



## AGRO-MORPHOLOGICAL EVALUATION AND IDENTIFICATION OF HIGH MARKETABLE ROOT YIELDING SWEET POTATO (*Ipomea batata* L.)

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### ABSTRACT

A field experiment was conducted in three diverse agroecological zones of Nigeria for two consecutive years to evaluate and identify high marketable root-yielding sweet potato accessions in Nigeria. The 21 sweet potato accessions used for the research were collected from various agroecological zones in Nigeria. The experiment was laid out in a randomized complete block design with three replicates. Data were collected on main vine length (cm), number of branches per plant, number of leaves per plant (cm), petiole length (cm), number of marketable roots per plant, number of unmarketable roots per plant, marketable root length (cm), marketable root diameter (cm) and marketable root weight per plant (g) and analyzed using IRRI STAR software. The result shows that accessions from Offa (980.41 g) had the highest marketable root weight followed by Otukpo (801.76 g), Alero (790 g), Ilorin (730 g) and Suleja (720 g) respectively. It is recommended that accessions from Offa, Otukpo, Alero, Ilorin and Suleja should be used as donors in breeding programs for developing high root-yielding sweet potato cultivars and sweet potato growers should be using them as planting materials for high marketable root yield pending the time-improved varieties will be readily accessible to farmers from the concerned research bodies.

**Keywords:** Accessions, Agroecology, Zone, Root, Yield.

### INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is a short-time maturing arable food crop that is cultivated in all the agroecological zones in Nigeria for its edible roots and tender leaves (Meng *et al.*, 2024). However, low root yield accessions in farmers' possession have been a significant setback to its production. The crop is grown in all the states in Nigeria (Abah *et al.*, 2022) though most growers did not commercialize its production compared to other crops like yam, rice, cowpea, and cassava. It is commercially propagated by vine. The colour of crop leaves, flesh and skin varies (Yusuf *et al.*, 2024). The crop is a creeper that can be intercropped with other arable crops. It is grown for its nutritious tender leaves and roots. The roots are processed into different forms domestically; they can be boiled alone or with other food like African yam beans, spiced and fried, boiled and pounded alone or with boiled yam or roasted (Agbowuro *et al.*, 2021). It also serves as a source of raw materials for various industries (Falade and Agbowuro, 2024). The roots yield quality starch, fermented products like ethanol, acetone, butanol and natural colourant (Duvernaya *et al.*, 2013). The food industries mill the root into flour for snack production and baby and dog weaning food. The fresh leaves, petiole and tender vines are consumed as vegetables. The aboveground vegetative parts are used as fodder for livestock. The crop contains vitamins, minerals, carbohydrates and antioxidant compounds (Alam, 2021). The leaf is one of the main constituents of herbal medicine used in the prevention and treatment of various diseases like inflammation, diabetes, hypertension etc (Behera *et al.*, 2022). Sweet potato can be grown to maturity within three to four months. It is not photosensitive; this shows that it can be grown twice in a year (early and late cropping seasons). However, if irrigation facilities are available, it can be grown three times a year.

The short maturity period of the plant, ability to adapt to drought, production of edible leaves and root for man and livestock, ease of propagation and processing, and affordability make it a suitable crop to combat the challenge of food insecurity in the face of climate change (Daniel *et al.*,



2024; Adewumi *et al.*, 2018). Despite the great potential the crop offered in strengthening food security and sustainability, the low yield has been a major discouraging factor, especially in farmer plots where good agronomic practices were not adequately adopted. Omoare *et al.* (2016) reported that Nigeria is one of the nations that experience the lowest average marketable sweet potato root yield globally. The marketable sweet potato root yield recorded in Nigeria is abysmal compared with the United States of America and Japan (Abah *et al.*, 2022). The low average sweet potato root yield per hectare in Nigeria is attributed to poor marketable root yield accessions grown by Nigerian farmers. However, there is a need for a sustainable increase in the crop yield per hectare to meet the ever-increasing national population (Bako *et al.*, 2025).

