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Research Article

Variations in Morphological and Tuber Attributes of Sweet Potato (*Ipomoea batatas*) Varieties in Response to NPK in Ogbomoso, Nigeria

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Abstract

Sweet potato (*Ipomoea batatas* (L.) Lam) is an essential resource for rural people due to its nutritional value, drought tolerance, and ability to adapt to various soil and climatic conditions. Despite the importance of sweet potato as a food crop, the low yield of this crop is caused by many factors such as low soil fertility of most arable fields, lack of improved varieties resistant to diseases, and good genetic traits. Therefore, as a result of low soil fertility in Nigeria, the soil must be supplemented with adequate macro-nutrients to improve and sustain the growth and yield of sweet potato varieties. This study examined the influence of NPK fertilizer application on the morphological characteristics and tuber yield of selected sweet potato varieties cultivated in Ogbomoso, Nigeria. Carried out at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso. It involved six sweet potato varieties (Ex-Igborian, Mother Delight, Butter, Tis 82/0087, King Jane, and Shaba) and two NPK rates (0 which is control, and NPK rate of 50 kgN, 11 kg P_2O_5 and 20 kg K_2O ha^{-1}) arranged in a 2X6 factorial experiment fitted into a randomized complete block design and replicated three times. Data were collected on growth parameters and yield attributes, and they were subjected to analysis of variance and means separated using the Least Significant Difference at a 5% probability level. Results showed that NPK fertilizer significantly (p=0.05) influenced the growth parameters such as vine length (84.60cm), number of leaves (54.70), and number of branches (11.70) obtained from plants under NPK application while control gave the least values. Fertilizer application had a significant effect (p=0.05) on the yield and yield attributes of sweet potatoes. Therefore, Mother Delight and Ex-Igborian with the application of 50 kgN, 11 kg P_2O_5 and 20 kg K_2O ha^{-1}can be recommended for optimum performance of sweet potato in the study area.

Keywords

Sweet Potato, NPK Fertilizer, Growth Parameters, Yield, Variety

1. Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) is a key root crop in tropical, subtropical, and frost-free temperate zones, highly prized for its resistance and nutritional advantages. Known for its capacity to survive drought and low soil fertility, sweet potato is widely cultivated as a major food crop in Nigeria and many other countries of sub-Saharan Africa.

It is a vital resource for rural families, particularly in countries where food security is challenged by climatic and

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economic volatility [14]. The crop's tolerance to varied soil and climatic conditions makes it a feasible alternative for small-scale farmers and an asset to complex, mixed cropping systems in Nigeria [15]. Sweet potato has numerous benefits: its tuber may be consumed boiled, fried, or roasted and can also be processed into flour, starch, or alcohol for industrial uses. Additionally, its leaves are rich in vitamins and minerals and are utilized in numerous traditional recipes [2]. The crop ranks fifth in significance among staple crops in developing nations, after rice, wheat, maize, and cassava [3].

Fertilizer use, notably nitrogen (N), phosphorus (P), and potassium (K), has been demonstrated to greatly affect sweet potato output. NPK fertilizers are known to increase vegetative growth, tuber development, and nutrient density in root crops, particularly in soils with poor natural fertility [4, 5]. The usage of fertilizers promotes important growth processes, such as chlorophyll formation and photosynthesis, root development, and disease resistance, all of which lead to better crop yield [7, 8]. Research has also demonstrated that nitrogen is crucial for protein synthesis and leaf formation, phosphorus boosts root and tuber growth, and potassium helps to drought tolerance and nutrient transport within the plant [10, 17]. In Nigeria, inadequate soil fertility is a key restriction on sweet potato yield [13]. The use of NPK fertilizers might play a crucial role in reducing nutritional deficits, consequently enhancing tuber output [4]. NPK recommended rates for sweet potato production are 20-50 kg/ha of nitrogen (N), 30-60 kg/ha of phosphorus (P_2O_5), and 60-100 kg/ha of potassium (K_2O) [20].

Selecting cultivars that are sensitive to fertilizer application and suited for local circumstances is also critical for increasing production and profitability [12]. However, despite its crucial role in food security, the potential of sweet potato remains underused due to restrictions such as low soil fertility, unavailability of improved varieties, and inefficient agronomic techniques [6, 11]. This study intends to examine the morphological and yield responses of selected sweet potato varieties to NPK fertilizer in Ogbomoso, Nigeria.

