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# Evaluation of Some Orange-Fleshed Sweet Potato (OFSP) Accessions for Growth and Yield Potentials in Jos-Plateau Environment

*O.A.T. Namo O.J. Akinbola and G.O. Utoblo*

Cytogenetics and Plant Breeding Unit, Department of Plant Science and Technology, University of Jos, P. M. B. 2084, Jos, Plateau State, Nigeria

**Abstract:** The orange-fleshed sweet potato (OFSP) contains β-carotene, a precursor of Vitamin A, which is used to address hunger and blindness in children. Therefore, there is the need to promote the cultivation and consumption of the OFSP. In this study, twelve accessions of the orange-fleshed sweet potato (*Ipomoea batatas* (L.) Lam.), namely F2M5/3, Ng – Jay, MD, F1M1/4, ELINDA, SOUL, AI2IB, TIS. 87/0087/08, KWARA/00, F1M4/11, SOLO – 1/100 and SOLO – 1/144, were screened to evaluate their growth and yield potentials in the Jos-Plateau environment in Nigeria between July and November, 2016. The study was carried out at the potato sub-station of the National Root Crops Research Institute,Kuru, Plateau State (Latitude 09°44'N, Longitude 08° 47'E, Altitude 1,293.3 m above sea level). The twelve accessions were laid out in a randomized complete block design with four replications. Results showed that establishment rate ranged from 97.8 % in the accession SOUL to 30 % in the accession AI2IB. The leaf area index increased with time up to 90 DAP and thereafter decreased in all the accessions. The relative growth rate decreased with time in all accessions.The net assimilation rate (NAR) increased with time up to 90 DAP and thereafter decreased in all but accessions F2M5/3, MD, ELINDA, F1M4/11, SOLO – 1/100 and SOLO – 1/144, where NAR increased up to 120 DAP. The mean number of tubers per plant, tuber length, tuber girth and dry matter content varied with accession. Root-top ratio was highest in the accession Ng-Jay (3.93) and lowest in the accession AI2IB (0.69). Harvest index increased with time up to 120 DAP in all the accessions. Total tuber yield was highest in the accession Ng-Jay (8.2 t/ha) and lowest in the accession ELINDA (2.0 t/ha). The OFSP accessions used in this study showed promising potentials for high yields in the Jos-Plateau environment. They are, therefore, recommended for further screening and selection.

**Key words:** Orange-fleshed sweet potato (OFSP) · Growth · Yield · Accession

## INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam.) is a dicotyledonous plant that belongs to the morning glory family, Convolvulaceae. It is a vegetable with roots that are sweet-tasting, starchy and tuberous. It is native to the tropical regions in America and requires warm days and nights for optimum growth and root development. It yields more and better quality roots on well drained, light, sandy loam or silt loam soils [1, 2].

Sweet potato is reckoned to be one of the world's most important food crops and the tuber has been reported to be high in food value, fibre and energy [3]. Sweet potatoes have also been reported to contain a high level of vitamins A, C, B6, potassium, phosphorus and niacin [4]. Johnson and Pace [5] reported that the leaves of sweet potato contain high amounts of vitamins, minerals, antioxidants, dietary fibre and essential fatty acids which play a vital role in promoting health.

According to Philpott *et al*. [6], the commonly cultivated varieties of sweet potato include orange/copper skin with orange flesh, white/cream skin with white/cream flesh and red/purple skin with cream/white flesh. Most of the sweet potato cultivars are landraces that are white, cream or purple-fleshed with low beta-carotene content.

The orange-fleshed sweet potato has a nutritional advantage over white- or cream-fleshed sweet potato because their beta-carotene and, therefore, vitamin A content is higher. This is evidenced by the deep-orange colour of the tuber flesh, which is related to the higher

**Corresponding Author:** O.A.T. Namo, Cytogenetics and Plant Breeding Unit, Department of Plant Science and Technology, University of Jos, P. M. B. 2084, Jos, Plateau State, Nigeria.

beta-carotene and vitamin A content. The highest beta-carotene and vitamin A contents are found in the deepest or brightest orange-fleshed accessions [7].

In addition to providing high levels of vitamin A, the orange-fleshed sweet potato roots contain high levels of vitamins B, C, E and K, all of which help to protect the human body and enhance recovery from illness. Orange-fleshed sweet potato tubers also have high carbohydrate content, which is responsible for the production of high edible energy per hectare per day compared to other common sources of carbohydrate such as rice and maize [7].

Sweet potato is widely grown and consumed traditionally in its white-fleshed form, which does not offer the nutritional benefit of the orange-fleshed varieties. There is a need to increase the availability of the beta-carotene-rich, orange-fleshed varieties. The cultivation of orange-fleshed sweet potato genotypes with higher yields could improve the socio-economic conditions of the farming community as well as their nutritional status [8].