This research aimed at evaluating and identifying sweet potato accessions with high root yield potential. The accession(s) with high marketable root yield identified will be used as a donor in a breeding programme to develop high root-yielding varieties and also recommended to farmers for cultivation.

## **MATERIALS AND METHODS**

### **Description of the Study Sites**

The multi-locational research was conducted in three diverse agroecological zones of Nigeria for two consecutive rainy seasons between 2023 and 2024. The three environments with their agroecological zones were; Oro Farm Cluster, Oro, Kwara State (Southern Guinea Savanna); Laje Farm Settlement, Ondo-City Ondo State (Evergreen Rainforest); Agricultural Demonstration Plot, Department of Crop, Horticulture and Landscape Design, Ekiti State University, Ado-Ekiti (Derived Guinea Savanna). The topography at all the experimental sites were moderately flat.

The experimental site at Oro Farm Cluster was predominantly occupied by guinea grass and some stands of goat and siam weeds with few shrubs. The site has been allowed to fallow for three years before the experiment. The research site at Laje Farm Settlement has very thick vegetation dominated by Siam weed and Mexican sunflower. The site has been left uncultivated for four years. The site at the Agricultural Demonstration Plot of the Department of Crop, Horticulture and Landscape Design, Ekiti State University, Ado-Ekiti has been previously used for the cultivation of vegetables and cowpeas and left to fallow for two years before the experiment. Table 1 presents the soil physiochemical properties of the experimental sites for the two seasons.

### **Plant Materials**

The plant materials used for the experiment consist of 21 sweet potato accessions obtained from local farmers across different agroecological zones in Nigeria to ensure genetic diversity. The accessions were named against the place of their collection. The collections were morphologically screened a season before the commencement of the research to ensure the genetic diversity of the accessions. Table 2 presents the list of the accessions used for the research and their place of collection.

**Table 1:** Some Physico-chemical Properties of Soil at the Experimental Sites

Properties	Values					
	Ado Ekiti		Oro		Laje	
	First Year	Second Year	First Year	Second Year	First Year	Second Year
Textural Class	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Clay loam	Clay loam
pH (H <sub>2</sub> O)	5.60	5.16	5.61	5.04	5.63	5.81
Organic Carbon (%)	1.84	1.43	1.54	1.04	1.40	1.00
Organic Matter (%)	1.90	2.01	1.84	1.90	1.70	1.81
Nitrogen (%)	1.67	1.76	1.91	1.81	1.63	1.95
Phosphorus (mgkg <sup>-1</sup> )	9.54	10.64	8.11	9.13	8.94	10.18
Ca <sup>2+</sup> (cmolkg <sup>-1</sup> )	1.67	1.36	1.63	1.11	1.73	1.34
Mg <sup>2+</sup> (cmolkg <sup>-1</sup> )	0.91	0.84	0.90	0.85	0.77	0.61
K <sup>+</sup> (cmol kg <sup>-1</sup> )	0.13	0.11	0.10	0.09	0.12	0.89

**Table 2:** List of 21 Sweet Potato Accessions Evaluated for Vegetative and Yield Performance and their Place of Collection

S/N	Accession Name	Place of Collection	S/N	Accession Name	Place of Collection
1.	Uromi	Uromi, Edo State	12.	Ijebu- Ode	Ijebu- Ode, Ogun State
2.	Esa Oke	Esa Oke, Osun State	13.	Jalingo	Jalingo, Taraba State
3.	Offa	Offa, Kwara State	14.	Ayingba	Ayingba, Kogi State
4.	Ikole-Ekiti	Ikole-Ekiti, Ekiti State	15.	Alero	Alero, Kebbi State
5.	Minna	Minna, Niger State	16.	Dangi	Dangi, Plateau State
6.	Kaduna	Kaduna, Kaduna State	17.	Gunki	Gunki, Nasarawa State
7.	Suleja	Suleja, Niger State	18.	Calabar	Calabar, Cross River State
8.	Otukpo	Otukpo, Benue State	19.	Abakaliki	Abakaliki, Ebonyi State
9.	Yola	Yola, Adamawa State	20.	Damaturu	Damaturu, Yobe State
10.	Zango	Zango, Katsina State	21.	Sokoto	Sokoto, Sokoto State
11.	Ilorin	Ilorin, Kwara State			

