EFFECT OF FERTILIZER ON GROWTH AND YIELD OF SWEET POTATO AT FARMER FIELD AT JAMALPUR, BANGLADESH

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DECEMBER, 2020

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REGISTRATION NO. 18-09254

A Thesis

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

AGRICULTURAL BOTANY
SEMESTER: JULY-DECEMBER, 2020

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TO

MY BELOVED PARENTS

CERTIFICATE

This is to certify that the thesis entitled "**EFFECT OF FERTILIZER ON GROWTH AND YIELD OF SWEET POTATO AT FARMER FIELD AT JAMALPUR, BANGLADESH**" *submitted to the Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* **MASTER OF SCIENCE** in **AGRICULTURAL BOTANY**, *embodies the result of a piece of bona- fide research work carried out by* **TANVIR MOHAMMAD ABDUL LATIF**, **REGISTRATION NO**.**18-09254** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated:

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ACKNOWLEDGEMENTS

All praises are due to the "Almighty Allah" who enabled the author to pursue higher education in Agricultural Botany and to submit the thesis for the degree of Master of Science (M.S.) in Agricultural Botany.

The author wishes to express his profound sense of appreciation and heartiest gratitude to his Supervisor, ***Dr. Md. Ashabul Hoque,*** *Professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for his help, scholastic supervision, continuous encouragement and constructive suggestion throughout the period of research and for taking immense care in preparing this manuscript. The author expresses his immense gratitude to his Co-supervisor,* ***A. M. M. Shamsuzzaman,*** *Professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for his valuable advice and constructive criticism during the critic period of research work.*

The author is grateful to all the respectable teachers of the Department of Agricultural Botany, Sher-e-Bangla Agricultural University for giving necessary suggestions. The author would like to extend his appreciation to all the staffs of the Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for their co-operation and encouragement during the study period.

The author is also thankful to Maruhisa group, japan an also Jica for providing research support. The author can never repay the debt of his beloved parents, uncle, aunty, sisters, brothers and well-wishers for their inspiration, constant encouragement and sacrifice for his higher education.

The author expresses his immense gratefulness to all of them who assisted and inspired him to achieve higher education and regret for his inability for not to mention everyone by name.

The Author

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ABSTRACT

Potato is one of the priority vegetable crops in the highlands of Eritrea growing as a key component in the livelihood systems of farmers. Potato requires a variety of balanced plant mineral nutrients for growth and development without which yield and qualities of tubers are reduced. Potato growers in Bangladesh commonly use both organic and inorganic fertilizer to support crop growth. However this assumption is based on the result obtained from recent years finding's. As a result the yield and quality of potato produced in Bangladesh is very low as compared with international standards. Therefore the present experiment was conducted to assess the effect of different fertilizers levels on growth and productivity of potato varieties at Jamalpur, Bangladesh. The experiment was conducted in factorial Randomized Complete Block Design with twelve treatment combinations of four varieties (V1: Annou Beni, V2: Annou Kougane, V3: Kokei 14 Go and V4: BARI Sweet potato12) and three fertilizer application (T0: No chemical fertilizer and no compost, T1: BARI fertilizer dose, and T2: Maruhisa dose (Chemical fertilizer + improved compost)) replicated thrice. The results of the study showed that V4 variety and T2 had significant effect on growth and yield parameters. Plant height, leaf number per plant and branch per plant were higher in V4 variety (plant height 21.33cm, leaf number per plant 24.44 and number of branch per plant 5.0 respectively), T2 fertilizer application, and V4T2 treatment. The highest plant height, number of leaf and number of branch per plant were shown in 100 days treatment for V4T2 treatment. The result also indicated that V4T2 (V4 variety treated with T2 fertilizer) produced significantly highest tuber length (19.43 cm), tuber diameter (18.70 cm) and tuber weight (1.01 kg) per plant, and tuber yield of 15.65 t/ha. The yield analysis result revealed that maximum yield of sweet potato was obtained from the application of T2 fertilizer on V4 variety than other varieties. On the whole, it gives an impression that using T2: Maruhisa fertilizer and V4 (BARI Sweet potato12) will have good influence on growth and tuber yield.

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Abbreviation List

AEZ : Agro-Ecological Zone

AMF : Arbuscular Mycorrhizal Fungi

ANOVA : Analysis of Variance

BARI : Bangladesh Agriculture Research Institute

BBS : Bangladesh Bureau of Statistics

CV% : Percentages of Co-efficient of Variance

Chl : Chlorophyll

Cm : Centimeter

FAO : Food and Agriculture Organization

Kg : Kilogram

LSD : Least Significant Difference

VL : Potential of Hydrogen

RCBD : Randomized Complete Block Design

Vl : Vine length

VAM : Vesicular arbuscular mycorrhiza

BRN : Branch number

M.S. : Master of Science

t ha^{-1} : Ton per hectare

% : Percentage

Var. : variety

CHAPTER I

INTRODUCTION

Sweet potato (*Ipomoea batatas L.)* is one of the most important root and tuber crops in sub-Saharan Africa with both domestic and industrial uses, and its nutritional value far exceeds yam, cassava and cocoyam (Onwueme, 1978). Sweet potatoes are an incredibly versatile food. They can be eaten at any time of day. They can be included in a sweet breakfast dish in a replacement for hash browns, they can be a great addition to a lunchtime entree, they can be a great accompaniment to dinner, and they can even be made into desserts. They contain a huge number of nutrients that are all necessary for our proper health and development (Zingore *et al*., 2003). They're an especially high source of vitamin A, a nutrient that's important for the health of our eyes (Gurunadh *et al*., 2005). Sweet potatoes differ from yams, and are actually commonly confused. The orange-colored, red-skinned potatoes that many people refer to are actually just one of the many varieties of sweet potatoes (Christine *et al*., 2012). However, the two different root vegetables provide a number of the same health benefits. Sweet potato is sold and widely consumed in various forms by man and livestock and for industrial uses.

However, sweet potato yield in the tropics is often low due to various reasons. One of the most important is the low fertility of the tropical soils. The soils are poor in organic matter and available nutrients and hence productivity and sustainability decline over time. Root yields as low as 7 t ha^{-1} compared with

yield potentials of 18 to 24 t $ha^{-1}$of improved varieties have been recorded in Ghana, due to low soil fertility, planting low yielding varieties and outdated agronomic practices (CRI, 2002). Sweet potato may be adapted to grow on poor soils; as such most farmers do not apply fertilizer to their crops, resulting in poor yield. Small-holder farmers apply little or no fertilizer, often citing high cost or non-availability of inorganic fertilizers as reasons for not applying recommended dosage. Though inorganic fertilizers have been the conventional method of soil mineral input in sweet potato production, these fertilizers may pose danger to the environment especially if inappropriately applied. According to Buresh *et al*. (1997) and Palm *et al*. (1997), it has generally been accepted that both inorganic and organic inputs are needed to increase crop production in West Africa. The concept of 'integrated nutrient management' utilizing all available organic and inorganic resources has become a dominant paradigm for improved or increased yields in smallholder agriculture system of sub-Saharan Africa (SSA) to ensure both efficient and economic use of scarce nutrient resources (Smailing *et al*., 1997; Vanluawe *et al*., 2001). Therefore, the use of organic manure to supplement inorganic fertilizer use, as an integrated management strategy, is of paramount importance to reducing the cost of soil mineral input, maximizing yields and sustaining sweet potato as well as other food crops production in Ghana. In the rural communities, cheaper sources of organic inputs especially poultry manure are in abundance.

A number of studies carried out on organic and inorganic fertilizer combination in sweet potato production, have attested to a positive interaction between them

when simultaneously applied. However, the use of poultry manure as a supplement has added positive benefits on the physical properties of the soil (Palm *et al*., 1997). In Ghana, very little information exists on the appropriate combination rates of organic and inorganic fertilizers for sweet potato production. However, it has been reported that the response of the crop to varying regimes of nitrogen, phosphorus and potassium fertilizers has been positive (Dapaah *et al*., 2004). The crop equally responds visibly to the application of organic fertilizers. Several hypothesis have been formulated concerning possible positive interaction between inorganic and organic inputs when applied simultaneously (Giller *et al*., 1998) resulting in added benefits in terms of improved crop yields, soil fertility or both, and lower cost of production (Palm *et al*., 1997).

There is a need to explore the huge and rich potential of sweet potato for commercial and industrial utilization. The identification and selection of an appropriate combination rate of inorganic and organic fertilizers will increase the production levels of sweet potato in the country to improve food security, reduce poverty, improve nutrition as well as contribute significantly to reduce the importation of wheat flour and other products meant for the food industry. Additionally, the crop has a significant role to play in the national crusade against Vitamin A deficiency because some varieties (that is, the orange-fleshed sweet potato varieties) have high levels of beta-carotene content, one of the major sources of vitamin A.

The objective of this study was to determine the growth and yield response of sweet potato to an integrated scheme of supplementing organic and inorganic fertilizer for sustainable production. keeping this thought in mind the study was used to fulfill the following objectives:

- To investigate the effects of different varieties on sweet potato growth and yield at farmer's field in Jamalpur, Bangladesh.
- To investigate the effects of different fertilizer treatment on sweet potato growth and yield at farmer's field in Jamalpur, Bangladesh.
- To reveal the combination effects of different varieties and fertilizer on sweet potato growth and yield at farmer's field in Jamalpur, Bangladesh.

CHAPTER II

REVIEW OF LITERATURE

2.1 Fertilizer or nutrients needs for sweet potato

Abundant sunshine, warm and well-drained soil are key factors in producing a great sweet potato yield, but it all starts with a good foundation of nutrients, boosted by fertilizer when soil conditions are inadequate. Of the "big three" nutrients, nitrogen (N), phosphorous (P) and potassium (K), potassium plays the largest role in a full and healthy crop (Pervez *et al*., 2013). Sweet potatoes need plenty of K, (~150-200 pounds per acre, as opposed to ~60 pounds of both nitrogen and phosphorous per acre). Although sweet potatoes don't need very much nitrogen, there is still a balancing act with proper application (Muriithi *et al*., 2004 and Abd El-Latif *et al*., 2011). An over-application will result in foliage overgrowth, but a lack of roots and too little nitrogen will also minimize crop yield. A lack of Phosphorus can result in stunted growth, further diminishing yield. Requirements of each of these three essential plant nutrients will vary between different varieties of sweet potatoes (Dampney *et al*., 2011).

