EFFECT OF ORGANIC (COMPOST) AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF POTATO

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CERTIFICATE

This is to certify that the thesis entitled **"**Effect of organic (compost) and inorganic fertilizers on growth and yield of potato**"** submitted to the **Faculty of Agriculture**, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **SOIL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **FARHANA AKTER**, Registration No. **15-06427** 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

EFFECT OF ORGANIC (COMPOST) AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF POTATO

ABSTRACT

The experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from November 2021 to February 2022 to examine the effect of organic (compost) and inorganic fertilizers on growth and yield of potato. The experiment consisted of seven treatments *viz*. T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost), T_2 (75% RCF of NPKZnS + 2 t ha^{-1} compost), T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost), T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost), T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost), T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost) and T_7 (50% RCF of NPKZnS + 8 t ha^{-1} compost). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Significant variation among the treatments was found for most of the parameter due to different levels of organic (compost) and inorganic fertilizers. The treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) exposed the minimum days to first emergence (15.67 days) and final emergence (17.00 days) while the maximum plant height (81.20 cm), number of leaves $plant^{-1}$ (78.24), number of stem $plant^{-1}$ (7.20), number of tuber $plant^{-1}$ (7.92), weight of tuber $plant^{-1}$ (277.50 g), tuber weight $plot^{-1}$ (14.43 kg) and tuber yield ha^{-1} (28.86 t) followed by T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) whereas the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) performed the lowest results regarding these parameters. Regarding the grading of potato, T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) treatment also showed the highest percentage of 28-45 mm grade tuber (45.24%) followed by T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) (43.80%) treatment whereas the minimum percentage (35.90%) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost). In case of post harvest soil, different treatments showed non-significant variation on pH, organic matter and organic carbon content but available P and S of post harvest soil affected significantly. The treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) showed the highest P (23.42 ppm) and S (28.47 ppm) content of post harvest soil whereas the lowest P and S content (18.80 and 23.85 ppm, respectively) was obtained from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost). So, this treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) can be considered as the best treatment for potato production compared to other treatments.

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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

Potato (*Solanum tuberosum* L.) is a tuber crop that belongs to the Solanaceae family. It is native to the central Andean region of South America, as documented by Keeps (1979). The crop was first introduced to the Indian subcontinent in the sixteenth century, where it was initially cultivated in small plots as a vegetable. In Bangladesh, potatoes have been grown since at least the 19^{th} century, with the first commercial production of the crop established by the 1920s, as reported by Kabir *et al*. (2021).

Potatoes are a rich source of several important nutrients, including carbohydrates, dietary fiber, vitamins, and minerals. A medium-sized potato (150 grams) with skin provides approximately; carbohydrates 26 grams, fiber 3.8 grams, protein 2.5 grams, fat 0.2 grams, vitamin C 27% of the daily value (DV), potassium 26% of the DV, vitamin B6 18% of the DV and iron 6% of the DV (USDA, 2021). Potatoes also contain other nutrients such as magnesium, phosphorus, niacin, and folate. The nutritional value of potatoes varies depending on their cooking method and preparation. Boiling or baking potatoes with the skin intact is the best way to preserve their nutrients (DiMarco-Crook, 2020).

Potato is one of the most important crops in Bangladesh, both in terms of production and consumption. According to the Bangladesh Bureau of Statistics (BBS, 2021), the country produced 11.42 million metric tons of potatoes in the 2020-2021 fiscal years, which is an increase of 4.9% from the previous year.

Potatoes are grown in almost all districts of Bangladesh, with the highest production being in the northern districts, particularly in Rangpur, Dinajpur, Nilphamari, and Lalmonirhat. The southern districts, including Barisal, Patuakhali, and Bhola, also contribute to potato production. Potato is usually grown in two seasons in Bangladesh: the winter season (November to February) and the summer season (March to June). The winter season is the main season for potato cultivation.

The cultivation of potato in Bangladesh has been increasing over the years, due to various initiatives taken by the government and non-governmental organizations to increase productivity and promote the use of modern farming technologies. For example, the use of high-yielding potato varieties, integrated nutrient management practices, improved irrigation systems, and better pest management practices has helped to increase potato production in the country.

The use of organic and inorganic fertilizers has been widely practiced to meet the crop's nutritional requirements and enhance growth and yield. Compost, a decomposed organic matter, has gained increasing attention as an alternative fertilizer source due to its ability to improve soil fertility and quality while reducing environmental pollution (Gupta and Gajri, 2017; Abdu and Tsegay, 2021). On the other hand, inorganic fertilizers provide a readily available source of nutrients, making them popular among farmers. Despite the widespread use of these fertilizers, their effects on potato growth and yield remain a topic of debate among researchers. Some studies have shown that compost can improve potato growth, yield, and quality, while others suggest that inorganic fertilizers can achieve similar or higher results (Zhang *et al*., 2019; Kaur and Kumar, 2020). Compost has been shown to enhance the growth and yield of various crops, including potato (Egamberdiyeva *et al*., 2017; Bhat *et al*., 2019; Ali *et al*., 2021). It improves the soil structure, water holding capacity, and nutrient availability, leading to increased plant growth and yield (Subhani *et al*., 2019). Compost application also promotes the growth of beneficial microorganisms in the soil, which contribute to nutrient cycling and disease suppression (Lopez-Valdez *et al*., 2017). However, the effects of compost on potato growth and yield may vary depending on the type of compost used, its application rate, and the soil and environmental conditions (Kumar *et al*., 2021; Sanchez-Monedero *et al*., 2021).

Inorganic fertilizers are widely used in potato cultivation due to their availability and cost-effectiveness. The nutrients in inorganic fertilizers, such as nitrogen (N), phosphorus (P), and potassium (K), are necessary for potato growth and development (Zhang *et al*., 2018). The use of inorganic fertilizers can enhance the growth and yield of potato by providing sufficient nutrients, improving soil fertility, and increasing photosynthetic capacity (Tolera *et al*., 2018). However, excessive use of inorganic fertilizers can lead to environmental pollution and negative impacts on soil health, plant growth, and yield (Sharma *et al*., 2018). Furthermore, the application of inorganic fertilizers may not always result in significant yield increases due to soil-specific factors such as pH, soil type, and microbial activity (Wu *et al*., 2020).

Organic fertilizers, such as compost, have been shown to improve soil fertility, increase water holding capacity, and promote the growth and yield of potato (Kumar *et al*., 2019). However, the nutrient content of organic fertilizers is relatively low compared to inorganic fertilizers, which can limit their effectiveness in improving potato yields. Combining organic and inorganic fertilizers can overcome this limitation by providing a balanced nutrient supply for potato growth and development. The combined use of organic and inorganic fertilizers has been reported to enhance soil health, increase nutrient uptake, and improve the growth and yield of potato crops (Islam *et al*., 2021).

The organic and inorganic fertilizers work synergistically to improve soil fertility, increase nutrient availability, and enhance plant growth and yield. Moreover, the use of organic and inorganic fertilizers in combination can reduce the amount of inorganic fertilizers needed, which can lead to lower costs and reduced environmental pollution (Kumar *et al*., 2019).

Depending on the above discussion, the present research was undertaken with the following objectives:

1. To observe the performance of compost and inorganic fertilizer for enhancing the growth and yield of potato
2. To find out the suitable combination dose of compost and inorganic fertilizers for successful potato production

CHAPTER II

REVIEW OF LITERATURE

Organic manure and inorganic fertilizers applications, both are important factors influencing the yield and quality of potato. The average yield of potato in Bangladesh is much lower than that of the other countries of the world. Many research works have been conducted on the effect of different organic manure application combined with inorganic fertilizers on the growth, yield, and quality of potato in various parts of the world. Some of the important research reports regarding potato cultivation with organic and inorganic fertilizers on potato growth, yield and quality have been reviewed here in this chapter.

Hensh *et al*. (2020) conducted a study with on growth and tuber yield of potato (*Solanum tuberosum* L.) using vermicompost combined with inorganic fertilizers. The study was consisted of 14 treatments with three replications. The results revealed that treatment T_{10}: 80% RDN through chemical fertilizer + 20% through vermicompost + biofertilizer exhibited highest growth attributes i.e. plant height (43.3 cm), leaf area index (4.42), dry matter accumulation (583.45 g m^{-2}) and crop growth rate (18.38 g m^{-2} day^{-1}) followed by treatment T_{11}: 80% RDN through chemical fertilizer + 20% through mustard oil cake + biofertilizer and T_9: 80% RDN through chemical fertilizer + 20% through FYM + biofertilizer. This treatment T_{10}: 80% RDN through chemical fertilizer + 20% through vermicompost + biofertilizer also showed highest total number of tubers per plant (9.05 tubers $plant^{-1}$), tuber weight per plant (517.8 gm) and tuber yield (32.05 t ha^{-1}) of potato and the tubers yield was 55% higher over 100% RDN through chemical fertilizer (T1). The higher tuber yield achieved in 80% RDN through chemical fertilizer + 20% through vermicompost + biofertilizer might be due to the integration of inorganic, organic and biofertilizers might have improved the physico-chemical conditions of the soil.