**Note:** The sweet potato accessions were named against their place of collection.

### Experimental Design and Trial Establishment

The experiment was laid out in a Randomized Complete Block Design with three replicates. The experimental sites were manually cleared, packed and ridged. Each experimental unit was 10 metres long. A spacing of 1 x 1 m was adopted. Good agronomic practices were adopted in all the experimental sites.

### Data Collection and Analysis.

Data were collected on vine length (cm), number of branches per plant, number of leaves per plant, petiole length (cm), number of marketable roots per plant, number of unmarketable roots per plant, marketable root lengths (cm), marketable root diameter (cm), marketable root weight per plant (g). Data collected were analysed using IRRISTAR Software (2014). The means were separated using the Duncan Multiple Range Test.

## RESULTS AND DISCUSSION

Table 3 presents the vegetative traits studied in 21 sweet potato accessions evaluated in three diverse agroecological environments for two years. There were significant differences ( $P < 0.05$ ) among the mean main vine length. The mean main vine length recorded ranges between Alero (83.94 cm) and Gunki (306.52 cm). Accession obtained from Gunki (306.52 cm) had the highest mean main vine length, followed by Jalingo (303.65 cm), Calabar (290.41 cm), Zango (241.78 cm) and Suleja (234.96 cm) respectively. This finding agreed with Nazrul (2018) and Shamil (2021) findings who reported significant variation in sweet potato vine length. The mean number of branches per plant was significantly different ( $P < 0.05$ ) among accessions studied. However, the mean number of branches per plant from accessions obtained from Esa-Oke, Offa, Kaduna, Suleja, Otukpo, Zango, Ilorin, Jalingo, Dangi, Calabar and Abakaliki were not significantly different. Accession from Ijebu-Ode (8.03) recorded the highest mean number of branches per plant while accession from Damaturu (2.09) had the least number of branches per plant. The mean numbers of leaves per plant were significantly different among the accessions studied. Accession from Alero (109.56) had the highest number of leaves per plant followed by Ayingba (107.53) and Dangi (98.56) respectively. However, the three accessions (Alero, Ayingba and Dangi) were not significantly different from each other statistically. Reddy *et al.* (2017) reported some level of variability in vegetative parts of sweet potato which include the number of leaves per plant and vine length in some sweet potato varieties under study. In egg plant, Aderemi *et al.* (2024) reported some level of significance ( $P < 0.05$ ) in the number of leaves per plant in egg plant. Reddy *et al.* (2017) findings conformed with the result of this research finding. Accession from Yola (51.03) recorded the least mean number of leaves per plant. Petiole length ranged from 6.88 and 15.07 cm. The level of significance ( $P < 0.05$ ) in all the vegetative traits studied shows the extent of genetic diversity among these accessions. The roles vegetative parts played in root development in sweet potato cannot be underestimated. The number of leaves, vine

length, petiole length, and leaf area play a vital role in marketable root development. These vegetative variables assist in sunlight interception leading to a high photosynthetic rate (Esan *et al.*, 2018). Thus, dry matter production will be enhanced. The level of significance in different accessions could be attributed to their genetic makeup (Agbowuro *et al.*, 2021). These levels of variability indicated positive varietal improvement opportunities in the crop (Akinyosoye *et al.*, 2017).

