BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE DEPARTMENT OF CROP SCIENCE

The effects of spacing and nitrogen levels on propagation of sweet potatoes.

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF AGRICULTURAL SCIENCE HONOURS DEGREE

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ABSTRACT

Sweet potato *(Ipomoea batatas)* is a vital food and income bringing crop in Zimbabwe and other developing countries due to its valued nutritional composition and adaptability. Despite its importance, production is often constrained by a shortage of vines at the beginning of the planting season. This research focused on evaluating the effects of different plant spacing and nitrogen levels on sweet potato vine propagation, with the objective of identifying optimal combinations for maximizing vine production. A field experiment was conducted using a 3 × 3 factorial arrangement of treatments comprising three plant spacing close (25 cm), moderate (35 cm), and wide (45 cm) and three nitrogen levels low (40 kg/ha), medium (60 kg/ha), and high (80 kg/ha). The parameters assessed included average vine length, cumulative number of plantable vines, multiplication factor, and turnover days. The results revealed that moderate plant spacing (35 cm) combined with medium nitrogen application (60 kg/ha) produced the best overall performance ($p<0.05$). Moderate spacing (35 cm) with medium nitrogen (60 kg/ha) gave the best results: longest vines (102.4 cm), most plantable vines (55), highest multiplication factor (4.6), and shortest turnover period (38 days). Wide spacing with high nitrogen caused excessive growth and poor vine quality, while close spacing led to overcrowding and reduced efficiency. The study concludes that moderate plant spacing and medium nitrogen levels significantly improve sweet potato vine propagation efficiency. These findings provide a practical, low input strategy for farmers to enhance vine availability, improve planting cycles, and increase productivity. The outcomes also support more efficient use of land and fertilizers, contributing to sustainable and climate resilient sweet potato production systems in Zimbabwe.

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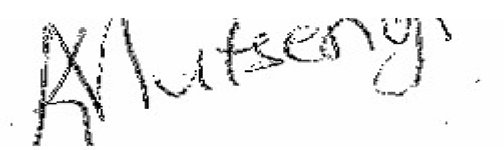

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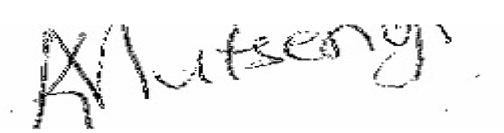

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DECLARATION

I Webster Mabika declare that the dissertation titled The effects of spacing and nitrogen levels on propagation of sweet potatoes is my own work and all sources used have been duly acknowledged. It has not been submitted for academic purposes at any other institution for.

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DEDICATION

I wholeheartedly dedicate this project to my mother the strongest woman I know. Your unwavering support, sacrifices, and unconditional love have kept me going even when the journey got tough. You are my biggest inspiration, and everything I do, I do with the hope of making you proud. This achievement is as much yours as it is mine.

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CONTENTS

CHAPTER 1: INTRODUCTION

1.1Background of the study.

Sweet potato (Ipomoea batatas) is a vital crop known for its versatility and nutritional benefits, contributing significantly to food security and income generation in many regions in the world. The crop is a rich source of carbohydrates 20.1g, vitamins2.4g, minerals337mg, and dietary fiber3.0g, making it an essential component of diets, especially in developing countries. Moreover, sweet potatoes play a pivotal role in combating malnutrition due to their high beta-carotene content, which is converted to vitamin A, which important for vision, immunity, and overall well-being (Low et al., 2017). With the growing global population and increasing demand for nutritious food, the demand for sweet potatoes has surged, making their efficient production critical. Zimbabwe consumes 64 000 tonnes per annum whereas global consumption stands at 88 million tonnes. (FAO 2023)

Despite their significance, sweet potato production has faced several challenges, notably a decline attributed to vine shortages especially at the beginning of the growing season. Sweet potato vines serve as the primary planting material, and their unavailability during planting seasons has led to reduced yields. Early plant the season begins must result in better yields yet it is unfortunate the vine multiplication normally starts as the season begins and the planting will usually start around January and February which may be late. This issue is exacerbated by the fact that many farmers do not procure vines in time, further impacting overall production levels. According to FAO (2021), smallholder farmers, who form the majority of sweet potato growers, often lack access to efficient propagation methods, resulting in limited vine availability.

In many parts of Africa and Asia, sweet potato cultivation is a family enterprise, contributing to household food security and income. The increasing demand for sweet potatoes, driven by both domestic consumption and export markets, has highlighted the need for innovative approaches to improve production efficiency (Ndolo et al., 2019). However, inadequate access to planting materials remains a bottleneck.

