GROWTH AND YIELD RESPONSE OF SWEETPOTATO *(Ipomoea batatas* [L.] Lam*)* TO THE TIMING AND RATES OF NPK APPLICATION

MICHELLE CORNESIO ALAMO

BACHELOR OF SCIENCE IN AGRICULTURE
MAJOR IN AGRONOMY

COLLEGE OF AGRICULTURE AND AGRI-INDUSTRIES
CARAGA STATE UNIVERSITY

DEPARTMENT OF PLANT AND SOIL SCIENCES

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INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam.) is one of the most important root crops cultivated worldwide. Because of its adaptability, high yield potential, and nutritional value, sweet potato has become an important food crop, particularly in developing countries (Yan et al., 2022)

Sweet potato now has a diversified market. It serves as an important staple food for small-holder farmers. This crop is highly recognized for its various uses as food, feed and raw material for industrial food products. It is also adapted to various production systems in a wide range of environmental conditions. It ranks fifth as the most important food crop after rice, wheat, maize and cassava in developing countries (Nyarko et al., 2022)

Farmers face challenges in determining the optimal timing for fertilizer application in sweet potato production. The critical issue revolves around pinpointing the precise growth stages when the plants are most receptive to specific nutrients. Applying fertilizers too early or too late can result in inefficient nutrient utilization, leading to suboptimal root development, reduced yields, and potentially imbalanced nutritional profiles in the harvested sweet potatoes. Consequently, the lack of clear guidance on ideal timing poses a practical challenge for farmers aiming to maximize their crop productivity and quality while maintaining sustainable agricultural practices (Liu et al., 2014)

In the realm of agricultural science, researchers are studying agricultural practices to increase crop productivity and quality. Fertilization treatment timing is crucial for growth and output. Understanding the timing of fertilizers for sweet potatoes can improve agricultural efficiency and food security, as it is a staple in many regions worldwide (Jama & Pizarro, 2008).

The timing of fertilizer application holds a crucial key to unlocking the full yield potential of sweet potatoes while minimizing environmental impacts. In doing so, the research not only contributes to the scientific understanding of sweet potato cultivation but also holds practical implications for farmers, offering evidence-based insights to optimize fertilization practices and ultimately elevate agricultural outcomes.

Adjusting the timing of fertilizer application, based on critical growth stages of sweet potato plants, can significantly influence their overall performance. It is anticipated that precise timing of fertilizer application, aligned with the specific nutrient demands during key developmental phases, could enhance root development, increase yield, and optimize the nutritional content of sweet potatoes. Through a comprehensive analysis of growth metrics, yield outcomes, and nutritional profiles, this research seeks to contribute valuable insights to the realm of agricultural practices, potentially leading to improved sweet potato cultivation techniques and sustainable food production systems.

Objectives of the study

The general objectives of this study is to evaluate the most appropriate timing of fertilizer application and rates of NPK fertilization. Specifically, it aims to:

1. To determine the effects of the rates and timing of NPK application on the growth and yield of sweetpotato NSIC Sp25;
2. To find out the optimum rate and appropriate timing of NPK application on sweetpotato NSIC Sp25; and
3. To assess the economic profitability of sweetpotato NSIC Sp25 to the timing and rates of NPK fertilization.

Scope and Limitation

The thesis explores the impact of fertilizer timing on sweet potato growth, yield, and quality, focusing on specific growth stages and evaluating pre-planting, post-planting, and split applications. However, limitations may arise from environmental conditions, soil types, and regional differences.

Date and Place of the Study

The experiment will be conducted at Caraga State University, Ampayon, Butuan City from September 2023 to January 2024.

REVIEW OF RELATED LITERATURE

Facts About Sweetpotato

Sweet potato (*Ipomoea batatas* [L.] Lam) belongs to the botanical family Convolvulaceae. In many countries, its culture and production are essential, because it contributes to reduce food shortages in times of crisis (natural disasters or wars). It is amongst the world's most important, versatile and under-exploited food crops with more than 90 million tons in annual production, contributed mostly by Asian and African countries, especially China (Alam, 2021). Sweet potato could potentially be used as an alternative to corn-based ethanol production to reduce fertilizer, water, and pesticide inputs and to utilize its ability to fix relatively large amounts of solar energy into starch in storage roots (Ziska et al., 2009).