Boron is more important in sweet potatoes than in most other crops, as it prevents blistering disorder. Boron (as well as manganese), is deficient in most soils in the coastal areas, so having these two micronutrients available in fertilizer is crucial (G. Byju *et al*., 2007). Boron deficiencies are difficult to see visually, but symptoms can include chlorosis, thickening of young leaves, puckered leaves, and damage to the root itself (splitting, wrinkling, and stunted growth). Blistering won't appear until sweet potatoes have been cured and

stored for some time and is characterized by raised dark spots on the crop (G. Byju *et al*., 2007).

Sweet potatoes rely on great soil conditions for optimal growth. They grow best in warm sandy to sandy-loam soils. As sweet potatoes are very sensitive to frost, the best time to plant your cuttings is well after the last frost date when the soils are at least 65°F (Haile *et al*., 2009).

Be sure to take soil samples before applying your fertilizer. Use the results as a guideline to determine pH levels, as too acidic or too alkaline can affect nutrient uptake in your sweet potato crop. Optimal soil pH is between 4.5 and 7.0, depending on your region and soil type. Liming or adding sulfur can help bring balance or change pH levels if necessary. Send your samples to your local lab to determine needs and necessities for your crops.

2.2 Effects of nitrogen (N) fertilizer on sweet potato cultivation

Nitrogen (N) availability is a very important determinant of crop yield. It is also one of the most expensive inputs in crop production. Thus, the efficient management of N by farmers with limited resource is a very important part of successful soil and crop management system.

A field study was conducted on a Norfolk sandy loam soil at the George Washington Carver Agricultural Experiment Station, Tuskegee, AL, to evaluate the influence of fertilizer source and timing on the yield of four sweet potato [*Ipomoea batatas* (L.)] cultivars (Ankumah *et al*., 2003). This study suggested that cultivar maturity group should play an important part in N fertilization recommendations for sweet potato.

In their study, they used two N sources urea, $CO(NH_2)_2$ and ammonium nitrate, NH_4NO_3), four sweet potato cultivars ('Georgia Jet', GA-Jet; 'TU-82-155', TU-155; 'TU-1892'; and 'Rojo Blanco', Rojo-Bl) and three times (zero, single, and split applications) were used in a factorial designed experiment. Plants were harvested after 80 and 120 days and total and marketable yields determined. Nitrogen recovery efficiency, yield efficiency and Physiological efficiency were also determined. Total and marketable yields of early maturing cultivars were significantly higher than of late maturing cultivars *(*$P < 0.05$*)*. The single application of N resulted in significantly higher yield in storage roots than split application *(*$P < 0.05$*)*. Physiological efficiency values were highly correlated with total marketable yields. Recovery rates increased with time. Late maturing cultivars tended to have higher N recovery and Physiological efficiency than early maturing cultivars (Ankumah *et al*., 2003).

Another study also reported that N influenced yield by increasing leaf area duration which in turn increased mean tuber weight and hence tuber yield (Bourke *et al*., 1985).

Additionally, one study revealed that inorganic N fertilizer is required for substantial yield increases of taro and sweet potato in the humid lowlands of Papua New Guinea (Alfred *et al*., 2000). Fertilizer N failed to substantially increase the yield of taro and sweet potato on coarse textured soils with low native N levels. Sweet potato made better use of the low native soil N levels than taro but data analysis through the use of a three-quadrant diagram showed a low N recovery for both root crops, which may be due to leaching losses of

applied N, other nutrients limiting growth or the weather conditions (Alfred *et al*., 2000).

Keep supporting the above evidence, a recent study by Ukom *et al*., (2009) illustrated that nitrogen fertilizer application improved the ß-carotene and protein contents of most varieties at 40-80 Kg-N ha^{-1} while the control (no nitrogen fertilizer) was associated with the highest crude fiber values. The variability in the ß-carotene and chemical composition of the various varieties of sweet potato can be useful in directing sweet potato research production and consumption with the view to increasing nutritional (provitamin A and protein) status of the consumers.

2.3 Effects of phosphorous (P) fertilizer on sweet potato cultivation

Phosphorus (P) is an important nutrient for both potato yield and tuber quality. Additionally, P is one of the vital minerals added for most vegetable species including sweet potato (El-Sayed *et al*., 2011). Under Egyptian soil conditions, P availability is considered one of the major growth-limiting factors for growing plants. The P of the applied fertilizers converts fast to unavailable form for plant absorption by its reaction with the soil constituents (Dawa *et al*., 2007). This could be explained why the cultivated soils require a high amount of mineral P fertilizers to complete supplies of plants. Yet, the use of large amounts of such fertilizers is responsible for rising production cost, as well as leads to the crisis of environmental pollution, particularly water and soil (Zarei *et al*., 2012). The use of bio-fertilizer and/or natural fertilizer is low-cost resources for providing the plants with P during their growth schedule, which

could fairly alternate the expensive applied chemical P fertilizers. Thus, leading to significant reduction in the production cost and pollution level in the soil and water could be decreased (Shaheen *et al*., 2012). The use of bio-Phosphate fertilizer; Arbuscular Mycorrhizal Fungi (AMF) is proposed as a low-cost and low-energy mechanism to amplify agronomic efficiency of rock Phosphate fertilizer (Antunes *et al*., 2007). The AMF symbiosis is recognized for its ability to increase uptake some insoluble sources of inorganic minerals, particularly P in the soil (Demir, 2004). Hence, employing of vesicular arbuscular mycorrhiza (VAM-fungi) to supplement mineral fertilizer use, as an integrated management system, is of supreme magnitude to reduce the cost of applied mineral fertilizer, maximizing yield and sustaining sweet potato.

In this respect, two field trials were performed in 2007 and 2008 summer seasons to determine the growth, root quantity and quality response of sweet potato to chemical and natural Phosphorus (P) fertilizer (super Phosphate and rock Phosphate) under four levels of P in combination with Vesicular Arbuscular Mycorrhiza (VAM) fungi inoculation treatment and their integrated effects. The obtained results showed superior growth, increased total and marketable yield, in addition improved root quality (total sugars, total carotene, total soluble solids and carbohydrates) with super Phosphate comparing with natural rock Phosphate (Antunes *et al*., 2007). Application of the highest level of P (100% P_2O_5) enhanced vine length, leaves number and vine fresh weight. Also, increased root quantity and quality traits. Inoculation plants with VAM-fungi significantly increased productivity and improved root organic

composition. Integrated effects between either super Phosphate under the recommended level (100% P_2O_5) or between VAM-fungi inoculation under the same level exhibited improving in plant growth and yield production. Sweet potato plants tended to reveal their best quality performance when super Phosphate is applied combined with VAM-fungi inoculation treatment. In general, the obtained results indicated that for increasing sweet potato root production and quality, a combination between super Phosphate at the recommended P level and VAM-fungi inoculation treatment was the best. The integrated effect between super Phosphate and VAM-fungi was better than either using inorganic or bio-Phosphate fertilizer alone.

Keep supporting this evidence, another study by Shaheen *et al*., (2012) was carried out to establish how different Phosphorus fertilizers release the nutrient and its influence on the crop. A variety of sweet potato (Shaba) was studied for its vegetative growth, yield and Phosphorus uptake under the influence of three different Phosphorus fertilizers which were Pacesetter organic fertilizer, single super Phosphate and crystallizer using Randomized Complete Block Design (RCBD) with three replications. Also Incubation study on how the fertilizers used released the nutritional element under investigation was concurrently carried out. The Incubation study revealed that single super Phosphate was the best in Phosphorus release with an attendant suppression of tuberous yield of the experimented plant. Sweet potato plots treated with crystallizer fertilizer at the rate of 500kgha^{-1} had the highest Phosphorus uptake and vegetative growth while control plots produced plants with highest tuberous yield. It is therefore

recommended that crystallizer applied at the rate of 500kgha^{-1} be used for significant phosphorous uptake which equally leads to better quality sweet potato tuber production and appreciable vegetative growth. It is also recommended that the soil Phosphorus be maintained at low level around 6.80mgkg^{-1} for achievement of high tuberous yield in sweet potato (Shaheen *et al*., 2012).

2.4 Effects of potassium (K) fertilizer on sweet potato cultivation

Potassium (K) is an essential elements or nutrients for plant or crops as well as sweet potato. Potassium impacts the plant's ability to efficiently use nitrogen and aids water uptake. K is also essential for: Improving nutrient value, Enhancing taste, color and texture, Promoting disease resistance and Optimizing yield and grade (Tang *et al*., 2015).

Lu *et al*., (2003) reported that when potassium application is increased, tubers swell and large sweet potatoes are obtained. The most important effect of potassium on sweet potato is that the enlargement of root tubers is expedited, and even with heavy nitrogen application, overgrowth of the aerial part is lessened and high root tuber yield is secured if potassium dosage is increased. From 1940 to 1945, NPK application experiments on sweet potato were conducted at various polices in Japan. Potassium produced the greatest effect on yield among the three nutrients (Karam *et al*., 2009).

Recent study results by Hafsi *et al*., (2014) showed that K deficiency significantly decreased total biomass productivity, root yield, photosynthetic

efficiency, and chlorophyll (Chl) content, while increased leaf sucrose and proline content of the three cultivars. K deficiency caused acute damage to chloroplast ultrastructure associated with leaf Chl biosynthesis and photosynthate accumulation, and also disturbed the protective enzymes involved in the antioxidative defense system. Compared with the other two cultivars, Xushu32 had higher root yield and better growth performance under K deficiency, which was mainly attributed to greater carbohydrate conversion and net photosynthetic efficiency (Heerdena & laurie., 2008).

Therefore, potato requires a variety of balanced plant mineral nutrients for growth and development without which yield and qualities of tubers are reduced. Potato growers in Eritrea commonly use Di-ammonium Phosphate, Urea and Farmyard manure while potassium fertilizers are overlooked assuming that the soil is developed from K rich parent material and contains sufficient amount of K to support crop growth (Gajanayake *et al*., 2014).

However, based on this assumption, one study was performed to assess the effect of potassium levels on growth and productivity of potato varieties at Hamelmalo Agricultural College, Eritrea. The experiment was conducted in factorial Randomized Complete Block Design (RCBD) with fifteen treatment combinations of three varieties (Ajiba, Zafira and Picasso) and five potassium levels (0, 75, 150, 225 and 300 kg K_2O ha^{-1}) replicated thrice. The results of the study showed that both variety and potassium had significant effect on growth and yield parameters. Aerial stem number, leaf number per plant and Vine length were increased with increasing K levels from 0 to 150 kg while number

of days to maturity was increased in the range of 0 - 300 kg K_2Oha^{-1}. The result also indicated that variety Ajiba treated with 300 kg K_2O ha^{-1} produced significantly highest tuber weight (1.14 kg) per plant and tuber yield of 49.38 tha^{-1}. The economic analysis result revealed that maximum gross margin 13,665.816 USD ha^{-1} was obtained from the application of 300 kg K_2O ha^{-1}. On the whole, it gives an impression that using potassium fertilizer according to soil requirements will have good influence on growth and tuber yield (Zelelew *et al.*, 2016).