2. Materials and Methods

2.1. Location of Experiment

The experiment was carried out at the Teaching and Research Farms, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State. The climatic condition of Ogbomoso is mostly influenced by the North East Trade Wind. The former is cold with drying effect which starts from November to March while the latter is warm and very moist, it starts from April to October. The area has maximum temperature of 33 ℃ and the minimum temperature of 28 ℃. The humidity of this area is high (74%) all year round except in January when the dry wind blows from the North. Annual rainfall is over 1000mm [16].

2.2. Source of Fertilizer and Planting Materials

The fertilizers used in this study were Urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP) which were acquired from KAL Farmers' Shopping Centre, Ogbomoso, Oyo State. Six varieties of sweet potato plants, namely Ex-Igborian, Mother Delight, Butter, Tis 82/0087 and King Jane were obtained from the National Root Crops Research Institute (NRCRI), Umudike, Abia State, while Shaba was sourced from a farmer in Iluju, Ogbomoso.

2.3. Experimental Design and Treatments

The experimental laid out consisted of 36 beds separated into three blocks, each contained 12 beds. Each bed was 1.1 m × 1.1 m, with 0.5 m spacing within beds and 1 m between blocks. A 2X6 factorial experiment fitted into a Randomized Complete Block Design (RCBD) and replicated three times was used, The treatments involved two fertilizer treatments: Control (no fertilizer) and 50kgN (Urea) + 11kgP_2O_5 (SSP) + 20kg K_2O (MOP) and 6 sweet potato varieties such as Ex-Igborian, Mother Delight, Butter, Tis 82/0087, King Jane and Shaba. The fertilizer rates were applied to the six sweet potato treatments at their respective plots.

2.4. Cultural Practices

It was propagated through vine cuttings. Weeding was carried out manually by hoeing or by pulling every 3 weeks to reduce the competition for water and nutrients. Four weeks after planting, the NPK fertilizer was applied using the drilling method. Pest control was carried out by using CYPERFORCE (cypermethrin 10% E. C.), a liquid insecticide was used. After diluting 30ml with 15l of water, the substance was applied using Knapsack Sprayer.

2.5. Data Collection

Data on growth parameters were obtained from selected plants per bed starting from 4 weeks after planting (WAP) up to 10 weeks after planting (WAP). Length of primary vine (cm) was measured from the plant base to the tip, number of leaves was counted visually, number of branches and number of flowers were counted visually on tagged plants and recorded.

Yield attributes measured; number of tubers were counted at harvest, diameter and length of tuber (cm) were measured with a vernier caliper, while weight of tuber/plot (kg) were weighed on a sensitive weighing balance.

2.6. Statistical Analysis

The data collected were analyzed using Analysis of Variance (ANOVA) with SAS software, and means were separated using the Least Significant Difference (LSD) at a 5% probability level.

3. Results

3.1. Effect of Fertilizer Application on Sweet Potato Growth

The application of NPK fertilizer significantly affected growth parameters, such as the number of branches, number of leaves, and vine length throughout sampling periods. Plants under fertilized plots typically demonstrated increased growth performance compared to the control plots.

3.2. Number of Branches

Application of fertilizer greatly enhanced the number of branches in sweet potato plants over time. At 10 weeks after planting (WAP), plants treated with NPK had highest (8.60) number of branches, compared to lowest (7.10) value recorded for the control plot. Among varieties, Mother Delight had the highest number of branches (11.70), while Butter gave the lowest (4.00) value. The interaction effect between fertilizer and variety also showed significant ($p \leq 0.05$) differences, with Ex-Igborian and Mother Delight with and without NPK treatments recorded the optimum plant growth; Mother delight (11.40) recorded the highest value while Butter (3.70) recorded the lowest value in the control plot, the interaction between fertilizer and variety for plant treated with NPK, Ex-Igborian (12.20) recorded the highest value while Butter (4.40) gave the lowest value.