In the 2017 International Potato Center (IPC) data, the Philippines has made few contributions to overcoming the global market's challenges. The center has reported that the Philippines' sweet potato production has been declining. It used to be 250,000 hectares in 1980, and in 2017 it is less than 80,000 hectares. There is a gap of 170,000 hectares over the three decades. The IPC has suggested that the government’s best way to fill this gap is to link the farmers to the market through science and technology intervention (Mustacisa-Lacaba et al., 2023).

Effects of fertilizer on Sweet Potato Production

Fertilizers are widely used in agriculture to increase crop production. In sweet potato, soil amendment using manure and inorganic fertilizers has a significant impact on plant growth and storage root development. Among chemical fertilizers, nitrogen, phosphorus (P), and potassium (K) are the major elements required for supporting shoot and root growth in sweet potato (Sakamoto & Suzuki, 2020).

As in other crops, correct and timely fertilization are very important to get high yields. Sweet potato productivity is constrained by poor fertility, especially low potassium (K), phosphorus (P), nitrogen (N), sulfur (S), and some micronutrients. Phosphorus requirements are quantitatively lower than K and N doses, but it affects increasing the average weight and the number of roots, and then, crop yields. Due to its slow diffusion and high degree of fixation, phosphorus is generally less available in the soil solution but its uptake and utilization are essential on the final yield of agricultural crops.

On the other hand, the application of chemicals in agriculture is often the cause of soil erosion and environmental deterioration, mainly when used indiscriminately. Fortunately, relationships between plants and some microorganisms improve the assimilation of nutrients and, therefore, that allows to obtain better yields (Santana-Fernández et al., 2021).

Fertilizer Rates and Timing of its Applicaton

According to (Caruana & Cagasan, 2020) timing of nutrient application is guided by some basic considerations which include nutrient availability when crops need it, avoiding waste and enhancing nutrient use efficiency.

Previous research has demonstrated uptake of K positively influences sweet potato yield and root formation, suggesting an increase in K availability results in greater yields and improved root set. This has resulted in a wide range of recommended K fertilizer rates (120–350 kg·ha−1 K2O) for sweet potato production, Previous research has revealed inconsistent responses of sweet potatoes to K fertilization. Some demonstrate no impact of increased K fertilization rate, whereas others report splitting K fertilization application across the growing season positively impacts yield (Harvey et al., 2022).

Sweetpotato response to phosphorus (p) is very low, doses of 25-50 kg P205ha-1 is considered optimum for sweet potato. A moderate dose of 75 to 100 kg K20 is recommended for sweet potato, besides, quality characters like starch and protein content were found to increase with increased K level. Generally, Onwudike, (2010), reported that application of NPK fertilizer at the rates of 100kg per hectare improved plant growth, tuber yield and soil fertility (Mudi et al., 2021).

MATERIALS AND METHODS

The Study Site Characteristics

The study site is located in Caraga State Univerity, Ampayon, Butuan City. The region is composed of various soil types dominated by soil and clay loam. The climate type in Caraga region is Type II, with no pronounced wet and dry season.