In Nigeria, most of the sweet potato landraces have white-fleshed tubers with negligible amount of the pro-vitamin A pigment. However, Ijeh and Ukpabi [9] reported that a popular local yellow-fleshed landrace, known as "Ex-Igbariam", has appreciable but relatively limited quantity of β-carotene (3 μg/g fresh root sample). Researchers have, therefore, advocated for an increase in the production and consumption of the orange- fleshed sweet potato [7]. The objective of this study was to evaluate the growth and yield potentials of some OFSP accessions in the Jos-Plateau environment.

## MATERIALS AND METHODS

The study was carried out in the field and in the laboratory. The field experiment was carried out at the Potato sub-Station of the National Root Crops Research Institute (NRCRI), Kuru, Plateau State (Latitude 09°44'N, Longitude 08° 47'E, Altitude 1,293.3 m above sea level).

Twelve (12) accessions of orange-fleshed sweet potato (OFSP) were sourced from the National Root Crops Research Institute (NRCRI), Umudike, Abia State. These include F2M5/3,Ng – Jay, MD,F1M1/4, ELINDA, SOUL, AI2IB,TIS.87/0087/08,KWARA/00,F1M4/11,SOLO–1/100 and SOLO – 1/144.

The accessions were laid out in a randomized complete block design (RCBD) with four replications. The fourth replication was used for the growth analysis studies. Ridging and plot mapping were done manually on July 6, 2016. The net plot size was 3 m x 3 m (9 $m^2$) while the gross plot size was 48 m x 17 m (816 $m^2$).

Planting was done on July 7, 2016. From each accession, 30 cuttings of about 30 cm long were planted in each plot at inter and intra row spacing of 1 m and 0.3 m, respectively, giving a total of 33, 333 plants per hectare. The plots were weeded manually at 31 and 66 days after planting (DAP) and then earthed up at 67 DAP.

Field observations and data collection were commenced 15 days after planting (DAP) and continued until harvest.

**Percentage Establishment:** The number of plants that were established was counted at 15 days after planting. The percentage establishment was computed as:

$$\text{Percentage Establishment} = \frac{\text{Number of cuttings established}}{\text{Total number of cuttings planted}} \times 100$$

**Petiole Length:** Petiole length was measured at 80 and 120 DAP. One plant was sampled from each plot from which the petiole lengths of five leaves were measured from the base to the canopy, using the measuring tape. The mean petiole length was used for the statistical analysis.

**Vine Length:** Vine length was measured at 80 and 120 DAP. Two plants were sampled from each plot and tagged for this purpose. Each plant was measured with a measuring tape from the base to the terminal leaf. The mean was used for the statistical analysis.

**Leaf Area Index (LAI):** Leaf area index was measured using the leaf-disc method [10]. The method involves the removal of leaves from the sampled plant from each plot, determination of the total dry weight and of the area/weight relationship of a sub-sample taken from the mass of leaves with a punch of a known diameter. The cross-sectional area of the punch used in this study was 1.77$cm^2$. Fifty discs were taken from each sample and placed in envelopes for drying to constant weight in a moisture-extraction oven at 100°C for 48 hours. The rest of the leaves along with the remains of the punched leaves were put into separate envelopes and dried at the same temperature and time. Leaf area index was then computed using the formula:

$$\text{LAI} = \frac{\text{Area of 1 disc X No of discs X Total leaf dry weight /Land area occupied by sampled plant}}{\text{Dry weight of leaf discs}}$$

**Date to Flowering:** The date to flowering was recorded as the number of days from planting to the onset of flowering in each plot.

**Relative Growth Rate (RGR):** The relative growth rate was computed on the basis of increase in dry weight of the plant parts over a fixed period, using the formula:

$$\text{RGR} = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

where,
$W_1$ and $W_2$ = Total dry weight at times $t_1$ and $t_2$.
ln = Natural Logarithm

**Net Assimilation Rate:** Net assimilation rate, defined as the rate of increase in dry weight per unit leaf area, was calculated from the data obtained on dry weight of plants using the method proposed by Gregory [11] as cited by Namo [10].

$$\text{NAR} = \frac{W_2 - W_1 \text{ Loge } L_2 - \text{Loge } L_1}{t_2 - t_1 \text{ X } L_2 - L_1}$$

where,
$W_1$ and $W_2$ are total plant dry weights at times $t_1$ and $t_2$, respectively.
$L_1$ and $L_2$ are leaf area at $t_1$ and $t_2$.
Loge $L_2$ – Loge $L_1$ are the natural logarithm of the leaf area.

**Stand Count at Harvest:** At harvest, the total number of plant stands in each plot was counted and recorded.

**Mean Number of Tubers per Plant:** The total number of tubers harvested in each plot was divided by the number of plant stands at harvest to obtain the mean number of tubers per plant.

**Root-Top Ratio (RTR):** After harvest, the vines (top) and the tubers (root) from each plot were weighed separately. The ratio of the weight of the tubers to that of the vines was calculated as the root-top ratio using the formula:

$$\text{Root-top ratio} = \frac{\text{Weight of tubers}}{\text{Weight of vines}}$$

**Tuber Length and Tuber Girth:** Three (3) tubers were sampled from each plot, the length of each of which was measured, using a measuring tape.The tubers used in the measurement of the length were also used for the measurement of tuber girth. Tuber girth was measured at the widest portion of the tuber.