Table 1. *Main impact of fertilizer and variety on the number of branches at various sampling occasions.*

	Number of branches			
	Weeks after planting			
Treatments	**4**	**6**	**8**	**10**
Fertilizer Control	1.60	3.60	5.30	7.10
NPK	2.10	4.80	6.10	8.60
LSD ($p \leq 0.05$)	0.31	0.78	1.01	1.41
Variety				
EI	2.40	4.30	7.50	10.80
MD	1.80	6.40	7.90	11.70
BT	1.70	3.80	2.80	4.00
TIS	1.70	3.70	6.60	8.10
KJ	2.00	4.00	6.30	7.00
SB	1.60	2.80	3.30	5.50
LSD ($p \leq 0.05$)	0.54	1.36	1.75	2.44

EI- Ex-Igborian; MD- Mother delight; BT- Butter; TIS- Tis82/0087; KJ- King Jane; SB-Shaba
LSD-Least Significant difference

Table 2. *Interaction effect of fertilizer and variety on the number of branches at various sampling occasions.*

		Number of branches			
		Weeks after planting			
Fertilizer	**Variety**	**4**	**6**	**8**	**10**
Control	EI	2.10	3.60	6.30	9.40
	MD	1.70	5.30	8.00	11.40

		Number of branches			
		Weeks after planting			
Fertilizer Variety		**4**	**6**	**8**	**10**
	BT	1.40	2.90	2.60	3.70
	TIS	1.70	3.40	5.70	7.00
	KJ	1.50	3.40	6.20	6.30
	SB	1.30	3.00	2.80	4.90
	EI	2.70	5.00	8.60	12.20
	MD	1.90	7.40	7.80	12.10
NPK	BT	2.00	4.80	2.90	4.40
	TIS	1.80	4.00	7.50	9.20
	KJ	2.50	4.70	6.30	7.70
	SB	2.00	2.70	3.70	6.10
LSD ($p \leq 0.05$)		0.76	1.92	2.48	3.45

EI- Ex-Igborian; MD- Mother delight; BT- Butter; TIS- Tis82/0087; KJ- King Jane; SB- Shaba
LSD-Least Significant difference

3.3. Number of Leaves

The number of leaves increased as the applied fertilizer rate increases (Table 3). The NPK fertilizer application significantly ($p \leq 0.05$) influenced number of leaves, especially at 4 and 6 weeks after planting (WAP). The plants treated with NPK recorded the highest number of leaves than the control, although the difference was not significant at 10 WAP. Among varieties, Ex-Igborian and Mother Delight consistently produced the highest number of leaves, while Butter gave the lowest leaf count. The interaction of fertilizer and variety was significant with respect to number of leaves from 4 - 10 WAP (Table 4). Both varieties; Ex-Igborian and Mother delight with no application of fertilizer had the highest number of leaves, followed by Tis 82/0087, while the least leaf number was Butter with no fertilizer at 10 WAP.

Table 3. *Main impact of fertilizer and variety on the number of leaves at various sampling occasions.*

	Number of leaves			
	Weeks after planting			
Treatments	**4**	**6**	**8**	**10**
Fertilizer Control	27.60	29.20	30.10	35.60
NPK	33.20	34.10	32.40	40.50
LSD ($p \leq 0.05$)	3.43	4.24	ns	ns
Variety				
EI	34.70	42.30	43.50	50.00
MD	35.20	39.10	43.10	54.70
BT	26.20	24.30	22.70	27.20
TIS	23.10	23.30	28.50	34.60

	Number of leaves			
	Weeks after planting			
Treatments	**4**	**6**	**8**	**10**
KJ	34.00	30.90	27.00	31.20
SB	29.10	29.70	22.80	30.50
LSD (p≤0.05)	5.95	7.35	6.84	10.17

EI- Ex-Igborian; MD- Mother delight; BT- Butter; TIS- Tis82/0087; KJ- King Jane; SB- Shaba
LSD-Least Significant difference

Table 4. *Interaction effect of fertilizer and variety on the number of leaves at various sampling occasions.*