The shortage of sweet potato vines is a critical issue, particularly during peak planting seasons. This problem has not only reduced the acreage under sweet potato cultivation but also limited the number of farmers engaging in its production. Consequently, there is a need to prioritize vine multiplication as a business opportunity for farmers. By adopting vine multiplication as an enterprise, farmers can ensure a consistent supply of planting materials while creating an additional income stream. This is important for those farmers who have reliable water supply especially those with boreholes, dams, perennial dams or wells that can make it across the dry season. Studies have shown that well-coordinated vine multiplication programs can significantly increase sweet potato productivity and profitability (Gibson et al., 2018).

Combining optimal nitrogen levels with appropriate plant spacing has the potential to accelerate vine multiplication and enhance tuber yields. Nitrogen plays a crucial role in vegetative growth, and its proper management can lead to increased vine production. On the other hand, spacing influences resource utilization, such as light, nutrients, and water, directly affecting plant growth and development. Integrating these factors into a cohesive strategy can provide rapid and sustainable solutions to sweet potato propagation challenges.

In summary, addressing the shortage of sweet potato vines through innovative agronomic practices is imperative. This research aims to explore the synergistic of nitrogen levels and plant spacing on sweet potato propagation, providing actionable insights for farmers and stakeholders. By optimizing these factors, it is possible to meet the rising global demand for sweet potatoes, enhance farmers' livelihoods, and contribute to food security.

1.2Main objective

To identify the optimal plant spacing and nitrogen level combination for maximizing rapid sweet potato vine growth.

1.3Specific objectives

Objectives:

1. To investigate the effects of plant spacing and Nitrogen levels on sweet potato vine growth.

2. To determine the effect of plant spacing and nitrogen level on the cumulative number of plantable vines.

3. To determine the effect of plant spacing and fertilizer level on the multiplication factor of sweet potato vines.

4. To determine the effect of plant spacing and fertilizer level on the turnover days of vine harvesting.

1.4 Hypotheses

1. Plant spacing and nitrogen levels have an effect on the growth of sweet potato vines
2. Plant spacing and nitrogen levels have an effect on level on the cumulative number of plantable vines.
3. Plant spacing and nitrogen levels have an effect on the multiplication factor of sweet potato vines.
4. Plant spacing and nitrogen levels have an effect on the turnover days of vine harvesting.

1.5 Problem Statement

. Despite its significance, vine propagation practices remain largely traditional, with limited optimization of agronomic factors such as plant spacing and nitrogen fertilization. These factors are crucial in determining vine growth performance, the number of plantable vines, multiplication rate, and the time it takes for vines to become ready for harvesting.

Currently, there is a research gap in understanding how varying plant spacing and nitrogen levels interact to affect the efficiency of sweet potato vine multiplication. Most available studies focus on root yield and tuber quality, with insufficient emphasis on vine propagation as a critical step in sweet potato production cycles, especially for farmers and institutions that depend on rapid and large-scale vine multiplication for distribution and planting. This gap limits the ability of farmers and extension agents to develop evidence-based management practices tailored for maximum vine productivity. Addressing this gap could revolutionize sweet potato farming by providing rapid and efficient propagation methods.

1.6 Justification

The justification for this study lies in the critical role that vine propagation plays in the sweet potato production cycle, particularly in regions where vegetative propagation is the sole method of crop establishment. Sweet potato is an important food crop in Zimbabwe and numerous other African countries due to its adaptability to diverse environmental conditions, short maturity period, and high nutritional value especially its vitamin A rich orange-fleshed varieties. However, the success of sweet potato farming depends heavily on the availability of sufficient, healthy planting material in the form of vines. Despite this, limited scientific attention has been given to optimizing the agronomic factors that influence vine multiplication, such as plant spacing and nitrogen fertilization. Most existing research focuses primarily on root yield and quality, leaving a significant knowledge gap regarding the best practices for maximizing vine production.

This study is important because it addresses this gap by investigating how different levels of nitrogen and plant spacing affect vine growth parameters such as length, the cumulative number of plantable vines, multiplication factor, and turnover days. These parameters are essential for achieving high propagation efficiency, which in turn ensures that farmers can meet seasonal planting demands and expand sweet potato production in a timely manner. By identifying the most effective combination of spacing and nitrogen levels, the study will enable more efficient land and resource use, reduce production costs, and potentially shorten propagation cycles benefits that are particularly relevant in low-input, smallholder farming systems.

Moreover, the research supports environmentally sustainable agriculture by promoting the judicious use of nitrogen, which, if over applied, can lead to soil degradation, groundwater contamination, and increased production costs. It also contributes to climate resilient agriculture, as enhanced vine production supports faster replanting after weather induced crop losses. In addition, the study's findings will provide a scientific basis for extension services and agricultural policy makers to develop and disseminate improved vine production guidelines. This can lead to broader adoption of efficient propagation methods, boosting productivity and food security. Ultimately, the study not only seeks to advance scientific understanding but also to deliver practical, field-level solutions that improve the livelihoods of farmers and contribute to sustainable food systems.