Bhujel *et al*. (2021) conducted an experiment to evaluate the yield performance of potato varieties with chemical and organic fertilizer at Chilime, Rasuwa. The experiment consisted of eight treatment combinations. Four potato varieties (Khumal-Seto-1, Khumal-Ujjwal, Janak-Dev and Kufri-Jyoti) with fertilizer (Recommended dose of chemical fertilizer (100:100:60 NPK kg ha^{-1}) and organic farmyard manure (15 mt ha^{-1}) were used to make eight treatment combinations. The results showed that Janak-Dev had the highest plant height (69.3 cm) and canopy diameter (60.92 cm). Khumal-Seto-1 had highest number of main stems per hill (3.75) which were statistically similar to Kufri-Jyoti (3.42) and Khumal-Ujjwal (3.25). Janak-Dev had the lowest number of main stems per hill (1.87). The effect of fertilizer was non-significant. Number of tubers per plant was not affected by types of fertilizers used. Maximum weight of each tuber (107.7 grams), yield per plant (780 grams) and yield per hectare (37.1 mt ha^{-1}) were obtained from Kufri-Jyoti. These parameters were the highest from chemical fertilizer application.

Phumlani *et al*. (2019) conducted a study with organic and inorganic fertilizers. Combinations of chemical fertiliser NPK [4:3:5 (36.5)] with [3:0:5 (48.5)] as the control, cattle manure, goat manure, cattle manure combined with NPK [4:3:5 (36.5)], goat manure combined with NPK [4:3:5 (36.5)], goat manure combined with NPK [4:3:5 (36.5)] and NPK [3:0:5 (48.5)] applied as topdressing, cattle manure combined with NPK [4:3:5 (36.5)] and NPK [3:0:5 (48.5)] applied as topdressing and NPK [4:3:5 (36.5)] applied alone were used in this study. Goat and cattle manure were both applied at 40 t/ha, basal fertiliser NPK [4:3:5 (36.5)] at 900 kg/ha and NPK [3:0:5 (48.5)] applied as topdressing at 350 kg/ha and their interactions with plant growth, yield and nutritional quality were evaluated during a field experiment in 2018 with the use of a split-plot design with the 2x8 factorial arrangement of three replications in Eswatini. Shoot emergence occurred 20 days after planting. Plant height and number of branches increased linearly and significantly in response to manure and fertiliser application, where cattle manure combined with NPK [4:3:5 (36.5)] and NPK [3:0:5 (48.5)] providing the highest plant height of 59.3 cm in Mondial cultivar. Mondial cultivar showed higher vegetative growth, yield and quality parameters when compared to BP1. Yield was significantly increased in response to manure and fertiliser application. Application of cattle manure combined with NPK [4:3:5 (36.5)] and NPK [3:0:5 (48.5)] gave the highest marketable yield of 14.4 t/ha in Mondial cultivar with goat manure showing the lowest yield (5.3 t/ha) in Mondial cultivar. The application of cattle manure combined with NPK [4:3:5 (36.5)] and NPK [3:0:5 (48.5)] induced the highest tuber dry matter content of 22.6% in BP1 cultivar.

Asadi *et al*. (2018) conducted a study in Iran to investigate the effects of compost and nitrogen fertilizer on the growth, yield, and quality of potato. The study used a split-plot design with three replications, and the treatments included four levels of compost (0, 10, 20, and 30 t ha^{-1}) and four levels of nitrogen fertilizer (0, 75, 150, and 225 kg ha^{-1}). The results showed that the application of compost with inorganic fertilizer increased the plant height, dry matter accumulation, tuber number per hill, tuber yield, total biomass, and nitrogen use efficiency of potato. They also reported that organic fertilizers promote the growth of beneficial microorganisms in the soil, which can help to suppress plant diseases and improve nutrient uptake providing available nutrients as NPKS in soil to plants. The study concluded that the combination of compost and inorganic fertilizer (nitrogen) in combination with recommended doses of other TSP and MoP fertilizer could be an effective strategy for attaining higher potato yield regarding sustainable potato production.

Kumar *et al*. (2017) conducted an experiment in India to evaluate the effect of organic and inorganic sources of nutrients on the growth, yield, and quality of potato. The study used a randomized block design with three replications, and the treatments included different combinations of organic and inorganic fertilizers.

The results showed that the application of organic and inorganic fertilizers significantly increased the plant height, dry matter and tuber yield of potato. The results also revealed that organic fertilizer contributed to increase available nutrients (N, P, K, S) to soil for plant nutrition which resulted higher growth and yield of potato. The study concluded that the integrated use of organic and inorganic fertilizers could improve the growth, yield, and quality of potato.

Singh *et al*. (2017) carried out a study to compare the effects of vermicompost and chemical fertilizer on the growth, yield, and quality of potato in India. The study used a randomized block design with three replications, and the treatments included different combinations of organic fertilizer (vermicompost) and chemical fertilizer. The results showed that the application of organic fertilizer (vermicompost) and chemical fertilizer significantly increased the plant height, number of tubers, and tuber weight of potato. The study concluded that the integrated use of vermicompost and chemical fertilizer could enhance the growth, yield, and quality of potato.

Khan *et al*. (2019) conducted an experiment in Pakistan to evaluate the effect of organic and inorganic fertilizers on the growth and yield of potato. The study used a randomized complete block design with four replications, and the treatments included different combinations of organic and inorganic fertilizers. The results showed that the application of organic and inorganic fertilizers significantly increased the plant height, number of stems and dry matter and also tuber yield of potato. The study concluded that the integrated use of organic and inorganic fertilizers could improve the growth and yield of potato.

Kumar *et al*. (2018) conducted a study in India to assess the effect of organic (compost and farm yard manure) and inorganic sources of nutrients on the growth, yield, and economics of potato. The treatments included different combinations of organic and inorganic fertilizers. The results showed that the application of compost and inorganic fertilizers significantly increased the stem number, tuber number, tuber yield, net return, and benefit-cost ratio of potato. Higher levels of available plant nutrients like N, P, K, S in soil also found from the treatment combinations of organic and inorganic fertilizers compared to inorganic fertilizers. The study concluded that the integrated use of organic and inorganic fertilizers could enhance the growth, yield, and economics of potato production.

Rodriguez *et al*. (2018) conducted an experiment in Spain to investigate the effect of compost and inorganic fertilizers on the growth and yield of potato. The study used a split-plot design with three replications, and the treatments included different combinations of compost and inorganic fertilizers. The results showed that the application of compost significantly increased the plant height, leaf number, tuber number, tuber size and weight, dry matter content of tuber, tuber yield and total biomass of potato, while the application of inorganic fertilizer as sole treatment had no significant effect. The study concluded that the application of compost could be an effective strategy for improving the growth and yield of potato.

Al-Homaidan *et al*. (2018) carried out a study in Saudi Arabia to compare the effect of vermicompost and chemical fertilizers on the growth and yield of potato. The treatments included different combinations of vermicompost and chemical fertilizers. The results showed that the application of vermicompost and chemical fertilizers significantly increased the plant height, number of tubers, and tuber weight of potato. The results also concluded that the integrated use of vermicompost and chemical fertilizer could enhance the growth and yield of potato compared to sole application of organic or inorganic fertilizers.

Khan *et al*. (2013) carried out an experiment to investigate the effects of integrated use of organic (farmyard manure and poultry manure) and inorganic (NPK) fertilizers with effective microorganisms (EM) on seed cotton yield in Pakistan.

Results showed that the integrated use of organic and inorganic nutrient sources with EM significantly improved seed cotton yield, fiber quality and soil properties compared to the control treatment. The highest seed cotton yield was obtained with the treatment that received a combination of 50% NPK, 50% farmyard manure, 20% poultry manure and EM. The results suggest that integrated use of organic and inorganic nutrient sources with EM can enhance cotton productivity and sustainability in Pakistan.

Shalaby and Ahmed (2016) conducted a study to investigate the effect of organic (compost and chicken manure) and inorganic (NPK) fertilizers on growth, yield and quality of potato in Egypt. Results showed that the application of organic fertilizers alone or in combination with inorganic fertilizers significantly improved potato growth parameters (plant height, leaf number, dry weight), yield parameters (number and weight of tuber per hill, yield per ha) and quality parameters (firmness and nutrients content) compared to the control treatment. The highest growth, yield and quality were obtained with the treatment that received a combination of 50% NPK and 50% compost. The results suggest that the integrated use of organic and inorganic fertilizers can improve potato productivity and quality.

