GROWTH AND YIELD OF POTATO (BARI Alu-25; ASTORIX) AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT

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CERTIFICATE

This is to certify that the thesis entitled **"GROWTH AND YIELD OF POTATO (BARI Alu-25; ASTORIX) AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT"**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 (M.S.)** in **SOIL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **ANIKA MEHEJABIN**, Registration No. **15-06796**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

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Dedicated to
My
Beloved Parents

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The Author

GROWTH AND YIELD OF POTATO (BARI Alu-25; ASTORIX) AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT

ABSTRACT

The experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from November 2021 to February2022 to examine the growth and yield of potato (BARI Alu-25; ASTORIX) as influenced by integrated nutrient management. The experiment consisted of nine treatments *viz*. T_1 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP - only inorganic), T_2 (130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost), T_3 (110 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost), T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost), T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost), T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost), T_7 (30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost), T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) and T_9 (control; no nutrient application). 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 integrated nutrient management practices. The treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) exhibited the minimum 15.3 days to 100% emergence. The maximum number of haulm hill^{-1} (7.50), fresh weight of haulm hill^{-1} (185.60 g) and dry weight of haulm hill^{-1} (33.70 g), number of tuber hill^{-1} (8.12), weight of tuber hill^{-1} (360.50 g), dry weight of 100 g fresh tuber (21.63 g), tuber weight plot^{-1} (14.55 kg) and tuber yield ha^{-1} (30.24 t) were obtained with T5 treatment followed by T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) whereas the control treatment T_9 (no nutrient application) showed the lowest results in all parameters as well as on yield. There was non signification of soil pH, organic carbon and exchangeable K in postharvest soil but significant variation was found in case of total N, agailable P and available S. The treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) showed the highest N (0.273%), P (23.27 ppm) and S (28.20 ppm) content followed byT_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) whereas the lowest was obtained from control treatment. So, the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) may be considered as the best treatment for potato production (BARI Alu-25; ASTORIX).

LIST OF CONTENTS

LIST OF CONTENTS (Cont'd)

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

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 an important crop globally, ranking fourth in terms of global food production after maize, wheat, and rice. The crop is grown for its edible underground tubers, which are rich in carbohydrates, vitamins, and minerals. According to FAOSTAT (2016), potato cultivation in Bangladesh covers 0.47 million hectares of land and produces 0.947 crore metric tons with an average yield of 19.91 tons per hectare. Being a carbohydrate-rich food crop, potato ranks second next to rice in Bangladesh.

Vermicompost is a organic fertilizer that is produced by the decomposition of organic materials by earthworms. Several studies have found that the use of vermicompost can improve the growth and yield of potato crops. A study by Dhunganа*et al*. (2018) found that the use of vermicompost increased potato yield by 19% compared to chemical fertilizer alone. It also improved soil fertility and microbial activity, which may have contributed to the increase in yield. Bhattarai *et al*. (2019) and Kumar *et al*. (2019) also found that the use of vermicompost increased potato yield by 22% and 26%, respectively compared to chemical fertilizer alone.

Inorganic fertilizers are commonly used in potato production to provide essential nutrients for plant growth and development. Wachira *et al*. (2017), Zerihun *et al*. (2018) and Islam *et al*. (2020) achieved 14%, 23% and 34%, respectively increased potato yield compared to control treatments with no fertilizer. These studies also found that the use of inorganic fertilizers improved soil nutrient content, potato tuber size, weight and quality.

Integrated nutrient management (INM) is an approach that involves the combination of organic and inorganic fertilizers to improve soil fertility and increase crop productivity. Vermicompost, a organic fertilizer produced by earthworms, has been found to be an effective soil amendment for potato cultivation. When combined with inorganic fertilizers, such as nitrogen, phosphorus, and potassium, vermicompost has been shown to significantly improve potato growth and yield (Prasad *et al*., 2017 and Fan *et al*., 2019). Sharma *et al*. (2018) and Dara *et al*. (2019) showed that the use of vermicompost and inorganic fertilizers increased potato growth, yield and improved soil fertility. So, it can be stated that the use of vermicompost can be a beneficial component of integrated nutrient management strategies for potato crops, improving both yield and soil health.

The combination of vermicompost and inorganic fertilizers is an effective approach for improving potato growth and yield. However, the optimal ratio of vermicompost to inorganic fertilizers, timing and method of application may vary depending on soil type and climatic conditions. Therefore, the present study was conducted with the following objectives:

1. To study the effect of vermicompost as organic source of nutrient on the growth and yieldof Potato.
2. To evaluate the effect of integrated nutrient management on soil health, productivity and sustainability.
3. To find out the suitable combination of vermicompost and inorganic fertilizer for successful potato production.

CHAPTER II

REVIEW OF LITERATURE

Integrated nutrient management (INM) is a holistic approach that combines the use of organic and inorganic fertilizers to enhance soil fertility and crop productivity. Vermicompost, a type of organic fertilizer, is a potent source of plant nutrients and beneficial microorganisms. Inorganic fertilizers, on the other hand, provide essential nutrients that may be lacking in the soil. The review of literature on the combined effect of vermicompost and inorganic fertilizers on the growth and yield of potato includes some relevant studies that were conducted in different parts of the world. These studies investigated the impact of the combined application of vermicompost and inorganic fertilizers on potato yield, growth, nutrient uptake, and soil fertility. Here are some literature reviewed and summarized with the relevant topics as follows:

Integrated nutrient management (INM) has also been shown to improve potato resistance to biotic and abiotic stresses. A study by Mondal *et al*. (2021) in India found that the use of vermicompost and inorganic fertilizers increased potato resistance to late blight disease, while also improving yield and quality. Highest potato yield was achieved with the integration of vermicompost with inorganic fertilizers compared to control treatments of vermicompost or inorganic fertilizers alone.

Hensh *et al*. (2020) conducted a field experiment to study the effect of integrated nutrient management on growth and tuber yield of potato (*Solanum tuberosum* L.). 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.

Bhattacharjee and Deka (2020) conducted a study and found that the combined application of vermicompost and inorganic fertilizers significantly increased potato growth and yield compared to the control treatment. The study recommended the use of vermicompost and inorganic fertilizers in potato cultivation. Plant height, leaf number per hill, tuber number per hill, tuber weight per hill, dry weight of tuber and tuber yield per hectare were significantly highest with the combined application of vermicompost and inorganic fertilizers compared to the control treatment.

Kim *et al*. (2020) investigated the effect of vermicompost and inorganic fertilizer on growth, yield, and quality of potato and found that the combined use of these inputs improved potato growth, yield, and quality compared to using only inorganic fertilizer. The study recommended the integrated use of vermicompost and inorganic fertilizer in potato cultivation.