CHAPTER 2: Literature review

2.1 Overview of Sweet Potatoes.

Sweet potato (Ipomoea batatas) is a globally recognized as a crop that is crucial in food security, nutrition, and generation of income, particularly in developing countries. Globally, sweet potato production has grown significantly because it adapts to various agro-ecological conditions, its ability to withstand drought, and its rich nutritional profile. Sweet potato is widely adaptable in areas of temperatures ranging between 20 to 30^{0}C, rainfall around 750 to 1500mm. It does well in short and long days and 2000m above sea level. It does well in pH ranging from 5.5 to 6.5. The Food and Agriculture Organization statistics (FAOSTATS), China is the largest producer, taking for over 60% of the world's sweet potato production, followed by India, Nigeria, and Indonesia (FAO, 2020). These countries have the ideal environmental conditions, including tropical climates and fertile soils, for the cultivation of sweet potato.

Country	CONTINENT	TONNES PRODUCED M/T
CHINA	Asia	51 000 000
MALAWI	Africa	5 500 000
NIGERIA	Africa	4 000 000
TANZANIA	Africa	3 700 000
INDONESIA	Asia	2 300 000
UGANDA	Africa	2 000 000
VIETNAM	Asia	1 500 000
INDIA	Asia	1 200 000
UNITED STATES	North America	1 100 000

ETHIOPIA	Africa	900 000
ZIMBABWE	Africa	700 000 – 800 000

Adapted from FAOSTATISTCS 2023

In contrast, many countries in Sub-Saharan Africa, while showing growing interest, remain among the least producers due to factors such as poor access to quality seed, lack of proper agronomic practices, and limited irrigation facilities (Zhang et al., 2019).

In Zimbabwe, sweet potato production has been expanding in recent years, although it still falls short of the levels achieved by top producers like China 51million tonnes and India 1.18million tonnes. Despite the favorable agro-ecological conditions in parts of Zimbabwe, especially in the highlands, the crop's production remains constrained by inadequate infrastructure, suboptimal agronomic practices, and limited availability of quality planting material. Zimbabwe's production is concentrated in regions such as Mashonaland and Manicaland, where farmers increasingly rely on sweet potato as a food crop and an income generating enterprise. The crop is grown secondarily after the main crops have been grown, it's relegated to the status "women's crop" The country's research stations, including Kutsaga and Marondera, have been pivotal in developing locally adapted varieties that offer improved disease resistance and higher yields, such as the Kutsaga Red and Yellow varieties. However, challenges such as the lack of certified seeds, inadequate irrigation, and suboptimal soil management continue to hinder the full potential of sweet potato cultivation.

Worldwide, sweet potato varieties are diverse, with different cultivars suited to various climatic and soil conditions. Some popular varieties, including Beauregard, Covington, and Jewel, have gained favor for their high yields, resistance to pests, and versatility. These varieties are known for their improved resistance to pests and diseases, making them more suitable for local farmers' needs (Chikodzi et al., 2020).

2.2 Climate and Environmental Requirements

Sweet potatoes thrive in warm temperatures, with an optimal range of 25–30°C during the growing season. They require well-drained, sandy loamy soils with favorable organic matter content and a pH level between 5.5 and 6.5. These conditions make sweet potato an ideal crop for many parts of Zimbabwe, particularly in regions such as Mashonaland and Manicaland, where the climate and soil conditions are favorable (Woolfe, 1992). However, sweet potato is also relatively tolerant of drought and can grow in less-than-ideal conditions, although yield potential is reduced in such cases. In Zimbabwe, climate variability poses a significant challenge to sweet potato production, with irregular rainfall patterns and prolonged dry spells affecting crop performance. Farmers are encouraged to adopt water conservation practices, such as harvesting rainwater and drip irrigation, to alleviate the consequences of climate variability and ensure consistent water availability during the growing season (Chikodzi et al., 2020).

2.3 Plant Spacing and Sweet Potato Vine Growth

Plant spacing plays a crucial role in the successful propagation of sweet potato vines. As a crop with vigorous vine growth and sprawling habits, sweet potato requires adequate spacing to ensure each plant accesses sufficient sunlight, moisture, and nutrients for optimal vine development. Proper spacing not only improves vine length and health but also enhances the overall multiplication rate of plantable vines, which is essential for establishing future crops.

According to FAO (2019), narrow plant spacing leads to high plant density, which can increase competition for critical growth resources such as light, nutrients, and water. This competition may limit vine elongation and the number of quality cuttings available for propagation. Conversely, overly wide spacing reduces competition and allows vines to grow more freely, but it may limit the total number of vines produced per unit area, thereby reducing propagation efficiency (Woofe2019). In sweet potato propagation, in-row spacing the distance between individual vine cuttings in the same row is particularly important as it directly affects vine length, shoot development, and the number of plantable cuttings per plot.

