_3F_1	10.20 a	31.24 a	15.60 a
$LSD_{0.05}$	0.9735	1.370	1.151
CV(%)	6.822	10.376	9.933

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_0 = Control (no compost), C_1 = Compost 6 t ha^{-1}. C_2 = Compost 8 t ha^{-1}, C_3 = Compost 10 t ha^{-1}
F_0 = Control (no chemical fertilizer), F_1 = Recommended fertilizer dose

Combined effect organic and inorganic fertilizer

The treatment combinations of organic (compost) and inorganic fertilizers had significant effect on number of leaves plant^{-1} of soybean at different growth stages (Table 2 and Appendix V). Results exhibited that at 30 DAS, the treatment combination of C_3F_1 registered the highest number of leaves plant^{-1} (10.20) that was statistically similar to the treatment combinations of C_1F_1 and C_2F_1 whereas the lowest number of leaves plant^{-1} (6.32) was found from the treatment combination of C_0F_0 that was significantly differed with other treatment combinations. At 50 DAS, the highest number of leaves plant^{-1} (31.24) was given by the treatment combination of C_3F_1 that was statistically identical to the treatment combinations of C_2F_1 whereas the lowest number of leaves plant^{-1} (20.40) was found from the treatment combination of C_0F_0 that was significantly different with other treatments. Similarly, at 70 DAS, the highest number of leaves plant^{-1} (15.60) was recorded from the treatment combination of C_3F_1 that was statistically identical to the treatment combination of C_2F_1 whereas the lowest number of leaves plant^{-1} (10.40) was recorded from the treatment combination of C_0F_0 that was significantly differed with other treatment combinations. Similar result was also observed by the findings of Yagoub *et al*. (2012) and Morya *et al*. (2018); they reported higher leaf number from organic and inorganic fertilizer combination compared to control or individual application of organic or inorganic sources of plant nutrients.

4.2 Yield contributing parameters

4.2.1 Number of pods plant^{-1}

Effect of organic (compost) fertilizers

Number of pods plant^{-1} of soybean affected significantly due to application of different organic (compost) fertilizer levels (Table 3 and Appendix VI). It was observed that the highest number of pods plant^{-1} (43.47) was recorded from the treatment C_2 (compost 8 t ha^{-1}) that was statistically identical to the treatment C_3 (compost 10 t ha^{-1}) (42.69) whereas the lowest number of pods plant^{-1} (37.96) was recorded from the control treatment C_0 (no compost) which was significantly different with other treatments. Pati and Udmale (2016) and Ashrafuzzaman *et al*. (2015) also found similar result with the present study.

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer gave significant effect on number of pods plant^{-1} of soybean (Table 3 and Appendix VI). The highest number of pods plant^{-1} (45.97) was recorded from the treatment F_1 (Recommended fertilizer dose) whereas the lowest number of pods plant^{-1} (36.48) was recorded from the control treatment F_0 (no chemical fertilizer). Liu *et al*. (2019), Hu *et al*. (2019) and Das *et al*. (2018) also found similar result with the present study.

Combined effect organic and inorganic fertilizer

Number of pods plant^{-1} of soybean influenced significantly due to different combination of organic (compost) and inorganic fertilizers (Table 3 and Appendix VI). The highest number of pods plant^{-1} (48.20) was recorded from the treatment combination of C_2F_1 that was statistically similar to the treatment combination of C_1F_1 and C_3F_1. The lowest number of pods plant^{-1} (32.11) was recorded from the treatment combination of C_0F_0 which was significantly different with other treatment combinations. The result obtained from the present study was similar with the findings of Morya *et al*. (2018) and Yagoub *et al*. (2012) who observed higher number of pods/plant from organic and inorganic fertilizer combination compared to sole application or control treatment.

4.2.2 Pod length (cm)

Effect of organic (compost) fertilizers

Different organic (compost) fertilizer levels had non-significant effect on pod length of soybean (Table 3 and Appendix VI). However, the treatment C_3 (compost 10 t ha^{-1}) registered the highest pod length (3.34 cm) whereas the lowest pod length (3.13 cm) was given by the control treatment C_0 (no compost). The result obtained from the present study was similar with the findings of Pati and Udmale (2016).

Effect of inorganic fertilizer

Different levels of inorganic fertilizer had significant effect on pod length of soybean (Table 3 and Appendix VI). Results showed that the highest pod length (3.48 cm) was recorded from the treatment F_1 (Recommended fertilizer dose) whereas the lowest pod length (3.02 cm) was recorded from the control treatment F_0 (no chemical fertilizer). Hu *et al*. (2019) and Das *et al*. (2018) also found significant variation on leaf number among different inorganic fertilizer treatments which supported the present findings.

Combined effect organic and inorganic fertilizer

Combined effect of organic (compost) and inorganic fertilizers showed significant variation on pod length of soybean (Table 3 and Appendix VI). Results exhibited that the treatment combination C_2F_1 exposed the highest pod length (3.60 cm) that was statistically similar to the treatment combination of C_3F_1, C_1F_1 and C_0F_1. Reversely, the lowest pod length (2.92 cm) was recorded from the treatment combination of C_0F_0 that was statistically similar to C_1F_0, C_2F_0 and C_3F_0. Similar result was also observed by Morya *et al*. (2018) who observed higher pod length from organic and inorganic fertilizer combination compared to control.