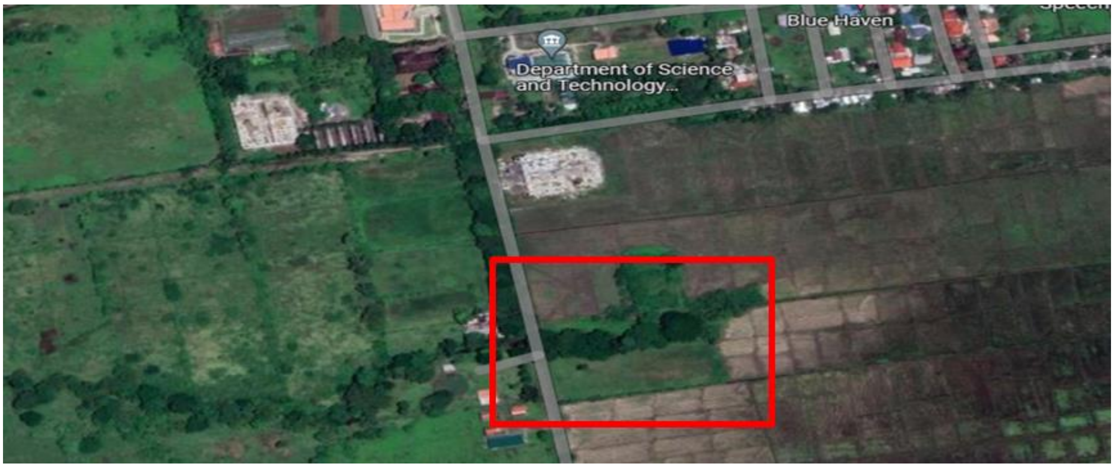


Figure 1. The site where soil samples will be collected, Caraga State University Near Carabao Center

Soil Sampling/Analysis

Initial soil samples will be collected from the experimental area before the conduct of the experiment. The soil samples will be collected at 0-20 cm depth. The soil samples gathered will be set for air-drying; pulverized and sieved. A 3 soil samples will be submitted for soil analysis to the Department of Agriculture Regional Soils Laboratory, Taguibo, Butuan City. The analyses will be soil pH, organic matter, total N, available P, and exchangeable K. A composite soil sample per treatment combinations will be collected after the conduct of the study. The soil pH, organic matter, total N, available P, and exchangeable K will be gathered for the final soil analysis.

Experimental Design and Layout

This study will be conducted in a Randomized Complete Block Design (RCBD). There are five treatments and three replicates. The rates of NPK fertilizers will be based from the recommended rate of 40-40-60kg ha^{-1} of N, P_2O_5 and K_2O. The treatments as follows;