As a whole, these data suggest that greater tolerance to K deficiency among sweet potato genotypes is associated to the capability to mount a stronger Physiological stress response during growth and tuber yield.

2.5 Effects of organic fertilizer on sweet potato cultivation

Like inorganic fertilizer, Organic fertilizers can improve the properties including Physical soil properties such as permeability, a porosity of the soil, soil structure, water holding capacity and cation of land, improve the nature - soil chemical and Physical properties, improving the ability to save water, improve ease of processing and soil fertility.

Now a day, the number of research reported that organic fertilizer plays a key role on sweet potato growth and yield. Recent study illustrated that application of organic fertilizer significantly increased VL, water content, organic carbon, total N, available P, total Kl, CEC, exchangeable Ca, plant height, tuber weight and levels of sweet potato starch.

Another study also described that combined application of NPK fertilizer and poultry manure at sub-optimal rates with any tillage method ensured more availability of major nutrients in soil and increased sweet potato leaf nutrient (N, P and K) concentrations and tuber yield compared with full rates of NPK fertilizer or poultry manure alone. Poultry manure or NPK fertilizer increased soil fertility and leaf nutrient concentrations and tuber yield compared with control, but soil conditions and leaf nutrient concentrations were better in poultry manure than NPK fertilizer (Eko Agus *et al*., 2016).

CHAPTER III

MATERIALS AND METHODS

3.1 Altitude and latitude of Study

The study was conducted at the Jamalpur districts, Bangladesh which occupies 2031.98 km^2. It is located between 24°34' and 25°26' North and between 89°40' and 90°12' East (see appendix I).

3.2 Characteristics of the soil

The soil had a pH (water: soil, 1:1) of 6.7, organic matter of 1.1% and CEC of 4.94 mmol kg^{-1} soil. The plot site had been left fallow during the summer and planted with rye grass during the winter prior to the study.

3.3 Climate condition of the experimental site

The experimental site is situated in the subtropical monsoon climate zone, which is characterized by heavy rainfall during the months from mid-March to mid-October, kharif season and scarcity of rainfall during rest of the year. From mid-october to mid-march is very suitable for growing sweet potato in Bangladesh.

3.4 Propagation sweet potato cuttings

Propagation sweet potato cuttings carried out at experiment garden of the department of Agricultural Botany, Sher-e-Bangla Agriculture University, Sher-e-Bangla Nagar, Dhaka, Bamgladesh. Four varities of sweet potato cultivars planted on land plots measuring 4 x 4 m^2, each plot planted 40 shoot

cuttings. Cultivars of sweet potato cuttings obtained from the first garden. Planting cuttings is done at the beginning of January 2019. This multiplication takes 3 months, is expected the 1400 shoot cuttings obtained for the purpose of planting in the field.

Four varieties are listed below,

V_1= Annou Beni,

V_2 = Annou Kougane,

V_3= Kokei 14 Go,

V_4 = BARI Misti Alu 12

3.5 Preparation of fertilizer and organic fertilizer treatment

Different fertilizer such as T_0: Control/No chemical fertilizer and no compost, T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost) were prepared, put in plastic and weighed according to treatment per plot or hectare. Fertilizer prepared then sown with bolt system. This way these applications can suppress the loss of fertilizer as evapotranspiration or erosion. The combination of fertilizer treatment are listed below,

V_1T_0 = Annou Beni + Control/No chemical fertilizer and no compost

V_1T_1 = Annou Beni + BARI fertilizer dose

V_1T_2 = Annou Beni + Maruhisa dose (Chemical fertilizer + improved compost)

V_2T_0 = Annou Kougane + Control/No chemical fertilizer and no compost

V_2T_1 = Annou Kougane + BARI fertilizer dose

V_2T_2 = Annou Kougane + Maruhisa dose (Chemical fertilizer + improved compost)

V_3T_0 = Kokei 14 Go + Control/No chemical fertilizer and no compost

V_3T_1 = Kokei 14 Go + BARI fertilizer dose

V_3T_2 = Kokei 14 Go + Maruhisa dose (Chemical fertilizer + improved compost)

V_4T_0 = BARI Misti Alu 12 + Control/No chemical fertilizer and no compost

V_4T_1 = BARI Misti Alu 12 + BARI fertilizer dose

V_4T_2 = BARI Misti Alu 12 + Maruhisa dose (Chemical fertilizer + improved compost)

3.6 Sweet potato planting

Sweet potato planting was done 3 days after fertilization. Each plot there are two mounds and every mounds planted 8 sweet potato shoot cuttings. Sweet potato shoot cuttings with about 25 cm long are planted at a depth of about 10 cm at an angle, so many books sweet potato stems are buried in the soil where the discharge of roots and tubers.

3.7 Recording of data

Experimental data were recorded from 40 days, 70 days and continued up to 100 days. The following data were recorded during the experiment.

a. Morphological characters

I. Vine length: Vine length was measured at three different time point 40, 70 and 100 days after planting in cm.

II. Number of leaf per plant: Number of leaf per plant was measured at three different time point 40, 70 and 100 days after planting.

III. Number of branch per plant: Number of branch per plant was measured at three different time point 40, 70 and 100 days after planting.

b. Yield contribution and yield characters

I. Tuber number per plant: It was measured during the final harvest

II. Tuber length: It was measured during the final harvest in cm

III. Tuber diameter: It was measured during the final harvest

IV. Tuber weight per plant: It was measured during the final harvest in kg

V. Yield per/Plot: It was measured during the final harvest in kg

VI. Yield/hectare: It was measured during the final harvest in ton.

3.8 Statistical Analysis

The data were collected from three different time point (40, 70 and 100 days). The analysis of variance (ANOVA) procedure was carried out to determine the differences in parameters using the SAS statistical package (SAS, 1999). The significantly different means were separated using the Least Significant Difference (LSD) at 5% significant level ($p < 0.05$).

CHAPTER IV

RESULTS AND DISCUSSION

The experiments were conducted to evaluate the effects of fertilizer on sweet potato growth and yield on different time stage. The results obtained with different time duration after use of different fertilizer treatment on sweet potato. Here, four varieties were used and three fertilizer treatments were implemented. The fertilizer effects on different sweet potato varieties specially growth (plant height, leafs and branch number) and yield (Tuber number, tuber length, tuber weight and total yield) are discussed in this chapter. Data on different morpho-Physiological parameters and yield contributing character of sweet potato have been described in both tables and figures.

4.1 Effect of different varieties on vine length

Vine length (Vl) is an important parameter for measuring plant growth. In my study Iused four varieties and collected their growth rate as a Vine length at different time stage (40 days, 70 days and 100 days) after treated by different fertilizer. The VL of different variety at different time period is described in table 1. Among four varieties, V_4 constantly has shown high VL than others. In 40 days, the VL of V_4 is higher (21.33) than V_1, V_2, V_3 and the similar picture has shown up to 100 days (77.27) (table 1). On the other hand, V_3 has shown second highest VL (18.38) than V_1 and V_2 in 40 days but it constantly reduced in 70 and 100 days. Additionally, V_1 variety has shown lower VL (16.61) than other varieties in 40, 70 and 100 days. Interestingly, V_2 variety showed an

emerging VL in 70 and 100 days than 40 days. Initially, VL of V_2 was lower than V_3 but in 70 days, the VL was dramatically increased and become steady. Keep supporting my study, recent study revealed that the plant growth of sweet potato can be depends on different varieties (Zelelew *et al*., 2016). They have reported that different varieties have different Vine length after fertilizer treatment. Kareem (2013) and his colleagues found that the growth and yield of sweet potato significantly vary from plant varieties. Additionally, Ali *et al*., (2009) described that the highest sweet potato yield was obtained from BARI SP-7 with (IPNS) among different varieties which is strongly support our experiments results. From our results we revealed that V_4 variety has shown the highest VL among four varieties.

Table 1. Effect of different varieties on vine length (cm)

Vine length(cm)			
Variety	**40 DAP**	**70 DAP**	**100 DAP**
V_1	16.61 c	28.89 b	49.83 c
V_2	18.11 bc	31.17 b	61.67 b
V_3	18.39 b	28.33 b	51.05 c
V_4	21.33 a	45.39 a	77.28 a

Mean value followed, Where, a = hight value, b= second highest value and c=lower value. V_1: Annou Beni, V_2: Annou Kougane, V_3: Kokei 14 Go, V_4: BARI Misti Alu12.

4.2 Effect of different fertilizer on vine length

Fertilizer or nutrient availability is a very important determinant of crop yield especially sweet potato. It is also one of the most expensive inputs in sweet

potato production. Thus, the efficient management of fertilizer or nutrient by farmers with limited resource is a very important part of successful soil and crop management system. In current study, we used three (T_0: Control/No chemical fertilizer and no compost, T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost)) fertilizer and evaluated their effect on sweet potato growth and yield in different time period (40, 70 and 100 days). The effects of different fertilizer treatment on sweet potato as Vine length (cm) has illustrated in figure 1. The data have shown the fertilizer effects on sweet potato at different time stage. Among three varieties, T_2 has shown higher Vine length in 40 and 70 days' time period (22.1 and 37.2 cm, respectively) except 100 days (62.3 cm) than T_0 and T_1 (figure 1). On the other hand, T_0 has shown lower Vine length in 40 and 70 days (14.5 and 29.8 cm, respectively) but in 100 days the Vine length surprisingly increased for T_0 condition and shown pick of plant height. Previous one study by Shaheen *et al*., (2012) found that fertilizer can directly influence plant growth and yield. Keep supporting this evidence El-Sayed *et al*., (2011) described that use of Phosphorus fertilizer increased the sweet potato plant growth and production. Alfred *et al*., (2000) illustrated that use of nitrogen can significantly improve sweet potato plant growth which is similar our recorded result. Our experiments result summarized that use of T_2 has shown the highest VL among three fertilizers.