Kassahun and Girma (2014) carried out an investigation to study the effect of organic (compost and farmyard manure) and inorganic (NPK) fertilizers on growth, yield and yield components of potato in Ethiopia. Results showed that the application of organic and inorganic fertilizers significantly reduce days to seedling emergence and improved potato growth, yield and yield components compared to the control treatment. The highest yield and yield components were obtained with the treatment that received a combination of 50% NPK and 50% compost. NPK fertilizers combined with farmyard manure also gave promising results on growth and yield compared to the control treatment. The results suggest that the integrated use of organic and inorganic fertilizers can improve potato productivity and yield components.

Razaq *et al*. (2018) investigated the role of organic (farmyard manure and compost) and inorganic (NPK) fertilizers in improving growth, yield and quality of potato in Pakistan. Results showed that the application of organic and inorganic fertilizers significantly improved potato growth, yield and quality compared to the control treatment. The highest yield and quality were obtained with the treatment that received a combination of 50% NPK and 50% farmyard manure followed by 50% NPK and 50% compost. The results suggest that the integrated use of organic and inorganic fertilizers can improve potato productivity and quality.

Nkebiwe *et al*. (2016) conducted an experiment to investigate the influence of organic and conventional fertilization and soil type on the yield and quality of potatoes. The results showed that organic fertilization with or without conventional fertilizers increased the yield of potatoes, especially in sandy soils, and improved the quality of potatoes in terms of higher starch content, dry matter, and tuber size distribution.

Pandit *et al*. (2018) conducted a field experiment with potato variety Kufri Ashoka to test the recommended dose of fertilizers (RDF) levels (0, 50, 75, 100, 125, 150%) with two organic manures (vermicompost 5 t/ha and mustard oil cake 2.5 t/ha). The experiment consisted of twelve treatments which replicated thrice. Among the bulking rate, grade wise yield and yield were recorded higher with the application of treatment T_{11} - 150% RDF + 5.0 t/ha vermicompost which was significantly superior over T_1, T_2, T_3, T_4, T_5 and T_6 but was statistically at par with treatments, T_7, T_8, T_9, T_{10} and T_{12}.

Singh *et al*. (2018) conducted an experiment to study the effect of organic and inorganic fertilizer management on growth, quality and yield of potato (kufri pukhraj) Totally eleven treatments in which one control, two treatments consist

100% RDF and 75% RDF alone and remaining eight treatments consist combination of inorganic fertilizers and organic manures. Growth attributes and yield attributes were recorded at the time of harvest. Integrated use of synthetic fertilizers, organic manures and biofertilizers showed the significant impact on growth and yield attributes of potato. Result indicate that the application of 75% RDF + 2 tonnes ha^{-1} FYM + 1tones ha^{-1} Vermicompost + 20kg ha^{-1} Sulphur + 20kg ha^{-1} Zinc sulphate + Azotobacter (seed treatment) showed significant positive impact on fresh weight ($plant^{-1}$), tuber weight ($plant^{-1}$), tuber numbers ($plant^{-1}$) and tuber yield (tonnes ha^{-1}) as compared to 100% RDF and control. The application of 100% RDF + 2 tonnes ha^{-1} FYM + 1 tones ha^{-1} Vermicompost + 20 kg ha^{-1} Sulphur + 20kg ha^{-1} Zinc sulphate showed positive impact on dry weight. Application of 75% RDF + 2tonnes ha^{-1} FYM + 1tones ha^{-1} Vermicompost + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate + Azotobacter (seed treatment) was more remunerative for sustainable production of potato.

Mohammed *et al*. (2018) carried out an experiment to assess the effects of organic manure combined with inorganic fertilziers on potato growth, yield and yield components. The treatments were three rates of farmyard manure (0, 5, 10, t ha^{-1}), three rates of N (0, 55.5, 111 kg N ha^{-1}), and three rates of phosphorus (0, 46, 92 kg P_2O_5 ha^{-1}). The results showed that the effect of integrated use of organic and inorganic fertilizer had significant influence on plant height, above ground bio1mass, day to maturity, total tuber yield, average tuber number/hill, average tuber mass/hill, marketable tuber number and tuber dry matter yield. The highest marketable tuber yields of 38.65 t ha^{-1} followed by 36.24 t ha^{-1} were obtained in response to a combined application of farm yard manure, N and P at the rates of 10 t FYM ha^{-1} + 111 kg N ha^{-1} + 92 kg P_2O_5 ha^{-1} and 10 ton FYM ha^{-1} + 111 kg N ha^{-1} + 46 kg P_2O_5 ha^{-1}, respectively. The marketable and total tuber yields were positively and significantly correlated with all growth and yield components studied but negatively and significantly correlated with the number of main stem/hill, unmarketable tuber yield. In conclusion, application of farm yard manure with, N and P not only significantly improved prod uctivity, but also profitability of the crop.

Singh *et al*. (2013) conducted a field experiment to evaluate lower doses of FYM (2, 4 and 6 tonnes FYM ha^{-1}) in combination with three NPK levels (180:34.9:100, 270:52.4:150 and 360:69.8:200 kg ha^{-1}). Integrated use of NPK 270:52.4:150 kg ha^{-1} along with 2 tonnes of FYM ha^{-1} recorded highest benefit:cost ratio (2.2). Increasing application of NPK (180:34.9:100 to 270:52.4:150 kg ha^{-1}) increased large-sized tuber yield (7.5 - 8.5 tonnes ha^{-1} and total tuber yield (28.4 - 32.4 tonnes ha^{-1}), however application of 2, 4 or 6 tonnes FYM ha^{-1} did not show any significant increase in total tuber yield. Increasing NPK levels increased potato equivalent yield from 32.2 to 37.3 tonnes ha^{-1}. Higher net return of 85.6 x 103 ha^{-1} was obtained with 2 tonnes FYM ha^{-1} compared to 4 and 6 tonnes FYM ha^{-1}. There was no significant effect of organic and inorganic nutrient doses on cutworm damage on potato crop.

Raghab *et al*. (2007) conducted a field experiment to study the growth parameters and yield of potato influenced by the organic manures and chemical fertilizers. Maximum plant height (68.66 cm), number of haulms per hill (7.55), number of tubers per hill (8.33), weight of tuber per hill (626.66 g), dry matter content of tuber (26.30%), total soluble solids (5.03oB), specific gravity (0.975 g/cm3) and yield (245.60 g ha^{-1}) were recorded with the application of 100% recommended dose of NPK (160:100:120 kg ha^{-1}) + 10 t FYM followed by 100% of recommended dose of NPK alone. Maximum number and weight of A and B grade tubers were recorded in treatment T_4 and T_5, respectively. The highest net income as well as benefit: cost ratio (1:25) were obtained with the application of 100% NPK.

Alam *et al*. (2007) conducted an experiment to study the effect of vermicompost and NPKS fertilizers on growth and yield of potato (cv. Cardinal). The organic matter of the experimental field soil was very low and in case of N, P, K and S also low. Application of vermicompost and NPKS significantly influenced the growth and yield of potato. The treatment, Vermicompost 10 t ha-1 +100% NPKS (doses of N-P-K-S were 90-40-100-18 kg ha^{-1} for potato) produced the highest (25.56 t ha^{-1}) tuber yield of potato. The lowest yield and yield contributing parameters recorded in control. Application of various amounts of vermicompost (2.5, 5, 10 t ha^{-1}) with NPKS fertilizers (50% and 100%) increased the vegetative growth and yield potato. Vermicompost at 2.5, 5 and 10 t ha-1 with 50% of NPKS increased tuber yield over control by 78.3, 96.9 and 119.5 t ha^{-1} respectively. And vermicompost at 2.5, 5 and 10 t ha^{-1} with 100% of NPKS increased tuber yield by 146.8, 163.1 and 197.9 %, respectively. The results indicated that vermicompost (10 t ha^{-1}) with NPKS (100%) produced the highest growth and yield of potato.

CHAPTER III

MATERIALS AND METHODS

3.1 Experimental site

The experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka, during the period from November 2021 to February 2022. Geographically the experimental area is located at 23°41´N latitude and 90°22´E longitudes at the elevation of 8.6 m above the sea level. The experimental site has been shown in the Appendix I.

3.2 Climate and weather

The experimental field was under subtropical climates characterized by heavy rainfall during the month of April to September and scanty rainfall during October to March. The monthly means of daily maximum, minimum and average temperature, relative humidity, total rainfall and sunshine hours received at the experimental site during the period from November 2021 to February 2022 have been presented in Appendix II.