Dev *et al*. (2020) carried out an investigation to evaluate the effect of nutrient management practices on the performance of potato (*Solanum tuberosum* L.) and soil fertility. The five treatments comprised with various levels of 75% and 100% recommended doses of NPK, $ZnSO_4$ (20, 30and 40 kg ha^{-1}) and 25% nitrogen by

Farm yard manure were tested against 100% NPK fertilizers alone were replicated four time using potato variety Kufri. Results revealed that the integrated use of 75% recommended doses of NPK fertilizers (180:80:100), 25% nitrogen by Farm yard manure as well as 20kg ha^{-1} $ZnSO_4$ in potato was found superior for higher plant growth, productivity and better marketable quality of tubers. The availability of NPK nutrients, organic carbon, moisture retention capacity of soil increased while bulk density, soil pH, and electrical conductivity decreased at higher rate by applying 75% recommended doses of NPK and 20kg ha^{-1} $ZnSO_4$ fertilizers with Farm yard manure as compared to 100% recommended doses of NPK fertilizers alone. The application of 75% recommended doses of NPK, 20 kg ha^{-1} $ZnSO_4$ fertilizers and 25% Nitrogen by Farm yard manure provided highest net returns (Rs. 193639) and cast benefit ratio (2.48). It was concluded that application of 75% RDF, 20 kg ha^{-1} $ZnSO_4$ fertilizers and 25% nitrogen by Farm yard manure may be recommended for higher productivity and returns, and build up soil fertility.

Choudhury *et al*. (2019) investigated the effect of vermicompost and inorganic fertilizers on potato yield and nutrient uptake and reported that the combined use of these inputs improved potato yield and nutrient uptake compared to using only inorganic fertilizers. The study recommended the integrated use of vermicompost and inorganic fertilizers in potato cultivation gave maximum plant height, leaf number per hill, tuber weight per hill tuber yield. The use of vermicompost and inorganic fertilizers together improved potato yield and nutrient uptake compared to using only inorganic fertilizers.

Das and Deka (2019) reviewed studies on integrated nutrient management in potato production and found that the combined use of vermicompost and inorganic fertilizers resulted in higher growth parameters *viz*. plant height, dry matter production and yield parameters *viz*. number and weight of tuber per hill and potato yield compared to using only inorganic fertilizers. The study recommended the use of integrated nutrient management practices in potato cultivation.

Elango and Subramanian (2019) investigated the impact of vermicompost and inorganic fertilizers on potato growth and yield and found that the combined use of these inputs increased potato growth and yield compared to using only inorganic fertilizers. The study recommended the use of vermicompost and inorganic fertilizers in potato cultivation. Combined application of vermicompost and inorganic fertilizers increased the number of potato leaf, stem length, stem number per hill, weight of tuber per hill and yield per ha compared to using only inorganic fertilizers.

Karmakar*et al*. (2019) investigated the effect of vermicompost and inorganic fertilizers on potato yield, nutrient uptake, and soil fertility and found that the combined use of these inputs improved potato yield, nutrient uptake, and soil fertility compared to using only inorganic fertilizers. The study recommended the integrated use of vermicompost and inorganic fertilizers for sustainable potato cultivation.

Majumder and Mazumdar (2019) investigated the combined effect of vermicompost and inorganic fertilizers on yield and nutrient uptake of potato and found that their combined use resulted in higher yield and nutrient uptake compared to using only inorganic fertilizers. The study recommended the integrated use of vermicompost and inorganic fertilizers in potato cultivation is very effective for higher yield contributing characters (tuber number and weight per hill) and yield of potato compared to control (organic or inorganic alone).

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}.

The use of integrated nutrient management (INM) can also have environmental benefits, such as reducing greenhouse gas emissions and improving soil health. A study by Tian *et al*. (2018) in China found that the combination of vermicompost and inorganic fertilizers reduced nitrous oxide emissions from potato fields, while improving soil organic matter content and microbial activity. In addition to vermicompost, other organic materials such as farmyard manure and green manure can also be combined with inorganic fertilizers to improve potato growth and yield. A study by Qayyum *et al*. (2019) in Pakistan found that the combination of farmyard manure and inorganic fertilizers increased potato yield and improved soil fertility.

Shubha *et al*. (2018) conducted a study to investigate the "effect of integrated nutrient management on growth, yield and quality of potato". Experiment was laid out in the randomized block design with 14 treatments. The results revealed that application of Azotobacter + PSB + KSB + $MgSO_4$ + micro nutrient mixture + 75% RDF recorded significantly maximum LAI (5.25), fresh weight of leaves (45.41 g), stem (74.67 g), tuber (301.67 g), dry weight of leaves (9.39 g), stem (17.90 g), tuber (55 g). Quality attributes like tuber length (8.79 cm) and tuber circumference (15 cm) were also found maximum in the same treatment compared to control.

The use of integrated nutrient management (INM) can be economically beneficial for potato farmers, as it can reduce the cost of chemical fertilizers while increasing yield and quality. A study by Awal *et al*. (2018) in Bangladesh found that the use of vermicompost and inorganic fertilizers increased potato yield by 36%, while reducing the cost of fertilizer by 45%. Integrated nutrient management (INM) using vermicompost and inorganic fertilizers can also improve the nutritional quality of crops, such as increasing the content of antioxidants and essential minerals (Kumar *et al*., 2018).

Pande and Singh (2018) investigated the response of potato to combined application of vermicompost and inorganic fertilizer. Results showed that the response was dependent on the level of nitrogen. The study reported that the combined use of vermicompost and inorganic fertilizer improved potato yield.

Singh *et al*. (2018) conducted an experiment to study the effect of integrated nutrient management on growth, quality and yield of potato (kufripukhraj) 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.

Gao *et al*. (2018) investigated the effects of vermicompost and inorganic fertilizer on potato yield and soil fertility and found that the combined use of these inputs resulted in higher yield and improved soil fertility. The study recommended the use of vermicompost and inorganic fertilizers for sustainable potato production. The maximum production of tuber number per hill, tuber weight per hill and tuber yield per hectare and also improved soil fertility were achieved by the combined use of these two inputs compared to use of organic or inorganic fertilizers alone.

Mohammed *et al*. (2018) conducted a field experiment to assess the effects of integrated nutrient management 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.

Integrated nutrient management (INM) using vermicompost and inorganic fertilizers can improve crop resilience to abiotic stresses, such as drought and salinity (Hussain *et al*., 2018). Vermicompost can enhance the nutrient uptake efficiency of inorganic fertilizers, reducing the amount of fertilizer needed for optimal crop growth (Garg and Kaushik, 2017).

The application of vermicompost in combination with inorganic fertilizers can lead to more sustainable agricultural practices, reducing the environmental impact of chemical fertilizers (Gao *et al*., 2017). Vermicompost and inorganic fertilizers can have different effects on soil pH and nutrient availability, and their combination can help balance these effects (Lal *et al*., 2017).

Devi and Sharma (2017) investigated the impact of vermicompost and chemical fertilizers on potato yield and quality and found that the combined use of vermicompost and inorganic fertilizers improved leaf number, dry matter content and yield and tuber quality. The study recommended the integrated use of vermicompost and chemical fertilizers in potato cultivation. The addition of vermicompost to inorganic fertilizers can improve soil microbial activity, leading to increased nutrient cycling and improved soil structure (Kumar *et al*., 2017).

