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Original Article

# Agronomic assessment of vine segment and variety influence on the production of sweet potato (*Ipomoea batatas*)

OPEN ACCESS

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## ABSTRACT

*Sweet potato (Ipomoea batatas L.) plays a vital role in enhancing food security in Nigeria, yet many farmers continue to propagate it using vine cuttings without regard to the specific segment—basal, middle, or apical. To evaluate the impact of vine segment and variety on growth and yield, a field experiment was conducted at the Osun State Water Mini Scheme, Ejigbo, Nigeria, on an experimental plot measuring 810 m². The study was laid out in a randomized complete block design in a 3 ×4 factorial arrangement with three replications. Treatments included three vine cutting positions (basal, middle, apical) and four sweet potato varieties (TIS87/0087, 440261, Modern Delight, and King J). Results revealed that variety had a significant effect (P < 0.05) on key parameters such as vine length, tuber weight per plant, number of tubers per plant, tuber weight per plot, and total yield (tons/ha). Among the varieties, TIS87/0087 produced the highest yield (3.03 tons/ha), followed closely by 440216 (3.10 tons/ha), while Mother's Delight (2.06 tons/ha) and King J (2.18 tons/ha) recorded the lowest. The vine segment also significantly influenced growth and yield. Apical cuttings (tip) consistently outperformed both middle and basal segments, with the highest vine length (36.93 cm in Week 1) and yield of 3.04 tons/ha, compared to 2.36 and 2.38 tons/ha for middle and base cuttings, respectively.*

**KEYWORDS:** *Osun State, Variety performance, Vine segment, Yield optimization,*

## INTRODUCTION

Sweet potato is known for its adaptability, nutritional richness, and economic potential. It belongs to the family *Convolvulaceae,* and it is the only species within the sweet potato with a vital root crop in tropical and subtropical regions, valued for its edible storage roots. Globally, sweet potato ranks among the top six food crops, with a production volume exceeding 89 million tons as of 2021, reflecting its growing importance in food security and climate-resilient agriculture (FAOSTAT, 2021) In sub-Saharan Africa, Nigeria stands out as a major producer, with cultivation spanning over 900,000 hectares and contributing significantly to household nutrition and income generation (Akpan & Udeagbara, 2020). Sweet potato's resilience to marginal soils, low input requirements, and short growth cycle make it especially suitable for smallholder farmers and regions prone to erratic rainfall.

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Propagation is typically done using vine cuttings, a method that allows for rapid multiplication and seasonal flexibility. However, the choice of vine segment, whether apical, middle, or basal, can significantly influence plant vigor, tuber development, and overall yield. Studies have shown that apical cuttings often exhibit superior sprouting and early growth due to higher concentrations of auxins and active meristems (Kiruthika *et al.,* 2020). Despite this, many farmers continue to use vine cuttings indiscriminately, often without considering the physiological differences between vine parts or their interaction with specific varieties.

Furthermore, varietal response to vine segment selection remains underexplored in many agro-ecological zones. Recent research emphasizes the need to match variety-specific traits with appropriate planting materials to optimize both vegetative growth and tuber yield (Akpan & Udeagbara, 2020). This is particularly relevant in Nigeria, where improved varieties such as UMUSPO-1 and TIS-87/0087 are gaining traction but lack tailored agronomic recommendations across regions. Therefore, this study aims to evaluate the performance of different sweet potato varieties in response to various vine segments used as planting materials. The objectives of the study were to evaluate the most effective vine part for promoting vegetative growth and to assess the influence of vine segment on tuber yield across selected varieties under local field conditions.

## MATERIALS AND METHOD

### Experimental Location and Design

The experiment was conducted between January and May 2021 at the Osun State Water Scheme, Ejigbo, Osun State, Nigeria (7° 52' 28.37" N, 4° 18' 13.76" E). The study area is situated within the derived savannah agro-ecological zone of southwestern Nigeria, a transitional belt between the humid rainforest and the northern guinea savannah. This zone is characterized by a tropical climate with bimodal rainfall distribution averaging 1,200–1,500 mm annually and mean temperatures ranging from 22°C to 34°C. The combination of moderate rainfall, favorable temperatures, and well-drained soils provides suitable conditions for the cultivation of a wide range of arable crops, including cereals, root and tuber crops, legumes, and leafy vegetables, thereby offering an appropriate environment for agricultural research.