**Table 3:** Mean Performance of Sweet Potato Vegetative Traits Studied Across three Agro-ecological Zone

S/N	Accession Name	Main Vine Length (cm)	Number of Branches per Plant	Number of leaves per plant	Petiole Length (cm)
1.	Uromi	106.63 <sup>g</sup>	6.88 <sup>b</sup>	86.91 <sup>b</sup>	8.64 <sup>d</sup>
2.	Esa Oke	173.95 <sup>d</sup>	4.05 <sup>e</sup>	90.42 <sup>b</sup>	7.42 <sup>e</sup>
3.	Offa	206.62 <sup>c</sup>	3.81 <sup>e</sup>	71.63 <sup>c</sup>	6.88 <sup>e</sup>
4.	Ikole-Ekiti	126.75 <sup>e</sup>	4.86 <sup>d</sup>	68.12 <sup>c</sup>	8.39 <sup>d</sup>
5.	Minna	196.11 <sup>d</sup>	5.91 <sup>c</sup>	88.09 <sup>b</sup>	10.42 <sup>c</sup>
6.	Kaduna	209.53 <sup>c</sup>	3.85 <sup>e</sup>	90.41 <sup>b</sup>	10.05 <sup>c</sup>
7.	Suleja	234.96 <sup>b</sup>	3.13 <sup>e</sup>	60.86 <sup>c</sup>	8.74 <sup>d</sup>
8.	Otukpo	219.90 <sup>c</sup>	4.09 <sup>e</sup>	64.53 <sup>c</sup>	10.32 <sup>c</sup>
9.	Yola	190.41 <sup>d</sup>	5.03 <sup>d</sup>	51.03 <sup>d</sup>	10.05 <sup>c</sup>
10.	Zango	241.78 <sup>b</sup>	3.12 <sup>e</sup>	94.31 <sup>b</sup>	10.52 <sup>c</sup>
11.	Ilorin	209.67 <sup>c</sup>	3.67 <sup>e</sup>	83.56 <sup>b</sup>	9.90 <sup>e</sup>
12.	Ijebu- Ode	96.03 <sup>h</sup>	8.03 <sup>a</sup>	74.41 <sup>c</sup>	7.36 <sup>e</sup>
13.	Jalingo	303.65 <sup>a</sup>	3.21 <sup>e</sup>	50.14 <sup>d</sup>	12.04 <sup>b</sup>
14.	Ayingba	254.92 <sup>b</sup>	2.00 <sup>g</sup>	107.53 <sup>a</sup>	6.34 <sup>e</sup>
15.	Alero	83.94 <sup>h</sup>	6.15 <sup>b</sup>	109.65 <sup>a</sup>	12.68 <sup>b</sup>
16.	Dangi	211.93 <sup>c</sup>	3.67 <sup>e</sup>	98.56 <sup>a</sup>	10.83 <sup>c</sup>
17.	Gunki	306.52 <sup>a</sup>	4.82 <sup>d</sup>	91.54 <sup>b</sup>	11.53 <sup>c</sup>
18.	Calabar	290.41 <sup>a</sup>	3.67 <sup>e</sup>	61.96 <sup>c</sup>	15.07 <sup>a</sup>
19.	Abakaliki	123.64 <sup>a</sup>	3.11 <sup>e</sup>	88.70 <sup>b</sup>	11.48 <sup>c</sup>
20.	Damaturu	102.93 <sup>g</sup>	2.90 <sup>f</sup>	106.92 <sup>d</sup>	14.06 <sup>a</sup>
21.	Sokoto	157.90 <sup>d</sup>	4.67 <sup>d</sup>	90.63 <sup>b</sup>	8.90 <sup>d</sup>
	SE (±)	1.56	0.05	1.14	0.51
	LS	*	*	*	*

**Note:** Means with the same letter (s) in each column are not significantly different ( $P < 0.05$ ) according to Duncan's Multiple Range Test (DMRT), LS: level of significance, SE(±): standard error and \* significant at 0.05 probability level.

Marketable root has the most economic value to most sweet potato growers. However, the leaves were consumed by some locals based on preferences or food sources during famine and used as fodder. The diverse uses of the leaves are less important to the majority of sweet potato growers. Thus, they tend to seek for high marketable root-yielding sweet potato cultivars.