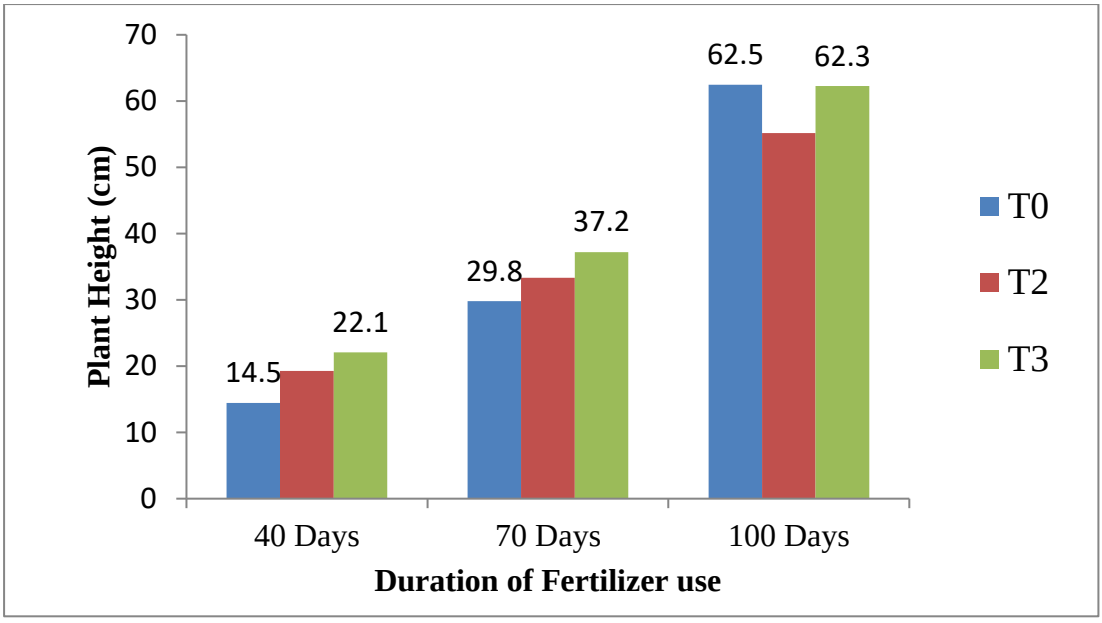

Figure 1. Effects of different fertilizer on plant height

Mean value followed, Where, T_0: Control (No chemical fertilizer and no compost), T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost).

4.3 Interaction effect of sweet potato variety and different doses of fertilizer on vine length

Interaction effects of different sweet potato varieties and fertilizer dosages on sweet potato have shown a significant effects on growth specially Vine length for different time duration (illustrated in table 2). The highest Vine length was 24.17 cm, which recorded from V_4T_2 treatment group after 40 days combination treatment. The lowest Vine length (13.00 cm) in 40 days was recorded V_3T_0 treatment group. Where, V_3T_2 and V_4T_1 have reported significantly similar Vine length (22.33 and 22.00 cm, respectively). On the other hand, V_4T_2 also has shown the highest Vine length in 70 and 100 days (52.00 and 85.33 cm, respectively). The lowest Vine length (25.33 cm) in 70

days was reported in V_3T_0 treatment group which was similar with 40 days result.

Additionally, in case of 100 days data has shown that the plant heights of different varieties are almost near to each other compared to previous day's results. V_1T_1, V_2T_1, and V_3T_0 have shown the lower Vine length in 100 days. Kareem (2013) and his colleagues found that the growth and yield of sweet potato significantly depends on plant varieties and use of fertilizer. Additionally, Ali *et al.*, (2009) described that the highest sweet potato growth and yield was obtained from BARI SP-7 with (IPNS) among different varieties which is strongly support our experiments results. Most importantly, one study by Agbede (2010) revealed that compared with control or no treatment group, NPK fertilizer, poultry manure and NPK fertilizer plus poultry manure increased plant growth and tuber yield by 39, 45 and 83%, respectively which is strongly support our results. Our results suggested that V_4T_2 has shown the highest Vine length among different varieties and treatment group.

Table 2. Interaction effect of sweet potato variety and different doses of fertilizer on vine length at different days after planting at Jamalpur location in 2019-20

Vine length(cm)			
Treatments	**40 DAP**	**70 DAP**	**100 DAP**
V_1T_0	13.50 fg	26.33 ef	49.17 e
V_1T_1	16.33 ef	29.67 def	51.50 e
V_1T_2	20.00 bcd	30.67 def	48.83 e
V_2T_0	13.50 fg	26.83 ef	72.50 bc
V_2T_1	19.00 cde	32.00 de	50.50 e
V_2T_2	21.83 abc	34.67 cd	62.00 d
V_3T_0	13.00 g	25.33 f	48.17 e
V_3T_1	19.83 bcd	28.17 ef	52.17 e
V_3T_2	22.33 ab	31.50 def	52.83 e
V_4T_0	17.83 de	40.67 bc	80.00 ab
V_4T_1	22.00 ab	43.50 b	66.50 cd
V_4T_2	24.17 a	52.00 a	85.33 a
LSD Value	2.84	6.22	8.65
CV(%)	9.02	10.99	8.52

Mean followed by the same letters are not significantly different ($p<0.05$) according to LSD test. V_1: Annou Beni, V_2: Annou Kougane, V_3: Kokei 14 Go, V_4: BARI Misti Alu 12, T_0: Control (No chemical fertilizer and no compost),T_1: BARI fertilizer dose, T_2: Maruhisa dose(Chemical fertilizer + Improved compost)

4.4 Effect of different varieties on leaf number plant^{-1}

Plant growth is also determined by leaves number of a plant. Plant variety may be affects plant growth in various ways. In my study used four varieties and collected their growth by counting leaf number per plant at different time stage (40 days, 70 days and 100 days) after treated by different fertilizer. The leaf number (LN) per plant of different varieties at different time period is described in Table 3. Among four varieties, V_4 constantly has shown high LN (24.44) than others. In 40 days, the LN of V_4(74.78) is higher than V_1, V_2, V_3 and the similar picture has shown up to 100 days (table 3). On the other hand, V_2 (20.55) has shown second highest LN than V_1 and V_2 in 40 days but it constantly reduced in 70 and 100 days. Additionally, V_3 (17.89) variety has shown lower LN than other varieties in 40 and 70 days but increased at 100 days. Interestingly, V_2 variety showed an emerging LN in 70 and 100 days than 40 days. Initially, LN of V_2 was lower than V_3 but in 70 days, the LN was dramatically increased and become steady. Keep supporting my study, recent study revealed that the plant growth of sweet potato can be depends on different varieties (Constantin *et al*., 1984). They have reported that different varieties have different leaves number after fertilizer treatment. Kareem (2013) and his colleagues found that the growth and yield of sweet potato significantly vary from plant varieties. Additionally, Ali *et al*., (2009) described that the highest sweet potato growth was obtained from BARI SP-7 with (IPNS) among different varieties which is strongly support our experiments results. From our

results we revealed that V_4 variety has shown the highest VL among four varieties.

Table 3. Effect of different varieties on leaf number plant^{-1}

Leaf Number Plant^{-1}			
Variety	**40 DAP**	**70 DAP**	**100 DAP**
V_1	21.33 b	52.33 b	80.44 b
V_2	20.55 b	53.11 b	80.67 b
V_3	17.89 c	49.11 b	81.22 b
V_4	24.44 a	74.78 a	109.33 a

Mean value followed, Where, a = hight value, b= second highest value and c=lower value. V_1: Annou Beni, V_2: Annou Kougane, V_3: Kokei 14 Go, V_4: BARI Misti Alu 12.

4.5 Effect of different fertilizer on leaves number plant^{-1}

In current experiment, we used three (T_0: Control/No chemical fertilizer and no compost, T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost)) fertilizer and evaluated their effect on sweet potato growth and yield in different time period (40, 70 and 100 days). The effects of different fertilizer treatment on sweet potato were monitored and results has illustrated in figure 2 as leaves number plant^{-1}. The data have shown the fertilizer effects on sweet potato at different time stage. Among three varieties, T_2 has shown higher number of leaves per plant in 40, 70 and 100 days' time period (25.25, 63.83 and 96.58, respectively) than others and peak reached in 100 days. On the other hand, T_0 has shown lower Vine length in 40, 70, 100 days (16.58,

51.08 and 78.42, respectively). One study by Eke-Okoro (2001) found that fertilizer can directly influence sweet potato growth including leaves number and yield. Keep supporting this evidence Njoku *et al*., (2001) described that use of Phosphorus fertilizer increased the sweet potato plant growth and production. Alfred *et al*., (2000) illustrated that use of nitrogen can significantly improve sweet potato plant growth which is similar our recorded result. Our experiments result summarized that use of T_2 has shown the highest VL among three fertilizers.

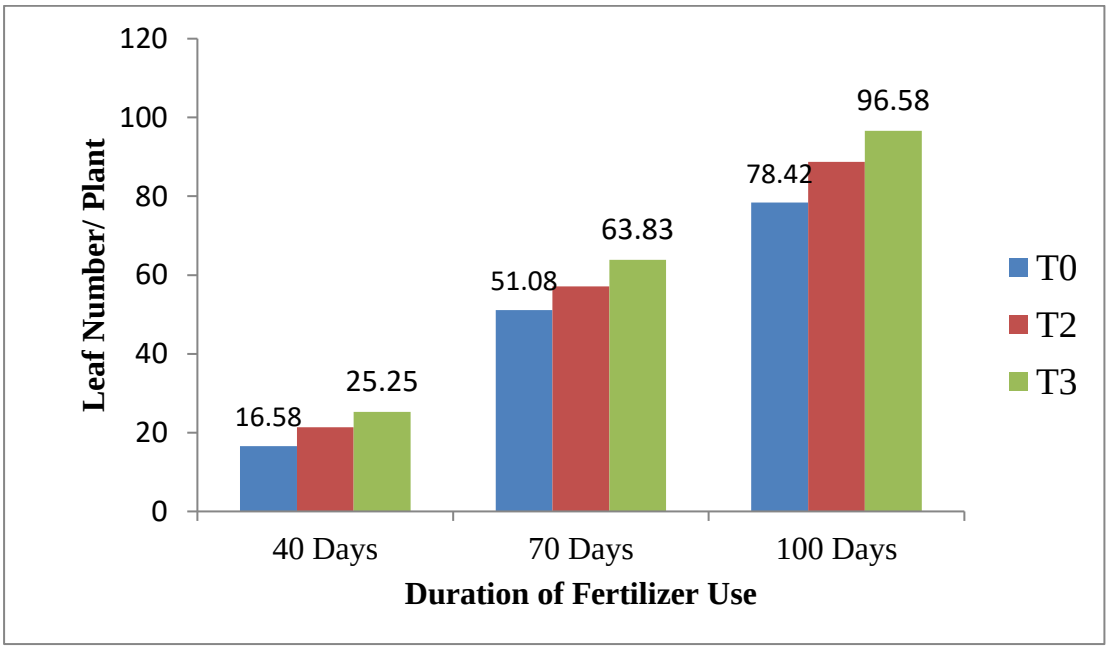

Figure 2. Effects of different fertilizer on leaves number / plant of sweet potato for different time period. Data were presented as a mean value. Where, T_0: Control (No chemical fertilizer and no compost), T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost).