The cost-effectiveness of integrated nutrient management (INM) using vermicompost and inorganic fertilizers depends on the availability and cost of inputs, the crop value, and the yields obtained (Eivazi*et al*., 2017). The optimal combination of vermicompost and inorganic fertilizers depends on the crop, soil type, and climatic conditions (García-Sánchez *et al*., 2016).

Integrated nutrient management (INM) can also improve the quality of potato tubers by increasing their starch and protein content. A study by Ganie*et al*. (2016) in India found that the use of vermicompost and inorganic fertilizers increased the starch and protein content of potato tubers, as well as their yield.

Katar*et al*. (2014) conducted a field experiment during two consecutive year of 2010-11 and 2011- 12. Potato cv. Kufri Ashoka was evaluated with seven treatment T_1= Full recommended NPK (150:100:120) kg ha-1 through inorganic fertilizer, T_2= FYM @ 20 t ha^{-1}, T_3= FYM @ 10t ha^{-1} + ½ NPK through inorganic fertilizer, T_4 = Vermicompost @ 5t ha^{-1}, T_5= Vermicompost @ 2.5t ha^{-1} + 1/2 NPK through inorganic fertilizer, T_6= Neem cake @ 3t ha^{-1}, T_7 = Neem cake @ 1.5t ha^{-}

^{1}+ 1/2 NPK through inorganic fertilizer. Thus twenty seven treatment combinations were arranged in random block design with three replications. Results obtained after the successful conduct of the experiment and statistical analysis of data revealed that the height of plant, number of compound leaves hill^{-1}, number of haulms hill^{-1}, yield attributes and yield. Further number of A, B, C and D grade tubers plot^{-1}, percent of A, B, C and D grade tubers plot^{-1}, yield of A, B, C and D grade tubers plot^{-1} (kg), total number of tubers plot^{-1}, total weight of tubers per plot (kg) and tuber yield (t ha^{-1}) showed the beneficial response by the use of integrated levels of NPK, FYM, Vermicompost and Neem Cake, however, on the basis of pooled data it was also further observed that the application of 150:100:120 kg NPK, 20t FYM, 5 ton Vermicompost and 3 ton Neem Cake ha^{-1} brought paramount of improvement in growth and tuber yield of potato.

The timing and rate of application of vermicompost and inorganic fertilizers can influence their effectiveness, with split applications being more beneficial than single applications (Sharma *et al*., 2015). Integrated nutrient management (INM) using vermicompost and inorganic fertilizers has been found to increase crop yields and improve soil fertility compared to the use of either fertilizer alone (Agrawal *et al*., 2013).

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.

Yourtchi*et al*. (2013) carried out a field experiment to study the effect of nitrogen fertilizer and vermicompost on vegetative growth, yield and NPK uptake by tuber of potato. Experimental factors included nitrogen fertilizer with three levels (50, 100 and 150 kg ha^{-1} as urea) and vermicompost with 4 levels (0, 4.5, 9, and 12 ton ha^{-1}). Results illustrated that the highest plant height, leaf and stem dry weight, Leaf Area Index (LAI), fresh and dry weight of tuber, total tuber weight, total number of tuber, tuber diameter, nitrogen percent of tuber, potassium percent of tuber and phosphorous percent of tuber were found from application of 150 kg N ha^{-1}. Data also demonstrated that vermicompost application at the rate of 12 ton ha^{-1} promoted all above traits except plant height in compared to control treatment. Furthermore, the interaction effects between different nitrogen rates and vermicompost application significantly improved growth parameters, yield and NPK content of tuber compared with nitrogen and/or vermicompost alone treatments. To gain highest yield and avoidance of environments pollution use of 150 kg N ha^{-1} nitrogen fertilizer and vermicompost application of 12 ton ha^{-1} are suggested.

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.

In conclusion, the literature supports the use of integrated nutrient management (INM) using vermicompost and inorganic fertilizers as a sustainable and effective approach to enhance soil fertility and crop productivity. The optimal combination and application of these fertilizers may vary depending on the specific crop and soil conditions, and further research is needed to refine the approach for different agro-ecosystems.

CHAPTER III

MATERIALS AND METHODS

This chapter presents a brief description about experimental period, site, climatic condition, crop or planting materials, treatments, experimental design and layout, crop growing procedure, intercultural operations, data collection and statistical analysis. The details of experimental materials and methods are described below:

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 5.6 and had organic matter 0.78%. 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 BARI Alu-25 (ASTORIX) 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 7^{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. The soil was treated with Furadan 5G @10 kg ha^{-1} when the plot was finally ploughed to protect the young seedlings from the attack of cut worm.

3.6 Experimental design and lay out

The two-factor experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The size of the unit plot was 2.75 m × 2.75 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.