The root yield and root yield-related traits in 21 sweet potato accessions evaluated in three diverse agroecological environments for two years are shown in Table 4. There were significant differences ( $P < 0.05$ ) in the number of marketable roots per plant among the 21 sweet potato accessions. The mean number of marketable roots per plant ranges from Damaturu (1.78) to Offa (6.16). The 21 accessions were statistically grouped into six; accessions from Offa and Yola were grouped, Kaduna, Otukpo, Ayingba, and Gunki were grouped, Ikole-Ekiti, Minna, Suleja, Ilorin, Dangi, Calabar, and Abakaliki were group together. Uromi, Esa-Oke, Zango, and Sokoto were grouped. Ijebu-Ode, Jalingo and Alero were in the same category. This result shows the extent of variation in these accessions, and these variations could be attributed to the genetic makeup of these accessions. The number of unmarketable root yield per plant varied significantly ( $P < 0.05$ ). It ranges from Ijebu-Ode (1.05) to Damaturu (4.41). Accessions from Damaturu, Alero and Uromi have the potential to produce a high number of roots but only a few could develop to a marketable root size. However, accession from Offa and Dangi produced a high number of roots and a greater percentage



of the roots developed to marketable size. The marketable root length and diameter range from Kaduna (7.83 cm) and Offa (18.53 cm), and Uromi (5.10 cm) and Offa (10.62 cm) respectively. The shape and size of the marketable root of each accession dictate their length and diameter. There were significant differences ( $P < 0.05$ ) in marketable mean root weight per plant among the 21 sweet potato accessions. Offa had the highest mean marketable root weight per plant value followed by Otukpo, Alero, Ilorin, Suleja, Gunki, Dangi, Yola, Ikole-Ekiti, Calabar, Zango, Kaduna, Ayingba, Abakaliki, Minna, Sokoto, Esa-Oke, Uromi, Ijebu-Ode, Damaturu and Jalingo respectively. These results are in agreement with the findings of Gobena *et al.* (2022) and Mohammed (2018) who reported that variability exists in sweet potato root yield. The high mean value for the numbers of marketable roots and root weight in accession from Offa, Kwara State could be the reason for the high sweet potato production rate in the axis (Yusuf *et al.*, 2024).