**Harvest Index:** The harvest index (HI) was computed at 45, 90 and 120 days after planting as follows:

$$\text{H.I.} = \frac{\text{Dry weight of tubers}}{\text{Total dry matter}}$$

**Dry Matter Content (DM):** Ten (10) grams of fresh tubers was taken from the harvested tubers in each plot, weighed and dried in a moisture-extraction oven to constant weight at 100°C for 48 hours. The dry matter percentage (DM %) was then computed as follows:

$$\text{DM\%} = \frac{b}{a} \text{ x } 100$$

where,
a = fresh weight of sample
b = dry weight of sample.

**Total Tuber Yield:** All the tubers harvested from each plot were weighed and the weight was converted to the equivalent in tonnes per hectare before the analysis.

**Data Analysis:** Data collected were analyzed using the one-way analysis of variance (ANOVA) test. The Statistical Package for Social Science (SPSS, 17.0 version) was used. Means were separated using the Duncan's new Multiple-Range Test at 5% level of probability [12].

## RESULTS AND DISCUSSION

**Percentage Emergence:** Table 1 shows the percentage establishment of some orange-fleshed sweet potato accessions grown in Vom in 2016. The accession SOUL had the highest percentage establishment (97.8%), which did not differ significantly from accessions F2M5/3, Ng – Jay, F1M1/4, TIS. 87/0087/08, SOLO – 1/100

Table 1: Percentage establishment ofsome orange-fleshed sweet potato accessionsgrown inVom in 2016

| Accession | Percentage Establishment* |
|---|---|
| F2M5/3 | 78.89[a] |
| Ng – Jay | 86.67[a] |
| MD | 37.78[c] |
| F1M1/4 | 87.78[a] |
| ELINDA | 80.00[ab] |
| SOUL | 97.78[a] |
| AI2IB | 30.00[c] |
| TIS. 87/0087/08 | 82.22[a] |
| KWARA/00 | 52.22[bc] |
| F1M4/11 | 36.67[c] |
| SOLO – 1/100 | 96.67[a] |
| SOLO – 1/144 | 97.78[a] |
| CV (%) | 29.23 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

*Values were subjected to arcsine transformation before the analysis and thereafter de-transformed.

Table 2: Mean petiole length and mean vine length in some orange-fleshed sweet potato accessionsat 80 and 120 days after planting

| | Petiole length (cm) | | Vine Length (cm) | |
|---|---|---|---|---|
| Accession | 80 | 120 | 80 | 120 |
| F2M5/3 | 3.62[cd] | 4.05[bc] | 54.11[de] | 71.17[bcd] |
| Ng – Jay | 3.49[cd] | 4.20[bc] | 52.00[de] | 60.50[cd] |
| MD | 7.16[a] | 7.82[a] | 114.44[ab] | 176.33[a] |
| F1M1/4 | 3.38[cd] | 3.94[bc] | 54.55[de] | 64.67[cd] |
| ELINDA | 5.64[ab] | 5.78[b] | 90.99[bc] | 117.17[bc] |
| SOUL | 3.04[cd] | 3.17[c] | 69.00[cd] | 81.00[bcd] |
| AI2IB | 3.25[cd] | 3.25[c] | 59.89[de] | 90.67[bcd] |
| TIS. 87/0087/08 | 2.49[d] | 2.93[c] | 35.33[e] | 44.17[d] |
| KWARA/00 | 4.46[bc] | 4.61[c] | 79.46[cd] | 123.67[b] |
| F1M4/11 | 4.23[bcd] | 4.89[bc] | 119.40[a] | 185.17[a] |
| SOLO – 1/100 | 2.76[cd] | 3.10[c] | 71.11[cd] | 93.17[bcd] |
| SOLO – 1/144 | 2.74[cd] | 3.99[bc] | 52.11[de] | 70.50[bcd] |
| CV (%) | 23.81 | 27.84 | 24.63 | 29.58 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's New Multiple-Range Test).

and SOLO – 1/144 with percentage establishments of 78.9, 86.7, 82.2, 96.7 and 97.8%, respectively. The accession AI2IB had the lowest percentage establishment of 30%.

Variation in the rate of establishment among the accessions could be attributed to genotypic and environmental influences. Yeng *et al.* [13] observed that the use of the most appropriate planting materials, health status of vine-cuttings, optimum planting depth and spacing help to enhance crop establishment. The generally high establishment rate in this study could be because healthy vine- cuttings were used as planting material.

**Petiole Length:** At 80 days after planting (DAP), the accession MD produced leaves with the longest petioles (7.2 cm), which differed significantly from those of accession ELINDA (5.6 cm). The accession TIS. 87/0087/08 produced leaves with the shortest petioles (Table 2).