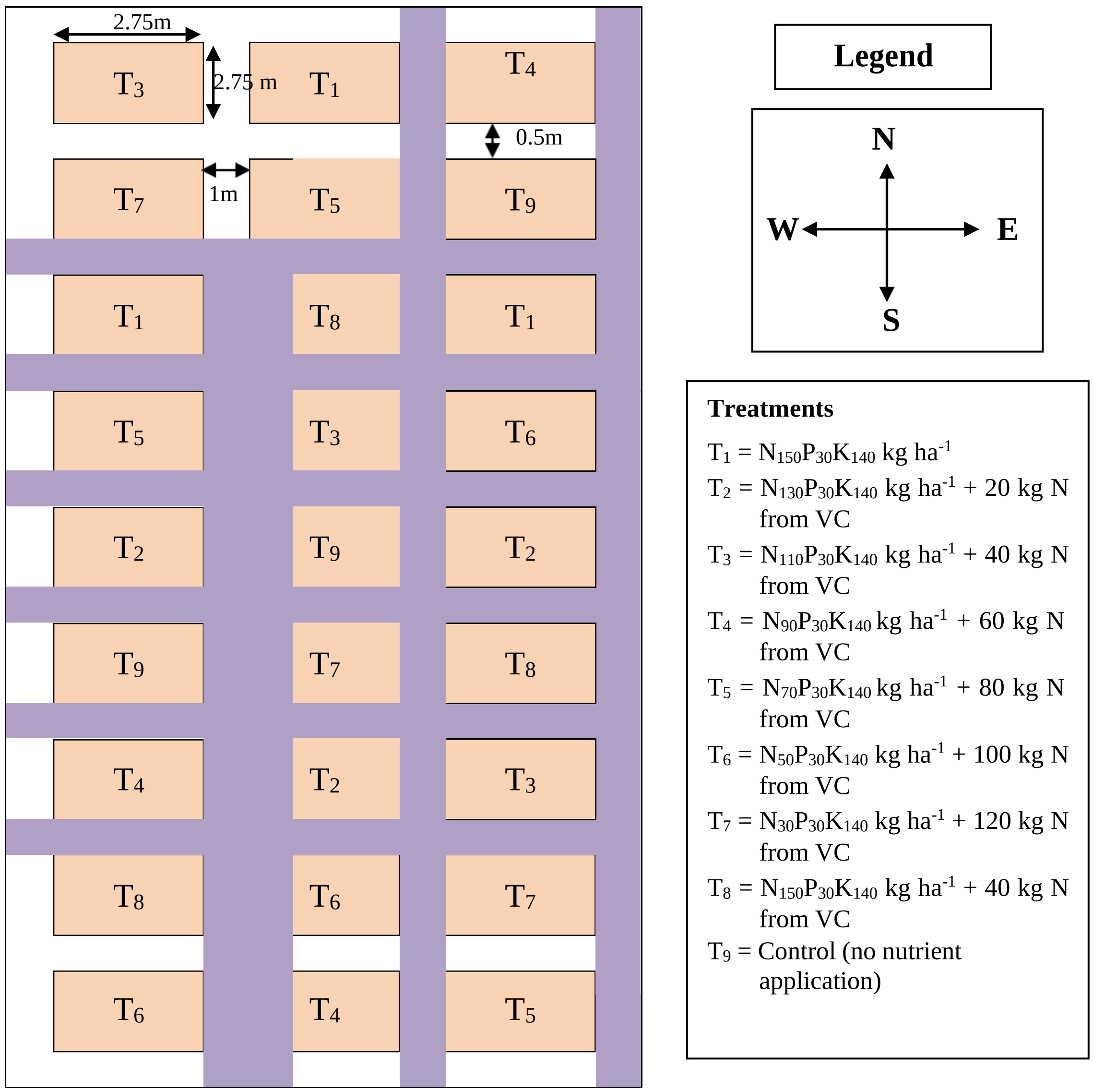

Figure 1. Layout of the experimental plot

3.7 Treatments of the experiment

1. T_1 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP (only inorganic)
2. T_2 = 130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost
3. T_3 = 110 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
4. T_4 = 90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost
5. T_5 = 70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost
6. T_6 = 50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost
7. T_7 = 30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost
8. T_8 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
9. T_9 = Control (no nutrient application)

3.8 Manure and fertilizer application

Vermicompost was used as organic manure as a source of nutrients. Again, urea, triple superphosphate (TSP) and muriate of potash (MoP)were considered as inorganic fertilizers which were used as sources of nitrogen, phosphorus and potassium, respectively. Urea and vermicompost at varying rates were used as source of nitrogen (N) according to the treatment. Again, 30 kg P/ha from TSP and 140 kg K/ha from MoP were used with every treatment excluding control. No nutrient was applied at control condition.

Vermicompost was applied at 10 days before of final land preparation. Total amount of TSP, MoP and half of urea was applied at basal doses during final land preparation. Boric acid, zinc oxide and gypsum fertilizer were applied in the field commonly as sources ofboron, zinc and sulphur, respectively as basal dose. 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 seedling 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 10, 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 2nd 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 15 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 on maturity at 85 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 Days to 100% emergence

After planting the potato tuber keenly observed the emergence twice in a day (morning and afternoon) until final emergence.

3.12.2 Plant height

Plant height was taken to be the length between the base of the plant to the tip at the time of harvest from randomly selected five plants. The height of each plant of each plot was measured in cm with the help of a meter scale and mean was calculated.

3.12.3 Number of leaves plant^{-1}

Number of leaves plant^{-1} was counted from randomly selected five plants at the time of harvest. Leaves number plant^{-1} were recorded by counting all leaves from each plant of each plot and mean was calculated.

3.12.4 Number of haulms hill^{-1}

Number of haulms 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.

3.12.5 Fresh weight of haulm hill^{-1} (g)

The average weight of haulm was recorded from selected plants for each plot at the time of harvesting.

3.12.6 Dry weight of haulm hill^{-1} (g)

The fresh haulms of the sample plants were sun dried for two days and then oven dried at 65°C for 72 hours.

3.12.7 Number of tubers hill^{-1}

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

3.12.8 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.

3.12.9 Dry weight of 100 g fresh tuber

One hundred grams of potatoes from sample plants were sliced, sun dried for 2 days and then dried at 70°C in an oven for 72 hours. Just after oven drying the dried pieces were weighed and were expressed in percentage.

3.12.10 Tuber yield plot^{-1}

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

3.12.11 Tuber yield ha^{-1}

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

3.12.12 Methods of Soil Analysis

3.12.12. 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).

3.12.12.2 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.

3.12.12.3 Total nitrogen (%)

Total nitrogen content in soil was determined by Kjeldahl method by digesting the soil sample with cone. H_2SO_4, 30% H_2O_2 and catalyst mixture (K_2SO_4 : $CuSO_4$.

$5H_2O$: Se = 10:1:0.1) followed by distillation with 40% NaOH and by titration of the distillate trapped in $H_3BO_3$with 0.01 N H_2SO_4 (Black, 1965).

3.12.12.4 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.

3.12.12.5 Exchangeable potassium

Five milli-liter of digest sample for the soil was taken and diluted 50 ml volume to make desired concentration so that the absorbance of sample were measured within the range of standard solutions. The absorbance was measured by atomic absorption flame photometer.

3.12.12.6 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 growth and yield of potato (BARI Alu-25 ASTORIX) as influenced by integrated nutrient management. The results have been presented and discusses with the help of table and graphs and possible interpretations has been given under the following headings:

4.1 Growth parameters

4.1.1 Days to 100% emergence

Days to 100% emergence of potato (BARI Alu-25) was influenced significantly by different levels of integrated nutrient management (Table 1 and Appendix IV). Results indicated that the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) required the minimum days to 100% emergence (15.3 days) which was significantly differed to other treatments. On the other hand, the control treatment T_9 (no nutrient application) required maximum days to 100% emergence of seedlings (18.0 days) which varied significantly to other treatments followed by the treatment T_7 (30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost). Kim *et al*. (2020) also found early emergence of potato seedlings with combined application of vermicompost and inorganic fertilizer.

4.1.2 Plant height

Significant difference on plant height of potato was recorded due to application of different levels of integrated nutrient management practices (Table 1 and Appendix IV). It was observed that the treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) produced the tallest plant (72.25 cm) which was statistically similar with the treatment T_2 (130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from

MoP + 20 kg N/ha from vermicompost).The shortest plant (60.20 cm) was recorded from the control treatment T_9 (no nutrient application). Supported result was achieved by the findings of Hensh *et al*. (2020), Choudhury *et al*. (2019) and Mohammed *et al*. (2018); they recorded higher plant height with combined application of vermicompost and inorganic fertilizers.

4.1.3 Number of leaves hill^{-1}

Significant difference on number of leaves hill^{-1}of potato was found due to application of different levels of organic and inorganic nutrient management (Table 1 and Appendix IV). Results revealed that the highest number of leaves hill^{-1}(74.22) was recorded from the treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) which was statistically identical to the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) (73.86). The lowest number of leaves hill^{-1} (61.50) was recorded from the control treatment T_9 (no nutrient application). The similar result was seen by the findings of Hensh *et al*. (2020), Choudhury *et al*. (2019) and Mohammed *et al*. (2018); they obtained higher leaf number with combined application of vermicompost and inorganic fertilizers compared to only inorganic fertilizers or control. The results are also in agreement with the findings of Hensh *et al*. (2020), Bhattacharjee and Deka (2020) and Choudhury *et al*. (2019).