The experiment was laid out using a randomized complete block design (RCBD) in a 3 × 4 factorial arrangement, consisting of four sweet potato varieties (TIS87/0087, 440261, Mother's Delight, and King J) and three vine cutting positions (basal, middle, and apical), with each treatment replicated three times. Vine cuttings were carefully prepared from healthy, disease-free mother plants. Each cutting was approximately 30 cm in length and contained at least 4–5 nodes to ensure uniform sprouting potential. The basal cuttings were taken from the lower portion of the vines closest to the root, middle cuttings from the central portion, and apical cuttings from the topmost, actively growing tips. All cuttings were taken early in the morning to minimize dehydration and were planted immediately to maintain viability.

### Field and experimental layout

The experimental area was mapped out and cleared of vegetation. The layout of the field was measured and pegged. The ridges were manually constructed, and sweet potato vines were planted 1.5 m apart, with 0.6 m spacing between plants and within the rows. Total plot area measuring 810 m² with 36 plots, plot size measuring 22.5 m² with 24 plants per plot, and total plant population of 864.

### Soil Sampling

Soil samples were taken from 12 randomly selected points at a depth of 0-10 cm and mixed thoroughly to form a composite sample. Sub-samples were taken, air-dried, sieved, and stored for laboratory analysis.

### Data Collection

Data were collected on the following growth and yield parameters at two weeks interval: vine length (cm), leaf area (cm²), number of non-marketable tubers per plot, weight of non-marketable tubers per plot (kg), percentage of non-marketable tubers, weight of tubers per plant (kg), number of tubers per plant, weight of tubers per plot (kg), and yield (tons/ha).

The two-week data collection interval was adopted to effectively capture vegetative and yield-related dynamics throughout the crop growth cycle. This approach ensured adequate temporal resolution for detecting treatment effects while minimizing excessive sampling burden, as recommended by Wariboko & Ogidi. (2014). and Yahaya *et al.* (2015)

### Statistical Analysis

All data obtained on the yield and agronomic characteristics in relation to cutting parts and varieties were subjected to analysis of variance (ANOVA) using SAS software (version 9.2; SAS Institute Inc., 2008). Treatment means were separated using the Least Significant Difference (LSD) test at $p \leq 0.05$.

## RESULTS AND DISCUSSION

### Results

Table 1 below shows the physicochemical properties of the soil used in the study location. The analysis showed that the soil texture is sandy loam (sand having 873 g/kg, silt having 107 g/kg, and clay having 20 g/kg), which possesses poor water holding retention. The pH of the soil was slightly acidic (6.7), which is considered suitable for sweet potato production. The percentage organic carbon was low (1.37%), the nitrogen concentration was low (0.51 g/kg), and the available phosphorus (1.05 mg/kg) value obtained from the analysis was lower than the reported critical values of 7 mg/kg and 20 mg/kg (Chude *et al.,* 2012).

The result in Table two shows a significant influence of cutting parts on the growth performance of sweet potato varieties, particularly in vine length. Varieties and blocks also showed significant differences across all weeks except for week 1, while the treatment interaction showed no significant difference in all the weeks for vine length. There is no significant difference in leaf area in all the weeks in the blocks, among the varieties, or the treatment-by-variety interaction.

Table three shows that at week 1, the Tip (36.93 cm) recorded significantly greater vine length than both the base (28.58 cm) and middle (28.18 cm) in week 1. However, there were no significant differences among the cutting parts in weeks 2 and 3. For varieties, TIS87/0087 consistently recorded the highest vine lengths, followed by 440216, with Mother's Delight and King J significantly lower. Leaf area differences were not statistically significant.

Table four below shows significant effects of cutting parts and varieties on yield components such as the number of tubers per plant, weight of tubers, and yield per hectare. However, interactions between varieties and treatments, as well as block effects, were not significant for any yield parameter.

**Table 1: Particle size and chemical analyses of the experimental soil**

| Parameters | Soil sample |
|---|---|
| pH | 6.7 |
| %Organic carbon | 1.37 |
| % Organic matter | 2.37 |
| Nitrogen (g/kg) | 0.51 |
| Available P (ppm) | 1.05 |
| Exchangeable Acidity (Cmol/kg) | 1.28 |
| CEC (mg/100g) | 8.3 |
| **Particle size (g/kg)** | |
| Clay | 20 |
| Silt | 107 |
| Sand | 873 |
| Textural Class | Sandy loam |