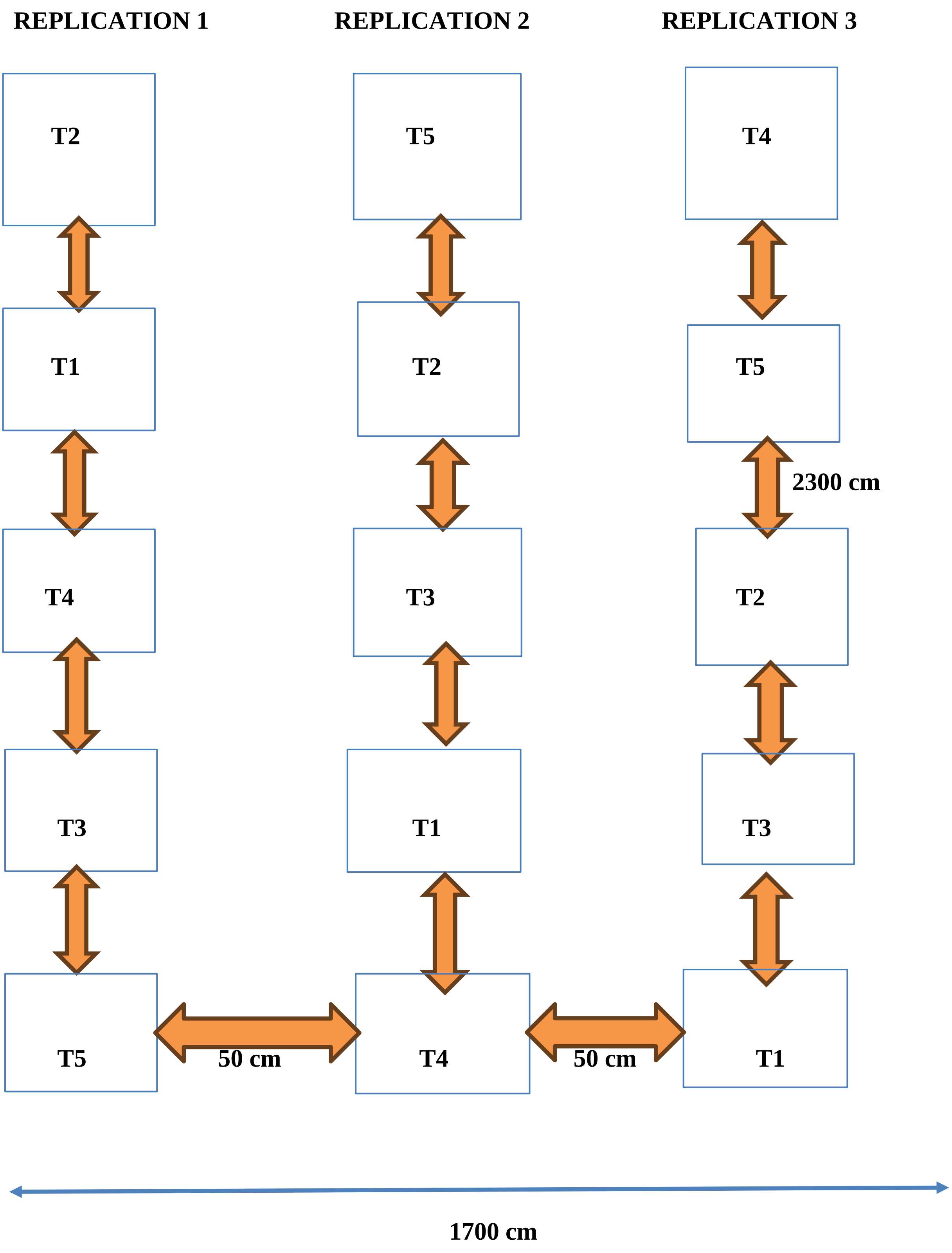
T1 = No fertilizer application (Control)

T2 = Applying full dose of the RR at 2 weeks after planting

T3 = Applying full dose of the RR at 4 weeks after planting

T4 = Applying half dose of the RR at 2 weeks after planting and another half dose at 4 weeks after planting

T5 = Applying half dose of the RR at 4 weeks after planting and another half dose at 6 weeks after planting