4.2.3 Number of seeds pod^{-1}

Effect of organic (compost) fertilizers

Application of different organic (compost) fertilizer levels showed significant influence on number of seeds pod^{-1} of soybean (Table 3 and Appendix VI). The highest number of seeds pod^{-1} (2.80) was recorded from the treatment C_2 (compost 8 t ha^{-1}) that was statistically identical to the treatment C_3 (compost 10 t ha^{-1}) (2.78) whereas the lowest number of seeds pod^{-1} (2.64) was recorded from the control treatment C_0 (no compost) that was statistically identical to the treatment C_1 (compost 6 t ha^{-1}) (2.69). Similar result was also observed by Singh *et al*. (2017) who achieved higher number of seeds per pod from organic manure compared to control

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer gave significant effect on number of seeds pod^{-1} of soybean (Table 3 and Appendix VI). The highest number of seeds pod^{-1} (2.85) was recorded from the treatment F_1 (Recommended fertilizer dose) whereas the lowest number of seeds pod^{-1} (2.61) was recorded from the control treatment F_0 (no chemical fertilizer). . Das *et al*. (2018) and Liu *et al*. (2019) also found similar result with the present study.

Combined effect organic and inorganic fertilizer

Number of seeds pod^{-1} of soybean was influenced significantly due to different combination of organic (compost) and inorganic fertilizers (Table 3 and Appendix VI). The highest number of seeds pod^{-1} (2.96) was recorded from the treatment combination of C_2F_1 that was statistically identical to C_3F_1. The lowest number of seeds pod^{-1} (2.52) was recorded from the treatment combination of C_0F_0 that was statistically similar to the treatment combination of C_1F_0. Supported result was also observed by the findings of Morya *et al*. (2018).

4.2.4 Weight of 1000 seeds (g)

Effect of organic (compost) fertilizers

Weight of 1000 seeds of soybean affected significantly due to application of different organic (compost) fertilizer levels (Table 3 and Appendix VI). The highest 1000 seed weight (119.90 g) was recorded from the treatment C_2 (compost 8 t ha^{-1}) that was statistically identical to the treatment C_1 (compost 6 t ha^{-1}), C_2 (compost 8 t ha^{-1}) and C_3 (compost 10 t ha^{-1}) whereas the lowest 1000 seed weight (111.20 g) was recorded from the control treatment C_0 (no compost). Pati and Udmale (2016) also found similar result with the present study.

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer gave significant effect on 1000 seed weight of soybean (Table 3 and Appendix VI). Results revealed that the highest 1000 seed weight (121.62 g) was recorded from the treatment F_1 (Recommended fertilizer dose) whereas the lowest 1000 seed weight (112.33 g) was recorded from the control treatment F_0 (no chemical fertilizer). Das *et al*. (2018) also reported similar result with the present study.

Table 3. Yield contributing parameters of soybean as influenced by inorganic and organic (compost) fertilizer

Treatments	Yield contributing parameters			
	Number of pod $plant^{-1}$	Pod length (cm)	Number of seeds pod^{-1}	1000 seed weight (g)
Effect of organic (compost) fertilizers				
C_0	37.96 c	3.13 a	2.64 b	111.20 b
C_1	40.77 b	3.20 a	2.69 b	117.10 a
C_2	43.47 a	3.32 a	2.80 a	119.90 a
C_3	42.69 a	3.34 a	2.78 a	119.80 a
$LSD_{0.05}$	1.403	0.288^{NS}	0.096	3.477
CV(%)	8.314	5.211	4.361	9.523
Effect of Inorganic fertilizer				
F_0	36.48 b	3.02 b	2.61 b	112.33 b
F_1	45.97 a	3.48 a	2.85 a	121.65 a
$LSD_{0.05}$	2.144	0.014	0.102	3.712
CV(%)	8.314	5.211	4.361	9.523
Combined effect of organic and inorganic fertilizer				
C_0F_0	32.11 e	2.92 c	2.52 e	102.60 f
C_0F_1	43.80 b	3.33 ab	2.75 bc	119.70 bc
C_1F_0	36.40 d	2.98 c	2.60 de	113.80 e
C_1F_1	45.14 ab	3.42 a	2.78 b	120.30 bc
C_2F_0	37.18 cd	3.04 c	2.63 d	115.60 de
C_2F_1	48.20 a	3.60 a	2.96 a	124.20 a
C_3F_0	40.22 c	3.12 bc	2.67 cd	117.30 cd
C_3F_1	46.72 ab	3.55 a	2.91 a	122.40 ab
$LSD_{0.05}$	3.099	0.287	0.095	3.473
CV(%)	8.314	5.211	4.361	9.523

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_0 = Control (no compost), C_1 = Compost 6 t ha^{-1}. C_2 = Compost 8 t ha^{-1}, C_3 = Compost 10 t ha^{-1}
F_0 = Control (no chemical fertilizer), F_1 = Recommended fertilizer dose

Combined effect of organic and inorganic fertilizer

Significant influence was observed on 1000 seed weight of soybean due to different combination of organic (compost) and inorganic fertilizers (Table 3 and Appendix VI). Results showed that the highest number of 1000 seed weight (124.20 g) was recorded from the treatment combination of C_2F_1 that was statistically similar to C_3F_1. Again, the lowest number of 1000 seed weight (102.60 g) was recorded from the treatment combination of C_0F_0 which was significantly different with other treatments combinations. Yagoub *et al*. (2012) and Morya *et al*. (2018) also achieved similar result with the present study.