		Number of leaves			
		Weeks after planting			
Fertilizer	**Variety**	**4**	**6**	**8**	**10**
Control	EI	31.70	38.10	40.30	47.20
	MD	34.10	39.50	43.30	51.40
	BT	22.90	21.20	21.10	25.40
	TIS	22.20	21.20	28.40	33.00
	KJ	28.80	29.20	25.30	28.90
	SB	25.70	25.60	22.40	27.70
NPK	EI	37.70	46.60	46.70	52.90
	MD	36.30	38.80	42.80	58.00
	BT	29.40	27.40	24.30	29.00
	TIS	23.90	25.40	28.60	36.10
	KJ	39.30	32.60	28.80	33.50
	SB	32.50	33.80	23.30	33.40
LSD (p≤0.05)	8.41	10.39	9.67	14.38	

EI- Ex-Igborian; MD- Mother delight; BT- Butter; TIS- Tis82/0087; KJ- King Jane; SB- Shaba
LSD-Least Significant difference

3.4. Vine Length

The vine length of sweet potato plants increased consistently with sampling periods (Table 5). The plants under NPK fertilizer treatment produced much longer vines across sampling periods. Mother Delight gave the longest vines, followed closely by Ex-Igborian, while Butter and Shaba varieties produced lowest values. The interaction of fertilizer and variety was significant (p≤0.05) as regards with vine length of sweet potato from 4 - 10 WAP (Table 6). Mother delight and Tis 82/0087 with no application of fertilizer had the longest vines, followed by Ex-Igborian, and the shortest vines were observed from variety King Jane and Shaba at 10 WAP.

Table 5. Main impact of fertilizer and variety on the vine length at various sampling occasions.

	Vine length (cm)			
	Weeks after planting			
Treatments	**4**	**6**	**8**	**10**
Fertilizer Control	17.60	33.20	45.50	50.60
NPK	23.20	48.00	52.90	59.90
LSD (p≤0.05)	4.46	8.18	ns	ns
Variety				
EI	18.30	42.20	55.90	67.50
MD	33.60	64.60	78.30	84.60
BT	15.70	28.00	33.00	37.60
TIS	21.40	43.80	53.60	61.80
KJ	18.60	39.70	42.60	42.10
SB	14.50	25.00	31.80	37.80
LSD (p≤0.05)	7.72	14.16	18.00	22.17

EI- Ex-Igborian; MD- Mother delight; BT-Butter; Tis82/0087; KJ- King Jane; SB- Shaba
LSD-Least Significant difference

Table 6. Interaction effect of fertilizer and variety on the vine length at various sampling occasions.

		Vine length (cm)			
		Weeks after planting			
Fertilizer	**Variety**	**4**	**6**	**8**	**10**
Control	EI	17.20	37.10	47.20	56.90
	MD	33.30	57.70	70.80	78.10
	BT	12.90	22.80	34.20	36.10
	TIS	18.00	35.90	53.30	63.30
	KJ	12.50	25.30	40.00	34.20
	SB	11.40	20.10	27.60	34.70
NPK	EI	19.40	47.30	64.50	78.00
	MD	34.00	71.50	85.80	91.10
	BT	18.40	33.20	31.90	39.20
	TIS	24.80	51.70	53.90	60.40
	KJ	24.60	54.10	45.30	50.00
	SB	17.70	29.90	36.10	40.90
LSD (p≤0.05)		10.91	20.03	25.46	31.35

EI- Ex-Igborian; MD- Mother delight; BT- Butter; TIS- Tis82/0087; KJ- King Jane; SB- Shaba
LSD-Least Significant difference

3.5. Yield and Yield Attributes

3.5.1. Number of Tubers

Application of NPK fertilizer significantly ($p \leq 0.05$) increased the number of tubers per plot, with plants under fertilizer treatments yielding the highest value of 15.60 tubers compared to 12.60 tubers in the control group. However, no significant varietal effect was identified on the number of tubers among the different sweet potato varieties. The interaction of fertilizer and variety was not significant with respect to number of tubers of sweet potato (Table 8).

3.5.2. Tuber Diameter and Length

NPK fertilizer treatment had a significant ($p \leq 0.05$) influence on both the tuber diameter and length. Sweet potatoes plants under NPK application exhibited an average tuber diameter of 25.20 cm and length of 17.60 cm, whereas the control plants had a diameter of 21.70 cm and length of 15.90 cm. Among the varieties, Ex-Igborian produced the biggest tubers with a diameter of 27.70 cm, while Shaba and Butter had the smallest tuber diameters.