3.3 Soil characteristics

The experimental site belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were silty clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 6.2 and had organic matter 1.03%. The experimental area was flat having available irrigation and drainage system. The experimental site was a medium high land. It was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The physicochemical properties of the soil are presented in Appendix III.

3.4 Planting material

The variety Diamond (BARI Alu-7) was used as the planting material for the present study and was collected from the Tuber Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.5 Land preparation

The land of the experimental site was first opened in the first week of November with power tiller. Later on, the land was ploughed and cross-ploughed four times followed by laddering to obtain the desirable tilth. The corners of the land were spaded and weeds and stubbles were removed from the field. The land was finally prepared on 9^{th} November 2021 three days before planting the seed. In order to avoid water logging due to rainfall during the study period, drainage channels were made around the land.

3.6 Experimental design and lay out

The single-factor experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The size of the unit plot was 2.5 m × 2.0 m. Block to block and plot to plot distances were 1 m and 0.5. Treatments were randomly distributed within the blocks. The plots were raised up to 10 cm. Layout of the experiment field is shown in Appendix IV.

3.7 Treatments of the experiment

1. T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost
2. T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost
3. T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost
4. T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost
5. T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost
6. T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost
7. T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

NB: RCF = Recommended chemical fertilizers

3.8 Manure and fertilizer application

The crop was fertilized as per recommendation of TCRC (2004). Urea, triple super phosphate (TSP), muriate of potash (MoP), zinc sulphate, gypsum and boric acid were used as sources of nitrogen, phosphorus, potassium, zinc, sulphur and boron, respectively. The recommended doses of fertilizers were 325, 220, 250, 10, 120 and 8 kg/ha. Compost was used as organic manure as a source of nutrients. Compost was applied as per treatment during final land preparation. Total amount of TSP, MoP, zinc sulphate, gypsum, boric acid and half of urea was applied at basal doses during final land preparation. The remaining 50% urea was side dressed in two equal splits at 25 and 45 days after planting (DAP) during first and second earthing up.

3.9 Seed preparation and sowing

The seed tubers were taken out of the cold store about three weeks before planting. The tubers were kept under diffuse light conditions to have healthy and good sprouts. Planting was done on November 12, 2021. The well sprouted seed tubers were planted at a depth of 5-7 cm in furrow made 60 cm apart. Hill to hill distance was 15 cm. After planting, the seed tubers were covered with soil.

3.10 Intercultural operations

3.10.1 Weeding

Weeding was necessary to keep the plant free from weeds. First weeding was done two weeks after emergence. Another weeding was done before 2^{nd} top dressing of urea.

3.10.2 Earthing up

Earthing up was done twice during growing period. The first earthing up was done at 25 DAP and second earthing up was done after 20 days of first earthing up.

3.10.3 Irrigation

Three irrigations were provided throughout the growing period in controlled way. The first irrigation was given at 25 DAP. Subsequently, another two irrigations were given at 45 and 60 DAP.

3.10.4 Plant protection

Furadan 5G @ 10 kg ha^{-1} was applied in soil at the time of final land reparation on 25 October, 2019 to control cut worm. Dithane M-45 was sprayed in 2 installments at an interval of 15 days from 45 DAP as preventive measure against late blight disease.

3.11 Harvesting

The crop was harvested at 83 DAP. The harvested plants were tagged separately plot wise. Five sample plants were randomly selected from each plot and tagged for recording necessary data and then the all plots was harvested with the help of spade. The maturity of plant was indicated by the plants showing 80 to 90% of leaf senescence and the top started drying. Haulm cutting was done before 7 days of harvesting. The yield of tuber was taken plot wise and converted into tons ha^{-1}. Care was taken to avoid injury in potatoes during harvesting.

3.12 Data collection

The following parameters were recorded and their mean values were calculated from the sample plants.

3.12.1 Plant height

Plant height was taken to be the length between the base of the plant to the tip from randomly selected five plants. The height of each plant of each plot was measured in cm at 30, 50 and 70 days after planting (DAP) with the help of a meter scale and mean was calculated.

3.12.2 Number of leaves plant^{-1}

Number of leaves plant^{-1} was counted from randomly selected five plants at 30, 50 and 70 days after planting (DAP). Leaves number plant^{-1} were recorded by counting all leaves from each plant of each plot and mean was calculated.

3.12.3 Number of stems hill^{-1}

Number of stems hill^{-1} was counted at the time of harvest from randomly selected five plants of each replication of each treatment. Stem numbers hill^{-1} was recorded by counting all stem from selected plants and mean was calculated.

3.12.4 Number of tubers hill^{-1}

The number of tubers hill^{-1} was determined from the average of 5 hills selected from each unit plot.

3.12.5 Weight of tuber hill^{-1}

Five hills were randomly selected from each plot. The total tuber was enumerated and weighted from five hills by using an electronic balance. It was recorded by dividing total fresh weight of tubers by the total number of selected hills.

3.12.6 Tuber yield plot^{-1}

Tubers of each plot were collected separately from which yield of tuber was recorded in kilogram.

3.12.7 Tuber yield ha^{-1}

All the tubers weight per plot was recorded and the tuber weight was finally converted into tons ha^{-1}.

3.12.8 Grade of tubers on the basis of diameter

The grading of tubers was done in the following manner: >55 mm in diameter, 45-55 mm in diameter, 28-45 mm in diameter and < 28 mm in diameter.

3.12.9 Methods of Soil Analysis

3.12.9.1 Soil pH

The pH of the soil was determined with help of a glass electrode pH meter using soil: water ratio being 1: 2.5 (Jackson, 1973).

3.12.9.2 Organic carbon (%)

Organic carbon of soil was determined by Walkley and Black's (1934) wet oxidation method. The underlying principle is to oxidize the organic carbon with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and to titrate the residual $K_2Cr_2O_7$ solution with 1N $FeSO_4$ solution. The result was expressed in percentage.

3.12.9.3 Organic matter (%)

Organic matter was calculated from the following formula:

$$\text{Organic matter (\%)} = \text{Total organic carbon (\%)} \times 1.72$$

3.12.9.4 Available phosphorus (ppm)

Available Phosphorus was extracted from soil shaking with 0.5 M $NaHCO_3$ solution of pH 8.5 (Olsen *et al*. 1954). The phosphorus in the extract was than determined by developing blue color using $SnCl_2$ reduction of phosphomolybdate complex. The absorbance of the molybdatephosphate blue color was measured at 660 nm wave length by spectrophotometer and available P was calculated with the help of standard curve.

3.12.9.5 Available sulphur

Available sulphur in soil was determined by extracting the soil sample with 0.15% $CaCl_2$ solution (Page *et al*., 1982). The S content in the extract was determined turbidimetrically and the intensity of turbid was measured by spectrophotometer at 420 nm length.

3.13 Statistical analysis

The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the means were separated by Least Significant Difference (LSD) using the statistical computer package program, MSTAT-C at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The study was conducted to find out effect of organic (compost) and inorganic fertilizers on growth and yield of potato. The results have been presented and discussed with the help of table and graphs and possible interpretations in the following headings:

4.1 Growth parameters

4.1.1 Plant height

Significant variation on plant height of potato was recorded at different growth stages due to different levels of organic (compost) and inorganic fertilizers (Figure 1 and Appendix V). It was observed that at 30 DAP, the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) gave the tallest plant (25.12 cm) which was statistically identical with the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost). The smallest plant (19.63 cm) at 30 DAP was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) which was statistically identical to T_2 (75% RCF of NPKZnS + 2 t ha^{-1} compost) and T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost) treatments. At 50 DAP, the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) gave the maximum plant height (46.83 cm) which was statistically identical with the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) whereas the minimum plant height (40.78 cm) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) which was significantly different from other treatments. At 70 DAP, the maximum plant height (81.20 cm) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) which was statistically similar to T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) and T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost) treatments whereas the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) showed the minimum plant height (64.24 cm) which was statistically similar to T_6

(50% RCF of NPKZnS + 4 t ha^{-1} compost) treatment. Application of compost with inorganic fertilizer increased the plant height which was reported by Asadi *et al*. (2018), Khan *et al*. (2019), Rodriguez *et al*. (2018) and Shalaby and Ahmed (2016) which supported the present findings.

