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# Improving Biomass Yield and Root Production in Sweetpotato using Vine Cuttings from Different Plant Sections

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**Abstract**

*Sweetpotato (Ipomoea batatas) is a versatile and underutilized crop with significant potential for food security and economic development. An experiment was conducted in the early planting season of 2022 to investigate the effects of different vegetative cuttings on the growth and yield of sweetpotato varieties in Nigeria. Treatments were three different vegetative cuttings (terminal, sub-terminal, and basal stem cuttings). Results indicate that sub-terminal stem cuttings consistently promoted increased leaf production and branch formation compared to other cuttings. Terminal stem cuttings exhibited longer vine lengths but did not significantly differ in biomass yield. However, they resulted in higher root numbers, highlighting their potential for root development. These findings contribute to our understanding of vegetative propagation methods and can inform agricultural practices aimed at improving sweetpotato production and food security in Nigeria and beyond.*

Keywords: Vegetative cuttings, sweetpotato, food security, yield,

## 1.0 Introduction

Sweetpotato *(Ipomea batatas*) stands as a crucial root crop, contributing significantly to global food security and nutritional well-being. Originating from Central and South America, this versatile crop boasts over 403 varieties, each with distinct characteristics such as white, yellow, red, purple, pink, violet, orange, or brown flesh, and varying skin colors of red, yellow, orange, and brown (Thomas *et al.*, 2023, Okpara *et al.*, 2014, Ekwere *et al*, 2023b). Its rich nutritional profile, encompassing vitamins, minerals, dietary fiber, and proteins, positions sweetpotato as a potential crop in combating malnutrition, especially in developing countries (Akpaninyang *et al.*, 2013, Ekwere *et al*, 2023a, Ben *et. al.*, 2024).

While widely cultivated across the globe, particularly in Asia, Africa, and Latin America, sweetpotatoes have gained recognition not only for their role as a staple food but also for their diverse applications in starch, alcohol, pharmaceutical, and textile industries (Ikeh *et al*., 2012, Inyang *et al*., 2022, Enyong *et al*., 2013). In Nigeria alone, approximately 80% of the sweetpotato yield is utilized for human consumption, underscoring its pivotal role in ensuring food security (Nedunchezhiyan and Ray, 2010, Udounang *et al.*, 2023,).

Despite its global significance, sweetpotato production faces challenges in various forms, including biological factors such as pests and diseases (Akpaninyang and Opara, 2017), economic fluctuations (Udounang *et al.*, 2022a), government policies, and changing market preferences (Akpaninyang *et al.*, 2015b, Udounang *et al*., 2022b). In this context, understanding the growth responses of sweetpotatoes becomes imperative, particularly when considering vegetative propagation, a common method employed in its cultivation (Thomas *et al.*, 2023, Efretuei *et al*., 2022, Akata *et al*., 2016).

This research aims to shed light on the growth and yield responses of sweetpotatoes using vine cuttings from different plant sections—tips, middle, and base. By identifying the most optimal vegetative cutting. The study seeks to contribute valuable insights to enhance sweetpotato cultivation practices, ultimately promoting increased yields and food security.

## 2.0 Materials and Methods

The research was conducted during the 2022 early cropping season at the Crop Science Teaching and Research Farm of the Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus. The experimental design was a randomized complete block design (RCBD) with three replications and 3 treatments which included three vegetative cuttings of orange - fleshed sweet potato (*Ipomea batatas*)- terminal, subterminal, and basal cuttings.

Land preparation involved manual clearing, stump removal, and ridge making. Sweetpotato (Umuspo 3) vine cuttings of 25cm length sourced from the National Root Crop Research Institute (NRCRI), Umudike, Abia State was planted on the crest of the ridges. The planting distance was 30 cm x 100 cm, giving a plant population of 33333 stands per hectare. N. P. K 15:15:15 fertilizer was applied four weeks after planting. Weeding was done at 4 and 8 weeks after planting, and harvesting took place at 18 weeks after planting.