An in-row Spacing of 20–25 cm is considered close spacing (Khan 2006). At this spacing, cuttings are planted close together to maximize vine multiplication within a limited area. It is commonly used in nurseries or when vine cuttings are in high demand. While this approach may produce a higher number of vines per square meter, it can lead to intense competition for nutrients, water, and light, which may reduce the quality and vigor of individual vines. This spacing is suitable when the priority is mass production of planting material rather than maximizing individual vine growth.

An in row Spacing of 30–40 cm is considered moderate spacing (Woolfe1992). This is considered optimal for balancing vine quality and quantity. The slightly wider spacing allows for better air circulation, reduced disease pressure, and more access to light and nutrients, promoting healthier and longer vines. It supports both good vine multiplication and strong plant development, making it ideal for propagation in field conditions where healthy, vigorous vines are required for further planting.

An in-row Spacing between 45-60cm is considered wide spacing (FAO2010). With more space between cuttings, vines grow with minimal competition, resulting in robust and lengthy growth. However, the reduced number of plants per unit area may limit the total vine yield, making this spacing less efficient for mass propagation. This method is better suited for situations where high-quality vines are preferred over large quantities.

FAO (2010) recommends an in-row spacing of 30 cm and an inter-row spacing of 100 cm, which results in approximately 33,333 plants per hectare. This configuration allows for efficient vine multiplication while ensuring that each plant has sufficient space for optimal vegetative development.

The choice of spacing should be guided by several factors, including the intended use of the vines (e.g., direct planting, resale, or nursery propagation), the variety of sweet potato, available land, and resource availability such as water and soil fertility. For propagation-focused systems, especially in Zimbabwe, studies from Marondera and Kutsaga Research Stations have shown that plant spacing of 25–30 cm in row offers a favorable balance between plant density and vine quality (Zhang et al., 2019). This spacing maximizes vine output without causing excessive competition, thereby ensuring strong, healthy cuttings for future cultivation.

Moreover, well-planned spacing reduces the incidence of pests and diseases, which are more prevalent under dense plantings due to poor air circulation and high humidity. Therefore, optimizing plant spacing is essential not only for enhancing vine propagation but also for promoting sustainable and efficient sweet potato cultivation systems in Zimbabwe and other developing regions.

2.4 Nitrogen Levels in Sweet Potato Growth

Nitrogen is one of the major plant nutrients for sweet potato growth, playing a critical role in promoting vegetative growth and tuber development. As a nitrogen-demanding crop, sweet potato requires a sufficient supply of this nutrient to produce robust vines and healthy tubers. Nitrogen facilitates the synthesis of proteins and enzymes, which are essential for growth, photosynthesis, and overall plant health. Insufficient nitrogen levels can result in slow growth, poor vine development, and reduces tuber yields, while too much nitrogen can result in overly lush vegetative growth instead of tuber formation (Zhang et al., 2019).

In Zimbabwe, farmers often face challenges with managing nitrogen due to limited access to chemical fertilizers and the high production costs. This has resulted in the exploration of organic sources of nitrogen, such as manure, compost, and green manures, which can help reduce dependency on synthetic fertilizers and improve soil fertility (Chikodzi et al., 2020). Research has shown that nitrogen application rates between 40–60 kg per hectare are optimal for maximizing sweet potato yield, depending on soil type and environmental conditions (FAO, 2020). In areas with fertile soils, lower nitrogen inputs may be sufficient, while in nutrient-depleted soils, higher rates may be necessary to achieve desired growth and yield.

The three nitrogen levels typically used in sweet potato propagation to optimize growth and multiplication include, Low Nitrogen Level: This is often applied in soils with naturally high fertility or when organic fertilizers (such as compost or manure) are used. A low nitrogen level helps maintain a balanced growth environment without promoting excessive vegetative growth. This level generally ranges between 30 to 40 kg of nitrogen per hectare.

Moderate Nitrogen Level, This is the most commonly recommended range for sweet potato propagation, especially in areas with moderate soil fertility. It encourages good vine growth and tuber formation without causing excessive vegetative growth. This level typically ranges between 50 to 60 kg of nitrogen per hectare.

High Nitrogen Level: A higher nitrogen level is used in soils with poor fertility or when farmers want to boost vine multiplication. High nitrogen levels (70 kg per hectare or more) promote rapid vegetative growth, which is beneficial for vine multiplication, but it needs to be managed carefully to avoid suppressing tuber development and reducing overall yield. These nitrogen levels are adapted depending on specific soil conditions, variety requirements, and other agronomic factors like irrigation and climate. Proper management ensures that nitrogen contributes to both healthy vine growth and the production of marketable sweet potato tubers.