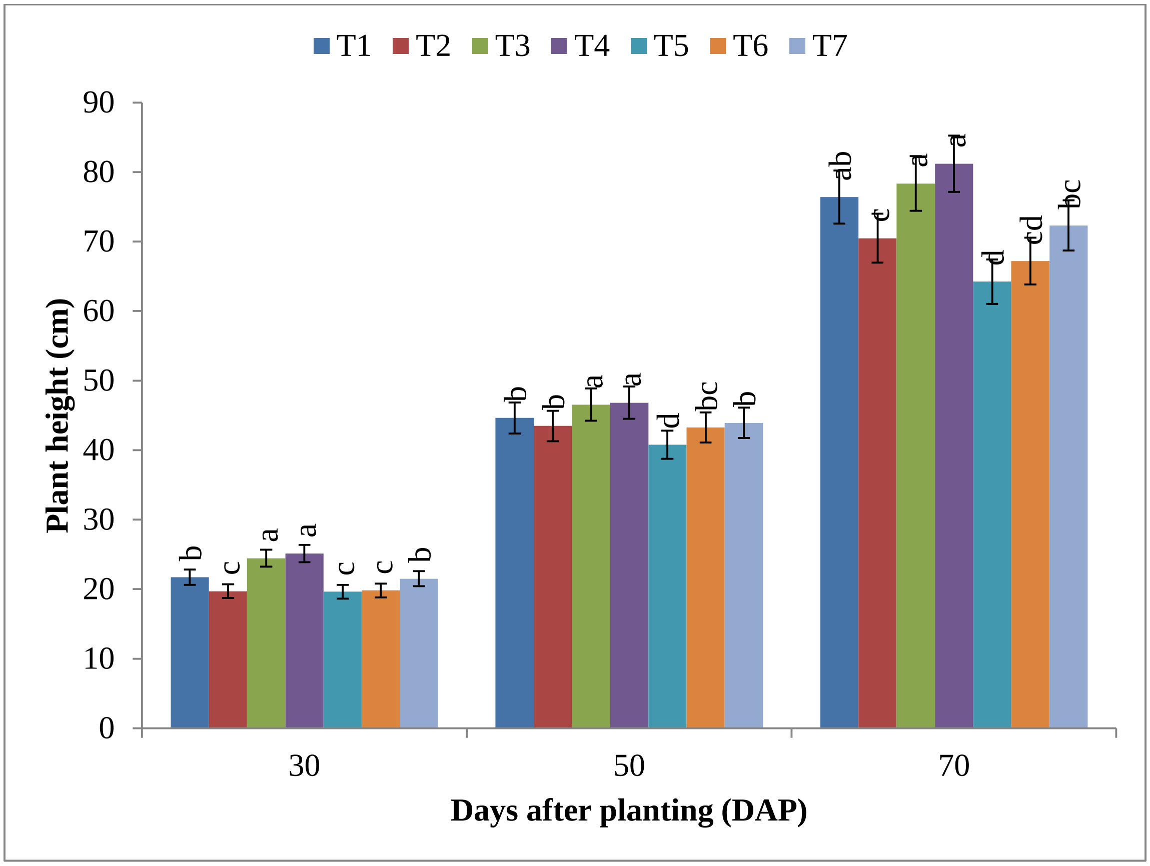

Figure 1. Effect of organic (compost) and inorganic fertilizers on plant height of potato at different growth stages

Here, T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost, T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost, T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost, T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost, T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost, T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost, T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

N.B. RCF = Recommended chemical fertilizers

4.1.2 Number of leaves plant^{-1}

Significant difference on number of leaves plant^{-1} at different growth stages of potato was recorded due to application of different levels of organic (compost) and inorganic fertilizers (Figure 2 and Appendix VI). Results revealed that the highest number of leaves plant^{-1} at 30 DAP (13.67) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) which was statistically identical to the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost). On the other hand, the lowest number of leaves plant^{-1} at 30 DAP (8.60) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) which differed significantly to other treatments. At 50 DAP, the highest number of leaves plant^{-1} (27.52) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) which was statistically identical to the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) and T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost) whereas the lowest number of leaves plant^{-1} (19.25) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) which was statistically identical to T_2 (75% RCF of NPKZnS + 2 t ha^{-1} compost) treatment. Similarly, At 70 DAP, the highest number of leaves plant^{-1} (78.24) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) which was statistically similar to T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) treatment whereas the lowest number of leaves plant^{-1} (65.12) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) which was statistically identical to T_2 (75% RCF of NPKZnS + 2 t ha^{-1} compost) and T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost) treatments. Supported result was achieved by the findings of Rodriguez *et al*. (2018) and Shalaby and Ahmed (2016); they reported higher leaf number with combined application of organic and inorganic fertilizers compared to control.

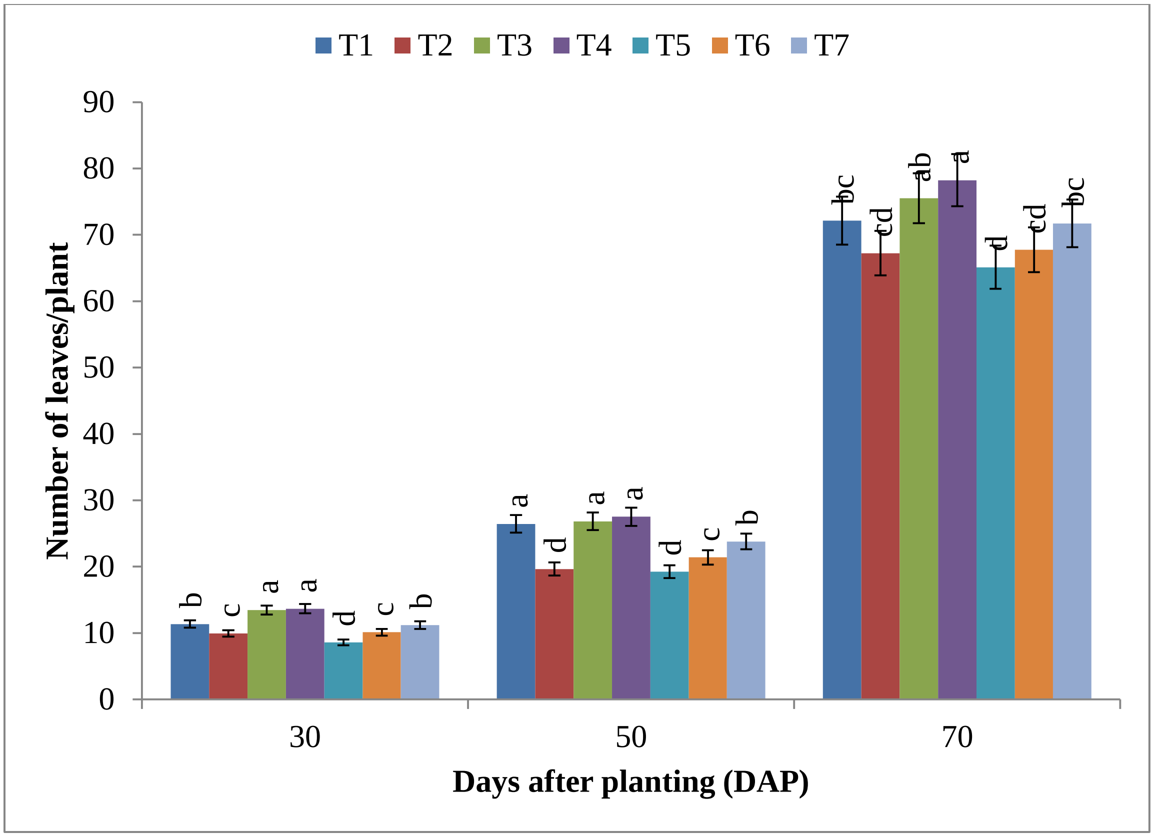

Figure 2. Effect of organic (compost) and inorganic fertilizers on number of leaves plant^{-1} at different growth stages

Here, T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost, T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost, T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost, T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost, T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost, T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost, T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

N.B. RCF = Recommended chemical fertilizers

4.1.3 Number of stems plant^{-1}

The differences in the number of stem plant^{-1} of potato among the treatments were statistically significant influenced by different levels of organic (compost) and inorganic fertilizers (Table 1 and Appendix VII). Results indicated that the highest number of stem plant^{-1} (7.20) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) which was statistically identical with the treatment T_1

(100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost) and T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost). Again, the lowest number of stem $plant^{-1}$ (5.12) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) which was statistically identical to T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost) treatment. Khan *et al*. (2019) also found similar result with the present study.