**Table 2: Mean Squares from ANOVA for growth performance of sweet potato varieties from different cutting parts**

| Source of variance | df | Vine length | | | Leaf area | | |
|---|---|---|---|---|---|---|---|
| | | Week 1 | Week 2 | Week 3 | Week 1 | Week 2 | Week 3 |
| Blocks | 2 | $4263.4^{***}$ | $63143.82^{***}$ | $5891.12^{***}$ | $138.88^{ns}$ | $102.05^{ns}$ | $158.33^{ns}$ |
| Treatments | 2 | $1464.45^{*}$ | $1092.29^{ns}$ | $1217.07^{ns}$ | 294.41 | $266.22^{ns}$ | $302.37^{ns}$ |
| Varieties | 3 | $10486.50^{***}$ | $13562.56^{***}$ | $14321.89^{***}$ | $262.09^{ns}$ | $268.09^{ns}$ | $202.09^{ns}$ |
| Varieties ×Treatments | 6 | $862.93^{ns}$ | 1072.14ns | $1120.24^{ns}$ | $661.48^{*}$ | $620.00^{**}$ | $640.24^{*}$ |
| Error | 166 | 458.94 | 614.28 | 643.26 | 193.91 | 196.22 | 188.70 |

**** significant at 0.001,** significant at 0.01, *significant at 0.05, ns- not significant, df- degree of freedom*

**Table 3: Effect of Cutting Parts on Growth Performance of Sweet Potato Varieties.**

| Cutting parts | Vine length(cm) | | | Leaf Area(cm) | | |
|---|---|---|---|---|---|---|
| | **Week 1** | **Week 2** | **Week 3** | **Week 1** | **Week 2** | **Week 3** |
| Tip | 36.93a | 42.23a | 45.82a | 65.22a | 64.67a | 60.34a |
| Base | 28.58b | 36.93a | 40.35a | 57.5a | 59.68a | 55.65a |
| Middle | 28.18b | 33.7a | 36.88a | 56.00a | 56.22a | 56.87a |
| SE | ±12.37 | ±14.32 | ±14.64 | ±8.07 | ±8.10 | ± 7.93 |
| **Varieties** | | | | | | |
| TIS87/0087 | 51.09a | 42.23a | 45.82a | 62.55a | 66.56a | 63.72a |
| 440216 | 35.31b | 42b | 45.8b | 60.03a | 61.44a | 61.00a |
| Mother's Delight | 20.27c | 23.71c | 26.82c | 64.99a | 65.65a | 64.78a |
| **King J** | 20.27c | 25.27c | 27.2c | 51.82a | 53.52a | 50.34a |
| **SE** | ±12.37 | ±14.32 | ±14.64 | ±8.07 | ±8.10 | ±7.93 |

*Values are means of three replicates ± standard error (SE), estimated using SE = √(MS error/r). Means in the same column with the same letter are not significantly different according to the Least Significant Difference (LSD) test at p ≤ 0.05.*

**Table 4: Mean Squares from Analysis of Variance for Yield Performance of Sweet Potato Varieties from Different Cutting Parts.**

| Source of variance | df | Number of tubers/ plants (kg) | Weight of tuber kg/ha | Yield (tons/ hectare) |
|---|---|---|---|---|
| Blocks | 2 | 1.52$^{ns}$ | 0.09$^{ns}$ | 0.82$^{ns}$ |
| Treatments | 2 | 1472$^{***}$ | 0.47$^{***}$ | 1.79$^{*}$ |
| Varieties | 3 | 12.25$^{***}$ | 0.43$^{***}$ | 2.75$^{**}$ |
| Varieties x Treatments | 6 | 4.76$^{*}$ | 0.11$^{ns}$ | 0.81$^{ns}$ |
| Error | | 1.79 | 0.05 | 0.41 |

**** significant at 0.001, ** significant at 0.01, *significant at 0.05, ns= not significant, df- degree of freedom*

Table five shows that the tip and base cutting parts significantly differed from the middle in terms of the number of tubers per plant and yield per hectare. However, for the weight of tubers per plant, only the tip showed a significant difference compared to the middle and base. Furthermore, the tip cutting part was highly significant than the middle and the base, but the middle cutting part showed no significant difference from the middle.

Variety 440216 and variety TIS87/0087 were highly significantly different from varieties Mothers Delight and King J, but variety 440216 is not significantly different from variety TIS87/0087, and variety Mothers Delight is not significantly different from variety King J for the yield performance.