2.5 Soil Fertility and Nutritional Requirements in Sweet Potato Production

Soil fertility is a critical factor in sweet potato production, as the crop requires nutrient-rich soil to grow optimally. Sweet potatoes prefer well-drained with good organic matter content which are normally sandy loamy soils. Nitrogen, phosphorus, and potassium in right amounts are essential for promoting healthy vine growth and tuber development (FAO, 2019). Nitrogen is particularly important for vegetative growth, while phosphorus supports root development and tuber formation. Potassium is necessary for improving resistance to diseases and stress. In Zimbabwe, many smallholder farmers face challenges with soil fertility, often due to inadequate use of organic or chemical fertilizers. Research has shown that farmers who apply balanced fertilizers, along with organic matter, achieve higher yields and better-quality sweet potatoes (Chikodzi et al., 2020).

To optimize soil fertility, farmers can do soil testing to find out on nutrient deficiencies and apply appropriate fertilizers based on the results. Sustainable soil management practices, like crop rotation and agroforestry, improves long-term soil health and reduce dependency on synthetic fertilizers, which are often costly and less accessible to smallholder farmers.

2.6 Variety Selection for Optimal Propagation

Variety selection plays a significant role in the success of propagation and productivity of sweet potato. Different varieties have different growth habits, resistance to diseases and pests, and yield potentials. For example, the Kutsaga Red and Kutsaga Yellow varieties developed in Zimbabwe have shown excellent performance under local growing conditions, particularly in terms of resistance to pests and diseases, which are major problems to sweet potato farming in the region (Chikodzi et al., 2020). Similarly, Marondera Research Station has developed varieties that perform well under the country's agro-ecological conditions, offering high yield potential and better storage characteristics.

The choice of variety is particularly important when it comes to vine propagation, as some varieties are more suitable for multiplication than others. Some varieties have a higher multiplication rate, meaning they can produce more vines over a given period, which is crucial for farmers looking to expand their production. Research into the optimal combination of nitrogen levels, plant spacing, and variety selection is necessary to improve the propagation process and increase overall yield, especially in countries like Zimbabwe. (Lemessa et al., 2019).

2.7 Interaction between Plant Spacing and Nitrogen Levels

The interaction between plant spacing and nitrogen levels can significantly impact the growth and yield. As plant spacing increases, the competition for nitrogen and other nutrients between plants decreases, allowing for more efficient utilization of available resources. However, the impact of nitrogen on sweet potato growth is also dependent on the spacing between plants. Research has shown that at wider spacing, higher nitrogen levels may result in more vigorous vegetative growth, which can lead to better tuber development, provided that other factors such as water and soil fertility are also optimized (Zhang et al., 2019).

Studies conducted at Marondera and Kutsaga Research Stations suggest that an optimal combination of plant spacing and nitrogen levels leads to faster vine multiplication, allowing for a more rapid increase in planting material for farmers. For instance, a combination of 25 cm spacing and 50 kg per hectare of nitrogen has been found to optimize both vine growth and tuber yield, enhancing productivity per unit area. This knowledge is crucial for farmers looking to maximize vine propagation efficiency while maintaining high yield potential.

CHAPTER 3: METHODOLOGY AND MATERIALS

3.1Research Site

The research was conducted at Nyavira Secondary school located along Lomagundi highway situated at 2km from the Harare Chinhoi road. The area is in the natural farming region 2a. According to Ministry of Lands, Agriculture Fisheries, Water and Rural Development the area receives 750mm to 830mm per annum. The region experiences average annual temperatures between 18^{o}c and 25^{o}c. The soils are predominantly red loam. The geographical coordinates of the area are Latitude/Longitude -17.680849/30.806973.

3.2 Experimental Design

The trial was arranged in factorial manner experimental design in a Completely Randomized Design (CRBD), incorporating two factors nitrogen level, and plant spacing. Nitrogen as one of the factors had 3 levels Low 30 kg N/ha, Medium 60 kg N/ha and High 120 kg N/ha. Spacing had also 3 levels that were Close 20 cm, Moderate 30 cm and Wide 40 cm. The trial was replicated 3 times.

3.3 General management of the Trial.

Nitrogen Application

Nitrogen was supplied as Ammonium Nitrate (34.5% N) and applied based on the designated treatment levels:

Low Nitrogen (30 kg N/ha) – Applied entirely at planting.

Medium Nitrogen (60 kg N/ha) – at planting

High Nitrogen (120 kg N/ha) – planting

The fertilizer was banded near the plants to minimize nitrogen loss and ensure effective uptake.

Irrigation

The plots were irrigated using furrow irrigation every 5 to 7 days depending on weather conditions. Tensiometers were used to monitor soil moisture levels, maintaining field capacity throughout the growing period and avoiding water stress. Irrigation was reduced two weeks before final data collection to harden the vines. Water was applied at a rate of 25l/m^2.