Table 1. Effect of organic (compost) and inorganic fertilizers on number of stem $plant^{-1}$ of potato

Treatments	Number of stem $plant^{-1}$
T_1	6.92 a
T_2	5.84 c
T_3	7.08 a
T_4	7.20 a
T_5	5.12 d
T_6	5.20 d
T_7	6.44 b
$LSD_{0.05}$	0.337
CV(%)	7.52

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

Here, T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost, T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost, T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost, T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost, T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost, T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost, T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

4.2 Yield contributing parameters

4.2.1 Number of tuber plant^{-1}

The effect of different levels of organic (compost) and inorganic fertilizers on number of tuber plant^{-1} of potato was significant (Table 2 and Appendix VIII). Results revealed that the highest number of tuber plant^{-1} (7.92) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) that was statistically similar to the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost). Again, the lowest number of tuber plant^{-1} (5.72) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) that was statistically similar to the treatment T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost). The result obtained from the present study was similar with the findings of Kassahun and Girma (2014) and Shalaby and Ahmed (2016) who reported higher tuber number plant^{-1} with combined application of compost and inorganic fertilizers compared to using sole application of inorganic fertilizers.

4.2.2 Weight of tubers plant^{-1}

Weight of tubers plant^{-1} of potato varied significantly due to different levels of organic (compost) and inorganic fertilizers (Table 2 and Appendix VIII). It was found that the highest weight of tubers plant^{-1} (277.50 g) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) that was statistically identical to the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) (274.20 g). The treatment T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost) also showed comparatively higher weight of tubers plant^{-1} (261.70 g) which was significantly different from other treatments followed by T_7 (50% RCF of NPKZnS + 8 t ha^{-1} compost) (245.00 g). Similarly, the lowest weight of tuber plant^{-1} (260.00 g) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) that was statistically identical to the treatment T_2 (75% RCF of NPKZnS + 2 t ha^{-1} compost) and T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost).

Supported results were also observed by the findings of Kassahun and Girma (2014), Shalaby and Ahmed (2016) and Al-Homaidan *et al*. (2018); they observed that the higher weight of tubers plant^{-1} with combined application of compost and inorganic fertilizers compared to using only inorganic fertilizers. Shalaby and Ahmed (2016) also reported the highest tuber weight from the treatment combination of 50% NPK and 50% compost compared to sole application.

Table 2. Effect of organic (compost) and inorganic fertilizers on yield contributing parameters of potato

Treatments	Yield contributing parameters	
	Number of tuber plant^{-1} (g)	Weight of tubers plant^{-1} (g)
T_1	7.44 b	261.70 b
T_2	6.24 cd	236.90 d
T_3	7.63 ab	274.20 a
T_4	7.92 a	277.50 a
T_5	5.72 e	230.00 d
T_6	5.94 de	231.50 d
T_7	6.52 c	245.00 c
$LSD_{0.05}$	0.323	8.058
CV(%)	5.92	10.36

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

Here, T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost, T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost, T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost, T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost, T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost, T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost, T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

N.B. RCF = Recommended chemical fertilizers

4.3 Yield parameters

4.3.1 Tuber weight plot^{-1}

Tuber weight plot^{-1} of potato was influenced significantly due to application of different levels of organic (compost) and inorganic fertilizers (Table 3 and Appendix IX). The highest tuber weight plot^{-1} (14.43 kg) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) which was statistically identical to the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) (14.26 kg). The lowest tuber weight plot^{-1} (11.96 kg) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) that was statistically identical to the treatment T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost) (12.04 kg). The treatment T_2 (75% RCF of NPKZnS + 2 t ha^{-1} compost) also gave similar result (12.32 kg) with T_5.

4.3.2 Tuber weight ha^{-1}

Different levels of organic (compost) and inorganic fertilizers exhibited significant variation on tuber weight ha^{-1} of potato (Table 3 and Appendix IX). Results revealed that the highest tuber yield ha^{-1} (28.86 t) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) that was statistically similar to the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) which was 2nd highest while the third highest tuber weight ha^{-1} (27.22 t) was achieved by the treatment T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost). The lowest tuber weight ha^{-1} (23.92 t) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) that was statistically similar to T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost) and T_2 (75% RCF of NPKZnS + 2 t ha^{-1} compost) treatments. The results of the current study provide the evidence for the positive effect of organic fertilizers on the growth parameters of potato. The study highlights the importance of integrated nutrient management practices that the combine use of organic and inorganic fertilizers for sustainable crop production.

The positive effect of organic fertilizers on the growth and yield of potato can be attributed to several factors. Firstly, organic fertilizers contain essential nutrients and micronutrients that are slowly released over time, providing a sustained source of nutrients to the plants (Kumar *et al*., 2017). Secondly, organic fertilizers improve soil structure and fertility, enhancing the ability of the soil to retain water and nutrients, and promoting better root and shoot development (Singh *et al*., 2017). Finally, organic fertilizers promote the growth of beneficial microorganisms in the soil, which can help to suppress plant diseases and improve nutrient uptake (Asadi *et al*., 2018). Several studies have reported similar findings regarding the positive effect of organic fertilizers on the growth and yield of potato. For example, a study conducted by Singh *et al*. (2017) showed that the application of organic manure along with inorganic fertilizers increased the yield and quality of potato. Similarly, a study by Asadi *et al*. (2018) found that the application of compost increased the tuber yield and quality of potato. Kumar *et al*. (2018), Rodriguez *et al*. (2018) and Shalaby and Ahmed (2016) also reported the highest yield and quality of potato with the treatment combination of NPK and compost which supported the present findings.

Table 3. Effect of organic (compost) and inorganic fertilizers on yield parameters of potato

Treatments	Yield parameters	
	Tuber weight plot^{-1} (kg)	Tuber yield ha^{-1} (t)
T_1	13.61 b	27.22 b
T_2	12.32 cd	24.63 cd
T_3	14.26 a	28.52 ab
T_4	14.43 a	28.86 a
T_5	11.96 d	23.92 d
T_6	12.04 d	24.08 cd
T_7	12.74 c	25.47 c
$LSD_{0.05}$	0.477	1.392
CV(%)	8.42	8.40

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

Here, T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost, T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost, T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost, T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost, T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost, T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost, T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

N.B. RCF = Recommended chemical fertilizers

4.4 Grading of tuber on the basis of diameter (% by number)

There was significant variation in grading of tuber on the basis of diameter was observed due to different levels of organic (compost) and inorganic fertilizers (Table 4 and Appendix X). Grading operation was done on the basis of size of potato by number in percentage (% by number).

In case of <28 mm size of potato, the maximum percentage of tuber on the basis of diameter (38.24%) was recorded on T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) treatment that was differed significantly to other treatments followed by T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost). The minimum percentage of tuber on the basis of diameter (18.63%) was recorded on T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) treatment that was significantly different with other treatments.

In case of 28-45 mm size of potato, the maximum percentage of tuber on the basis of diameter (45.24%) was recorded on T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) treatment followed by the treatment T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) (43.80%) treatment whereas the minimum percentage of tuber on the basis of diameter (35.90%) was recorded on T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) treatment.

In case of 45-55 mm size of potato, the maximum percentage of tuber on the basis of diameter (23.75%) was recorded on T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) treatment followed by T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) treatment (22.44%) whereas minimum percentage of tuber on the basis of diameter (18.40%) was recorded on T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) treatment that was statistically identical to T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost).

In case of >55 mm size of potato, the maximum percentage of tuber on the basis of diameter (12.38%) was recorded on T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) treatment which was statistically identical to T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) (12.24%) whereas minimum percentage of tuber on the basis of diameter (7.46%) was recorded on T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) treatment which differed significantly to other treatments.

Table 4. Effect of organic (compost) and inorganic fertilizers on grading of tuber on the basis of diameter (% by number) of potato

Treatments	Grading of tuber on the basis of diameter (% by number)			
	<28 mm	28-45 mm	45-55 mm	>55 mm
T_1	25.62 e	42.36 c	20.80 c	11.22 b
T_2	32.27 c	39.62 d	19.27 d	8.84 c
T_3	21.52 f	43.80 b	22.44 b	12.24 a
T_4	18.63 g	45.24 a	23.75 a	12.38 a
T_5	38.24 a	35.90 f	18.40 e	7.46 e
T_6	35.32 b	37.47 e	18.93 e	8.28 d
T_7	30.36 d	40.14 d	20.48 c	9.02 c
$LSD_{0.05}$	1.244	1.072	0.632	0.385
CV(%)	6.72	8.36	5.29	5.07

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

Here, T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost, T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost, T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost, T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost, T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost, T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost, T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

N.B. RCF = Recommended chemical fertilizers

4.5 Quality parameters of post harvest soil

4.5.1 pH content of post harvest soil

pH content of post harvest soil of potato field was not influenced significantly due to different levels of organic (compost) and inorganic fertilizers (Table 5 and Appendix XI). However, the highest pH content of post harvest soil (6.27) was recorded from the treatment T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}

+ 0 t ha^{-1} compost) whereas the lowest pH content of post harvest soil (6.23) was recorded from the treatment T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost).