4.6 Interaction effect of sweet potato variety and different doses of fertilizer on number of leaf plant^{-1}

Interaction effects of different sweet potato varieties and fertilizer dosages on sweet potato have shown significant effects on growth especially number of leaves per plant for different time duration (illustrated in Table 4). The highest leaves per plant were 28.00 and 26.0, which recorded from V_4T_2 and V_1T_2 treatment group respectively after 40 days combination treatment. The lowest number of leaves per plant (12.67) in 40 days was recorded V_3T_0 treatment group. Where, V_2T_2 and V_4T_1 have reported significantly similar leaves number per plant (25.0 and 25.0, respectively). On the other hand, V_4T_2 also has shown the highest leaf number per plant in 70 and 100 days (84.67 and 121.0, respectively). The lowest leaf number per plant (43.33) in 70 days was reported in V_3T_0 treatment group which was similar with 40 days result. Additionally, in case of 100 days data has shown that the leaf number per plant of different varieties is almost near to each other compared to previous day's results. V_2T_1 and V_2T_0 have shown the lower leaf number per plant in 100 days. Current study by Dawa *et al*., 2007 suggested that different fertilizer on different varieties showed the growth of sweet potato and production significantly depends on different fertilizer. Another study reported that use of fertilizer significantly increased both the number of storage roots and leaves per plant increased by 14.01%, and the average fresh weight per storage root increased by 13.7%, while the yield was also obviously increased by 29.56% (Chen *et al*., 2017) which is similar to our results. Our results explained that

application of different fertilizer on different varieties have various effects on plant growth and production. Interestingly, another study concluded that suggested that N application rates and ratio of base to top dressing had different influences on maize N concentration and production between maize/soybean and maize/sweet potato intercropping (Wang *et al*., 2014). Current study, suggested that interaction between four varieties and three fertilizer, V_4T_2 treatment has reported higher leaf number per plant than other group.

Table 4. Interaction effect of sweet potato variety and different doses of fertilizer on number of leaf per plant at different days after planting at Jamalpur location in 2019-20

Number of leaf plant^{-1}			
Treatments	**40 DAP**	**70 DAP**	**100 DAP**
V_1T_0	17.67 de	46.33 fg	70.00 ef
V_1T_1	20.33 cd	53.67 def	84.00 cdef
V_1T_2	26.00 a	57.00 de	88.00 bcde
V_2T_0	15.67 ef	47.00 fg	74.33 def
V_2T_1	21.00 cd	51.67 ef	80.00 def
V_2T_2	25.00 ab	60.67 cd	87.00 cdef
V_3T_0	12.67 f	43.33 g	68.33 f
V_3T_1	19.00 cde	51.00 ef	85.00 cdef
V_3T_2	22.00 bc	53.00 ef	90.33 bcd
V_4T_0	20.33 cd	67.67 bc	101.00 bc
V_4T_1	25.00 ab	72.00 b	106.00 ab
V_4T_2	28.00 a	84.67 a	121.00 a
LSD Value	3.77	7.5	18.73
CV(%)	10.60	7.73	12.58

Mean followed by the same letters are not significantly different ($p<0.05$) according to LSD test. V_1: Annou Beni, V_2: Annou Kougane, V_3: Kokei 14 Go, V_4: BARI Misti Alu 12, T_0: Control (No chemical fertilizer and no compost),T_1: BARI fertilizer dose, T_2: Maruhisa dose(Chemical fertilizer + Improved compost)

4.7 Effect of different varieties on number branch plant^{-1}

The plant growth of different crops depends on soil nutrient and environment. Number of branches per plant is a key parameter for evaluating plant growth. Plant variety may be affected plant growth in various ways. In my study Iused four varieties and collected their growth by counting branch number (BRN) per plant at different time stage (40 days, 70 days and 100 days) after treated by different fertilizer. The branch number (BRN) per plant of different varieties at different time period is described in Table 5. Among four varieties, V_4 has shown high BRN (13.33) than others up to 100 days. In 40 days, the BRN of four varieties were same but V_4 variety has shown more BRN per plant at 70 and 100 days (table 5). On the other hand, V_3 has shown second highest BRN than V_1 and V_2 in 70 and 100 days. Additionally, V_1 variety has shown lower BRN than other varieties in 40 and 70 days. Interestingly, V_2 variety showed an emerging BRN in 70 and 100 days than 40 days. Initially, BRN of V_2 was lower than V3 but in 70 days, the BRN was dramatically increased and become steady. Keep supporting my study, recent study revealed that the growth and yield of sweet potato significantly depends on potato varieties, soil condition and fertilizer use for cultivation (Mao *et al*., 2001). Another study found that inorganic as well as organic fertilizers significantly increased the number of branch, leaves per plant and final fresh tuber yield of the crop. It was also found that leaves of sweet potato had higher levels of quality indicators than the tubers except for energy content which was higher in the tubers (Kareem, 2013).

Table 5. Effect of different varieties on number of branch plant^{-1}

Number of Branches Plant^{-1}			
Variety	**40 DAP**	**70 DAP**	**100 DAP**
V_1	5.00 a	7.33 b	8.56 c
V_2	4.67 a	7.33 b	9.56 b
V_3	5.00 a	7.44 b	10.00 b
V_4	5.00 a	9.44 a	13.33 a

Mean value followed, Where, a = hight value, b= second highest value and c=lower value. V_1: Annou Beni, V_2: Annou Kougane, V_3: Kokei 14 Go, V_4: BARI Misti Alu 12.

4.8 Effect of different fertilizer on number branch plant^{-1}

Fertilizer or nutrient may be affected plant growth in various ways such as branch per plant, height per plant and leaves per plant. In current experiment, we used three (T_0: Control/No chemical fertilizer and no compost, T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost)) fertilizer and evaluated their effect on sweet potato growth and yield in different time period (40, 70 and 100 days). The effects of different fertilizer treatment on sweet potato were monitored and results has illustrated in figure 3 as leaves number plant^{-1}. The data (figure 3) have shown the fertilizer effects on sweet potato at different time stage. Among three varieties, T_2 has shown higher number of leaves per plant in 40, 70 and 100 days' time period (6.0, 9.58 and 13.08, respectively) than others and peak reached in 100 days. On the other hand, T0 has shown lower leaves number in 40, 70, 100 days (16.58, 51.08 and 63.83 cm, respectively). However, Kareem, (2013) has illustrated

that inorganic as well as organic fertilizers significantly increased the number of branch, leaves per plant and final fresh tuber yield of the crop. It was also found that number of branch and leaves of sweet potato had higher levels of quality indicators than the tubers except for energy content which was higher in the tubers. Recently study revealed that nitrogen fertilization may affect the plant growth (number of branch and plant height) and root yield, starch yield and starch physicochemical properties of the sweet potato cultivar Jishu 25 (Duan *et al.*, 2019). In my study I found that use of different fertilizers on different varieties showed different effects on sweet potato plant growth, yield and production.

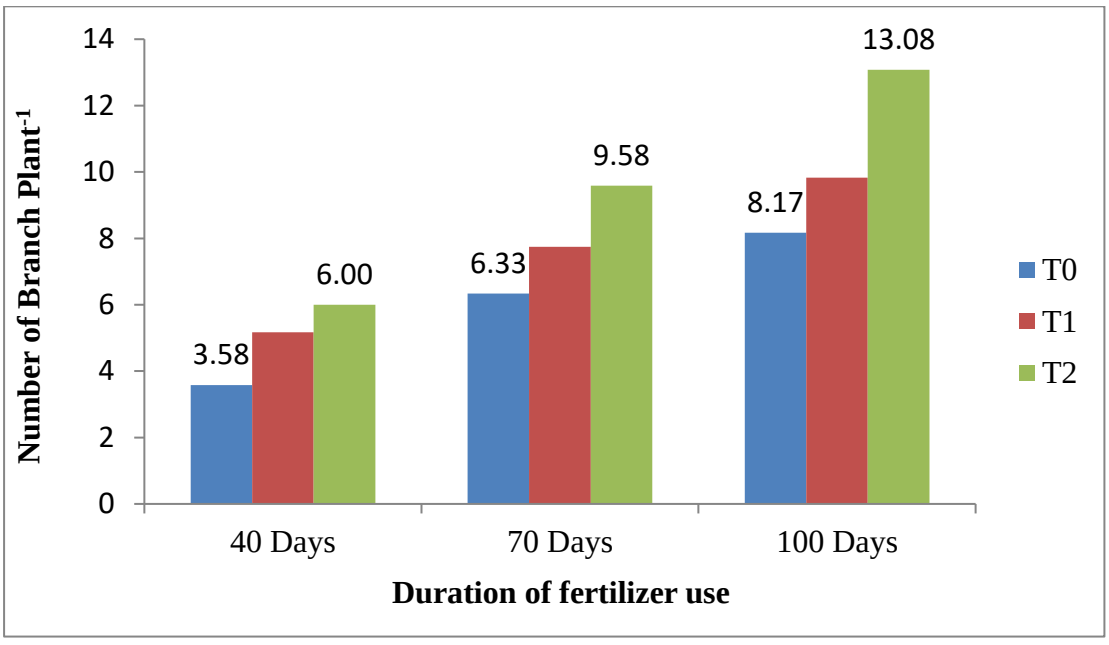

Figure 3. Effect of different fertilizer on number branch / plant of sweet potato for different time period. Data were presented as a mean value. Where, T_0: Control (No chemical fertilizer and no compost), T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost).

4.9 Interaction effect of sweet potato variety and different doses of fertilizer on branch plant^{-1}

Interaction effects of different sweet potato varieties and fertilizer dosages on sweet potato have shown significant effects on growth especially number of branch per plant for different time duration (illustrated in table 6). The highest branch per plant was 6.33 and 6.35, which recorded from V_1T_2 and V_3T_2 treatment group respectively after 40 days combination treatment. The lowest number of branch per plant (3.33) in 40 days was recorded from V_1T_0, V_2To and V_3T_0 treatment group. Where, V_2T_2 and V_4T_2 have reported significantly similar branch number per plant (5.67). On the other hand, V_4T_2 also has shown the highest branch number per plant in 70 and 100 days (12.33 and 17.67, respectively). The lowest branch number per plant (5.67) in 70 days was reported in V_2T_0 and V_3T_0 treatment group which was similar with 40 days result. Additionally, in case of 100 days data has shown that the branch number per plant of different varieties is almost near to each other compared to previous day's results. Furthermore, V_2T_0 has shown the lower branch number per plant (7.00) in 100 days for combination treatment. On the other hand, V_2T_2, V_3T_2 and V_4T_1 also have shown the second highest branch number per plant in 100 days (12.67, 12.33 and 12.67, respectively). Keep supporting my study, recent study revealed that the growth and yield of sweet potato significantly depends on potato varieties, soil condition and fertilizer use for cultivation (Mao *et al.*, 2001). Another study found that inorganic as well as organic fertilizers significantly increased the number of branch, leaves per

plant and final fresh tuber yield of the crop. It was also found that leaves of sweet potato had higher levels of quality indicators than the tubers except for energy content which was higher in the tubers (Kareem 2013). In my study I found that use of different fertilizers on different varieties showed different effects on sweet potato plant growth, yield and production. Among all varieties and fertilizer treatment V_4T_2 treatment has shown the highest branch number per plant.