Weed Management

Weeds were controlled manually using hoes at two-week intervals. Care was taken to avoid disturbing the developing vines. No herbicides were used to avoid chemical interference with the treatments.

Pest Management

Field scouting was conducted weekly to detect any pest infestations. Insect pests were controlled using organic neem extract at the rate of 50ml per one liter of water and, when necessary, chemical pesticides such as Lambda-cyhalothrin at a rate of 30ml per 15l of water were used following recommended application rates. The main pests observed were Cutworms and Aphids (*Myzus persicae*).

3.4 Data Collection

Data collection began three weeks after planting and was conducted at three-week intervals for a total of 12 weeks. The following parameters were measured:

1. Vine Length (cm) – Measured from the base to the tip of the main vine using a meter rule.

2. Number of Plantable Vines – Counted based on vines with at least three nodes and a minimum length of 30 cm.

3. Multiplication Factor – Calculated as the ratio of plantable vines harvested to the number of vines originally planted.

4. Turnover Days – Recorded as the number of days it took each plot to produce harvestable vine cuttings.

3.5 Statistical Analysis

The data were analyzed using ANOVA (Analysis of Variance) to test for significant differences between treatments for each variable measured. Where differences were significant, Least

Significant Difference (LSD) tests at the 5% significance level were used to compare treatment means. GenStat 20th edition was used for the statistical analysis.

CHAPTER 4: DISCUSSION OF RESULTS

4.1 Vine Length

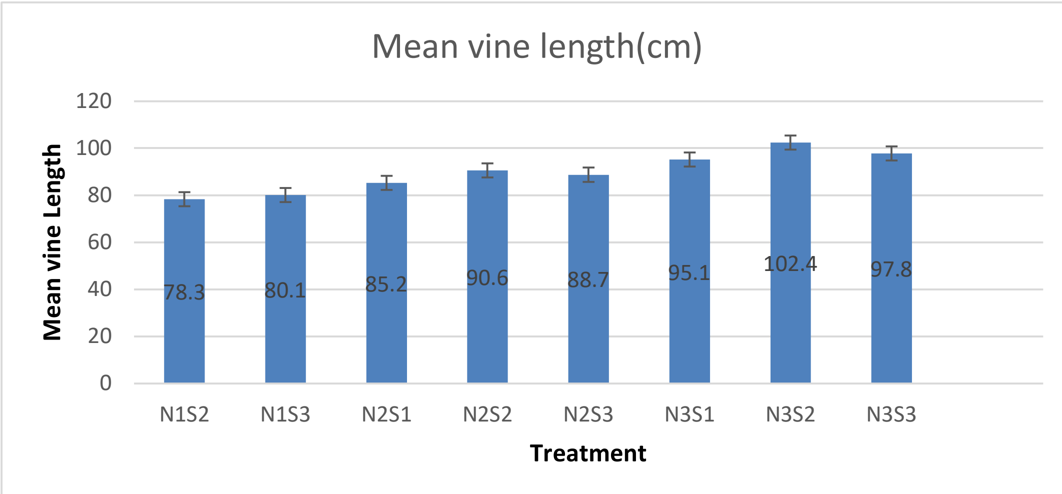

Figure 4.1. Showing vine length

There was an interaction between spacing and fertilizer level ($p < 0.05$). Spacing S2 (moderate spacing) and fertilizer level N3 (high nitrogen) produced the longest vines of 102.4 cm, which was not significantly different from spacing S3 and fertilizer N3 (97.8 cm), as well as from spacing S2 and fertilizer N2 (90.6 cm).In contrast, the shortest vine length (72.6 cm) was recorded under spacing S1 and fertilizer N1, which was significantly different from all other combinations. This suggests that vine elongation in sweet potatoes is optimized under a moderate spacing regime with sufficient nitrogen supply, supporting better canopy expansion and internode development.

4.2 Number of Plantable Vines

Table 4.1. Showing the number of plantable vines

Treatment	N1S1	N1S2	N1S3	N2S1	N2S2	N2S3	N3S1	N3S2	N3S3
Plantable vines	30	35	37	42	48	46	50	55	53

There was an interaction between spacing and fertilizer level ($p < 0.05$). The highest number of plantable vines (55) was recorded under spacing S2 and fertilizer level N3, which was not significantly different from spacing S3 and N3 (53 vines) and spacing S1 and N3 (50 vines).The lowest number of plantable vines (30) was obtained from spacing S1 and fertilizer N1, which was significantly different from all other treatments. The findings indicate that increased nitrogen availability, when paired with adequate spacing, enhances the development of lateral shoots, contributing to greater vine multiplication potential.