3.5.3. Tuber Weight and Total Tuber Yield

Application of NPK fertilizer significantly ($p \leq 0.05$) influenced tuber weight and total yield of sweet potato. Ex-Igborian produced the highest tuber weight and total yield at 2.40kg and 19.83t/ha. while the lowest were from Tis 82/0087 (1.20kg and 9.92 t/ha) respectively.

The interaction between fertilizer and variety was significant with respect to tuber weight although the total yield of sweet potato was similar.

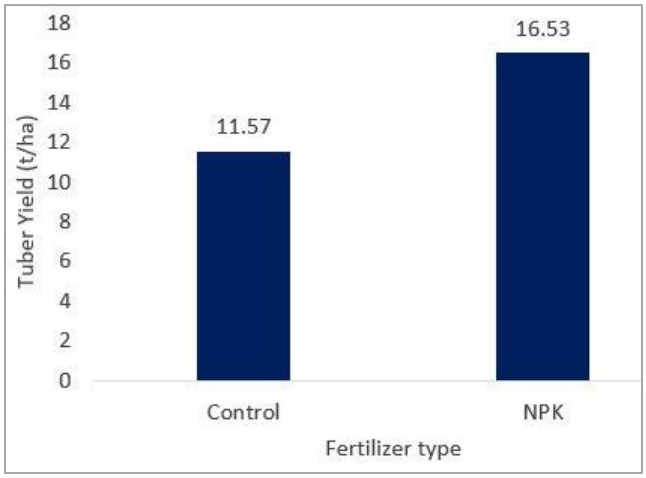

Figure 1. *Main impact of Fertilizer on Tuber yield (t/ha).*

Table 7. *Main impact of fertilizer and variety on the tuber number, diameter, tuber length and weight.*

Treatments	No of tuber	Tuber diameter cm/tuber	Tuber length	Tuber weight kg/plant
Control	12.60	21.70	15.90	1.40
NPK	15.60	25.20	17.60	2.00
LSD ($p \leq 0.05$)	2.08	3.89	2.22	0.58
Variety				
EI	13.00	27.70	19.10	2.40
MD	14.70	25.50	17.80	2.00
BT	15.20	20.30	15.50	1.50
TIS	13.00	25.50	15.60	1.20
KJ	15.50	21.40	16.30	1.60
SB	13.20	20.20	16.00	1.60
LSD ($p \leq 0.05$)	ns	6.74	ns	1.01

EI- Ex-Igborian; MD- Mother delight; BT- Butter; TIS- Tis82/0087; KJ- King Jane; SB-Shaba
LSD-Least Significant difference