Table 1. Influence of chemical fertilizers and vermicompost on days to 100% emergence, plant height and number of leaves plant^{-1} as influenced by integrated nutrient management

Treatments	Growth parameters		
	Days to 100% emergence	Plant height (cm)	Number of leaves hill^{-1}
T_1	16.3 e	69.32 b	70.52 b
T_2	15.7 f	70.52 ab	71.80 b
T_3	16.3 e	69.44 b	70.48 b
T_4	17.0 d	67.14 c	67.72 c
T_5	15.3 g	66.63 c	73.86 a
T_6	17.3 c	65.78 cd	66.48 cd
T_7	17.7 b	63.92 d	65.12 d
T_8	15.7 f	72.25 a	74.22 a
T_9	18.0 a	60.20 e	61.50 e
$LSD_{0.05}$	0.134	1.901	1.672
CV(%)	6.74	9.52	8.77

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

T_1 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP (only inorganic)
T_2 = 130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost
T_3 = 110 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_4 = 90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost
T_5 = 70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost
T_6 = 50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost
T_7 = 30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost
T_8 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_9 = Control (no nutrient application)

4.1.4 Number of haulms hill^{-1}

There was a significant variation on number of haulm hill^{-1} of potato influenced by different levels of organic and inorganic nutrient management (Table2 and Appendix V). Results indicated that the highest number of haulm hill^{-1} (7.50) was recorded from the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) which was statistically similar with the treatment T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) (7.33). The lowest number of haulm hill^{-1} (4.00) was recorded from the control treatment T_9 (no nutrient application). These findings are in at par with Elango and Subramanian (2019).

4.1.5 Fresh weight of haulm hill^{-1}

Significant variation on fresh weight of haulm hill^{-1} of potato was observed by different levels of integrated nutrient management practices (Table 2 and Appendix V). Results exhibited that the highest fresh weight of haulm hill^{-1} (185.60 g) was recorded from the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) that was statistically similar to the treatment T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost). The treatment T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost) and T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) showed similar variation between them on fresh weight of haulm hill^{-1} but it varied significantly to other treatments. On the other hand, the lowest fresh weight of haulm hill^{-1} (163.40 g) was recorded from the control treatment T_9 (no nutrient application). Again, it was found that the treatment T_1 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP) and T_7 (30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost) also gave comparatively lower fresh weight of haulm hill^{-1} but significantly higher than control treatment T_9 (no nutrient application).

Table 2. Effect of inorganic fertilizers and vermicompost on number of haulm hill^{-1}, fresh weight and dry weight of haulm hill^{-1}

Treatments	Growth parameters		
	Number of haulm hill^{-1}	Fresh weight of haulm hill^{-1} (g)	Dry weight of haulm hill^{-1} (g)
T_1	5.33 f	172.30 e	26.48 e
T_2	6.50 d	178.80 cd	29.24 cd
T_3	5.80 e	175.70 de	27.72 de
T_4	7.12 bc	180.70 bc	31.33 b
T_5	7.50 a	185.60 a	33.70 a
T_6	7.33 ab	183.80 ab	31.92 b
T_7	5.45 f	174.20 e	26.87 e
T_8	6.88 c	180.30 bc	30.82 bc
T_9	4.00 g	163.40 f	23.80 f
$LSD_{0.05}$	0.314	3.925	1.675
CV(%)	5.83	10.86	6.73

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

T_1 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP (only inorganic)
T_2 = 130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost
T_3 = 110 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_4 = 90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost
T_5 = 70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost
T_6 = 50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost
T_7 = 30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost
T_8 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_9 = Control (no nutrient application)

4.1.6 Dry weight of haulm hill^{-1}

Dry weight of haulm hill^{-1} of potato varied significantly due to the application of inorganic fertilizers and vermicompost (Table 2 and Appendix V). Results exposed that the highest dry weight of haulm hill^{-1} (33.70 g) was recorded from the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) which was significantly differed to other treatments. Again, it was seen that T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost) and T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) similar results. On the other hand, the lowest dry weight of haulm hill^{-1} (23.80 g) was recorded from the control treatment T_9 (no nutrient application). It was also revealed that inorganic fertilizer treatment T_1 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP) gave lower dry weight of haulm hill^{-1} (26.48 g) compared to other combined application of inorganic fertilizers and vermicompost but significantly higher than control treatment T_9 (no nutrient application). These findings are similar with the findings of Hensh *et al*. (2020), Das and Deka (2019) and Shubha *et al*. (2018).

4.2 Yield contributing parameters

4.2.1 Number of tuber hill^{-1}

The effect of different levels of inorganic fertilizers and vermicompost application on number of tuber hill^{-1} of potato was significant (Table 3 and Appendix VI). Results revealed that the highest number of tuber hill^{-1} (8.12) was recorded from the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) which was statistically identical to the treatment T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost) and T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) and the lowest number of tuber hill^{-1} (5.80) was recorded from the control treatment T_9 (no nutrient application). The result obtained from the present study was similar with the findings of Hensh *et al*. (2020) and Das and Deka (2019) who reported higher tuber number hill^{-1} with combined application of vermicompost and inorganic fertilizers compared to using only inorganic fertilizers or control.

4.2.2 Weight of tubers hill^{-1}

Weight of tubers hill^{-1} affected significantly due to different inorganic fertilizers and vermicompost application (Table 3 and Appendix VI). It was found that the highest weight of tubers hill^{-1} (360.50 g) was recorded from the treatmentT_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) which was significantly higher to other treatments. The treatment T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost) showed comparatively higher weight of tubers hill^{-1} (344.00 g) which was statistically similar to the treatment T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost). The lowest weight of tuber hill^{-1}(293.30 g) was recorded from the control treatment T_9 (no nutrient application). The inorganic fertilizer treatment T_1 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP) also gave comparatively lower weight of tubers hill^{-1} (303.30 g) compared to combined application of inorganic fertilizers and vermicompost but significantly higher than control treatment T_9 (no nutrient application). The same results were also observed by Hensh *et al*. (2020), Bhattacharjee and Deka (2020) and Das and Deka (2019); they observed higher weight of tubers hill^{-1} with combined application of vermicompost and inorganic fertilizers compared to using only inorganic fertilizers.