4.3Multiplication Factor

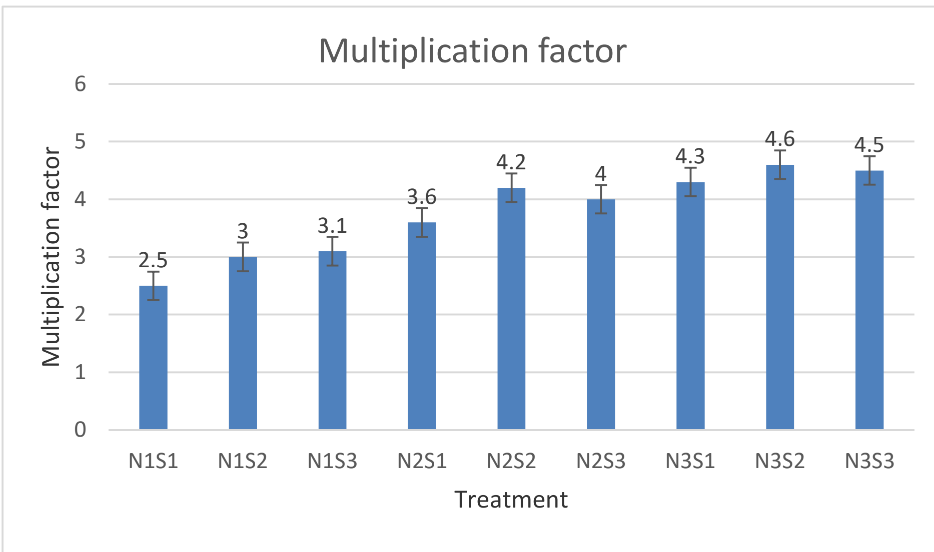

Fig 4.2 showing the multiplication factor

There was an interaction between spacing and fertilizer level ($p<0.05$). The highest multiplication factor (4.6) was obtained under spacing S2 and fertilizer level N3, and this was not significantly different from spacing S3 and N3 (4.5) and spacing S2 and N2 (4.2). The lowest multiplication factor (2.5) was recorded in spacing S1 and fertilizer level N1, which was significantly different from all other combinations. This shows that vine propagation efficiency is maximized when both nitrogen and spacing are optimized, reducing intra-plant competition and enhancing shoot productivity.

4.4 Turnover Days

Table 4.2 showing the turnover days

Treatment	N1S1	N1S2	N1S3	N2S1	N2S2	N2S3	N3S1	N3S2	N3S3
Turnover Days	53	50	48	45	41	42	40	38	39

There was an interaction between spacing and fertilizer level ($p < 0.05$). The shortest turnover period (38 days) was recorded under spacing S2 and fertilizer N3, which was not significantly different from spacing S3 and N3 (39 days) and spacing S1 and N3 (40 days).The longest turnover period (53 days) was recorded under spacing S1 and fertilizer level N1, and this was significantly different from all other treatments. These results highlight the role of high nitrogen input and optimal spacing in accelerating vine maturity, thereby increasing the frequency of propagation cycles in a growing season.

The results clearly show that there were interaction effects between spacing and fertilizer level ($p < 0.05$) for vine length, number of plantable vines, multiplication factor, and turnover days.

CHAPTER FIVE: DISCUSSION

The results from this study clearly demonstrate that both nitrogen levels and plant spacing significantly influenced sweet potato vine propagation parameters. These parameters include vine length, number of plantable vines, multiplication factor, and turnover days.

Among the treatment combinations, the use of high nitrogen level (120 kg/ha) combined with moderate spacing (30 cm) represented by Treatment N3S2 consistently produced the best results across all observed traits. The vine length was observed to be significantly longer in plots that received higher nitrogen doses, particularly where spacing allowed for moderate canopy development. This finding supports the biological understanding that nitrogen stimulates vegetative growth by enhancing chlorophyll synthesis, leading to increased cell expansion and elongation. On the other hand, moderate spacing helped reduce competition between plants for light, water, and nutrients, thus supporting healthy and vigorous growth.

The number of plantable vines also showed a clear upward trend with increasing nitrogen levels. The highest number of plantable vines (55) was recorded in Treatment N3S2. This suggests that both nitrogen availability and adequate spacing play crucial roles in ensuring that each plant has enough resources to produce more lateral branches, which can be used as vine cuttings for further propagation.

The multiplication factor, which indicates how many new vines can be generated from a single vine, was also highest under the N3S2 treatment. This implies that optimal conditions of nitrogen and spacing not only improve plant growth but also increase propagation efficiency — a critical factor in seed system development and commercial vine production.

Regarding turnover days, which measure the time taken to reach sufficient vine maturity for the next harvest, the shortest turnover period (38 days) was again observed under N3S2. This shorter growth cycle allows farmers to harvest vines more frequently, supporting multiple propagation cycles in a single season. Faster turnover is especially beneficial in commercial vine production systems, as it enables continuous and sustained availability of planting material.