4.3 Yield parameters

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

Effect of organic (compost) fertilizers

Seed yield of soybean was significantly influenced due to application of different organic (compost) fertilizer levels (Table 4 and Appendix VII). Results showed that the highest seed yield (1.34 t ha^{-1}) was recorded from the treatment C_2 (compost 8 t ha^{-1}) that was significantly differed to other treatments followed by C_3 (compost 10 t ha^{-1}) whereas the lowest seed yield (1.11 t ha^{-1}) was recorded from the control treatment C_0 (no compost). Pati and Udmale (2016), Ashrafuzzaman *et al*. (2015), Khaosaad *et al*. (2018) and Dusane *et al*. (2018) reported higher seed yield with organic manure compared to control which supported the present study.

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer showed significant variation on seed yield ha^{-1} of soybean (Table 4 and Appendix VII). Results revealed that the treatment F_1 (Recommended fertilizer dose) registered the highest seed yield (1.43 t ha^{-1}) whereas the lowest seed yield (1.07 t ha^{-1}) was given by the control treatment F_0 (no chemical fertilizer). Kang *et al*. (2019), Liu *et al*. (2019), Fageria (2018) and Das *et al*. (2018) also found similar result with the present study.

Combined effect organic and inorganic fertilizer

Significant variation was recorded on seed yield ha^{-1} of soybean influenced by different combination of organic (compost) and inorganic fertilizers (Table 4 and Appendix VII). Results exhibited that the treatment combination C_2F_1 gave the highest seed yield (1.51 t ha^{-1}) followed by C_3F_1. In contrast, the lowest seed yield (0.88 t ha^{-1}) was recorded from the treatment combination of C_0F_0 that was significantly different from other treatment combinations. Similar result was also observed by the findings of Yagoub *et al*. (2012), Morya *et al*. (2018), Sandrakirana and Arifin (2021) and Murthy *et al*. (2017); they reported higher seed yield from organic and inorganic fertilizer combination compared to control or individual application of organic or inorganic sources of plant nutrients.

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

Effect of organic (compost) fertilizers

Significant variation on stover yield ha^{-1} of soybean was recorded as influenced by the application of different organic (compost) fertilizer levels (Table 4 and Appendix VII). Results showed that the highest stover yield (1.67 t ha^{-1}) was recorded from the treatment C_2 (compost 8 t ha^{-1}) that was significantly differed to other treatments followed by C_3 (compost 10 t ha^{-1}) whereas the lowest stover yield (1.55 t ha^{-1}) was recorded from the control treatment C_0 (no compost).

Effect of inorganic fertilizer

Different levels of inorganic fertilizer showed significant variation on stover yield ha^{-1} of soybean (Table 4 and Appendix VII). Results revealed that the treatment F_1 (Recommended fertilizer dose) registered the highest stover yield (1.69 t ha^{-1}) whereas the lowest stover yield (1.54 t ha^{-1}) was given by the control treatment F_0 (no chemical fertilizer).

Combined effect organic and inorganic fertilizer

Significant variation was recorded on stover yield ha^{-1} of soybean influenced by different combination of organic (compost) and inorganic fertilizers (Table 4 and Appendix VII). Results exhibited that the treatment combination C_2F_1 gave the highest stover yield (1.71 t ha^{-1}) that was statistically identical to the treatment combination of C_3F_1. The lowest stover yield (1.45 t ha^{-1}) was recorded from the treatment combination of C_0F_0 that was significantly different from other treatment combinations.

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

Effect of organic (compost) fertilizers

Biological yield ha^{-1} of soybean influenced significantly due to application of different organic (compost) fertilizer levels (Table 4 and Appendix VII). Results showed that the highest biological yield (3.01 t ha^{-1}) was recorded from the treatment C_2 (compost 8 t ha^{-1}) that was significantly differed to other treatments followed by C_3 (compost 10 t ha^{-1}) whereas the lowest biological yield (2.66 t ha^{-1}) was recorded from the control treatment C_0 (no compost).

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer showed significant variation on biological yield ha^{-1} of soybean (Table 4 and Appendix VII). Results revealed that the treatment F_1 (Recommended fertilizer dose) registered the highest biological yield (3.11 t ha^{-1}) whereas the lowest biological yield (2.60 t ha^{-1}) was given by the control treatment F_0 (no chemical fertilizer).

Combined effect organic and inorganic fertilizer

Significant variation was recorded on biological yield ha^{-1} of soybean influenced by different combination of organic (compost) and inorganic fertilizers (Table 4 and Appendix VII). Results exhibited that the treatment combination C_2F_1 gave the highest biological yield (3.22 t ha^{-1}) followed by C_3F_1. In contrast, the lowest biological yield (2.33 t ha^{-1}) was recorded from the treatment combination of C_0F_0 that was significantly different from other treatment combinations.

4.3.4 Harvest index (%)

Effect of organic (compost) fertilizers

Significant variation on harvest index of soybean was recorded as influenced by the application of different organic (compost) fertilizer levels (Table 4 and Appendix VII). Results showed that the highest harvest index (44.60%) was recorded from the treatment C_2 (compost 8 t ha^{-1}) that was statistically to the treatments C_3 (compost 10 t ha^{-1}) whereas the lowest harvest index (41.22%) was recorded from the control treatment C_0 (no compost).