Table 3. Combined application of inorganic fertilizers and vermicompost on yield contributing parameters of potato (BARI Alu-25 ASTORIX)

Treatments	Yield contributing parameters		
	Number of tuber hill^{-1}	Weight of tuber hill^{-1} (g)	Dry weight of 100 g fresh tuber
T_1	6.44 e	303.30 f	18.20 ef
T_2	6.90 c	329.20 d	19.75 cd
T_3	6.70 cd	319.70 e	19.18 d
T_4	7.93 a	344.00 bc	20.63 bc
T_5	8.12 a	360.50 a	21.63 a
T_6	8.00 a	348.00 b	20.88 ab
T_7	6.52 de	131.00 h	18.80 de
T_8	7.48 b	337.20 cd	20.23 bc
T_9	5.80 f	293.30 g	17.60 f
$LSD_{0.05}$	0.251	8.748	0.958
CV(%)	6.72	11.24	7.92

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

T_1 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP (only inorganic)
T_2 = 130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost
T_3 = 110 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_4 = 90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost
T_5 = 70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost
T_6 = 50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost
T_7 = 30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost
T_8 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_9 = Control (no nutrient application)

4.2.3 Dry weight of 100 g fresh tuber

Dry weight of 100 g fresh tubers of potato affected significantly due to different levels of integrated nutrient management (Table 3 and Appendix VI). Results revealed that the highest dry weight of 100 g fresh tubers (21.63 g) was recorded from the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) which was statistically similar with the treatment T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) (20.88 g). The treatment T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost) and T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) showed non-significant variation between them which also showed comparatively higher dry weight of 100 g fresh tubers (20.63 and 20.23 g, respectively) but significantly varied with other treatments. Similarly, the lowest dry weight of 100 g fresh tubers (17.60 g) was recorded from the control treatment T_9 (no nutrient application) which was statistically similar with the inorganic fertilizer treatment T_1 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP). Similar result was also observed by the findings of Hensh *et al*. (2020), Bhattacharjee and Deka (2020) and Das and Deka (2019) who reported higher dry matter content of potato tuber with integrated nutrient management of vermicompost and inorganic fertilizers.

4.3 Yield parameters

4.3.1 Tuber weight plot^{-1}

Tuber weight plot^{-1} of potato affected significantly due to application of inorganic fertilizers and vermicompost (Table 4 and Appendix VII). The highest tuber weight plot^{-1} (14.55 kg) was recorded from the treatmentT_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) which was statistically similar to the treatment T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) (14.33 kg) and T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost) (14.05 kg). The lowest tuber weight plot^{-1} (6.35 kg) was recorded from the control treatment T_9 (no nutrient application). Similar result was also observed by the findings of Katar*et al*. (2014) who reported higher per plot yield with integrated nutrient management of vermicompost and NPK fertilizers.

4.3.2 Tuber yield

Different inorganic fertilizers and vermicompost exhibited significant variation on tuber yield ha^{-1} of potato (Table 4 and Appendix VII). Results revealed that the highest tuber yield ha^{-1} (30.24 t) was recorded from the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) which was significantly differed to other treatments followed by T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) and T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost). The lowest tuber yield ha^{-1} (13.20 t) was recorded from the control treatment T_9 (no nutrient application). The result obtained from the present study is conformity with the findings of Mondal *et al*. (2021), Bhattacharjee and Deka (2020), Choudhury *et al*. (2019) who achieved highest potato yield with the vermicompost + inorganic fertilizers treatment compared to control treatments of vermicompost or inorganic fertilizers alone.

Table 4. Effect of inorganic fertilizers and vermicompost combination on yield parameters of potato (BARI Alu-25 ASTORIX)

Treatments	Yield parameters	
	Tuber weight plot^{-1} (kg)	Tuber yield ha^{-1} (t)
T_1	12.72 e	26.44 f
T_2	13.29 cd	27.64 e
T_3	13.13 cde	27.30 e
T_4	14.05 ab	29.20 c
T_5	14.55 a	30.24 a
T_6	14.33 a	29.80 b
T_7	12.87 de	26.76 f
T_8	13.62 bc	28.32 d
T_9	6.35 f	13.20 g
$LSD_{0.05}$	0.569	0.435
CV(%)	8.92	8.93

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

T_1 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP (only inorganic)
T_2 = 130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost
T_3 = 110 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_4 = 90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost
T_5 = 70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost
T_6 = 50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost
T_7 = 30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost
T_8 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_9 = Control (no nutrient application)

4.4 Quality parameters of postharvest soil

4.4.1 pH content of postharvest soil

pH of postharvest soil was not affected significantly due to different levels of integrated nutrient management (Table 5 and Appendix VIII). However, the highest pH of postharvest soil (6.30) was recorded from the treatmentT_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) whereas the lowest pH of postharvest soil (6.20) was recorded from the control treatment T_9 (no nutrient application).

4.4.2 Organic carbon (OC) content of postharvest soil

Nonsignificant variation was found among the treatment of different levels of integrated nutrient management on OC content of postharvest soil of potato field (Table 5 and Appendix VIII). However, the highest OC content of postharvest soil (0.64%) was recorded from the treatment T_7 (30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost) and the lowest OC content of postharvest soil (0.48%) was recorded from the control treatment T_9 (no nutrient application).

4.4.3 Total nitrogen (N) content of postharvest soil

Total N content of postharvest soil affected significantly due to different levels of integrated nutrient management (Table 5 and Appendix VIII). The highest total N content of postharvest soil (0.273%) was recorded from the treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) which was statistically identical to the treatment T_7 (30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost) and the lowest total N content of postharvest soil (0.092%) was recorded from the control treatment T_9 (no nutrient application).

Table 5. Analytical values of post harvest soil of potato as influenced by inorganic fertilizers and vermicompost combination

Treatments	Quality parameters of post harvest soil					
	pH	Organic carbon (%)	Total nitrogen (N) (%)	Available phosphorus (ppm)	Exchangeable potassium (K) (meq/100 g soil)	Available sulphur (ppm)
T_1	6.28	0.52	0.158 e	19.40 d	0.121	24.33 d
T_2	6.27	0.55	0.163 e	20.32 cd	0.128	27.30 ab
T_3	6.27	0.57	0.187 d	19.52 d	0.122	25.40 c
T_4	6.24	0.58	0.190 d	20.80 bc	0.132	27.63 ab
T_5	6.25	0.62	0.214 c	22.75 a	0.133	28.12 a
T_6	6.22	0.62	0.242 b	21.00 bc	0.123	26.72 b
T_7	6.22	0.64	0.263 a	21.40 b	0.125	24.60 cd
T_8	6.30	0.60	0.273 a	23.27 a	0.135	28.20 a
T_9	6.20	0.48	0.092 f	18.30 e	0.115	22.70 e
$LSD_{0.05}$	0.134^{NS}	0.164^{NS}	0.018	0.981	0.211^{NS}	1.003
CV(%)	3.14	2.76	4.36	5.27	2.84	4.33

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

T_1 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP (only inorganic)
T_2 = 130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost
T_3 = 110 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_4 = 90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost
T_5 = 70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost
T_6 = 50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost
T_7 = 30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost
T_8 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost
T_9 = Control (no nutrient application)

4.4.4 Available phosphorus (P) content of postharvest soil

Available P content of postharvest soil of potato field affected significantly due to different levels of integrated nutrient management (Table 5 and Appendix VIII). The highest available P content of postharvest soil (23.27 ppm) was recorded from the treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) which was statistically identical to the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) whereas the lowest available P content of postharvest soil (18.30 ppm) was recorded from the control treatment T_9 (no nutrient application) which was significantly differed to other treatments.