**Table 4:** Performance of Sweet Potato Root Yield and Yield Related Traits Studied Across Three Agro-ecological Zones

S/N	Accession Name	Number of marketable roots per plant	Number of unmarketable roots per plant	Marketable root length (cm)	Marketable root diameter (cm)	Marketable root weight per plant (g)
1.	Uromi	3.60 <sup>d</sup>	2.56 <sup>d</sup>	7.84 <sup>e</sup>	5.10 <sup>d</sup>	280.73 <sup>h</sup>
2.	Esa Oke	3.42 <sup>d</sup>	1.96 <sup>e</sup>	11.61 <sup>d</sup>	7.84 <sup>b</sup>	302.43 <sup>g</sup>
3.	Offa	6.16 <sup>a</sup>	4.22 <sup>a</sup>	18.53 <sup>a</sup>	10.62 <sup>a</sup>	980.41 <sup>a</sup>
4.	Ikole-Ekiti	4.30 <sup>c</sup>	1.96 <sup>e</sup>	8.42 <sup>e</sup>	8.11 <sup>b</sup>	520.50 <sup>e</sup>
5.	Minna	4.04 <sup>c</sup>	2.86 <sup>c</sup>	12.30 <sup>d</sup>	10.23 <sup>a</sup>	390.13 <sup>f</sup>
6.	Kaduna	5.18 <sup>b</sup>	1.45 <sup>e</sup>	7.83 <sup>e</sup>	5.11 <sup>d</sup>	420.64 <sup>f</sup>
7.	Suleja	4.69 <sup>c</sup>	2.65 <sup>c</sup>	14.30 <sup>c</sup>	5.23 <sup>d</sup>	720.86 <sup>c</sup>
8.	Otukpo	5.32 <sup>b</sup>	1.98 <sup>e</sup>	10.36 <sup>e</sup>	7.38 <sup>b</sup>	801.76 <sup>b</sup>
9.	Yola	5.89 <sup>a</sup>	2.43 <sup>d</sup>	8.33 <sup>e</sup>	5.28 <sup>d</sup>	603.60 <sup>d</sup>
10.	Zango	3.68 <sup>d</sup>	1.87 <sup>e</sup>	10.64 <sup>e</sup>	6.23 <sup>c</sup>	500.43 <sup>e</sup>
11.	Ilorin	4.17 <sup>c</sup>	2.11 <sup>e</sup>	14.11 <sup>c</sup>	7.28 <sup>b</sup>	730.75 <sup>c</sup>
12.	Ijebu- Ode	2.19 <sup>e</sup>	1.05 <sup>a</sup>	16.34 <sup>b</sup>	8.11 <sup>b</sup>	214.09 <sup>i</sup>
13.	Jalingo	2.89 <sup>e</sup>	1.97 <sup>e</sup>	13.11 <sup>c</sup>	6.28 <sup>c</sup>	160.54 <sup>j</sup>
14.	Ayingba	5.41 <sup>b</sup>	2.54 <sup>d</sup>	10.11 <sup>e</sup>	6.11 <sup>c</sup>	420.12 <sup>f</sup>
15.	Alero	2.61 <sup>e</sup>	3.07 <sup>b</sup>	18.26 <sup>a</sup>	10.14 <sup>a</sup>	790.89 <sup>b</sup>
16.	Dangi	4.27 <sup>c</sup>	2.76 <sup>c</sup>	13.33 <sup>c</sup>	7.81 <sup>b</sup>	630.21 <sup>d</sup>
17.	Gunki	5.81 <sup>b</sup>	1.98 <sup>e</sup>	11.63 <sup>d</sup>	6.81 <sup>c</sup>	700.45 <sup>c</sup>
18.	Calabar	4.78 <sup>c</sup>	2.11 <sup>e</sup>	15.98 <sup>b</sup>	10.60 <sup>a</sup>	506.93 <sup>e</sup>
19.	Abakaliki	4.01 <sup>c</sup>	1.89 <sup>e</sup>	16.19 <sup>b</sup>	8.43 <sup>b</sup>	411.64 <sup>f</sup>
20.	Damaturu	1.78 <sup>f</sup>	4.41 <sup>a</sup>	10.65 <sup>e</sup>	7.45 <sup>b</sup>	211.76 <sup>i</sup>
21.	Sokoto	3.96 <sup>d</sup>	1.95 <sup>e</sup>	11.13 <sup>e</sup>	5.90 <sup>d</sup>	364.04 <sup>f</sup>
	SE ( $\pm$ )	0.34	0.21	0.41	0.33	1.05
	LS	*	*	*	*	*

**Note:** Means with the same letter (s) in each column are not significantly different ( $P < 0.05$ ) according to Duncan's Multiple Range Test (DMRT), LS: level of significance, SE( $\pm$ ): standard error and \* significant at 0.05 probability level.

## CONCLUSION AND RECOMMENDATIONS

This study revealed the extent of vegetative and marketable root yield variability in 21 sweet potato accessions evaluated. Accession from Offa had the highest mean root weight per plant followed by Yola, Otukpo, Alero, Suleja and Gunki respectively while Jalingo had the lowest mean root weight per plant followed by Damaturu and Uromi respectively. Accessions from Alero, Gunki, Ilorin, Offa and Otukpo recorded high mean values for both root weight per plant and mean numbers of leaves per plant. It is thereby recommended that sweet potato farmers that are primarily concerned about marketable root yield should be growing accessions from Offa, Yola, Otukpo, Alero, Suleja or Gunki while farmers that utilized both marketable root yield and the leaves should be growing



accession from Gunki, Ilorin, Offa and Otukpo in the agroecological zones where the experiment was conducted. However, accessions from Jalingo, Damaturu, Ijebu-Ode, Uromi, Esa-Oke and Sokoto should be avoided in these agroecological zones. Moreover, accessions from Offa, Yola, Otukpo, Alero, Suleja or Gunki should be used as donors in a breeding programme for developing high-root yielding sweet potato cultivars.

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