At 120 DAP, the longest petioles (7.8 cm) were observed in the accession MD. The shortest petioles were observed in the accession TIS. 87/0087/08 (2.8 cm) and these were similar to those of accessions SOLO – 1/100 (3.10 cm), SOUL (3.17 cm), AI2IB (3.25 cm), F1M1/4 (3.94 cm), SOLO-1/144 (3.99cm), F2M5/3(4.05 cm), Ng-Jay (4.20) and F1M4/11 (4.89 cm) (Table 2).

It has been observed that the variation in petiole length of sweet potato is due to genotypic differences [1, 10, 14]. Accessions with erect leaves and long petioles are better placed to capture photosynthetically active radiation than those with short petiole length or those that are prostrate [10].

**Vine Length:** At 80 DAP, the accession F1M4/11 produced the longest vines (119.4 cm) while the shortest vines were observed in the accession TIS.87/0087/08 (35.3 cm). At 120 DAP, the longest vines were also observed in the accession F1M4/11 (185.2 cm), which were similar to those in the accession MD (176.3 cm). The shortest vines were observed in the accession TIS.87/0087/08 (44.2 cm) (Table 2).

It has been observed that genotypes with long vines also produced a large number of leaves [15, 16]. The accession F1M4/11, with the longest vines,could, therefore, be used as forage for feeding ruminants due to their richness in protein.

**Leaf Area Index:** Table 3 shows the leaf area index of some orange-fleshed sweet potato accessions at different stages of growth in Vom in 2016. The LAI increased with time up to 90 DAP and thereafter decreased in all the accessions. At 45 DAP, the highest LAI value of 1.28 was observed in the accession SOLO – 1/144, while the lowest LAI value (0.17) was observed in the accession MD. At 90 DAP the highest LAI value of 2.23 was observed in the accession SOLO – 1/144, while the lowest value of 0.73 was observed in the accession F1M4/11. At 120 DAP, the highest LAI value (1.05) was observed in the accession KWARA/00; the lowest value of 0.11 was observed in the accession F1M1/4.

Differences in LAI values have been attributed to the high number of leaves in plants that were closely spaced compared to the plants planted at a wider spacing, as well

Table 3: Leaf area index in some orange-fleshed sweet potato accessionsat 45, 90 and 120 days after planting (DAP) inVom in 2016

| | Days After Planting | | |
|---|---|---|---|
| Accession | 45 | 90 | 120 |
| F2M5/3 | $0.57^{bc}$ | $1.39^{abc}$ | $0.40^{bcde}$ |
| Ng – Jay | $0.58^{bc}$ | $1.51^{abc}$ | $0.27^{cde}$ |
| MD | $0.17^{c}$ | $1.21^{abc}$ | $0.15^{de}$ |
| F1M1/4 | $0.53^{bc}$ | $1.42^{abc}$ | $0.11^{e}$ |
| ELINDA | $0.36^{c}$ | $0.95^{c}$ | $0.17^{de}$ |
| SOUL | $0.18^{c}$ | $0.77^{c}$ | $0.49^{bcde}$ |
| AI2IB | $0.64^{abc}$ | $0.84^{c}$ | $0.77^{ab}$ |
| TIS. 87/0087/08 | $1.20^{ab}$ | $1.02^{bc}$ | $0.68^{abc}$ |
| KWARA/00 | $0.80^{abc}$ | $1.32^{abc}$ | $1.05^{a}$ |
| F1M4/11 | $0.21^{c}$ | $0.73^{c}$ | $0.14^{de}$ |
| SOLO – 1/100 | $1.14^{ab}$ | $2.01^{ab}$ | $0.60^{abcd}$ |
| SOLO – 1/144 | $1.28^{a}$ | $2.23^{a}$ | $0.40^{bcde}$ |
| CV (%) | 42.81 | 34.90 | 47.47 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

Table 4: Days to flowering in some orange-fleshed sweet potato accessionsinVom in 2016

| Accession | Days to flowering |
|---|---|
| F2M5/3 | $70.67^{bc}$ |
| Ng – Jay | $82.33^{a}$ |
| MD | $79.67^{a}$ |
| F1M1/4 | $79.00^{ab}$ |
| ELINDA | $79.00^{ab}$ |
| SOUL | $80.33^{a}$ |
| AI2IB | $52.67^{d}$ |
| TIS. 87/0087/08 | $75.00^{abc}$ |
| KWARA/00 | $68.33^{c}$ |
| F1M4/11 | $82.33^{a}$ |
| SOLO – 1/100 | $79.00^{ab}$ |
| SOLO – 1/144 | $82.00^{a}$ |
| CV (%) | 6.31 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

as the growth habit of different accessions [17]. An accession with a large leaf area index can trap more incident light from the sun, which is used for a higher dry matter production than those with low leaf area index [18]. This could also help the crop to smother weeds which may affect crop growth and yield [19].