4.5.2 Organic matter (%) content of post harvest soil

Non-significant variation was observed among the treatment of different levels of organic (compost) and inorganic fertilizers on organic matter (OM) content of post harvest soil (Table 5 and Appendix XI). However, the highest OM content of post harvest soil (1.22%) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) whereas the lowest OM content of post harvest soil (1.00%) was recorded from the treatment T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost).

4.5.3 Organic carbon (OC) content of post harvest soil

Non-significant variation was observed among the treatment of different levels of organic (compost) and inorganic fertilizers on OC content of post harvest soil (Table 5 and Appendix XI). However, the highest OC content of post harvest soil (0.71%) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) whereas the lowest OC content of post harvest soil (0.58%) was recorded from the treatment T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost).

4.5.4 Available phosphorus (P) content of post harvest soil

Available P content of post harvest soil varied significantly due to different levels of organic (compost) and inorganic fertilizers (Table 5 and Appendix XI). The highest available P content of post harvest soil (23.42 ppm) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) which was statistically similar to the treatment T_7 (50% RCF of NPKZnS + 8 t ha^{-1} compost) whereas the lowest available P content of post harvest soil (18.80 ppm) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) that was statistically similar to T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost) treatment. Supported result was also achieved by the findings of Kumar *et al*. (2018) and Asadi *et al*. (2018).

Table 5. Effect of organic (compost) and inorganic fertilizers on quality parameters of potato post harvest soil

Treatments	Quality parameters of post harvest soil				
	pH	Organic matter (%)	Organic carbon (%)	Available phosphorus (ppm)	Available sulphur (ppm)
T_1	6.27	1.00	0.58	21.92 b	27.33 ab
T_2	6.26	1.08	0.63	20.32 c	25.72 cd
T_3	6.26	1.17	0.68	20.50 c	28.20 ab
T_4	6.24	1.22	0.71	23.42 a	28.47 a
T_5	6.22	1.07	0.62	18.80 d	23.85 e
T_6	6.23	1.12	0.65	19.75 cd	24.63 de
T_7	6.25	1.19	0.69	22.76 ab	26.80 bc
$LSD_{0.05}$	0.168	0.236	0.137	1.415	1.53
CV(%)	2.11	2.14	2.07	6.32	5.19

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

Here, T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost, T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost, T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost, T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost, T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost, T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost, T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

N.B. RCF = Recommended chemical fertilizers

4.5.5 Available sulphur (S) content of post harvest soil

Available S content of post harvest soil influenced significantly due to different levels of organic (compost) and inorganic fertilizers (Table 5 and Appendix XI). The highest available S content of post harvest soil (28.47 ppm) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) which was statistically similar to the treatment T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost) and T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) whereas the lowest available S content of post harvest soil (23.85 ppm) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) which was closely followed by T_6 (50% RCF of NPKZnS + 4 t ha^{-1} compost) treatment. This findings was similar with the findings of Asadi *et al*. (2018) and Kumar *et al*. (2018).

CHAPTER V

SUMMARY AND CONCLUSION

An experiment was carried out to study the effect of organic (compost) and inorganic fertilizers on growth and yield of potato at the experimental field of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207 during the period from November 2021 to February 2022. Seven treatments was considered as single factor experiment *viz*. T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost, T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost, T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost, T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost, T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost, T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost and T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The data on different crop characters and yield were recorded.

Significant variation was found for the most of the parameters of the study influence by different levels of organic (compost) and inorganic fertilizers. For growth parameters, at 30, 50 and 70 DAP, the highest plant height (25.12, 46.83 and 81.20 cm, respectively) and number of leaves $plant^{-1}$ (13.67, 27.52 and 78.24, respectively) were recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) whereas the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) showed the lowest plant height (19.63, 40.78 and 64.24 cm, respectively). Again, the highest number of stem $plant^{-1}$ (7.20) was recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) followed by T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) whereas the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) showed the lowest number of stem $plant^{-1}$ (5.12).

For yield contributing parameters and yield, treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) also performed the best results and showed the highest number of tuber plant^{-1} (7.92), weight of tuber plant^{-1} (277.50 g), tuber weight plot^{-1} (14.43 kg) and tuber yield ha^{-1} (28.86 t) followed by T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) whereas the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost) performed the lowest number of tuber plant^{-1} (5.72), weight of tuber plant^{-1} (230.00 g), tuber weight plot^{-1} (11.96 kg) and tuber yield ha^{-1} (23.92 t).

In case of grading of potato tuber, regarding the the maximum percentage of 28-45 mm grade tuber (45.24%) was recorded from T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) treatment followed by T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) (43.80%) whereas the minimum percentage (35.90%) was recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost).

Regarding the post harvest soil status, pH, organic matter and organic carbon content were not influenced by different levels of organic (compost) and inorganic fertilizers, however, the maximum pH (6.27) was obtained from T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost) and maximum organic matter (1.22%) and organic carbon (0.71%) were recorded from T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) treatment whereas the lowest pH value (6.22) was recorded from the treatment T_5 but the lowest organic matter (1.00%) and organic carbon (0.0.58%) content were recorded from the treatment T_1 (100% RCF of NPKZnS; $N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1} + 0 t ha^{-1} compost), respectively. The available P and S content of post harvest soil affected significantly by different levels of organic (compost) and inorganic fertilizers. The maximum available P (23.42 ppm) and S (28.47 ppm) were recorded from the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) whereas the lowest (18.80 ppm and 23.85 ppm, respectively) were recorded from the treatment T_5 (50% RCF of NPKZnS + 2 t ha^{-1} compost).

From the above results, it can be concluded that the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) was the best treatment for growth and yield of potato followed by T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) compared to other treatments. In terms of analysis of post harvest soil, pH and organic carbon content were not varied significantly among the treatments but available P and S of post harvest soil affected significantly. The treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) showed highest P and S content of post harvest soil. So, the treatment T_4 (75% RCF of NPKZnS + 8 t ha^{-1} compost) was the best under the present study followed by T_3 (75% RCF of NPKZnS + 4 t ha^{-1} compost) compared to other treatments for potato production.

Recommendation

The present research work was carried out at the Sher-e-Bangla Agricultural University in one season only. Further trial of this work in different locations of the country is needed to justify the present results.