On data collection, Number of sweetpotato leaves and branches were gotten by counting the number of leaves and branches on the sampled plant. With the aid of a metre rule, vine length was determined by taking measurement from the base to the terminal bud of the plant.
Leaf area was determined using the method described by Pandey and Singh (2011). Each leaf was spread over a millimeter graph paper, and the outline of leaf was drawn. Using a scissor, the area of the millimeter graph paper covered by the outline was cut and weighed on an electronic balance. One $cm^2$ of the same millimeter graph paper was also cut and weighed. The following equation was used to calculate the leaf area index nondestructively:

$$Leaf\ area\ = x/y \quad \text{..........Equation 2.1}$$

Where:
x = the weight of the graph paper covered by the leaf outline (g)

y = the weight (g), of the $cm^2$ area of the graph paper

Thereafter, the LAI was calculated using the formula:

$$Leaf\ area\ index\ (LAI) = LA/P$$ ………………………………………..Equation 2.2

Where:
LA= Total leaf area/plant
P= Land area occupied by plant

Number of roots per plant was determined by counting the number of harvested roots per plot and dividing by the number of plants in the plot. To determine storage root weight (kg/plot) sweetpotato roots were harvested and weighed using a weighing balance. Biomass weight (kg/plot) was obtained by gathering the vines after harvest and measuring them on the scale on a per plot basis.

Storage root yield was calculated using the formula:

*Root yield t/ha = Root weight (kg/plant) x Number of root /plant x plant population/ha/1000*………………………………………………………......Equation 2.3

While biomass yield was calculated using the formula:

*Biomass yield = Shoot weight (kg/plant) x Plant population/ha ÷ 1000*..……………………………………………………………………Equation 2.4

All data collected were subjected to Analysis of variance (ANOVA) and means separated using Least Significant Difference (LSD) at 5% probability level.

## 3.0 Results and Discussion

There were no significant differences observed between stem cutting treatments at all measurement times for number of leaves. However, numerically there were higher numbers of leaves among the sub-terminal stem cuttings (Table 3.1) indicating a superior influence on leaf production when using this treatment as a planting material. The observed trend in leaf development aligns with findings by Elameen *et al*. (2008) and Akpaninyang *et al*. (2022), who also reported that sub-terminal stem cuttings tend to promote increased leaf production in sweetpotatoes.

Additionally, No significant difference was observed in the number of branches between the treatments at all sampling intervals. Nonetheless, there was consistent superiority of sub-terminal stem cuttings in producing more branches than other cuttings (Table 3.2). This agrees with Woolfe (1992), who emphasized the role of sub-terminal buds in lateral shoot development. The results highlight the importance of selecting appropriate vegetative cuttings to encourage branching, a key factor in sweetpotato yield (Akpaninyang *et al.*, 2015a).

There was also no significant difference in vine lengths at the 6th 8th 12th and 14th week but differences were observed at the 10th week of measurement. Similar to results from branch and leaf numbers the sub terminal cutting gave the longest vines (numerically) followed by the terminal cutting (Table 3.3). This corroborate with the findings of Udoh *et al*. (2005), who noted that terminal cuttings contribute to robust vine growth. The substantial growth in sub-terminal and terminal stem cuttings suggests a potential for their use in achieving desirable vine length while maintaining apical dominance.

No significant difference in LAI was observed amongst the treatments at all weeks after planting (Table 3.4). The LAI appeared to increase between week 6-8 across treatments but reached a plateau between the 10th -14th week of measurement. The fluctuating Leaf Area Index (LAI) may be attributed to variations in apical dominance, and varietal variations influencing overall leaf area. Similar trends have been reported by Osiru *et al*. (2009) and Akpaninyang *et al*. (2015a), emphasizing the dynamic nature of LAI during sweetpotato growth.

There were no significant differences in biomass weight or yield between the treatments (Table 3.5). While terminal stem cuttings exhibited slightly lower biomass weight and yield, the overall non- significant differences align with the findings of Laurie and Van Heerden (2012). Their research emphasized the adaptability of sweetpotato to diverse vegetative cuttings, suggesting that the choice of cutting may not significantly impact biomass yield.

There was a significant difference in the number of roots amongst treatments but no significant difference in root weight or root yield (Table 3.6). The low yield may be due to the use of low-quality vines, as the variety is susceptible to virus infection. Working with clean vines in a similar environment, Akpaninyang et al. (2015a) reported high average root yield of 19.6 t/ha for Umuspo 3 as against the 8.83 t/ha obtained in the present study. The significant difference in the number of storage roots highlights the need for careful consideration of cutting part in sweetpotato cultivation. The higher number of storage roots in terminal stem cuttings corresponds with results from Elameen *et al*. (2008), who reported enhanced root development in terminal cuttings.