Effect of inorganic fertilizer

Different levels of inorganic fertilizer showed significant variation on harvest index of soybean (Table 4 and Appendix VII). Results revealed that the treatment F_1 (Recommended fertilizer dose) registered the highest harvest index (45.80%) whereas the lowest harvest index (40.89%) was given by the control treatment F_0 (no chemical fertilizer).

Combined effect organic and inorganic fertilizer

Significant variation was recorded on harvest index of soybean influenced by different combination of organic (compost) and inorganic fertilizers (Table 4 and Appendix VII). Results exhibited that the treatment combination C_2F_1 gave the highest harvest index (46.93%) that was statistically similar to the treatment combination of C_0F_1, C_1F_1 and C_3F_1. The lowest harvest index (37.63%) was recorded from the treatment combination of C_0F_0 that was significantly different from other treatment combinations. The result obtained from the present study was conformity with the findings of Yagoub *et al*. (2012) who obtained higher harvest index from organic and inorganic fertilizer combination compared to control and individual application of fertilizers.

Table 4. Yield parameters of soybean as influenced by inorganic and organic (compost) fertilizer

Treatments	Yield parameters			
	Seed yield ($t\ ha^{-1}$)	Stover yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest index (%)
Effect of organic (compost) fertilizers				
C_0	1.11 d	1.55 d	2.66 d	41.22 c
C_1	1.22 c	1.60 c	2.82 c	42.98 b
C_2	1.34 a	1.67 a	3.01 a	44.60 a
C_3	1.32 b	1.63 b	2.95 b	44.58 a
$LSD_{0.05}$	0.013	0.013	0.015	1.477
CV(%)	12.07	11.71	11.94	10.083
Effect of Inorganic fertilizer				
F_0	1.07 b	1.54 b	2.60 b	40.89 b
F_1	1.43 a	1.69 a	3.11 a	45.80 a
$LSD_{0.05}$	0.015	0.016	0.018	1.376
CV(%)	12.07	11.71	11.94	10.083
Combined effect of organic and inorganic fertilizer				
C_0F_0	0.88 h	1.45 g	2.33 h	37.63 e
C_0F_1	1.34 d	1.65 c	2.98 d	44.82 ab
C_1F_0	1.02 g	1.51 f	2.54 g	40.38 d
C_1F_1	1.41 c	1.69 b	3.10 c	45.58 ab
C_2F_0	1.13 f	1.55 e	2.68 f	42.29 cd
C_2F_1	1.51 a	1.71 a	3.22 a	46.93 a
C_3F_0	1.24 e	1.63 d	2.87 e	43.28 bc
C_3F_1	1.44 b	1.70 a	3.14 b	45.87 a
$LSD_{0.05}$	0.013	0.015	0.015	2.421
CV(%)	12.07	11.714	11.94	10.083

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_0 = Control (no compost), C_1 = Compost 6 t ha^{-1}. C_2 = Compost 8 t ha^{-1}, C_3 = Compost 10 t ha^{-1}
F_0 = Control (no chemical fertilizer), F_1 = Recommended fertilizer dose

4.4 Quality parameters of post harvest soil

4.4.1 Particle density (g cm^{-3})

Effect of organic (compost) fertilizers

Particle density of post harvest soil of soybean was not affected significantly due to application of different organic (compost) fertilizer levels (Table 5 and Appendix VIII). However, the highest particle density of post harvest soil (2.56 g cm^{-3}) was recorded from the control treatment F_0 (no chemical fertilizer) whereas the lowest particle density of post harvest soil (2.51 g cm^{-3}) was recorded from the treatment C_3 (compost 10 t ha^{-1}).

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer gave non-significant effect on particle density of post harvest soil of soybean (Table 5 and Appendix VIII). However, the highest particle density of post harvest soil (2.58 g cm^{-3}) was recorded from the control treatment F_0 (no chemical fertilizer) while the lowest particle density of post harvest soil (2.50 g cm^{-3}) was recorded from the treatment C_3 (compost 10 t ha^{-1}).

Combined effect organic and inorganic fertilizer

Particle density of post harvest soil of soybean influenced significantly due to different combination of organic (compost) and inorganic fertilizers (Table 5 and Appendix VIII). However, the highest particle density of post harvest soil (2.61 g cm^{-3}) was recorded from the treatment combination of C_0F_0 whereas the lowest particle density of post harvest soil (2.47 g cm^{-3}) was recorded from the treatment combination of C_3F_1.