**Days to Flowering:** The shortest number of days to flowering (52.7 DAP) was observed in the accession AI2IB, which was followed by the accession KWARA/00 (68.3 DAP).All the other accessions did not differ significantly ($p = 0.05$) in the number of days to flowering (Table 4). Variations in the mean number of days to flowering have been reported to be due to varietal

Table 5: Relative growth rate ($gg^{-1}$ $day^{-1}$) ($x10^{-2}$) of some orange-fleshed sweet potato accessionsatdifferent stages of growth inVom in 2016

| | Growth Stage (Days after Planting) | | |
|---|---|---|---|
| Accession | 45 | 90 | 120 |
| F2M5/3 | $4.65^{abc}$ | $2.07^{a}$ | $0.28^{a}$ |
| Ng – Jay | $4.95^{ab}$ | $2.15^{a}$ | $0.46^{a}$ |
| MD | $2.66^{e}$ | $2.42^{a}$ | $0.50^{a}$ |
| F1M1/4 | $4.78^{abc}$ | $2.55^{a}$ | $0.81^{a}$ |
| ELINDA | $3.21^{de}$ | $2.69^{a}$ | $1.36^{a}$ |
| SOUL | $3.41^{cde}$ | $3.09^{a}$ | $1.57^{a}$ |
| AI2IB | $4.37^{bcd}$ | $3.23^{a}$ | $1.74^{a}$ |
| TIS. 87/0087/08 | $4.83^{ab}$ | $3.31^{a}$ | $1.90^{a}$ |
| KWARA/00 | $5.62^{ab}$ | $3.47^{a}$ | $2.20^{a}$ |
| F1M4/11 | $2.75^{e}$ | $3.49^{a}$ | $3.31^{a}$ |
| SOLO – 1/100 | $5.76^{ab}$ | $4.31^{a}$ | $3.31^{a}$ |
| SOLO – 1/144 | $5.83^{a}$ | $5.16^{a}$ | $3.36^{a}$ |
| CV (%) | 13.88 | 44.29 | 9.10 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

differences in response to photoperiod [20, 21]. In this study, the variation in the mean number of days to flowering might have been due to genotypic differences and response to photoperiod. Accessions that flowered late took a longer time to transit from the vegetative to reproductive phase and could be classified as late-maturing.

**Relative Growth Rate:** Table 5 shows the relative growth rate (RGR) of some orange-fleshed sweet potato accessions grown in Vom in 2016. The relative growth rate decreased with time up to 120 DAP in all the accessions.

At 45 DAP, the highest RGR was observed in the accession SOLO – 1/144 (5.83 $gg^{-1}$ $day^{-1}$), but this did not differ significantly from those of the accessions SOLO – 1/100 (5.76 $gg^{-1}$ $day^{-}1$), KWARA/00 (5.62 $gg^{-1}$ $day^{-1}$), Ng – Jay (4.95 $gg^{-1}$ $day^{-1}$), TIS.87/0087/08 (4.83 $gg^{-1}$ $day^{-1}$), F1MI4 (4.78 $gg^{-1}$ $day^{-1}$) and F2M5/3 (4.65 $gg^{-1}$ $day^{-1}$). The accession MD had the lowest RGR value of 2.66 $gg^{-1}$ $day^{-1}$.At 90 and 120 DAP, the RGR values did not differ significantly ($p = 0.05$) in all the accessions.

The results of this study show a general decrease in the relative growth rate (RGR) with time. Vimala and Hariprakash [22] reported a decrease in relative growth rate over time. As the cropping season progresses, the amount of sunlight intercepted by the leaves becomes less due to the mutual shading of lower leaves and senescence of older leaves. Therefore, the amount of dry matter produced by the leaves and partitioned to different parts of the plant is reduced, thereby reducing the growth rate of the plant. Also, with time more assimilates were

Table 6: Net assimilation rate (NAR) ($gm^{-2}$ $week^{-1}$) ($x10^{-3}$) of some orange-fleshed sweet potato accessionsat different stages of growth inVom in 2016

| | Growth Stage (Days After Planting) | | |
|---|---|---|---|
| Accession | 45 | 90 | 120 |
| F2M5/3 | 6.79$^{ab}$ | 1.12$^{ab}$ | 1.33$^{ab}$ |
| Ng – Jay | 6.85$^{ab}$ | 1.64$^{ab}$ | 0.84$^{b}$ |
| MD | 7.09$^{ab}$ | 1.96$^{ab}$ | 2.19$^{ab}$ |
| F1M1/4 | 6.89$^{ab}$ | 0.82$^{b}$ | 0.43$^{b}$ |
| ELINDA | 4.81$^{b}$ | 1.36$^{ab}$ | 1.85$^{ab}$ |
| SOUL | 10.79$^{a}$ | 2.79$^{ab}$ | 1.70$^{ab}$ |
| AI2IB | 5.15$^{ab}$ | 2.80$^{ab}$ | 1.53$^{ab}$ |
| TIS. 87/0087/08 | 3.64$^{b}$ | 0.61$^{b}$ | 0.33$^{b}$ |
| KWARA/00 | 6.86$^{ab}$ | 1.94$^{ab}$ | 0.28$^{b}$ |
| F1M4/11 | 6.05$^{ab}$ | 4.08$^{a}$ | 4.99$^{a}$ |
| SOLO – 1/100 | 5.55$^{ab}$ | 0.96$^{b}$ | 1.44$^{ab}$ |
| SOLO – 1/144 | 5.25$^{ab}$ | 0.93$^{b}$ | 1.69$^{ab}$ |
| CV (%) | 35.22 | 68.93 | 10.81 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