Table 6. Interaction effect of sweet potato variety and different doses of fertilizer on branch per plant at different days after planting at Jamalpur location in 2019-20

Branch plant^{-1}			
Treatments	**40 DAP**	**70 DAP**	**100 DAP**
V_1T_0	3.33 e	6.67 e	7.67 de
V_1T_1	5.33 bc	7.33 de	8.33 cde
V_1T_2	6.33 a	8.00 cd	9.67 c
V_2T_0	3.67 e	5.67 f	7.00 e
V_2T_1	4.67 cd	7.33 de	9.00 cd
V_2T_2	5.67 ab	9.00 b	12.67 b
V_3T_0	3.33 e	5.67 f	8.33 cde
V_3T_1	5.33 bc	7.67 d	9.33 c
V_3T_2	6.3 a	9.00 b	12.33 b
V_4T_0	4.00 de	7.33 de	9.67 c
V_4T_1	5.33 bc	8.67 bc	12.67 b
V_4T_2	5.67 ab	12.33 a	17.67 a
LSD Value	0.96	0.71	1.55
CV(%)	11.60	5.36	8.87

Mean followed by the same letters are not significantly different ($p<0.05$) according to LSD test. V_1: Annou Beni, V_2: Annou Kougane, V_3: Kokei 14 Go, V_4: BARI Misti alu 12, T_0: Control (No chemical fertilizer and no compost),T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + Improved compost)

4.10 Effect of different varieties on Tuber number, tuber length and diameter plant^{-1}

In my study, we used different parameter such as number of tuber per plant, tuber length, and tuber diameter for determining the yield of sweet potato. The yield of sweet potato may be affected by different variety. In current study, we used four varieties and three fertilizer groups and collected data after 100 days treatment. The data of yield of sweet potato on the basis of number of tuber per plant, tuber length and tuber diameter were presented in table 7. The table 7 illustrated that the V_2 varieties has shown higher tuber number (8.22) per plant than other varieties and V_3 showed lower tuber number (5.88) per plant. On the other hand, in case of tuber length, four varieties have shown very similar (table 7). Almost all varieties showed tuber length is about 15.5 except V_4. Additionally, tuber diameter data from four varieties showed that V_4 variety shown higher tuber diameter (17.20) than other three varieties. Where, V_1 and V_2 showed almost similar tuber diameter but higher than V_3 variety and lower that V_4 variety (table 7). Currently, recent study revealed that the growth and yield of sweet potato significantly depends on potato varieties, soil condition and fertilizer use for cultivation (Mao *et al*., 2001). Another study found that inorganic as well as organic fertilizers significantly increased the number of branch, leaves per plant and final fresh tuber growth and yield of the crop. It was also found that leaves of sweet potato had higher levels of quality indicators than the tubers except for energy content which was higher in the

tubers (Kareem 2013). In our experiments has shown that the tuber number, length and weight significantly varies from sweet potato varieties to varieties.

Table 7. Effect of different varieties on Tuber number, tuber length and diameter plant^{-1}

Yield of Sweet Potato			
Variety	**No. of Tuber/plant**	**Tuber Length**	**Tuber Diameter**
V_1	7.00 b	15.33 a	15.93 b
V_2	8.22 a	15.90 a	15.88 b
V_3	5.89 c	15.89 a	14.62 c
V_4	6.667 bc	16.44 a	17.20 a

Mean value followed, Where, a = hight value, b= second highest value and c=lower value. V_1: Annou Beni, V_2: Annou Kougane, V_3: Kokei 14 Go, V_4: BARI Misti Alu 12.

4.11 Effect of different fertilizer on Tuber number, tuber length and diameter plant^{-1}

Previous study reported that fertilizer had a crucial role on sweet potato yield and growth. In my study, we have tried to reveal the effects of different fertilizer groups after 100 days treatment. We used different parameter such as number of tuber per plant, tuber length, and tuber diameter for determining the yield of sweet potato. The effects of different fertilizer on sweet potato yield were determined on the basis of number of tuber per plant, tuber length and tuber diameter and data were presented figure 4 and appendix II & III. Figure 4 illustrated that the T_2 varieties has shown higher tuber number (7.58) per plant than other fertilizer and T_0 showed lower tuber number (6.50) per plant

compare with T_2. Where, the effects of T_1 shown similar tuber number with T_0. On the other hand, in case of tuber length, T_2 treatment has shown higher tuber length (18.38) compare with T_0 and T_1 (see appendix III). Interestingly, like tuber length and tuber number, T_2 treatment in sweet potato in Jamalpur district has shown higher tuber diameter (17.9) than control (T_0) and T_1 treatment group (see appendix III). Recently, one study reported that the organic fertilizer treatments were showed significant effect on the increase of stem length at 4, 8 and 12 weeks after planting which is similar with our reported results. Importantly, study described that tuber diameter, length of roots, and weight of tuberous roots exhibited improvement with increment in the amount of applied farm yard manure while none of these parameters were affected by the application of P_2O_5 fertilizer (Boru *et al*., 2017). (Godfrey *et al*., 1997) reported that used of potash and nitrogen fertilizer showed significant effects on leaf nutrients and their relationships to tuber number and tuber yields of sweet potato which is strongly support my reported results.

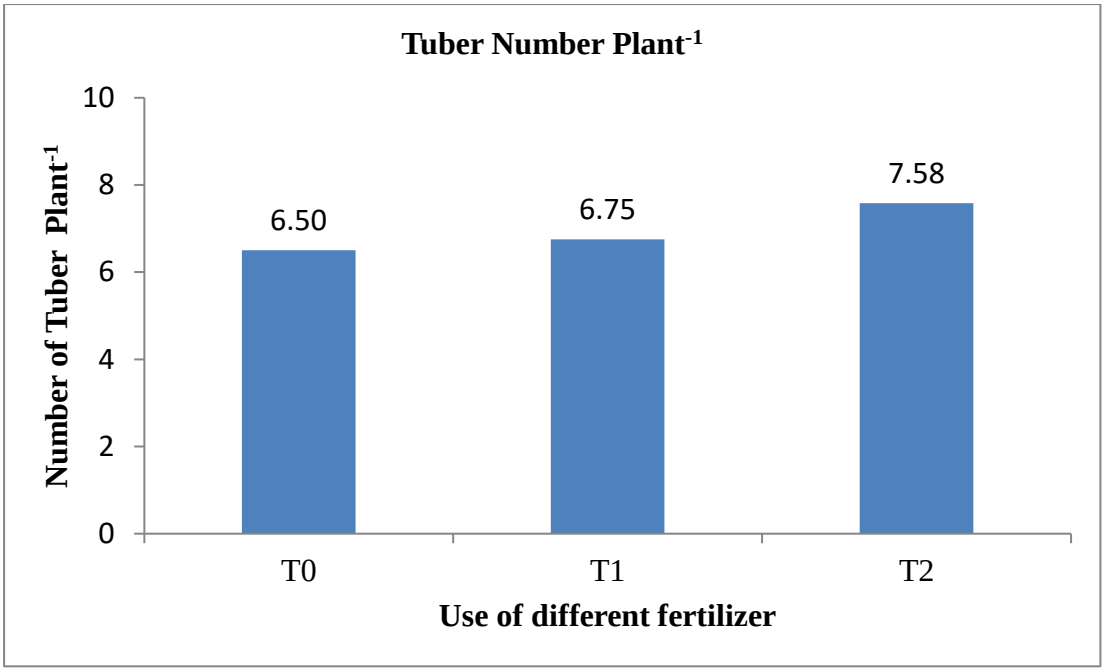

Figure 4. Effects of different fertilizer on tuber number, tuber length and diameter plant^{-1} of sweet potato for different time period. Data were presented as a mean value. Where, T_0: Control (No chemical fertilizer and no compost), T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost).

4.12 Effect of different varieties on Tuber weight / Plant, Yield/ Plot and Total yield ha^{-1}

In current experiment, i used different parameter such tuber weight per plant, yield/plot, and total yield per hectare for determining the yield of sweet potato. The yield of sweet potato may be affected by different variety. In current study, i used four varieties and three fertilizer groups and collected data after 100 days treatment. The data of yield of sweet potato on the basis of tuber weight per plant, yield per plot, and total yield per hectare were presented in table 9. The Table 9 illustrated that the V_4 variety has shown very small difference in tuber weight (0.823) per plant than other varieties and V_1, V_2 and V_3 showed almost similar tuber weight per plant. On the other hand, in case of yield per plot, four varieties have shown very similar (Table 9) yield per plot. Almost all varieties

showed yield per plot is near about 11.11 Kg $plot^{-1}$. Additionally, total yield data from four varieties showed that total yield of all varieties are near about 12.22 tons per hectare. Recently, one study reported that the organic fertilizer treatments were showed significant effect on the increase of stem length at 4, 8 and 12 weeks after planting. The chicken manure gave the highest yield of 28.906 t ha^{-1} (Dumbuya *et al.*, 2016) which is similar with our recorded results. Another study illustrated that The treatment of 300 kg ha^{-1} NPK fertilizer produced the highest root yield of 21.45 and 22.44 t ha^{-1} in 2015 and 2016, followed by 17.13 and 17.17 t ha^{-1} obtained from compost manure in both cropping seasons (Nwanne, 2020). This evidence recommended that use of fertilizer (such as organic and inorganic) has important effects on sweet potato cultivation.

Table 8. Effect of different varieties on Tuber weight / Plant, Yield/ Plot and Total yield ha^{-1}

Yield of Sweet Potato			
Variety	**Tuber weight/pt in kg**	**Yield/plot (in kg)**	**Total Yield ha^{-1} (in Tons)**
V_1	0.79 a	11.14 a	12.37 a
V_2	0.78 a	10.97 a	12.18 a
V_3	0.79 a	11.04 a	12.27 a
V_4	0.82 a	11.56 a	12.84 a

Mean value followed, Where, a = hight value, b= second highest value and c=lower value. V_1: Annou Beni, V_2: Annou Kougane, V_3: Kokei 14 Go, V_4: BARI Misti Alu12.