4.4.5 Exchangeable potassium (K) content of postharvest soil

Non-significant variation was found among the treatment of different levels of integrated nutrient management on exchangeable K content of postharvest soil of potato field (Table 5 and Appendix VIII). However, the highest exchangeable K content of postharvest soil (0.135meq/100 g soil) was recorded from the treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) whereas the lowest exchangeable K content of postharvest soil (0.115 meq/100 g soil) was recorded from the control treatment T_9 (no nutrient application).

4.4.6 Available sulphur (S) content of postharvest soil

Available S content of postharvest soil affected significantly due to different levels of integrated nutrient management (Table 5 and Appendix VIII). The highest available S content of postharvest soil (28.20 ppm) was recorded from the treatmentT_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) which was statistically similar to the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost), T_2 (130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost) and T_4 (90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost) whereas the lowest available S content of postharvest soil (22.70 ppm) was recorded from the control treatment T_9 (no nutrient application) which was significantly differed to other treatments.

CHAPTER V

SUMMARY AND CONCLUSION

This experiment was conducted to study the growth and yield of potato (BARI Alu-25 ASTORIX) as influenced by integrated nutrient management 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. Single factor experiment was considered for the present study with nine treatments *viz*. T_1 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP (only inorganic), T_2 = 130 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 20 kg N/ha from vermicompost, T_3 = 110 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost, T_4 = 90 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 60 kg N/ha from vermicompost, T_5 = 70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost, T_6 = 50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost, T_7 = 30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost, T_8 = 150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost and T_9 = Control (no nutrient application). 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 integrated nutrient management. For growth parameters, treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) exhibited the minimum days to 100 percent emergence (15.3 days) while the highest plant height (72.25 cm) and number of leaves hill^{-1} (74.22) were recorded from the treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) whereas the control treatment T_9 (no nutrient application) showed the maximum days to 100 percent emergence (18.0 days) and lowest plant height (60.20 cm) and number of leaves hill^{-1} (61.50). Again, the highest number of haulm hill^{-1} (7.50), fresh weight of haulm hill^{-1} (185.60 g) and dry weight of haulm hill^{-1} (33.70 g) were recorded from the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) followed by T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) whereas the control treatment T_9 (no nutrient application) showed the lowest number of haulm hill^{-1} (4.00), fresh weight of haulm hill^{-1} (163.40 g) and dry weight of haulm hill^{-1} (23.80 g).

For yield contributing parameters and yield, treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) performed the best results and showed the highest number of tuber hill^{-1} (8.12), weight of tuber hill^{-1} (360.50 g), dry weight of 100 g fresh tuber (21.63 g), tuber weight plot^{-1} (14.55 kg) and tuber yield ha^{-1} (30.24 t) followed by T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) whereas the control treatment T_9 (no nutrient application) performed the lowestnumber of tuber hill^{-1} (5.80), weight of tuber hill^{-1} (293.30 g), dry weight of 100 g fresh tuber (17.60 g), tuber weight plot^{-1} (6.35 kg) and tuber yield ha^{-1} (13.20 t).

Regarding the postharvest soil status, pH, organic carbon and exchangeable potassium content were not influenced by different levels of integrated fertilizer management, however, the maximum pH (6.30) and exchangeable potassium content (0.135 meq/100 g soil) was obtained from T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) treatment and maximum organic carbon (0.64%) was recorded from T_7 (30 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 120 kg N/ha from vermicompost) treatment whereas the lowest pH (6.20), organic carbon (0.48%) and exchangeable potassium content (0.115 meq/100 g soil) were recorded from control treatment T_9 (no nutrient application). The total N, available P and S content of postharvest soil affected significantly by different levels of integrated fertilizers management. The maximum total N (0.273%), available P (22.75 ppm) and S (28.20 ppm) were recorded from the treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) whereas the lowest N, P and K content of postharvest soil (0.092%, 18.30 ppm and 22.70 ppm, respectively) were recorded from the control treatment T_9 (no nutrient application).

From the above results, it can be concluded that the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) was the best treatment compared to other treatments followed by T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) for potato production. In terms of analysis of postharvest soil, pH and organic carbon content were not varied significantly among the treatments of organic and inorganic fertilizers combinations but available P and S of postharvest soil affected significantly. The treatment T_8 (150 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 40 kg N/ha from vermicompost) showed highest N, P and S content of postharvest soil. So, yield of potato, the treatment T_5 (70 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 80 kg N/ha from vermicompost) was the best under the present study followed by T_6 (50 kg N/ha from urea + 30 kg P/ha from TSP + 140 kg K/ha from MoP + 100 kg N/ha from vermicompost) 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