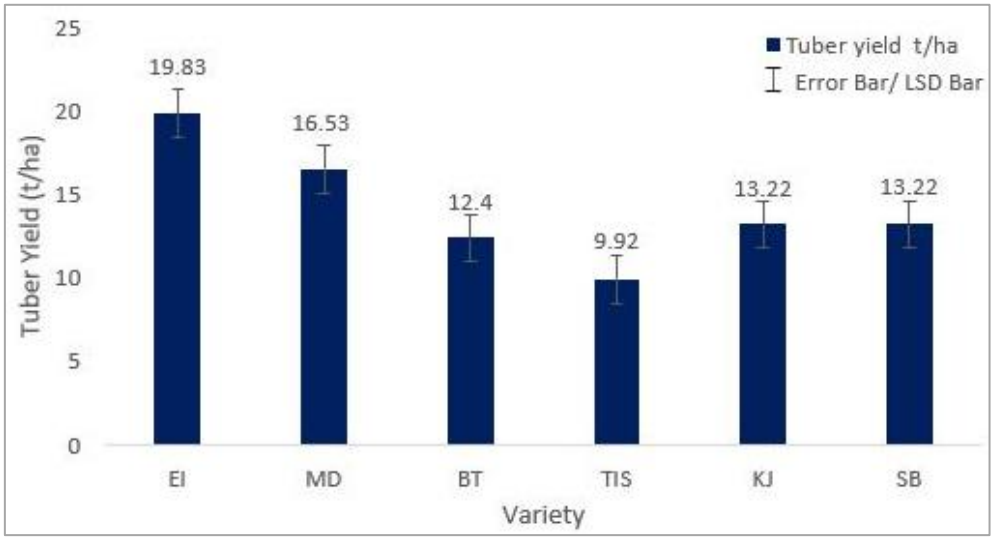

Figure 2. *Main impact of Variety on Tuber yield (t/ha).*

3.6. Interaction of Fertilizer and Variety on Yield Attributes

The interaction effect of fertilizer and variety had significant ($p \leq 0.05$) influence on the tuber length, tuber weight and total tuber yield of sweet potato. The highest number of tuber was obtained from Mother Delight with and without NPK application. Ex-Igborian followed by Mother Delight recorded highest tuber diameter, length, weight and total yields with and without NPK fertilizer application.

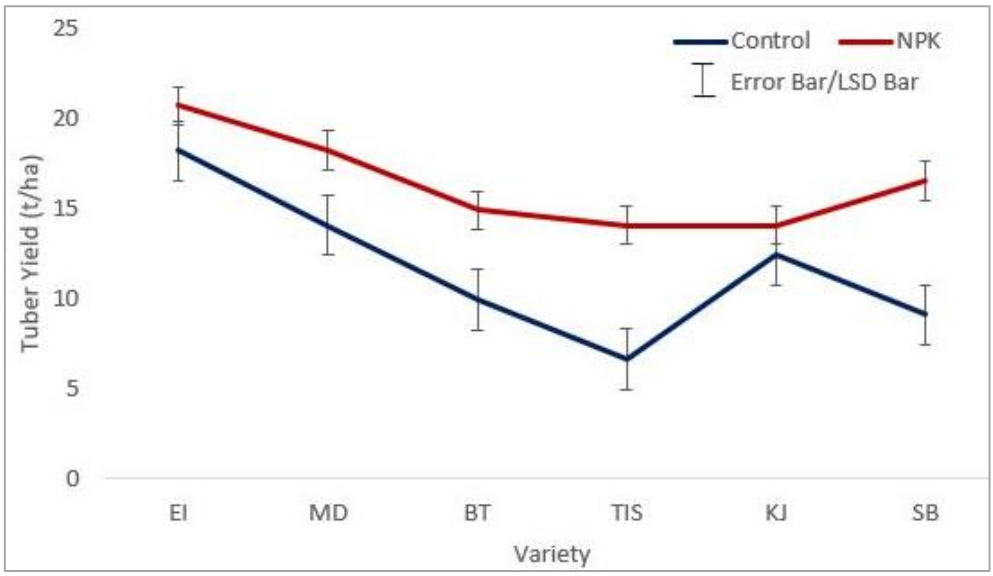

Figure 3. *Interaction effect of fertilizer and variety on Tuber yield (t/ha).*

Table 8. *Interaction effect of fertilizer and variety on number of tuber, tuber diameter, tuber length and tuber weight.*

Interaction			Tuber diameter	Tuber length	Tuber weight
Fertilizer	**Variety**	**No of tuber**	**cm/tuber**		**kg/plant**
Control	EI	11.70	26.50	17.50	2.20

Interaction			Tuber diameter	Tuber length	Tuber weight
Fertilizer	Variety	No of tuber	cm/tuber		kg/plant
	MD	14.00	22.70	16.40	1.70
	BT	12.00	19.00	14.80	1.20
	TIS	11.30	24.50	16.50	0.80
	KJ	13.70	19.40	15.60	1.50
	SB	12.70	17.90	14.50	1.10
	EI	14.30	28.80	20.80	2.50
NPK	MD	17.30	28.30	19.20	2.20
	BT	16.30	21.60	16.20	1.80
	TIS	14.70	26.60	14.80	1.70
	KJ	17.30	23.40	17.00	1.70
	SB	13.70	22.50	17.50	2.00
LSD ($p \leq 0.05$)	ns	ns	5.45	1.43	

EI- Ex-Igborian; MD- Mother delight; BT- Butter; TIS- Tis82/0087; KJ- King Jane; SB- Shaba
LSD-Least Significant difference

4. Discussion

4.1. Growth Parameters

The use of NPK fertilizer led to major benefits in plant development, including increased vine length, number of leaves, and number of branches. These findings coincide with earlier research that suggests the favorable function of nutrient management in boosting the vegetative development of crops, particularly in nutrient-depleted soils like those seen in many regions of Nigeria [9, 11].