4.13 Effect of different fertilizer on Tuber weight / Plant, Yield/ plot and Total yield ha^{-1}

In my study, i also tried to reveal the effects of different fertilizer groups after 100 days treatment on sweet potato. i used different parameter such as tuber weight per plant, yield/plot, and total yield per hectare for determining the yield of sweet potato. The effects of different fertilizer on sweet potato yield were determined on the basis of pre-defined parameter and data were presented figure 5 and appendix V & VI. Figure 5 illustrated that the T_2 varieties has shown higher tuber weight (1.03 kg/plant) per plant than other fertilizer and T_0 showed lower tuber weight (0.61 kg/plant) per plant compare with T_2. Where, the effects of T_1 shown higher tuber weight compare with T_0. On the other hand, in case of tuber yield per plot, T_2 treatment has shown higher yield per plot (14.47 kg) than other treatment group (see appendix III). Additionally, T_0 treatment has shown lower yield per plot than T_1 and T_2 treatment.

Interestingly, like tuber weight per plant and yield per plot, T_2 treatment in sweet potato in Jamalpur district has shown higher than control (T_0) and T_1 treatment group (see appendix IV). Recently, one study reported that the organic fertilizer treatments were showed significant effect on the increase of stem length at 4, 8 and 12 weeks after planting. The chicken manure gave the highest yield of 28.906 t ha^{-1} (Dumbuya *et al.*, 2016) which is similar with my recorded results. Another study illustrated that The treatment of 300 kg ha^{-1} NPK fertilizer produced the highest root yield of 21.45 and 22.44 t ha^{-1} in 2015 and 2016, followed by 17.13 and 17.17 t ha^{-1} obtained from compost manure in both cropping seasons (Nwanne & ikhe., 2020). This evidence recommended that use of fertilizer (such as organic and inorganic) has important effects on sweet potato cultivation.

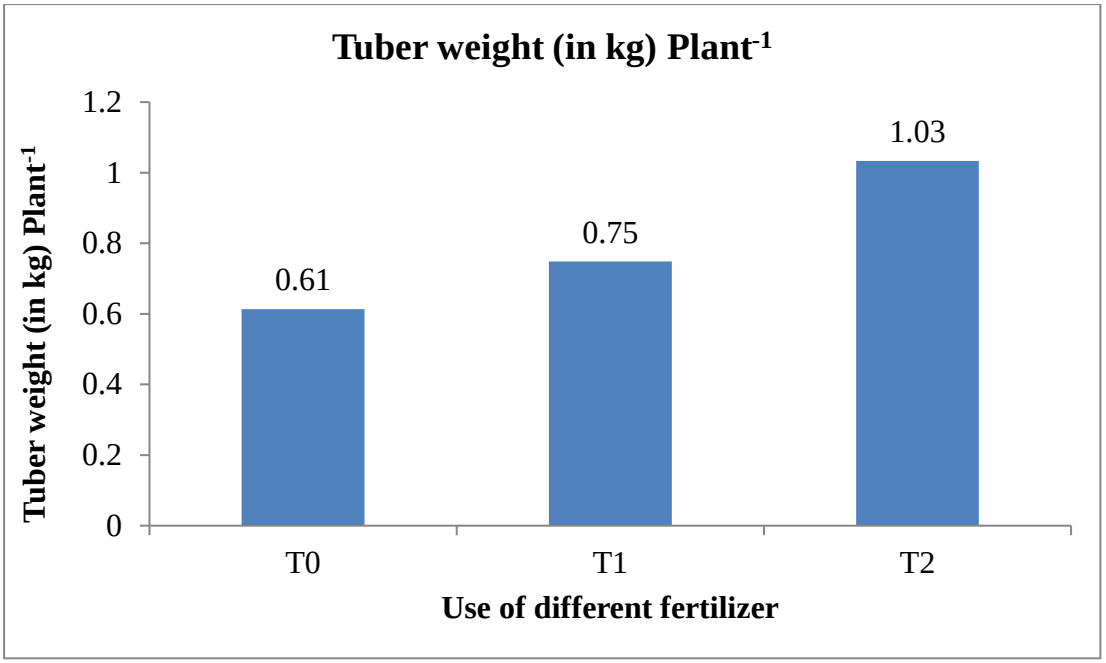

Figure 5. Effects of different fertilizer on Tuber weight Plant^{-1}, Yield plot^{-1} and Total yield ha^{-1} of sweet potato for different time period. Data were presented as a mean value. Where, T_0: Control (No chemical fertilizer and no compost), T_1: BARI fertilizer dose, T_2: Maruhisa dose (Chemical fertilizer + improved compost).

4.14 Interaction effect of variety and different doses of fertilizer on yield of sweet potato

The interaction effects of varieties and different fertilizer on sweet potato yield was determined and data were presented at table 9. Table 9 has illustrated that the different yield parameter for determining sweet potato yield on the basis of combination treatment of different varieties and fertilizer for 100 days. Firstly, In case of tuber length, the highest tuber length (19.43 cm) was observed in V_4T_2 treatment group which was significantly higher than other treatment groups and varieties. In contrast, the lower tuber length (11.67) was recorded from V_3T_0 treatment group. Secondly, the highest tuber diameter was recorded from same treatment group like tuber length (table 9). It has shown that sweet

potato from V_4T_2 group has higher tuber diameter (18.70 cm) and sweet potato from V_3T_0 and V_3T_1 treatment group has shown significantly lower tuber diameter (13.63 and 13.70 cm respectively) than other treatment groups. Thirdly, the table 9 reported that V_4T_2 treatment group has shown the highest production of sweet potato on the basis of yield per plant (1.01 kg plant^{-1}) and total yield per hectare (15.65 t ha^{-1}). On the hand, V_2T_0, V_3T_0 have shown significantly lower yield of sweet potato (0.54 kg plant^{-1} and 8.34 t ha^{-1}) compared with other treatment groups. Recently, one study reported that the organic fertilizer treatments were showed significant effect on the increase of stem length at 4, 8 and 12 weeks after planting. The chicken manure gave the highest yield of 28.906 t ha^{-1} (Dumbuya *et al*., 2016) which is similar with our recorded results. Another study illustrated that The treatment of 300 kg ha^{-1} NPK fertilizer produced the highest root yield of 21.45 and 22.44 t ha^{-1} in 2015 and 2016, followed by 17.13 and 17.17 t ha^{-1} obtained from compost manure in both cropping seasons (Nwanne & ikhe., 2020). This evidence recommended that use of fertilizer (such as organic and inorganic) has important effects on sweet potato cultivation.

Table 9. Interaction effect of variety and different doses of fertilizer on yield of sweet potato at Jamalpur location in 2019-20

Treatments	Tuber length (cm)	Tuber dia (cm)	plant (kg)	Yield (t ha^{-1})
V_1T_0	13.33 ef	15.87 bc	0.67 cd	10.42 cd
V_1T_1	15.90 cde	16.07 bc	0.78 bc	12.13 bc
V_1T_2	16.76 bcd	15.87 bc	0.94 ab	14.56 ab
V_2T_0	14.53 de	15.00 cd	0.54 d	8.34 d
V_2T_1	15.16 de	14.96 cd	0.77 bc	11.98 bc
V_2T_2	18.00 abc	17.66 ab	1.04 a	16.23 a
V_3T_0	11.67 f	13.63 d	0.54 d	8.50 d
V_3T_1	15.17 de	13.70 d	0.67 cd	10.47 cd
V_3T_2	19.33 ab	16.53 bc	1.14 a	17.83 a
V_4T_0	14.67 de	17.00 abc	0.70 cd	10.88 cd
V_4T_1	15.23 de	15.90 bc	0.77 bc	11.97 bc
V_4T_2	19.43 a	18.70 a	1.01 a	15.65 a
LSD Value	2.57	2.13	0.21	3.37
CV(%)	9.64	7.94	16.06	12.41

Mean followed by the same letters are not significantly different ($p<0.05$) according to LSD test

CHAPTER V

CONCLUSION

From the above mentioned experiment the following conclusions can be drawn:

I. Application of different fertilizers on different sweet potato varieties has significant and positive effect on the growth and yield of sweet potato. There were significant differences among potato varieties in their performance and it was found that variety V_4 is the best and high yielding variety in the study area.

II. Interactions of T_2 fertilizer with different varieties were significant and provided the highest yield. The results of the study showed that V_4 variety and T_2 treatment interaction had significant effect on growth and yield parameters. Plant height, leaf number per plant and branch per plant were higher in V_4 variety (Vine length 21.33 cm, leaf number per plant 24.44 and number of branch per plant 5.0 respectively), T_2 fertilizer application, and V_4T_2 treatment.

III. The highest plant height, number of leaf and number of branch per plant were shown in 100 days treatment for V_4T_2 treatment. The result also indicated that V_4T_2 (V_4 variety treated with T_2 fertilizer) produced significantly highest tuber length (19.43 cm), tuber diameter (18.70 cm) and tuber weight (1.01 kg) per plant, and tuber yield of 15.65 t ha^{-1}. The yield analysis result revealed that maximum yield of sweet potato was

obtained from the application of T_2 fertilizer on V_4 variety than other varieties.

IV. On the whole, it gives an impression that using T_2: Maruhisa fertilizer and V_4 (BARI Misti Alu12) will have good influence on growth and tuber yield. Treatment T_2 and variety V_4 (BARI Misti Alu12) can be suggested to the farmers for cultivation at the field level and it can be assumed that it will be economically profitable. Further study is recommended to develop a suitable combination which will be economically profitable for farmers and also sustainable.