REPLICATION 1
REPLICATION 2
REPLICATION 3
T2
T5
T4
T1
T2
T5
2300 cm
T4
T3
T2
T3
T1
T3
T5
50 cm
T4
50 cm
T1
1700 cm

Area size: 2300cm x 1700cm

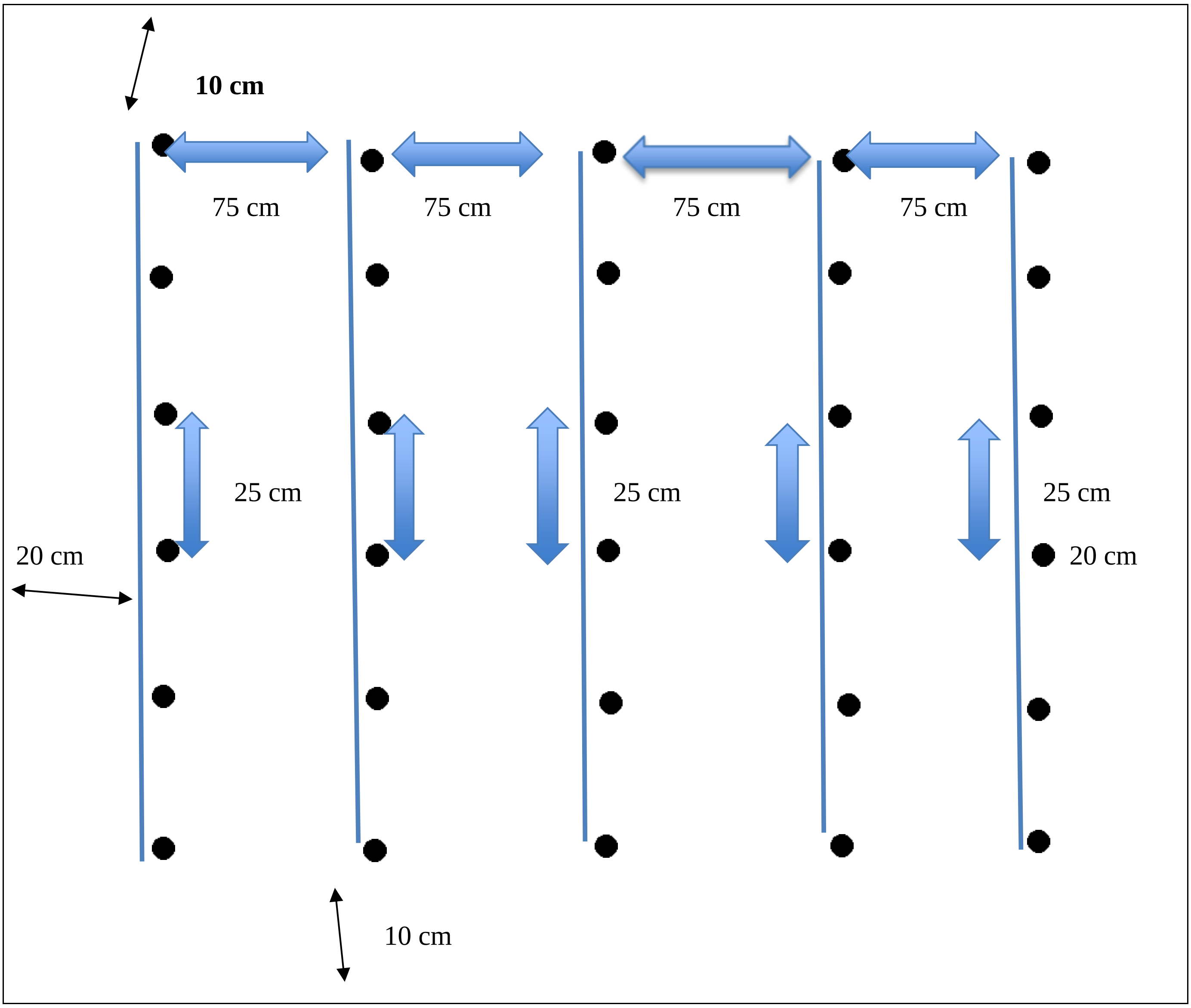
Plot size: 4x5m

Spacing between replication: 50 cm

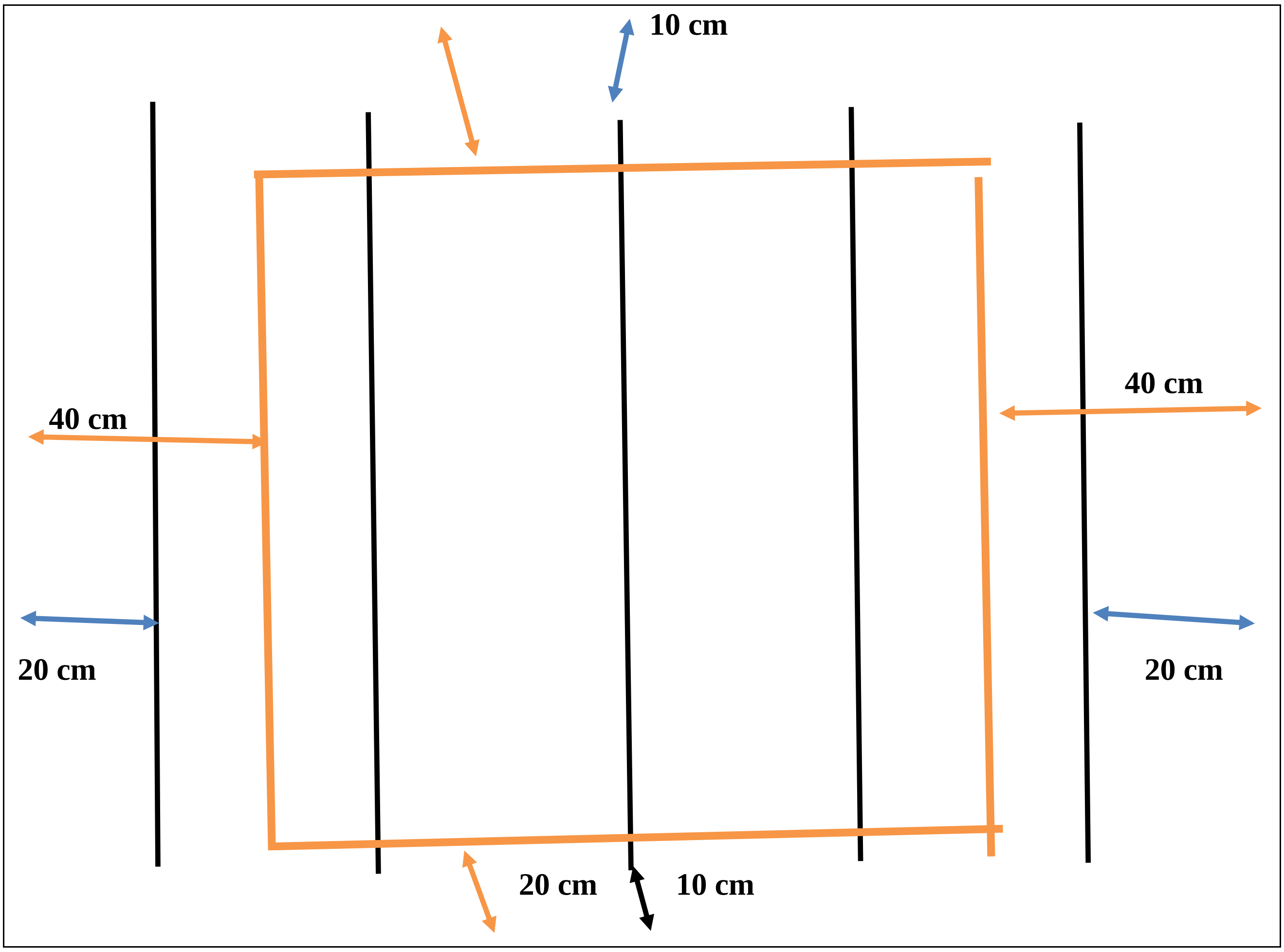
Spacing between plot: 50 cm

Border effect per plot: 40 cm x 20 cm

Plot Layout Design



Harvestable Area



Land Preparation

The experimental area will be cleared from undesirable materials like branches of trees and weeds. The primary plow material has bolo, grab, and the secondary harrowing will use a Hand Rotavator Machine to pulverize the soil. The land is plowed twice at an interval of two (2) weeks and harrowing is done afterward.

Planting Materials Procurement and Preparation

Sweet potato (NSIC Sp25) tip cuttings with lengths of 25–30 cm with 6-8 nodes will be gathered from healthy plants. A total of 1380 cuttings for the whole experiment were procured at Lemon, Butuan City, a day before planting. A day before planting, it will be kept in a damp, shaded area close to the experimental site to avoid dehydration. One cutting of sweet potato will be planted per hill on the ridges at a distance of 75 cm between rows and 25 cm between hills.

Fertilizer Preparation and Application

Yara mila Unik-16 (16-16-16) and Muriate of Potash (0-0-60) are the fertilizer materials to be used in the study. The timing and rates of these two fertilizer materials will be based on the imposed treatments. All fertilizer materials regardless of the treatments will be applied in a band.

Weeding

Two weeks after planting of the crop, removal of the weeds will be done. Hand weeding will be done using a bolo to control the weeds. This is to avoid the competition to the nutrients absorbed by the main crop against unwanted weeds.