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APPENDICES

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

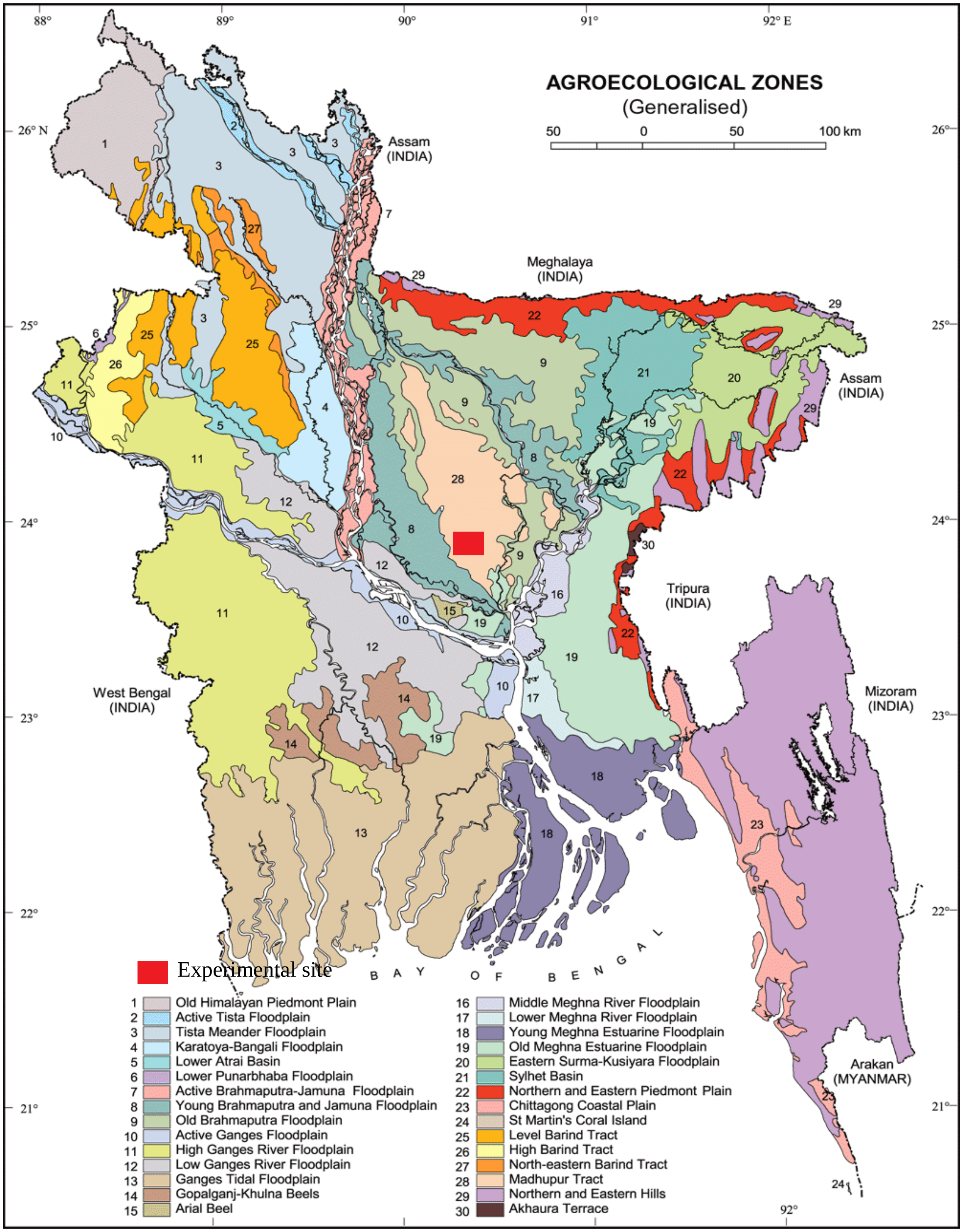


Fig. 3. Experimental site

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

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

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

A. Morphological characteristics of the experimental field of Sher-e-Bangla Agricultural University Research Farm

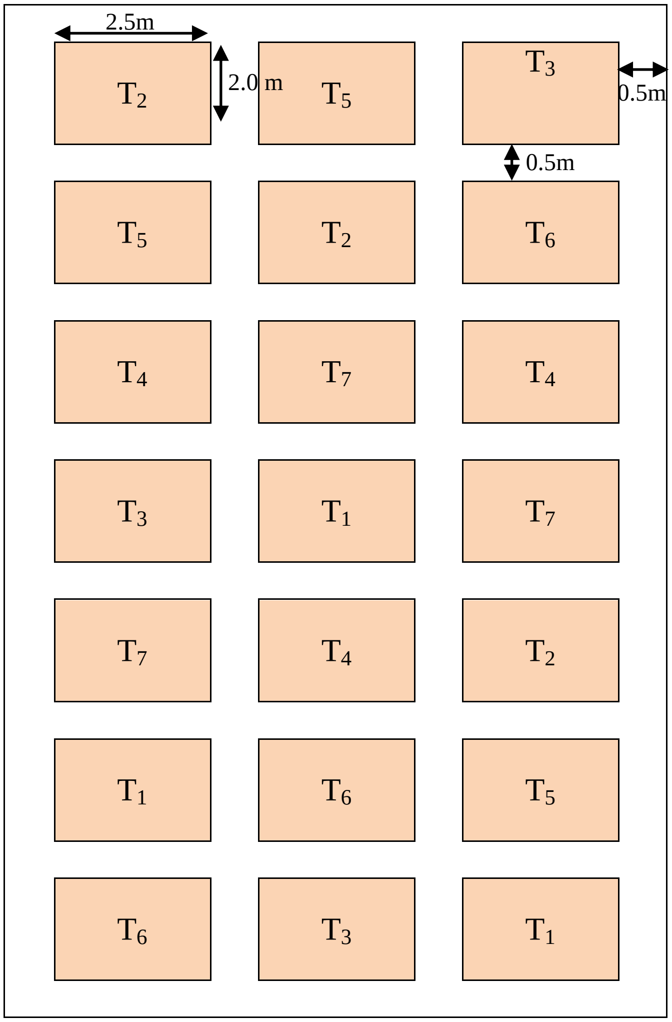
Morphological features	**Characteristics**
Location	Research Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

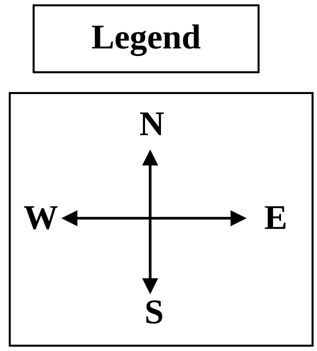
Source: Soil Resource Development Institute (SRDI)

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 (USDA)
pH	6.20
Organic carbon (%)	0.60
Organic matter (%)	1.03
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Appendix IV. Layout of the experimental field including legend and experimental treatments





Treatments

1. T_1 = 100% RCF of NPKZnS ($N_{150}P_{40}K_{150}Zn_4S_{20}$ kg ha^{-1}) + 0 t ha^{-1} compost
2. T_2 = 75% RCF of NPKZnS + 2 t ha^{-1} compost
3. T_3 = 75% RCF of NPKZnS + 4 t ha^{-1} compost
4. T_4 = 75% RCF of NPKZnS + 8 t ha^{-1} compost
5. T_5 = 50% RCF of NPKZnS + 2 t ha^{-1} compost
6. T_6 = 50% RCF of NPKZnS + 4 t ha^{-1} compost
7. T_7 = 50% RCF of NPKZnS + 8 t ha^{-1} compost

- Plot size = 2.5 m × 2.0 m

Fig. 4. Layout of the experimental plot

Appendix V. Analysis of variance on the effect of organic (compost) and inorganic fertilizers on plant height of potato

Sources of variation	Degrees of freedom	Mean square of plant height (cm)		
		30 DAP	50 DAP	70 DAP
Replication	2	0.314	2.371	5.211
Factor A	6	42.36*	132.48*	167.29*
Error	12	0.204	2.037	3.104

* = Significant at 5% level

Appendix VI. Analysis of variance on the effect of organic (compost) and inorganic fertilizers on number of leaves plant^{-1} of potato

Sources of variation	Degrees of freedom	Mean square of number of leaves plant^{-1}		
		30 DAP	50 DAP	70 DAP
Replication	2	0.078	1.711	3.514
Factor A	6	12.314**	102.53*	488.267*
Error	12	0.102	0.516	2.703

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

Appendix VII. Analysis of variance on the effect of organic (compost) and inorganic fertilizers on number of stem plant^{-1} of potato

Sources of variation	Degrees of freedom	Number of stem plant^{-1}
Replication	2	0.014
Factor A	6	23.92**
Error	12	0.012

** = Significant at 1% level

Appendix VIII. Analysis of variance on the effect of organic (compost) and inorganic fertilizers on yield contributing parameters of potato

Sources of variation	Degrees of freedom	Mean square of yield contributing parameters	
		Number of tuber plant^{-1}	Weight of tuber plant^{-1} (g)
Replication	2	0.141	6.812
Factor A	6	18.60*	579.21*
Error	12	0.323	8.058

* = Significant at 5% level

Appendix IX. Analysis of variance on the effect of organic (compost) and inorganic fertilizers on yield parameters of potato

Sources of variation	Degrees of freedom	Mean square of yield parameters	
		Tuber weight $plot^{-1}$ (kg)	Tuber yield ha^{-1} (t)
Replication	2	0.502	0.263
Factor A	6	61.703*	61.214*
Error	12	0.024	0.205

* = Significant at 5% level

Appendix X. Analysis of variance on the effect of organic (compost) and inorganic fertilizers on grading of tuber on the basis of diameter (% by number) of potato

Sources of variation	Degrees of freedom	Grading of tuber on the basis of diameter (% by number)			
		<28 mm	28-45 mm	45-55 mm	>55 mm
Replication	2	0.342	1.032	0.517	0.367
Factor A	6	56.28*	82.63*	71.24*	48.941*
Error	12	1.204	1.052	0.758	0.633

* = Significant at 5% level

Appendix XI. Analysis of variance on the effect of organic (compost) and inorganic fertilizers on quality parameters of potato post harvest soil

Sources of variation	Degrees of freedom	Mean square of quality parameters of post harvest soil				
		pH	Organic matter (%)	Organic carbon (%)	Available phosphorus (ppm)	Available sulphur (ppm)
Replication	2	0.001	0.001	0.001	1.132	1.024
Factor A	6	0.104^{NS}	0.524^{NS}	0.306^{NS}	15.041*	27.401*
Error	12	0.003	0.005	0.002	0.211	0.247

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

PHOTOGRAPHY

Plate 1. Land preparation using inorganic fertilizers

Plate 2. Sowing of potato tuber in the field

Plate 3. Seedling emergence of potato

(a)

(b)

Plate 4. (a) Overall field condition at vegetative stage, (b) Intercultural operation (insecticide spray)

(a) (b)

Plate 5. (a) Harvested potato tuber, (b) Overall field view after harvest of potato

Plate 6. Postharvest soil analysis of potato field