CHAPTER VI

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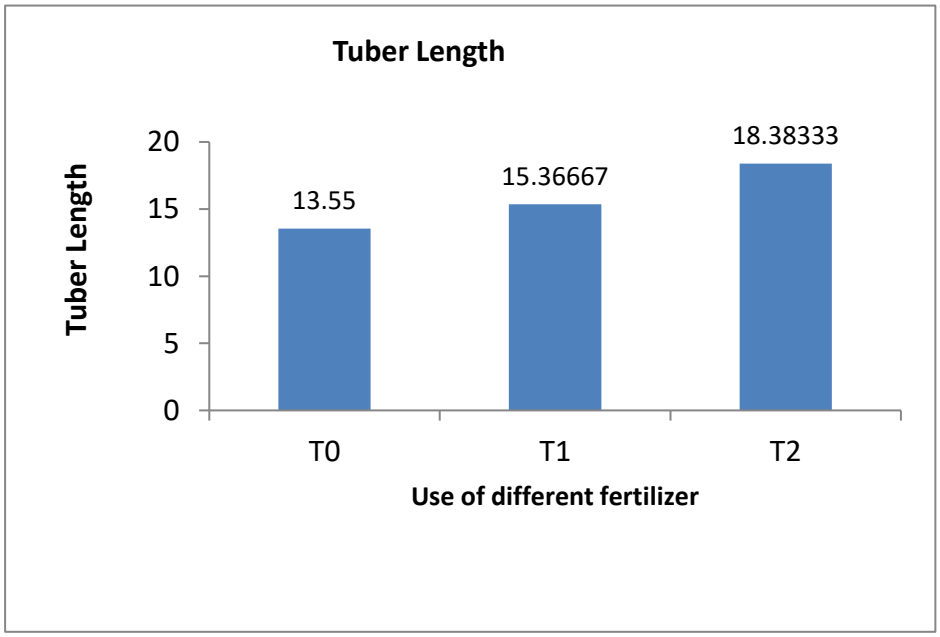
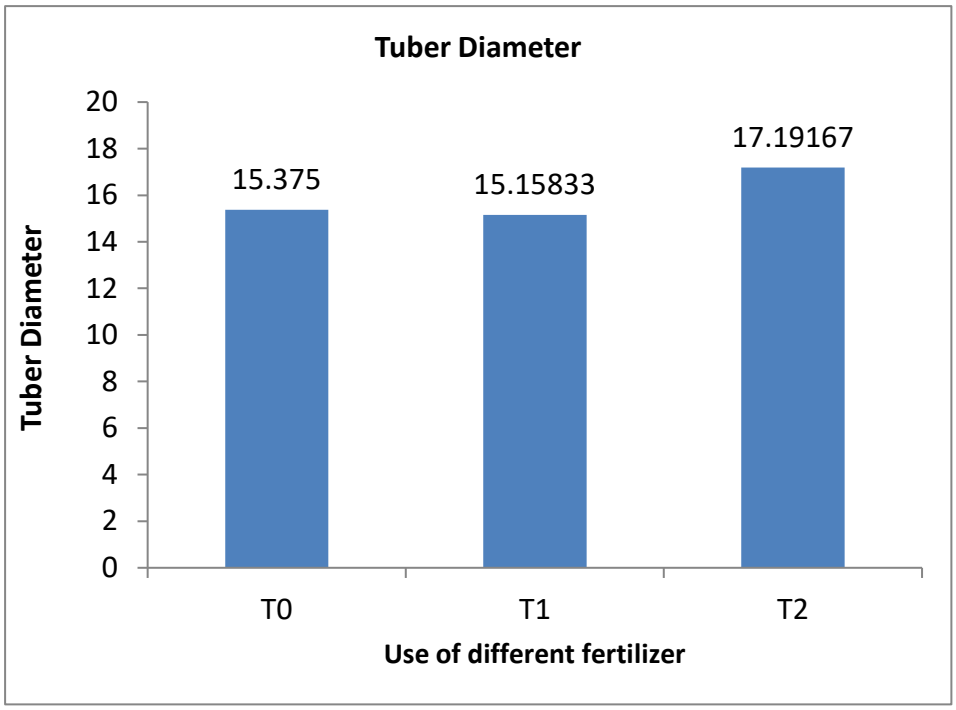
APPENDICES

Appendix I: Map showing the study area (red marked) in Bangladesh

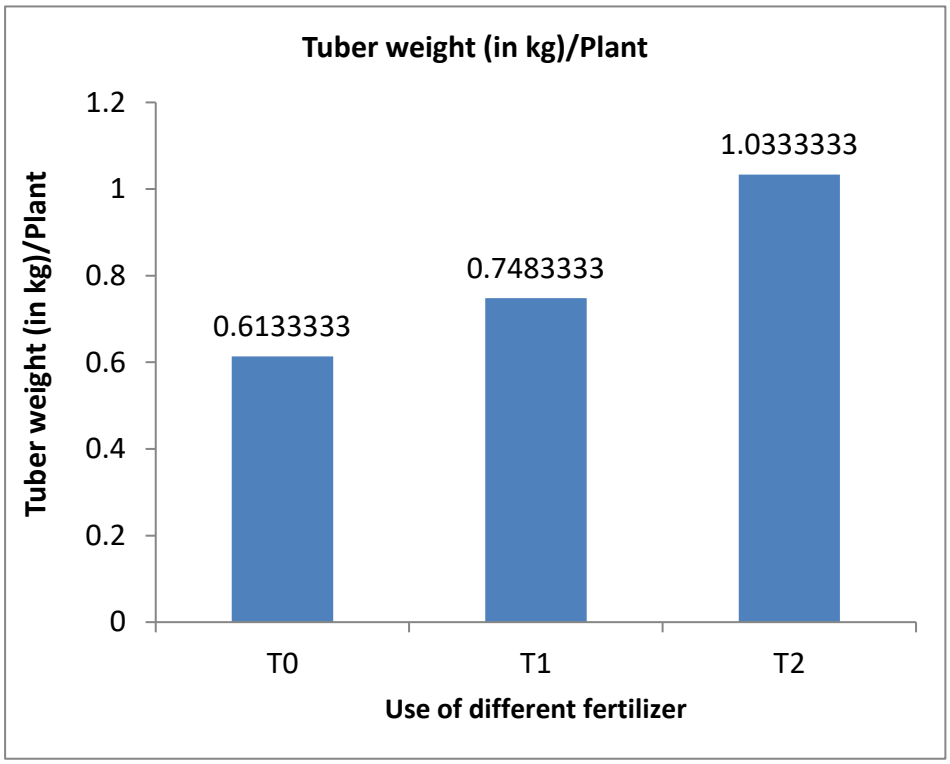
Appendix II: Effects of different fertilizer on Tuber length



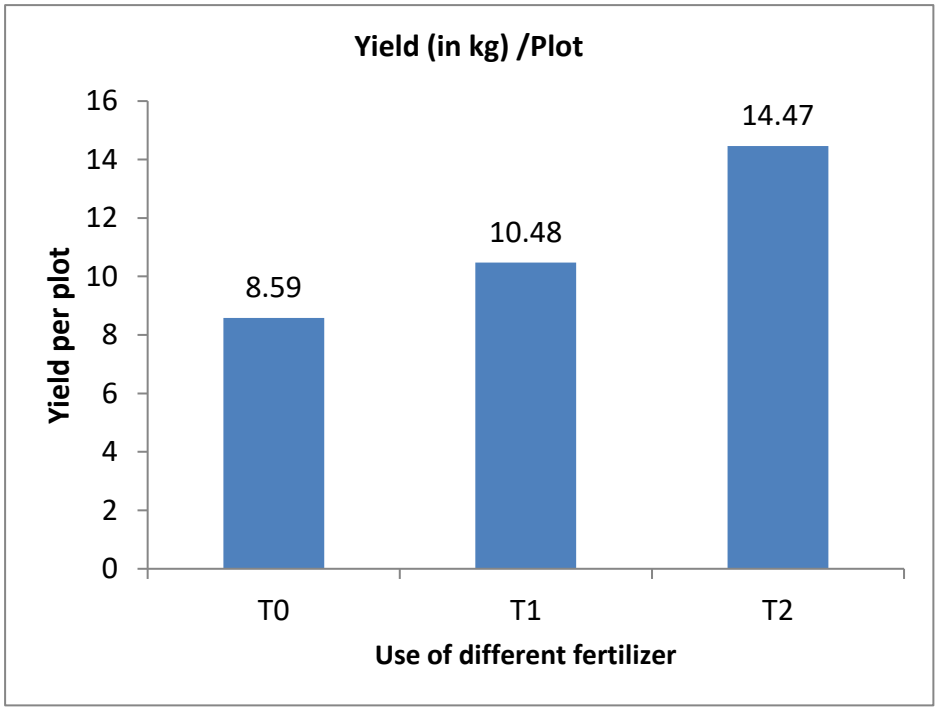
Appendix III: Effects of different fertilizer on tuber diameter



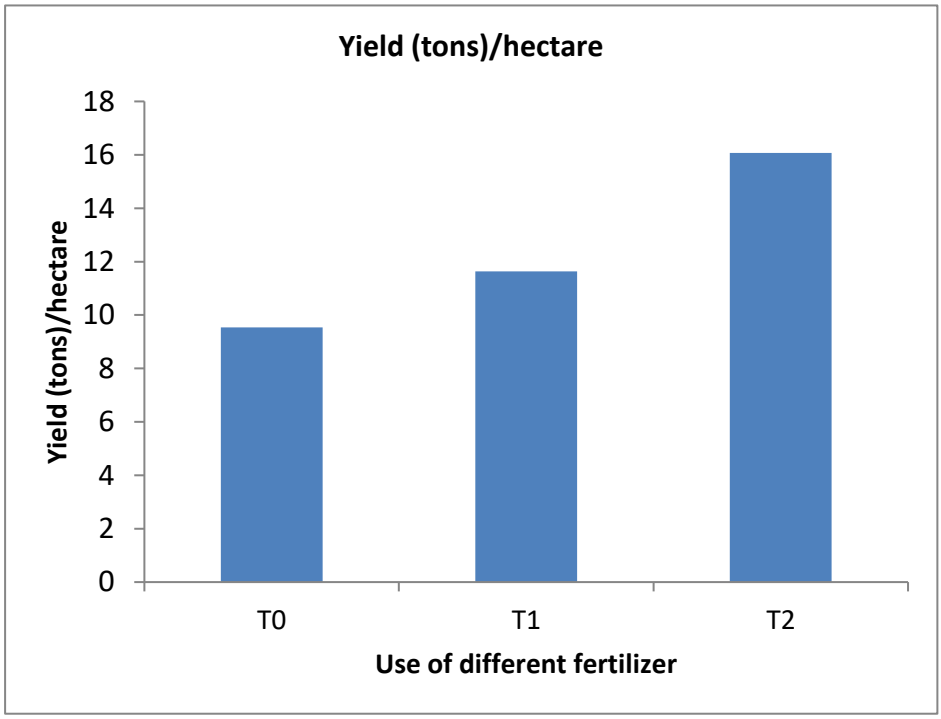
Appendix IV: Effects of different fertilizer on tuber weight in kg per plant



Appendix V: Effects of different fertilizer on tuber weight in kg per plot



Appendix VI: Effects of different fertilizer on yield (tons)/hectare



Appendix VII: A view of the experimental field at early stage

Appendix VIII: A view of the experimental field at later stage