Water Management

Watering of the sweet potato plants will occasionally be watered based on the soil moisture. The plants need to be watered daily during their first week.

Pest and Disease Management

The pest and disease management of the sweetpotato will be done depending on the organisms that will attack and cause a disease on a plant.

Harvest Management

Harvesting will be done 3-4 months after planting, and will be using bolo to dig up the fleshy roots within the harvestable area. The roots will be cleaned and classified into marketable and non-marketable ones.

Data to be Collected

A. Growth parameters

1. Length (cm) of the main vine- this will be obtained by measuring the main vine of the plant from the base to the tip of the vine per treatment plot. This will be done by carefully locating the specific vine of the particular sample where the lateral vines were connected. This will be collected during harvesting.

2. Number of primary lateral vines per plant- this will be recorded by counting the number of primary lateral vines from (3) sample plants in each treatment plot. This will be collected during harvesting.

3. Fresh herbage yield- this will be determined by weighing the vines of all the harvested plants from the three inner rows in each treatment plot, excluding the border row in each side of the plot and 1 end plant in each row. This will be converted into tons per hectare using the formula:

$$\text{Herbage yield (t ha}^{-1}) = \frac{Fresh\ herbage\ yield\ (kg\ ha-1)}{Harvestable\ area\ (10.5\ m2)} \times \frac{10{,}000\ m2\ ha-1}{1{,}000\ kg\ ton}$$

B. Morphological Parameters

1. **Leaf area index (LAI)-** this will be obtained by measuring the length and width of all functional leaves within the 50 cm ×50 cm quadrant at 60 days after planting. The total leaf area within the quadrat will be divided by the effective ground area (cm2) within the quadrat to get the leaf area index (LAI)

$$\text{TLA} = \text{Sum } (L \times W)\ \text{CF } (0.497)$$

$$\text{LAI} = \frac{Total\ Leaf\ Area\ (TLA)}{Area\ of\ the\ quadrat\ (2{,}500\ cm2}$$

Correction factor=0.497 (Cajefe, 2003)

2. Harvest Index (HI). HI will be determined by taking the ratio of the economic yield (weight of roots) to the biological yield (weight of roots +herbage yield) on a fresh weight basis. All the sample plants per treatment per replication within theharvestable area were harvested to measure HI value and was calculated using the formula below:

$$\text{HI} = \frac{\text{Economic Yield (total root yield)}}{\text{Biological Yield (root yield + herbage yield)}}$$

C. Yield and Yield Components

1**. Number of marketable and non-marketable roots per hill-** this will be obtained by sorting the marketable and non-marketable roots of sample hills within the harvestable area per plot. Marketable storage roots were those that have 2.5 cm diameter and 6.5 cm long and were healthy and free from pests and diseases. Those that did not meet the criteria will be considered as non-marketable roots.

2. Weight (g) of marketable and non-marketable roots per hill- this will be obtained by weighing separately the marketable and non-marketable fleshy roots from sample hills within the harvestable area per treatment plot.

3. Number of marketable and non-marketable roots per plot- this will be obtained by sorting the marketable and non-marketable roots from the inner rows within the harvestable area per treatment plot.

4. Weight of marketable and non-marketable roots per plot- This will be obtained by weighing separately the marketable and non-marketable fleshy roots harvested per treatment plot.

Root yield (t ha−1) $= \frac{Root\ yield\ (kg\ plot{-}1)}{Harvestable\ area\ (10.5\ m2)}\ x = \frac{10{,}000\ m2\ ha{-}1}{1{,}000\ kg\ ton{-}1}$

D. Economic Analysis

Gross margin will be computed by subtracting the total variable cost from the gross income using the formula: Gross Margin = Gross Income – Total Variable Cost

E. Agrometeorological Data

Data on total monthly rainfall (mm), average daily minimum and maximum temperatures (˚C) and relative humidity (%) from the time of planting up to the time of harvesting will be taken from the records of the Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA), Butuan Weather Station.