Table 5. Quality parameters of post harvest soil of soybean as influenced by inorganic and organic (compost) fertilizer

Treatments		Quality parameters of post harvest soil				
		Particle density (g cm^{-3})	Organic carbon (%)	Organic matter (%)	Available phosphorus (ppm)	Available sulphur (ppm)
Effect of organic (compost) fertilizers						
C_0		2.56 a	0.53	0.91	20.07	23.28 b
C_1		2.54 a	0.55	0.94	20.92	24.55 ab
C_2		2.54 a	0.57	0.97	21.62	25.40 a
C_3		2.51 a	0.58	1.00	21.66	25.68 a
$LSD_{0.05}$		0.168^{NS}	0.135^{NS}	0.114^{NS}	1.935^{NS}	1.363
CV(%)		4.312	3.711	3.73	5.524	6.376
Effect of Inorganic fertilizer						
F_0		2.58 a	0.52	0.90	19.51 b	22.68 b
F_1		2.50 a	0.59	1.01	22.63 a	26.77 a
$LSD_{0.05}$		0.104^{NS}	0.113^{NS}	0.112^{NS}	1.036	1.431
CV(%)		4.312	3.711	3.73	5.524	6.376
Combined effect of organic and inorganic fertilizer						
C_0F_0	8	2.61 a	0.50	0.86 c	18.25 c	20.75 d
C_0F_1	4	2.52 a	0.55	0.95 b	21.88 ab	25.80 ab
C_1F_0	6	2.55 a	0.51	0.88 c	19.63 c	22.90 cd
C_1F_1	3	2.52 a	0.58	1.00 ab	22.20 a	26.20 a
C_2F_0	7	2.60 a	0.53	0.91 b	20.00 bc	23.32 c
C_2F_1	2	2.48 a	0.60	1.03 a	23.18 a	27.48 a
C_3F_0	5	2.54 a	0.54	0.93 b	20.14 bc	23.75 bc
C_3F_1	1	2.47 a	0.62	1.07 a	23.24 a	27.60 a
$LSD_{0.05}$		0.166^{NS}	0.137^{NS}	0.053	1.935	2.170
CV(%)		4.312	3.711	3.73	5.524	6.376

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_0 = Control (no compost), C_1 = Compost 6 t ha^{-1}. C_2 = Compost 8 t ha^{-1}, C_3 = Compost 10 t ha^{-1}
F_0 = Control (no chemical fertilizer), F_1 = Recommended fertilizer dose

4.4.2 Organic carbon content (%)

Effect of organic (compost) fertilizers

Non-significant influence was found for organic carbon content of post harvest soil of soybean due to application of different organic (compost) fertilizer levels (Table 5 and Appendix VIII). However, the highest organic carbon content of post harvest soil (0.58%) was recorded from the treatment C_3 (compost 10 t ha^{-1}) whereas the lowest organic carbon content of post harvest soil (0.56%) was recorded from the control treatment C_0 (no compost).

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer gave non-significant effect on organic carbon content of post harvest soil of soybean (Table 5 and Appendix VIII). However, the highest organic carbon content of post harvest soil (0.59%) was recorded from the treatment F_1 (Recommended fertilizer dose) while the lowest organic carbon content of post harvest soil (0.52%) was recorded from the control treatment F_0 (no chemical fertilizer).

Combined effect organic and inorganic fertilizer

Organic carbon content of post harvest soil of soybean was not influenced significantly due to different combination of organic (compost) and inorganic fertilizers (Table 5 and Appendix VIII). However, the highest organic carbon content of post harvest soil (0.62%) was recorded from the treatment combination of C_3F_1 whereas the lowest organic carbon content of post harvest soil (0.50%) was recorded from the treatment combination of C_0F_0.

4.4.2 Organic matter (%)

Effect of organic (compost) fertilizers

Non-significant influence was found for organic matter content of post harvest soil of soybean due to application of different organic (compost) fertilizer levels (Table 5 and Appendix VIII). However, the highest organic matter content of post harvest soil (1.00%) was recorded from the treatment C_3 (compost 10 t ha^{-1}) whereas the lowest organic matter content of post harvest soil (0.91%) was recorded from the control treatment C_0 (no compost).

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer gave non-significant effect on organic matter content of post harvest soil of soybean (Table 5 and Appendix VIII). However, the highest organic matter content of post harvest soil (1.01%) was recorded from the treatment F_1 (Recommended fertilizer dose) while the lowest organic matter content of post harvest soil (0.90%) was recorded from the control treatment F_0 (no chemical fertilizer).

Combined effect organic and inorganic fertilizer

Organic matter content of post harvest soil of soybean influenced significantly due to different combination of organic (compost) and inorganic fertilizers (Table 5 and Appendix VIII). The highest organic matter content of post harvest soil (1.07%) was recorded from the treatment combination of C_3F_1 which was statistically similar with C_2F_1 and C_1F_1 whereas the lowest organic matter content of post harvest soil (0.86%) was recorded from the treatment combination of C_0F_0.

4.4.3 Available phosphorus (P) content

Effect of organic (compost) fertilizers

Non-significant variation was found on P content of post harvest soil influenced by different organic (compost) fertilizer levels (Table 5 and Appendix VIII). However, the highest P content of post harvest soil (21.66 ppm) was recorded from the treatment C_3 (compost 10 t ha^{-1}) whereas the control treatment C_0 (no compost) recorded the lowest P content of post harvest soil (20.07 ppm).

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer showed significant effect on P content of post harvest soil (Table 5 and Appendix VIII). The highest P content of post harvest soil (22.63 ppm) was found from the treatment F_1 (Recommended fertilizer dose) whereas the lowest P content of post harvest soil (19.51 ppm) was recorded from the control treatment F_0 (no chemical fertilizer).

Combined effect organic and inorganic fertilizer

P content of post harvest soil influenced significantly due to different combination of organic (compost) and inorganic fertilizers (Table 5 and Appendix VIII). The highest P content of post harvest soil (23.24 ppm) was recorded from the treatment combination of C_3F_1 that was statistically similar to the treatment combinations of C_0F_1, C_1F_1 and C_2F_1. The lowest P content of post harvest soil (18.25 ppm) was recorded from the treatment combination of C_0F_0 that was significantly similar to the treatment combination of C_1F_0, C_2F_0 and C_3F_0.