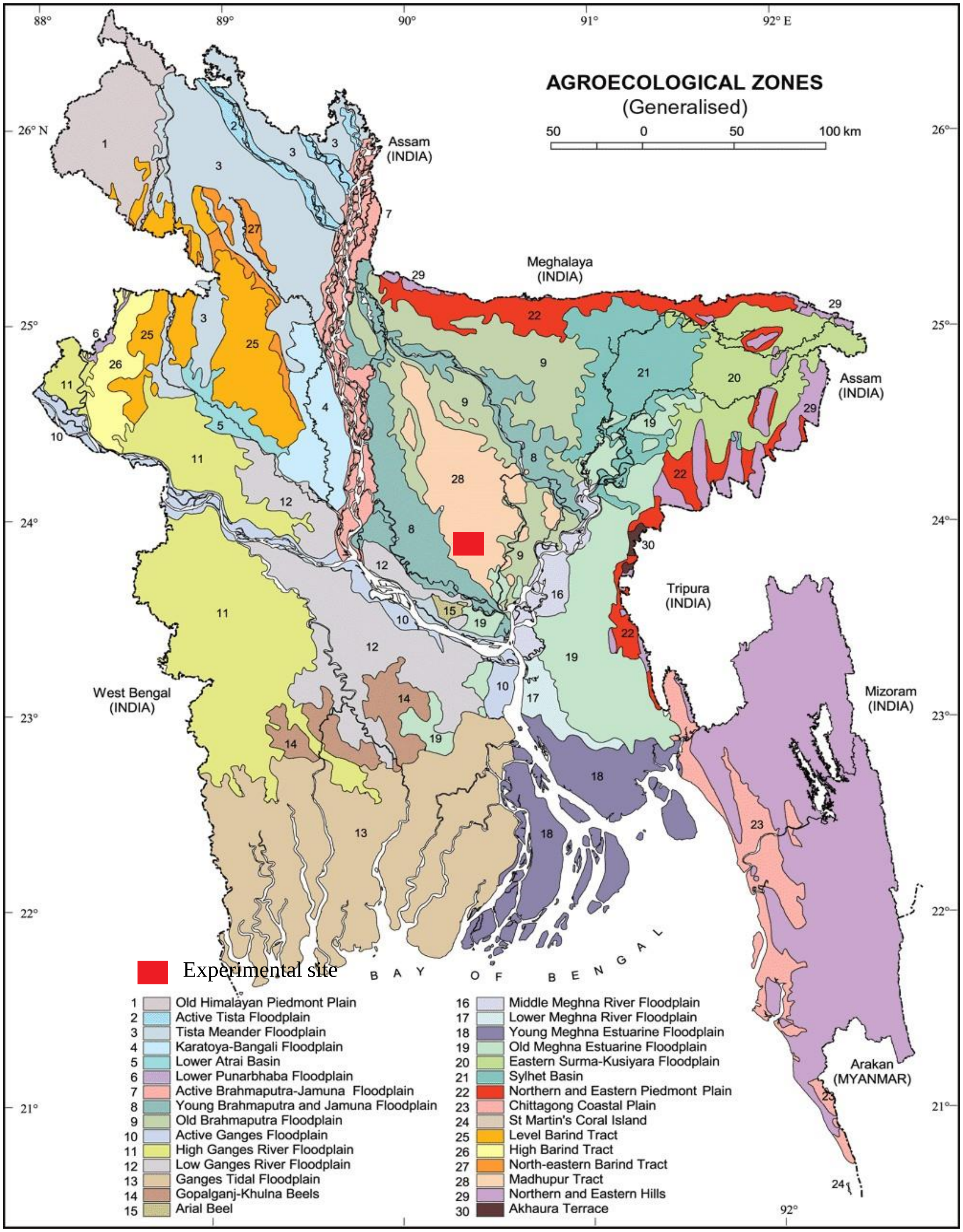

Figure 2. Experimental site

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-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. Analysis of variance for growth parameters of potato (BARI Alu-25 ASTORIX) on days to 100% emergence, plant height and number of leaves plant^{-1} as influenced by inorganic fertilizers and vermicompost

Sources of variation	Degrees of freedom	Mean square of growth parameters		
		Days to 100% emergence	Plant height (cm)	Number of leaves hill^{-1}
Replication	2	0.807	9.195	3.824
Factor A	8	18.743**	144.96*	524.224*
Error	16	0.012	0.403	0.311

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

Appendix V. Analysis of variance for growth parameters of potato (BARI Alu-25 ASTORIX) on number of haulm hill^{-1}, fresh weight and dry weight of haulm hill^{-1} as influenced by inorganic fertilizers and vermicompost

Sources of variation	Degrees of freedom	Mean square of growth parameters		
		Number of haulm hill^{-1}	Fresh weight of haulm hill^{-1} (g)	Dry weight of haulm hill^{-1} (g)
Replication	2	0.044	6.436	1.403
Factor A	8	26.32**	424.218*	114.712*
Error	16	0.011	1.714	0.312

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

Appendix VI. Analysis of variance for yield contributing parameters of potato (BARI Alu-25 ASTORIX) as influenced by inorganic fertilizers and vermicompost

Sources of variation	Degrees of freedom	Mean square of yield contributing parameters		
		Number of tuber hill^{-1}	Weight of tuber hill^{-1} (g)	Dry weight of 100 g fresh tuber
Replication	2	0.032	7.103	3.211
Factor A	8	21.371*	502.63*	43.402**
Error	16	0.007	0.514	0.102

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

Appendix VII. Analysis of variance for yield parameters of potato (BARI Alu-25 ASTORIX) as influenced by integrated nutrient management

Sources of variation	Degrees of freedom	Mean square of yield parameters	
		Tuber weight plot^{-1} (kg)	Tuber yield ha^{-1} (t)
Replication	2	0.376	0.371
Factor A	8	64.211*	65.223*
Error	16	0.036	0.021

* = Significant at 5% level

Appendix VIII. Analysis of variance for analytical value of postharvest soil of potato as influenced by inorganic fertilizers and vermicompost

Sources of variation	Degrees of freedom	Mean square of quality parameters of postharvest soil					
		pH	Organic carbon (%)	Total nitrogen (N) (%)	Available phosphorus (ppm)	Exchangeable potassium (K) (meq/100 g soil)	Available sulphur (ppm)
Replication	2	0.012	0.001	0.107	1.044	0.016	1.018
Factor A	8	3.414^{NS}	0.207^{NS}	4.113**	18.214*	1.047^{NS}	22.033*
Error	16	0.002	0.003	0.102	0.107	0.002	0.112

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

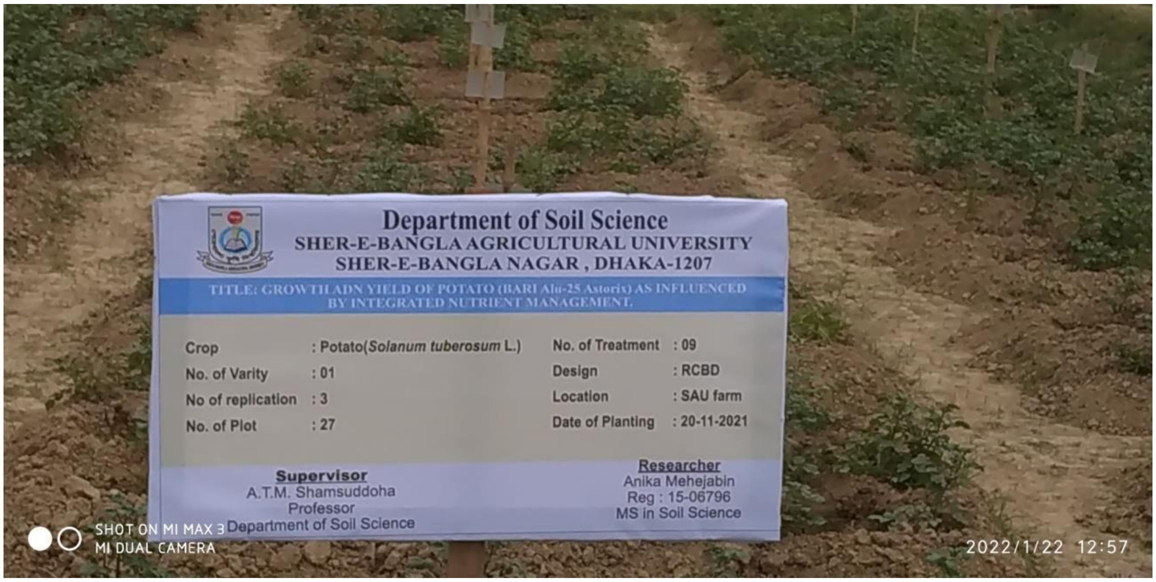

Plate 1. Signboard of the experiment field

Plate 2. Layout of the experiment field

Plate 3. Sowing of potato tuber the experiment field

Plate 4. Experimental field showing seedling emergence

Plate 5. Experimental field after seedling emergence

Plate 6. Data collection the experiment field

Plate 7. Pesticide spray as intercultural operation in the experiment field

Plate 8. Field visit of the experiment plot