Statistical Analysis

The data will be computed and the analysis of variance (ANOVA) was analyzed using Statistical Tool for Agricultural Research (STAR) software.

Comparison of means was done using Fisher’s Least Significant Difference (LSD) Test. This statistical analysis' findings contributed to a better understanding of the agronomic performance and overall characteristics, paving the way for informed decision-making in conservation efforts, and sustainable agricultural practices.

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APPENDICES

(Please show here your fertilizer computations)

For Full dose:

Recommended rate: **40-40-60 kg/ha**

$$\text{Amount of complete} = \left(\frac{\text{Recommended Rate}}{\text{Fertilizer Grade}} \times 100 \right)$$

$$= \frac{40\ kg/ha^{-1}}{16} \times 100$$

$$\mathbf{= 250\ kg/ha^{-1}}$$

$$250\ kg/ha^{-1} = \frac{x}{20m^2}$$

$$x = \frac{250\ kg/ha^{-1}}{10000\ m^2} \times (20\ m^2)$$

$$=0.5\ kg/ha^{-1} \text{ or } \mathbf{500g\ plot^{-1}}$$

$$\text{Amount of MOP} = \left(\frac{\text{Recommended Rate}}{\text{Fertilizer Rate}} \times 100 \right)$$

$$= \frac{20\ kg/ha^{-1}}{60} \times 100$$

$$\mathbf{= 33.3\ kg/ha^{-1}}$$

$$33.3\ kg/ha^{-1} = \frac{x}{20m^2}$$

$$x = \frac{33.3\ kg/ha^{-1}}{10{,}000m^2} \times (20\ m^2)$$

$$=0.0666\ kg/ha^{1} \mathbf{\text{ or } 66.6g\ plot^{-1}}$$

For half dose:

Recommended rate: 40-40-60 kg/ha

$$\text{Amount of complete} = \left(\frac{\text{Recommended Rate}}{\text{Fertilizer Grade}} \times 100\right)$$

$$= \frac{40\ kg/ha^{-1}}{16} \times 100$$

$$= 250\ kg/ha^{-1}/2$$

$$\mathbf{= 125\ kg/ha^{-1}}$$

$$125\ kg/ha\text{-}1 = \frac{x}{20m^2}$$

$$x = \frac{125\ kg/ha^{-1}}{10000\ m^2} \times (20\ m2)$$

$=0.25\ kg/ha^{-1}$ or **250g plot^{-1}**

$$\text{Amount of MOP} = \frac{\text{Recommended Rate}}{\text{Fertilizer Rate}} \times 100$$

$$= \frac{20\ kg/ha^{-1}}{60} \times 100$$

$$= 33.3\ kg/ha^{-1}/2$$

$$\mathbf{=16.65\ kg/ha^{-1}}$$

$$16.65\ kg/ha^{-1} = \frac{x}{20m^2}$$

$$x = \frac{16.65\ kg/ha^{-1}}{10{,}000m^2} \times (20\ m^2)$$

$=0.0333\ kg/ha^{-2}$ or **33.3g plot^{-1}**

To compute how many rows and hills per plot:

Number of Row = (length of plot -2 border length)/Row Spacing

Number of Column = (width of plot – 2 border width)/Column spacing

Length of plot- = 4m

Width of plot = 5m

Row spacing = 75cm (0.75m)

Border length = 10cm

Border width = 20 cm

Solution

NR = 4m-(2x0.1m)/0.75m	NC = 5m – (2x0.2) / 0.25m
= (4m-0.2m)/0.75m	= (5m-0.4m) / 0.25 m
= 3.8/ 0.75m	= 4.6 / 0.25
= 5.0 row	=**18.4 hill**

= 18.4 x 5 = 92 cutting of sweet potato per plot

To compute how many cuttings will be use in the whole experiment:

=No. of cuttings per plot x no. of treatment

=92x15

=1380 cuttings in the whole experiment