4.4.4 Available sulphur (S) content

Effect of organic (compost) fertilizers

Significant variation was found on S content of post harvest soil influenced by different organic (compost) fertilizer levels (Table 5 and Appendix VIII). The highest S content of post harvest soil (25.68 ppm) was recorded from the treatment C_3 (compost 10 t ha^{-1}) which was statistically similar to the treatment C_1 (compost 6 t ha^{-1}) and C_2 (compost 8 t ha^{-1}) whereas the control treatment C_0 (no compost) recorded the lowest S content of post harvest soil (23.28 ppm).

Effect of inorganic fertilizer

Application of different levels of inorganic fertilizer showed significant effect on S content of post harvest soil (Table 5 and Appendix VIII). The highest S content of post harvest soil (26.77 ppm) was found from the treatment F_1 (Recommended fertilizer dose) whereas the lowest S content of post harvest soil (22.62 ppm) was recorded from the control treatment F_0 (no chemical fertilizer).

Combined effect organic and inorganic fertilizer

S content of post harvest soil influenced significantly due to different combination of organic (compost) and inorganic fertilizers (Table 5 and Appendix VIII). The highest S content of post harvest soil (27.60 ppm) was recorded from the treatment combination of C_3F_1 that was statistically similar to the treatment combinations of C_0F_1, C_1F_1 and C_2F_1. The lowest S content of post harvest soil (20.75 ppm) was recorded from the treatment combination of C_0F_0 that was significantly similar to the treatment combination of C_1F_0.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was carried out during the period of November 2021 to March 2022 at the Agronomy farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 to find out the role of inorganic and organic (compost) fertilizer on the growth and yield of soybean (*Glycine max* L.). Two factors experiment was laid out in RCBD (Randomized Complete Block Design) with three replications. Four different organic (compost) fertilizer levels *viz*. C_0 = Control (no compost), C_1 = Compost 6 t ha^{-1}, C_2 = Compost 8 t ha^{-1} and C_3 = Compost 10 t ha^{-1} were combined with two treatments of inorganic fertilizers *viz*. F_0 = Control (no chemical fertilizer) and F_1 = Recommended fertilizer dose were considered for the present study.

Different organic (compost) fertilizer treatments had significant effect on most of the parameters of soybean. At 30, 50 and 70 DAS, the treatment C_3 (compost 10 t ha^{-1}) gave the highest plant height (35.40, 49.91 and 52.02 cm, respectively) and number of leaves $plant^{-1}$ (9.10, 28.32 and 14.00, respectively) whereas the lowest plant height (31.09, 46.53 and 47.73 cm, respectively) and number of leaves $plant^{-1}$ (7.72, 24.00 and 12.15, respectively) were found from the control treatment C_0 (no compost). Similarly, regarding yield contributing parameters and yield of soybean, maximum parameters not influenced significantly by different organic (compost) fertilizer levels except pod length and 1000 seed weight. the maximum number pods $plant^{-1}$ (43.47), number of seeds pod^{-1} (2.80), seed yield (1.34 t ha^{-1}), stover yield (1.67 t ha^{-1}), biological yield (3.01 t ha^{-1}) and harvest index (44.60%) were found from the treatment C_2 (compost 8 t ha^{-1}) whereas the minimum number pods $plant^{-1}$ (37.96), number of seeds pod^{-1} (2.64), seed yield (1.11 t ha^{-1}), stover yield (1.55 t ha^{-1}), biological yield (2.66 t ha^{-1}) and harvest index (41.22%) were recorded from control treatment C_0 (no compost).

Again, F_1 (Recommended fertilizer dose) treatment showed significantly higher plant height (36.50, 51.14 and 52.66 cm, at 30, 50 and 70 DAS, respectively) and number of leaves plant^{-1} (9.68, 29.52 and 14.92, at 30, 50 and 70 DAS, respectively) than control treatment F_0 (no chemical fertilizer) which showed the lowest plant height (30.53, 45.87 and 47.34 cm, respectively) and number of leaves plant^{-1} (7.40, 23.38 and 11.65, respectively). Similarly, the treatment F_1 (Recommended fertilizer dose) also gave the highest pod length (3.48 cm), number pods plant^{-1} (45.97), number of seeds pod^{-1} (2.85), 1000 seed weight (121.65 g), seed yield (1.43 t ha^{-1}), stover yield (1.69 t ha^{-1}), biological yield (3.11 t ha^{-1}) and harvest index (45.80%) whereas the control treatment F_0 (no chemical fertilizer) gave the lowest pod length (3.02 cm), number pods plant^{-1} (36.48), number of seeds pod^{-1} (2.61), 1000 seed weight (112.33 g), seed yield (1.07 t ha^{-1}), stover yield (1.54 t ha^{-1}), biological yield (2.60 t ha^{-1}) and harvest index (40.89%).