**Table 3.1 Effect of vegetative cuttings on number of leaves of sweetpotato at different sampling intervals**

| | Weeks After Planting | | | | |
|---|---|---|---|---|---|
| Treatment | 6 | 8 | 10 | 12 | 14 |
| Terminal stem cutting | 18.50 | 24.40 | 39.50 | 53.50 | 60.70 |
| Sub terminal stem cutting | 23.00 | 36.00 | 48.20 | 64.20 | 73.20 |
| Basal stem cutting | 17.00 | 28.50 | 35.00 | 69.20 | 75.00 |
| LSD(P<0.05) | NS | NS | NS | NS | NS |

NS=Not significant at 5% probability level

**Table 3.2 Effect of vegetative cuttings on number of branches of sweetpotato at different sampling intervals**

| | Weeks after planting | | | | |
|---|---|---|---|---|---|
| Treatment | 6 | 8 | 10 | 12 | 14 |
| Terminal stem cutting | 1.50 | 1.70 | 2.67 | 3.50 | 4.50 |
| Sub terminal stem cutting | 2.83 | 3.00 | 4.33 | 5.17 | 5.67 |
| Basal stem cutting | 1.50 | 2.16 | 2.67 | 4.00 | 4.67 |
| LSD(P<0.05) | NS | NS | NS | NS | NS |

**Table 3.3 Effect of vegetative cuttings on sweetpotato vine length (cm) at different sampling intervals**

| | Weeks After Planting | | | | |
|---|---|---|---|---|---|
| Treatment | 6 | 8 | 10 | 12 | 14 |
| Terminal stem cutting | 66.30 | 111.80 | 176.50 | 282.50 | 307.20 |
| Sub terminal stem cutting | 72.30 | 136.80 | 235.80 | 215.80 | 227.70 |
| Basal stem cutting | 62.20 | 99.20 | 122.50 | 202.80 | 216.00 |
| LSD(P<0.05) | NS | NS | 111.30 | NS | NS |

**Table 3.4 Effect of vegetative cuttings on leaf Area Index of sweetpotato at different sampling intervals**

| | Weeks After Planting | | | | |
|---|---|---|---|---|---|
| Treatment | 6 | 8 | 10 | 12 | 14 |
| Terminal stem cutting | 0.004 | 0.013 | 0.014 | 0.008 | 0.008 |
| Sub terminal stem cutting | 0.004 | 0.033 | 0.014 | 0.008 | 0.008 |
| Basal stem cutting | 0.005 | 0.009 | 0.012 | 0.007 | 0.008 |
| LSD(P<0.05) | NS | NS | NS | NS | NS |

**Table 3.5: Effect of vegetative cuttings of sweetpotato biomass weight/yield at harvest**

| Treatment | Biomass weight/plant | Biomass yield (t/ha) |
|---|---|---|
| Terminal stem cutting | 0.27 | 8.87 |
| Sub terminal stem cutting | 0.31 | 10.44 |
| Basal stem cutting | 0.31 | 10.44 |
| LSD(P<0.05) | NS | NS |

NS=Not significant at 5% probability level

**Table 3.6 Effect of vegetative cuttings on number of root/plant, root weight (kg/plant), root yield (t/ha) of sweetpotato at harvest**

| Treatment | Number of root/plant | Root weight (kg/plant) | Root yield (t/ha) |
|---|---|---|---|
| Terminal stem cutting | 1.83 | 0.16 | 8.83 |
| Sub terminal stem cutting | 0.90 | 0.21 | 6.03 |
| Basal stem cutting | 1.27 | 0.18 | 6.47 |
| LSD(P<0.05) | 0.83 | NS | NS |

NS=Not significant at 5% probability level

## 4.0 Conclusion

Sub-terminal stem cuttings consistently displayed favorable results across various parameters, aligning with previous research findings. However, the choice of cutting type may depend on specific objectives, such as maximizing leaf production or promoting robust root development. These results emphasize the importance of considering the choice of vegetative cuttings, in sweetpotato cultivation. Further studies could explore the underlying physiological mechanisms driving these observed differences to enhance our understanding of sweetpotato growth dynamics.

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