The ANOVA results confirmed these observations by showing statistically significant differences among the treatment combinations ($p < 0.05$). Furthermore, the interaction between nitrogen level and spacing was also significant, indicating that the effects of one factor depend on the level of the other. This synergistic interaction highlights the importance of optimizing both inputs together rather than in isolation.

Overall, the findings underscore that the most effective vine propagation strategy requires a balanced approach: sufficient nitrogen to stimulate vegetative growth and appropriate spacing to reduce interplant competition.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study has shown that sweet potato vine propagation can be significantly enhanced by adjusting nitrogen levels and plant spacing. All the measured parameters vine length, plantable vines, multiplication factor, and turnover days were positively influenced by higher nitrogen and wider spacing, with the most favorable outcomes consistently observed under the high nitrogen (120 kg/ha) and moderate spacing (30 cm) treatment (N3S2).

The application of high nitrogen stimulated the development of strong, long, and leafy vines that are ideal for propagation. At the same time, moderate spacing allowed the plants to develop their canopy without much competition for resources such as light and nutrients, which could otherwise restrict growth.

Importantly, the shorter turnover days observed under optimal conditions allow for more frequent harvesting cycles, thereby improving productivity and providing a steady supply of planting materials. The interaction between nitrogen and spacing was also statistically significant, emphasizing that both factors must be considered simultaneously to maximize sweet potato vine production.

These findings are especially useful for farmers, agronomists, and agricultural extension officers, as they offer a science-based recommendation for improving the availability of planting materials through optimized management practices.

6.2 Recommendations

To Farmers:

1. Apply nitrogen fertilizer at a rate of 120 kg/ha to support vigorous and healthy vine growth.

2. Use a plant spacing of 30 cm to strike the right balance between plant competition and land use efficiency.

3. Monitor soil fertility regularly, and adjust nitrogen application accordingly to ensure optimal nutrient availability throughout the crop cycle.

4. Aim to harvest vines more frequently, especially when turnover days are reduced, to maximize the number of vines produced per season.

5. Keep accurate records of planting dates, vine growth rates, and harvests to support informed decisions and continuous improvement.

To Agricultural Extension Services

1. Promote and support the adoption of high nitrogen application (120 kg/ha) and 30 cm spacing among sweet potato growers, especially those engaged in vine multiplication programs.

2. Offer training workshops for farmers on correct fertilizer usage, timing, and plant spacing to improve adoption and outcomes.

3. Organize on-farm trials in various agro-ecological zones to confirm and adapt these recommendations for broader application.

4. Disseminate research findings and recommendations through demonstration plots, field days, and farmer field schools.

5. Encourage the use of certified and improved varieties such as Jewel, which respond favorably to optimize nitrogen and spacing conditions.

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Appendixes

The following tables present the ANOVA summary statistics for the four key parameters observed in the sweet potato propagation experiment: vine length, number of plantable vines, multiplication factor, and turnover days. The treatments involved nine combinations of three nitrogen fertilizer levels (N1 = low, N2 = medium, N3 = high) and three plant spacing levels (S1 = close, S2 = moderate, S3 = wide), arranged in a 3×3 factorial design with three replications. All results are interpreted at the 5% significance level.

Appendix 1

ANOVA Table for Vine Length

Source of Variation	Degrees of Freedom (D.F.)	Sum of Squares (SS)	Mean Square (MS)	F-value	P-value
Treatments	8	2443.2	305.4	18.72	<0.001
Blocks (Replication)	2	118.5	59.25	3.63	0.042
Error	16	261.1	16.32		
Total	26	2822.8			

Appendix 2

ANOVA Table for Number of Plantable Vines

Source of Variation	Degrees of Freedom (D.F.)	Sum of Squares (SS)	Mean Square (MS)	F-value	P-value
Treatments	8	396.5	49.56	21.87	<0.001
Blocks (Replication)	2	31.2	15.6	6.89	0.007
Error	16	36.2	2.26		
Total	26	463.9			

Appendix 3

ANOVA Table for Multiplication Factor

Source of Variation	Degrees of Freedom (D.F.)	Sum of Squares (SS)	Mean Square (MS)	F-value	P-value
Treatments	8	10.64	1.33	15.79	<0.001
Blocks (Replication)	2	0.45	0.225	2.67	0.098
Error	16	1.35	0.084		
Total	26	12.44			

Appendix 4

ANOVA Table for Turnover Days

Source of Variation	Degrees of Freedom (D.F.)	Sum of Squares (SS)	Mean Square (MS)	F-value	P-value
Treatments	8	731.4	91.43	22.56	<0.001
Blocks (Replication)	2	28.9	14.45	3.57	0.051
Error	16	64.9	4.06		
Total	26	825.2			