**Table 5: Effect of Cutting Parts on Yield Performance of Sweet Potato Varieties.**

| Cutting parts | Number of Tuber/ plant(kg) | Weight of tuber/ plant(kg) | Yield (tons/ hectare) |
|---|---|---|---|
| Tip | 3.07$^{a}$ | 0.55$^{a}$ | 3.04$^{a}$ |
| Base | 3.62$^{a}$ | 0.43$^{b}$ | 2.38$^{b}$ |
| Middle | 2.08$^{b}$ | 0.33$^{b}$ | 2.36$^{b}$ |
| **Varieties** | | | |
| TIS87/0087 | 2.91$^{a}$ | 0.54$^{a}$ | 3.03$^{a}$ |
| 440216 | 3.11$^{a}$ | 0.53$^{a}$ | 3.10$^{a}$ |
| Mother's Delight | 2.09$^{b}$ | 0.38$^{b}$ | 2.06$^{b}$ |
| King J | 2.2$^{b}$ | 0.38$^{b}$ | 2.18$^{b}$ |

*Means with the same letter(s) in each column are not significantly different ($p \leq 0.05$, LSD)*

**Discussion**

The soil at the experimental site was classified as sandy loam, with a high sand content (873 g/kg), low silt (107 g/kg), and minimal clay (20 g/kg). This texture, while promoting aeration and drainage, is known for poor water retention, which can limit moisture availability during tuber bulking. However, sweet potato has demonstrated adaptability to such soils, especially when organic amendments are used to improve structure and moisture conservation (Obalum *et al.,* 2020). The slightly acidic pH (6.7) falls within the optimal range for sweet potato cultivation. According to Edem *et al.* (2020), sweet potato thrives in soils with a pH between 5.5 and 6.8, which supports nutrient solubility and microbial activity.

The results from the analysis of variance in Table 2 revealed that cutting position had a significant effect ($p < 0.01$) on vine length across all weeks of observation. Specifically, apical cuttings produced the longest vines, particularly in week 1, with the trend persisting through weeks 2 and 3. This observation aligns with findings by Afolabi *et al.* (2021), who reported that apical vine segments exhibited superior vegetative growth due to higher concentrations of endogenous auxins and greater physiological activity. Similarly, Oycha *et al*. (2023) demonstrated that apical and middle cuttings enhanced vine elongation and shoot biomass in sweet potato under tropical conditions.

Varietal differences were also significant for vine length from week 2 onward. The variety TIS87/0087 consistently recorded the highest vine length, followed by 440216, while Mothers Delight and King J showed the least performance, with no significant difference between them. These results are consistent with the work of Akpan *et al.* (2020), who found that TIS87/0087 exhibited superior early growth and canopy development under southeastern Nigerian conditions.

Cutting position and variety alone had no significant effect on leaf area at any stage; their interaction (Variety × Cutting Position) significantly influenced leaf area at Weeks 1, 2, and 3. This suggests that leaf expansion may be less directly influenced by the physiological origin of the cutting and more responsive to environmental or post-establishment factors. Afolabi *et al*. (2021) similarly observed that while cutting origin significantly affected vine length, leaf area remained relatively stable across treatments.

The yield performance of sweet potato in Table 4 revealed that cutting position and variety had significant effects ($p < 0.01$) on yield-related traits, including number of tubers per plant, tuber weight, and total yield per hectare. However, there were no significant interactions between variety and cutting position. Cutting position significantly influenced yield, with apical and basal cuttings producing a higher number of tubers and greater yield per hectare compared to middle cuttings, as presented in Table 5. However, only the tip cuttings showed a significant advantage in tuber weight per plant, suggesting that apical segments not only enhance vegetative growth but also contribute to improved assimilate partitioning into storage roots. These findings are consistent with Afolabi *et al.* (2021), who reported that apical cuttings produced higher marketable tuber yield due to their superior sprouting vigor and early canopy establishment. Similarly, Oycha *et al.* (2023) observed that apical and basal cuttings outperformed middle segments in both root number and yield under tropical field conditions.

## CONCLUSION AND RECOMMENDATIONS

The study demonstrated that cutting position and variety significantly influenced sweet potato growth and yield performance. Apical cuttings promoted superior vine elongation and tuber yield, likely due to their physiological vigor. Among the varieties, TIS87/0087 and 440216 consistently outperformed Mothers Delight and King J, highlighting clear differences in early growth and productivity. Leaf area was not significantly affected by the treatments, suggesting that factors influencing vegetative expansion may differ from those driving elongation and yield formation.

However, for improved establishment and optimal yield under field conditions in Nigeria, the use of apical vine cuttings from varieties like TIS87/0087 is recommended. Farmers and extension agents are encouraged to adopt these practices to enhance sweet potato performance, particularly in sandy loam soils with low fertility. Further studies should be done to determine nutrient management strategies to complement varietal and propagation choices for increased productivity.

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### Authors' Contributions

AIA conceptualized the study. AIA & MSA designed the experiment, AIA, AAO & YSO collected data and performed data analysis, GGA & AMR wrote the first draft of the manuscript. MSA & AIA performed literature searches and reviewed the first draft of the manuscript. All authors read and approved the final draft of the manuscript.

### Ethical Statement

Not applicable

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