The increase in the number of branches and vine length in response to NPK fertilizer is consistent with the concept that nitrogen, phosphorus, and potassium are important nutrients that stimulate vegetative development. Nitrogen is particularly vital for vegetative development, boosting the plant's capacity to create leaves and branches, while phosphorus helps root development and potassium aids in general plant health and stress tolerance [10, 17]. The maximum number of branches and vine length recorded in varieties like Ex-Igborian and Mother Delight, particularly under fertilized circumstances, indicated the better development potential of these kinds when fed with enough nutrients. This research shows that these varieties might be more sensitive to fertilizer treatment, making them suited for cultivation in locations with nutrient-poor soils. The number of leaves per plant was substantially higher in fertilized plots compared to the control. This is in accordance with earlier researchers observations indicating that fertilizer treatment promotes leaf formation, which is critical for photosynthesis and overall plant output [19].

4.2. Yield Parameters

In terms of yield, the use of NPK fertilizer considerably enhanced the number of tubers, tuber diameter, and tuber length. The bigger and more numerous tubers seen in the treated plots show the good effects of fertilizer on tuber formation and growth. Previous studies have similarly reported that effective nutrition management boosts tuber output by enhancing both vegetative development and nutrient allocation to storage organs [18]. The variety Ex-Igborian, in instance, displayed the biggest tuber diameter, followed by Mother Delight, possessed great production potential and might be suggested for places with fertile soils and appropriate water availability to enhance their output. The smaller tubers produced by varieties like Butter and Shaba, especially under the control treatment, may reflect their lower fertility requirements or less capacity to respond to fertilizer compared to more sensitive types. However, despite these variances, all varieties demonstrated enhanced tuber production with fertilizer treatment, showing the necessity of nutrient supplementation for optimal yield potential.

4.3. Varietal Response to Fertilizer Application

The interaction between fertilizer and variety was significant for most growth indices, demonstrating that different varieties respond differently to nutrient inputs. Mother Delight and

Ex-Igborian displayed improved growth and production in fertilized circumstances, suggesting that these cultivars may be better adapted to high-input farming methods. In contrast, cultivars like Butter and Shaba exhibited lower responses, suggesting that they may be better suited to low-input, organic farming systems where fertilizer application is minimal or nonexistent. This heterogeneity in response underlines the necessity of selecting appropriate types depending on local soil conditions and fertilization strategies [1, 13].

5. Conclusion & Recommendation

This study showed that the use of NPK fertilizer significantly improves the development and yield of sweet potato varieties in Ogbomoso, Nigeria. Sweet potato plants under NPK application revealed considerable gains in vine length, leaf count, branch number, and tuber characteristics, with Ex-Igborian and Mother Delight varieties reacting most favorably. These findings underscore the relevance of balanced applied fertilizer in resolving nutrient limits, boosting sweet potato yield, and contributing to food security initiatives in locations with similar agro-ecological characteristics. The strong relationship between variety and fertilizer treatment shows that careful selection of fertilizer-responsive cultivars, such as Ex-Igborian and Mother Delight, might further enhance productivity. For farmers in nutrient-deficient locations, blending NPK fertilizer with adaptable sweet potato varieties such as Ex-Igborian and Mother Delight may lead to sustainable output gains. Future study should focus on developing alternate organic fertilizer application options to enable sustainable sweet potato growing for smallholder farmers in low-input settings.

Abbreviations

ANOVA	Analysis of Variance
BT	Butter
CM	Centimetre
EI	Ex-Igborian
KG	Kilogramme
KJ	King Jane
LSD	Least Significant Difference
MD	Mother Delight
MM	Millimetre
MOP	Muriate of Potash
NPK	Nitrogen Phosphorus and Potassium
SB	Shaba
SSP	Single Super Phosphate
TIS	Tis82/0087
WAP	Weeks After Planting

Author Contributions

Deborah Oluwasemilore Oni: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Resources, Visualization, Writing – original draft, Writing – review & editing

Joel Oyekunle Olaniyi: Conceptualization, Project administration, Supervision, Validation, Writing – review & editing

Conflicts of Interest

The authors declare no conflict of interest.

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Biography

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