Table 7: Stand count and number of tubers per plantat harvest in some orange-fleshed sweet potato accessions grown inVom in 2016

| Accession | Stand count | Tuber No/ per plant |
|---|---|---|
| F2M5/3 | 18.67$^{ab}$ | 6.67$^{a}$ |
| Ng – Jay | 19.33$^{ab}$ | 4.33$^{abc}$ |
| MD | 6.00$^{e}$ | 2.33$^{c}$ |
| F1M1/4 | 20.00$^{ab}$ | 3.67$^{bc}$ |
| ELINDA | 17.33$^{abcd}$ | 1.67$^{c}$ |
| SOUL | 25.00$^{a}$ | 2.67$^{c}$ |
| AI2IB | 8.33$^{cde}$ | 2.67$^{c}$ |
| TIS. 87/0087/08 | 18.00$^{abc}$ | 3.33$^{bc}$ |
| KWARA/00 | 12.00$^{bcde}$ | 4.00$^{abc}$ |
| F1M4/11 | 7.67$^{de}$ | 2.00$^{c}$ |
| SOLO – 1/100 | 25.33$^{a}$ | 6.00$^{ab}$ |
| SOLO – 1/144 | 25.33$^{a}$ | 4.00$^{abc}$ |
| CV (%) | 29.31 | 39.17 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

accumulated in the storage roots at the expense of the leaves and stem; this led to a reduction in the translocation of assimilates to the leaves and stems, so that the relative growth rate was reduced. In the accession F1M4/11, RGR was low at the early and later stages of growth. This could have been due to the slow rate of leaf production.

**Net Assimilation Rate:** At 45 DAP, the lowest net assimilation rate (NAR) of 3.64 $gm^{-2}$ $week^{-1}$ was observed in the accession TIS. 87/0087/08 and this was followed by the accession ELINDA (4.81$gm^{-2}$ $week^{-1}$). All the other accessions did not differ significantly (P = 0.05) in net assimilation rate.

At 90 DAP, the lowest NAR of 0.61 $gm^{-2}$ $week^{-1}$ was observed in the accession TIS. 87/0087/08, while the highest NAR of 4.08 $gm^{-2}$ $week^{-1}$was observed in the accession F1M4/11.At 120 DAP,the lowest NAR of 0.28 $gm^{-2}$ $week^{-1}$ was observed in the accession KWARA/00. The highest NAR value of 4.99 $gm^{-2}$ $week^{-1}$was observed in the accession F1M4/11 (Table 6).

Net assimilation rate varied with genotype and the stage of growth in this study. In most accessions, NAR was higher at the early than at the latter stages of growth. As the cropping season progresses, light interception improves and the rate of dry matter production goes up. But due to mutual shading, photosynthesis no longer exceeds respiration in the older leaves, which then cease to be net producers of dry matter [10]. However, in accessions where NAR was higher at the later stages of growth, there might have been less mutual shading of leaves, due to leaf orientation, which might have resulted in a continuous production of dry matter.

**Stand Count at Harvest:** The highest stand count of 25.3 at harvest was observed in the accessions SOLO – 1/100 and SOLO – 1/144 but these did not differ significantly from the accessions F2M5/3, Ng – Jay, F1M1/4, ELINDA, SOUL and TIS. 87/0087/08 with mean stand counts of 18.7, 19.3, 20.0, 17.3, 25.0 and 18.0, respectively. The lowest stand count of 6.0 was observed in the accession MD (Table 7). The differences observed in stand count among the OFSP accessions could be attributed to their genotypic differences.

**Numbers of Tubers per Plant:** Table 7 shows the mean number of tubers per plant in some orange-fleshed sweet potato accessions grown in Vom in 2016. The accession F2M5/3 produced the highest number of tubers per plant (6.7) while the accession ELINDA produced the lowest number of 1.7 tubers per plant. The number of tubers per plant produced in the accessions F2M5/3, Ng – Jay, KWARA/00, SOLO – 1/100 and SOLO – 1/144 did not differ significantly (P=0.05). The differences in number of tubers per plant could be attributed to genotypic differences.