Different treatment combination of organic (compost) and inorganic fertilizers showed statistically significant variation on all the studied parameters of the present study. Result revealed that at 30, 40 and 50 DAS, the maximum plant height (38.40, 52.62 and 54.60 cm, respectively) and number of leaves plant^{-1} (10.20, 31.24 and 15.60, respectively) were achieved from the treatment combination of C_3F_1 followed by the treatment combination of C_2F_1 whereas C_0F_0 gave the lowest plant height (27.82, 43.30 and 44.25 cm, respectively) and number of leaves plant^{-1} (6.32, 20.40 and 10.40, respectively). Again, the treatment combination of C_2F_1 gave the highest pod length (3.60 cm), number pods plant^{-1} (48.20), number of seeds pod^{-1} (2.96), 1000 seed weight (124.20 g), seed yield (1.51 t ha^{-1}), stover yield (1.71 t ha^{-1}), biological yield (3.22 t ha^{-1}) and harvest index (46.93%) followed by the treatment combination of C_3F_1 whereas the treatment combination of C_0F_0 gave the lowest pod length (2.92 cm), number pods plant^{-1} (32.11), number of seeds pod^{-1} (2.52), 1000 seed weight (102.60 g), seed yield (0.88 t ha^{-1}), stover yield (1.45 t ha^{-1}), biological yield (2.33 t ha^{-1}) and harvest index (37.63%).

Different organic (compost) fertilizer levels, showed non-significant variation on particle density, organic carbon and organic matter content and available P content of post harvest soil but available S content of post harvest soil varied significantly. The highest S content (25.68 ppm) was found in C_3 (compost 10 t ha^{-1}) treatment whereas the lowest (23.28 ppm) was from the control treatment C_0 (no compost). Again, different levels of inorganic fertilizer showed non-significant variation on particle density and organic carbon and organic matter content of post harvest soil but available P and S content of post harvest soil varied significantly. The highest P and S content (22.63 and 25.68 ppm, respectively) was found in F_1 (Recommended fertilizer dose) treatment whereas the lowest (19.51 and 22.68 ppm, respectively) was from the control treatment F_0 (no chemical fertilizer). Similarly, treatment combination of organic (compost) and inorganic fertilizers, non-significant variation on particle density and organic carbon content of post harvest soil was found but organic matter content, available P and S content of post harvest soil varied significantly. The highest organic matter, P and S content (1.07%, 23.24 ppm and 7.60 ppm, respectively) was found in C_3F_1 whereas the lowest (0.86%, 18.25 ppm and 20.75 ppm, respectively) was from the treatment combination of C_0F_0.

From the above result, the following conclusions may be drawn:

1. Among 8 treatment combinations of organic (compost) and inorganic fertilizers, C_2F_1 (compost 8 t ha^{-1} × Recommended fertilizer dose) was the best regarding higher yield of soybean followed by C_3F_1 (compost 10 t ha^{-1} × Recommended fertilizer dose).
2. Treatment combination of C_3F_1 (compost 10 t ha^{-1} × Recommended fertilizer dose) showed better performance on organic matter content,

available P and S content of post harvest soil compared to others followed by C_2F_1 (compost 8 t ha^{-1} × Recommended fertilizer dose).

Recommendations

Considering this situation of the present study, further studies in the following areas may be suggested:

1. Similar study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability;
2. Some other combinations of organic (compost) and inorganic fertilizers may be included in the future study
3. Different types of organic fertilizer may also be included for further study

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APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

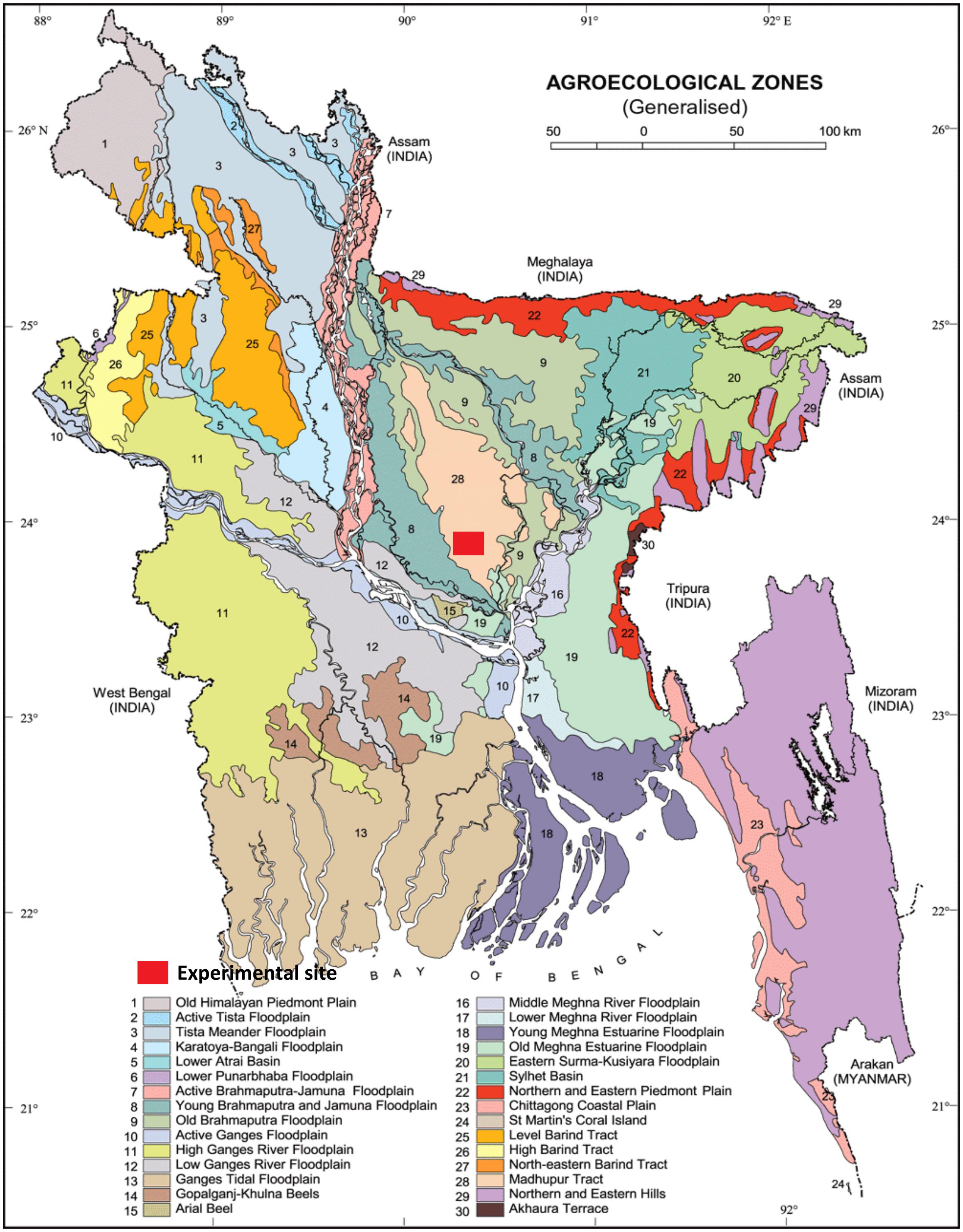

Fig. 7. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from November 2021 to March 2022.

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max	*Min*	*Mean*		
2021	November	28.60	8.52	18.56	56.75	14.40
2021	December	25.50	6.70	16.10	54.80	0.0
2022	January	23.80	11.70	17.75	46.20	0.0
2022	February	22.75	14.26	18.51	37.90	0.0
2022	March	35.20	21.00	28.10	52.44	20.4

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV. Plant height of soybean as influenced by inorganic and organic (compost) fertilizer

Sources of variation	Degrees of freedom	Mean square of plant height (cm)		
		30 DAS	50 DAS	70 DAS
Replication	2	0.176	0.244	0.376
Factor A	3	16.412*	24.201*	39.188*
Factor B	1	284.36*	341.58*	488.23*
AB	3	3.714**	5.632*	4.706*
Error	14	1.012	1.104	0.314

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix V. Number of leaves plant^{-1} of soybean as influenced by inorganic and organic (compost) fertilizer

Sources of variation	Degrees of freedom	Mean square of number of leaves plant^{-1}		
		30 DAS	50 DAS	70 DAS
Replication	2	0.244	0.312	0.052
Factor A	3	9.611**	11.039*	13.60*
Factor B	1	68.14*	91.24*	88.15*
AB	3	1.108**	3.109*	2.128**
Error	14	0.103	0.204	0.144

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VI. Yield contributing parameters of soybean as influenced by inorganic and organic (compost) fertilizer

Sources of variation	Degrees of freedom	Mean square of yield contributing parameters			
		Pod length (cm)	Number of pod plant^{-1}	Number of seeds pod^{-1}	1000 seed weight (g)
Replication	2	0.003	2.014	0.002	4.011
Factor A	3	0.102^{NS}	163.42*	0.057*	358.32*
Factor B	1	0.371**	465.02*	0.214*	536.21*
AB	3	0.052**	21.706*	0.044*	27.914*
Error	14	0.009	1.044	0.001	1.314

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VII. Yield parameters of soybean as influenced by inorganic and organic (compost) fertilizer

Sources of variation	Degrees of freedom	Mean square of yield parameters			
		Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Replication	2	714.802	639.71	802.39	1.264
Factor A	3	5203.72*	6142.83*	8314.72*	18.731*
Factor B	1	44315.4*	51311.7*	60428.3*	319.11*
AB	3	436.019*	488.364*	537.927*	2.706**
Error	14	20.90	22.71	26.84	0.637

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VIII. Quality parameters of post harvest soil of soybean as influenced by inorganic and organic (compost) fertilizer

Sources of variation	Degrees of freedom	Mean square of quality parameters of post harvest soil				
		Particle density (g cm^{-3})	Organic carbon (%)	Organic matter (%)	Available phosphorus (ppm)	Available sulphur (ppm)
Replication	2	0.002	0.001	0.002	22.09	0.401
Factor A	3	0.011^{NS}	0.003^{NS}	0.004^{NS}	43.27^{NS}	23.61*
Factor B	1	0.026^{NS}	0.001^{NS}	0.002^{NS}	72.85*	59.50*
AB	3	0.012^{NS}	0.002^{NS}	0.001	3.025**	2.181**
Error	14	0.003	0.002	0.002	0.407	0.512

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

PHOTOGRAPHY

Plate 1. Prepared land before layout preparation

Plate 2. Sowing of seeds in experiment field

Plate 3. Field view of experiment field (soybean) at vegetative stage

Plate 4. Experiment field view with signboard at vegetative stage

Plate 5. Intercultural operations

Plate 6. Tagging of experiment plot

Plate 7. Data collection