**Root-Top Ratio:** The highest root-top ratio of 3.93 was observed in the accession Ng – Jay, which did not differ significantly from accessions SOLO – 1/100 and SOLO – 1/144 with root-top ratios of 2.23 and 3.28, respectively. The lowest root-top ratio of 0.69 was observed in the accession AI2IB, which was similar to the accessions F2M5/3, MD, F1M1/4, ELINDA, SOUL, TIS. 87/0087/08, KWARA/00, F1M4/11 and SOLO-1/100 with root-top

Table 8: Root-Top Ratio, mean tuber length (cm) and mean tuber girth (cm) in some orange-fleshed sweet potato accessions grown inVom in 2016

| Accession | Root-Top Ratio | Tuber Length (cm) | Tuber girth (cm) | Dry matter content (%) |
|---|---|---|---|---|
| F2M5/3 | 1.93[bc] | 17.27[abc] | 13.60[ab] | 33.05[ab] |
| Ng – Jay | 3.93[a] | 16.21[abc] | 17.91[a] | 31.09[ab] |
| MD | 1.38[c] | 15.76[bc] | 14.99[ab] | 25.45[ab] |
| F1M1/4 | 1.37[c] | 17.80[abc] | 13.92[ab] | 28.19[ab] |
| ELINDA | 1.56[bc] | 11.88[c] | 10.35[b] | 35.89[ab] |
| SOUL | 1.07[c] | 16.13[abc] | 13.59[ab] | 35.59[ab] |
| AI2IB | 0.69[c] | 17.31[abc] | 14.78[ab] | 30.09[ab] |
| TIS. 87/0087/08 | 1.34[c] | 19.09[ab] | 13.68[ab] | 20.12[b] |
| KWARA/00 | 1.50[bc] | 14.37[bc] | 11.05[b] | 34.59[ab] |
| F1M4/11 | 1.21[c] | 16.59[abc] | 10.71[b] | 25.07[ab] |
| SOLO – 1/100 | 2.23[abc] | 17.12[abc] | 14.44[ab] | 41.64 [a] |
| SOLO – 1/144 | 3.28[ab] | 22.38[a] | 17.41[a] | 30.78[ab] |
| CV (%) | 55.30 | 19.59 | 18.49 | 27.66 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

Table 9: Harvest index in some orange-fleshed sweet potato accessions at 45, 90 and120 days after planting (DAP) inVom in 2016

| | Growth Stage (Days After Planting) | | |
|---|---|---|---|
| Accession | 45 | 90 | 120 |
| F2M5/3 | 0.20[abc] | 0.30[abc] | 0.75[ab] |
| Ng – Jay | 0.29[abc] | 0.54[a] | 0.87[a] |
| MD | 0.29[abc] | 0.18[bc] | 0.69[ab] |
| F1M1/4 | 0.19[abc] | 0.13[c] | 0.86[a] |
| ELINDA | 0.14[c] | 0.23[abc] | 0.42[b] |
| SOUL | 0.31[a] | 0.32[abc] | 0.52[ab] |
| AI2IB | 0.14 [c] | 0.47[ab] | 0.53[ab] |
| TIS. 87/0087/08 | 0.18[abc] | 0.53[a] | 0.63[ab] |
| KWARA/00 | 0.30[ab] | 0.40[abc] | 0.66[ab] |
| F1M4/11 | 0.20[abc] | 0.49[ab] | 0.52[ab] |
| SOLO – 1/100 | 0.16[bc] | 0.33[abc] | 0.68[ab] |
| SOLO – 1/144 | 0.19[abc] | 0.37[abc] | 0.57[ab] |
| CV (%) | 29.65 | 38.72 | 25.90 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

ratios of 1.93, 1.38, 1.37, 1.56, 1.07, 1.34, 1.50, 1.21 and 2.23, respectively (Table 8). Accessions with high root-top ratios are believed to have large sink capacities which enable them to capture assimilates produced by the source (leaves and stems). In other words, more assimilates were partitioned to the tubers in these accessions compared to the leaves and stems. In this study, the accessions Ng – Jay, SOLO – 1/100, SOLO – 1/144 and F2M5/3 with high root-top ratios also had high total fresh tuber yield, as has also been reported by Mbwaga [23].

**Tuber Length and Tuber Girth:** Table 8 shows the mean tuber length of some orange-fleshed sweet potato accessions grown in Vom in 2016. The accessions SOLO – 1/144 (22.4 cm), TIS. 87/0087/08 (19.1 cm), F1M1/4 (17.8 cm), A121B (17.3 cm), F2M5/3 (17.3 cm), SOLO-1/100 (17.1 cm), F1M4/11 (16.6 cm), Ng-Jay (16.2 cm) and SOUL (16.1 cm) produced tubers which were statistically similar in length. The accession ELINDA produced tubers with the lowest mean tuber length of 11.9 cm.

The highest tuber girth of 17.9 cm was observed in the accession Ng – Jay, which was similar to the tuber girth in the accessions SOLO – 1/144 (17.4 cm), F2M5/3 (13.6 cm), MD (15.0 cm), F1M1/4 (13.9 cm), SOUL (13.6 cm), AI2IB (14.8 cm), TIS. 87/0087/08 (13.7 cm) and SOLO – 1/100 (14.4 cm). The lowest tuber girth of 10.4 cm was observed in the accession F1M4/11 (10.7 cm) and this was similar to that of accession KWARA/00 (11.1 cm) (Table 8).

The differences observed in tuber length and tuber girth among the OFSP accessions could be attributed to their genotypic differences, as has also been reported by Rahman *et al.* [24] and Ogedengbe *et al*. [25]. Namo [10] noted that selection based on length or girth of tubers was highly desirable for improving sweet potato yield.

**Dry Matter Content:** Table 8 shows the dry matter content of some orange-fleshed sweet potato accessions grown inVom in 2016. The highest dry matter content of 41.6% was observed in the accession SOLO – 1/100, which was similar to the dry matter content in the accessions SOLO – 1/144 (30.8 %), Ng – Jay (31.1), F2M5/3 (33.1 %),F1M4/11 (25.1 %), ELINDA (35.9 %), MD (25.5 %), F1M1/4 (28.2 %), SOUL (35.6 %), KWARA/00 (34.6%) and AI2IB (30.1 %). The lowest dry matter content of 20.1 % was observed in the accession TIS.87/0087/08.

The dry matter content of 27% and above has been observed to be acceptable to most processors of sweet potatoes [26]. Most of the accessions used in this study have dry matter content of 27% and above (Table 8). Dry matter content has been reported to be related to starch content in sweet potato [27]. The result of this study indicates that the OFSP accessions used could be used for industrial processing.

**Harvest Index:** Table 9 shows the harvest index of some accessions of orange-fleshed sweet potato at different stages of growth at Vom in 2016. At 45 DAP, the highest harvest index was observed in the accession SOUL (0.31)

Table 10: Total tuber yield (t/ha) in some orange-fleshed sweet potato accessions inVom in 2016

| Accession | Total Tuber Yield (t/ha) |
|---|---|
| F2M5/3 | 5.99[ab] |
| Ng – Jay | 8.18[a] |
| MD | 2.51[c] |
| F1M1/4 | 3.37[bc] |
| ELINDA | 2.08[c] |
| SOUL | 2.65[c] |
| AI2IB | 2.46[c] |
| TIS. 87/0087/08 | 3.56[bc] |
| KWARA/00 | 3.35[bc] |
| F1M4/11 | 2.33[c] |
| SOLO – 1/100 | 6.90[a] |
| SOLO – 1/144 | 6.10[ab] |
| CV (%) | 42.13 |

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

and this was followed by accessions KWARA/00 (0.30), MD (0.29), F2M5/3 (0.20), F1M4/11 (0.20), SOLO – 1/144 (0.19), F1M1/4 (0.19) and TIS.87/0087/08 (0.18). The lowest harvest index of 0.14 was observed in the accessions ELINDA and AI2IB.

At 90 DAP, the accession Ng-Jay had the highest harvest index of 0.54, which was followed by accessions TIS. 87/0087/08 (0.53), F1M4/11 (0.49), AI2IB (0.47), KWARA/00 (0.40), SOLO – 1/144 (0.37), SOLO – 1/100 (0.33), SOUL (0.32), F2M5/3 (0.30) and ELINDA (0.23). The lowest harvest index of 0.13 was observed in the accession F1M1/4.

At 120 DAP, the highest harvest index of 0.87 was observed in the accession Ng-Jay, followed by the accessions F1M1/4 (0.86), F2M5/3 (0.75), MD (0.69), KWARA/00 (0.66), TIS.87/0087/08 (0.63), AI2IB (0.53), F1M4/11 (0.52), SOUL (0.52), SOLO – 1/100 (0.68) and SOLO – 1/144 (0.57).

Harvest index is a very valuable index of yield as it represents the efficiency of the crop to convert photosynthetic products to economically valuable products [28]. Harvest index increased with time in all the accessions used in this study, an indication of the effective conversion rate of assimilates by the accessions.

**Total Tuber Yield:** Table 10 shows the total tuber yield of some orange-fleshed sweet potato accessions grown in Vom in 2016. The highest total tuber yield of 8.2 t/ha was observed in the accession Ng-Jay, which did not differ significantly from accessions SOLO- 1/100 (6.9 t/ha), SOLO-1/144 (6.1 t/ha) and F2M5/3 (6.0 t/ha). The lowest total tuber yield of 2.1 t/ha was observed in the accession ELINDA.

Yield is a quantitative trait which is influenced by both genotypic and environmental factors [29]. Differences in yield due to genotypic differences have been reported in sweet potato [24, 30, 31].

Based on the National Agricultural Research Organization (NARO) yield classification criteria, sweet potato can be grouped into three tuber yield classes: high-yielding (18-30 t/ha), moderate-yielding (11-17 t/ha) and low-yielding genotypes (<11 t/ha) [26]. None of the accessions used in this study fell within the high- and moderate-yielding classes. This might be due to the fact these accessions were newly introduced to the Jos-Plateau environment.

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