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# Effect of Seedbed Types and time of Vine Harvesting on Shoot and Tuber Yields of Sweet Potato [*Ipomoea batatas (L.) Lam.*] in South-south, Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Authors LDG and VW designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors LDG and VW managed the analyses of the study. Authors LDG and VW managed the literature searches. Both authors read and approved the final manuscript.*

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## ABSTRACT

A field experiment was conducted at Rivers Institute of Agricultural Research and Training (RIART), Rivers State University, Port Harcourt, Nigeria with the objective of evaluating the influence of seedbed types and vine harvesting time on shoot and tuber yields of sweet potato and make recommendations for optimal and sustainable production. The treatments consisted of three seedbed types (ridge, flat, and mound), and four vine harvesting time (8, 12, 16 and 20 weeks after planting). The experiment was laid out as a 3 x 4 in factorial arrangement fitted into a randomized complete block design (RCBD) and replicated three times. The results revealed that planting of sweet potato on ridge produced the highest root tuber yield followed by mound seedbeds; planting on flat seedbed produced the highest shoot (vine) and lowest tuber yields. While planting on ridge seedbed and harvesting the vines 16 weeks after planting (when about 80% of the growth phase of the plant was completed) produced optimum shoot yield which could be used as fodder with no significant effect on root tuber yield. In general, vine harvesting during active growth phase of the sweet potato

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plant seriously depressed tuber yield more than it affected shoot production. These results therefore stand as our recommendations for sweet potato production in the South-south zone of Nigeria.

*Keywords: Sweet potato; seedbed types; shoot (vine) yield; root tuber yield; dry matter weight.*

## 1. INTRODUCTION

Sweet potato [*Ipomoea batatas* L. (Lam.)] is a herbaceous warm-weather creeping plant that belongs to the botanical family Convolvulaceae (Morning Glory Family) and genus of Ipomoea, species batatas [1]. It is an important food security crop grown as a source of food and family cash income [2]. The carbohydrate rich root tuber is used as a subsidiary food after boiling, frying or baking. In some countries, the vine tips are used as vegetables while the whole top forage form an excellent source of green fodder for livestock [3-4]. The tubers and leaves are an excellent source of carbohydrate, protein, iron, vitamins A, C and fibre for both human and livestock [5,6].

Although the productivity of sweet potato in Nigeria is mostly by smallholder farmers, producing more than 85% of the country's output [7], Nigeria is rated the number one producer in Africa with annual output of 3.46 million metric tons [8]. Like most other root and tuber crops, the major constraints militating against sweet potato production in most parts of Nigeria include: high labour cost, low access to improved sweet potato varieties, poor storage facilities by the farmers, poor marketing outlet, high incidence of pest and diseases, no access to credits and inadequate government aid to farmers [9].

The recognition therefore, of the great potential of sweet potato as an economic and nutritious food crop for humans and fodder for livestock, research efforts have been intensified to enhance its production and consumption in recent times [8,1]. The efforts are not only intensified towards production of high root tuber but as well as dual-purpose sweet potato varieties that allow a low number of toppings which guarantees the availability of fodder over the year without significantly affecting the tuber yields [10,11]. This will go a long way to alleviate the problem of acute livestock feed scarcity as well as food insecurity.

In tackling the above constraints for positive solutions, proper technologies including methods of seedbed preparation must be put in place for successful cultivation of the crop. It is a common phenomenon that planting of sweet potato on mounds and occasionally on flat land have been the conventional practices adopted by most smallholder farmers in Nigeria [12]. Ridge cropping has also evolved as an integral component of subsistence farming and it is well adapted for small, low inputs subsistence farms [13]. Generally, seedbed preparation is tedious, expensive, time consuming, may increase soil erosion, and in some cases may not necessarily increase yields. According to Agbede [14] tillage methods adopted by farmers vary widely depending upon crop type, soil type and depth, micro-climate and topography. Results from tillage studies have shown the contributions of tillage methods in sweet potato production. Van Vugt and Franke [15] observed that tillage methods and soil nutrient limitations may be critical factors responsible for the yield gap among small holder farmers in Africa which prevents them from achieving attainable yield gains from improved sweet potato cultivars. Ahmed et al. [16] reported that planting sweet potato on ridges and harvesting the vines 105 days after planting (when about 60% of the growth phase of the plant was completed) led to optimum production of herbage for fodder without compromising yield of tubers. Similarly, Chagonda et al. [17] noted that planting on ridges recorded longer mean storage root length and higher yields while those from mounds had shorter root length and lower yields. Dumbuya et al. [18] reported that plant growth was not significantly affected by tillage, but root yield was affected significantly with ridging produced the highest root tuber yield. On the other hand, Mu'azu [19] reported that planting sweet potato on the mound performed better than planting on the ridges or on the flat with no significant differences between ridges and flats. According to Agbede and Adekiya [20] the growth and yield performances of sweet potato in a tillage exercise were in increasing order of: manual clearing, row tillage, manual mounding, manual ridging and conventional tillage. Ravindran and Mohankumar [21] compared the effect of ridge, bed and furrow, flat and mound tillage practices on the yield of sweet potato grown under upland conditions. They found that tilled soils, especially mound significantly increased sweet potato root yield compared with flat planting. Whereas, Midmore [22] had found no significant differences in the root yield of sweet potato under row-ridge, two-row bed, on-the-flat and row furrow. They also use varied seedbed types to cultivate the crop.

In mixed crop-livestock production systems, one limitation on productivity is the year-round requirement for fodder (feed) [23]. In the southern part of Nigeria, most smallholder farmers also keep some livestock, predominantly goats and sheep. Livestock feed is sometimes scarce during most period of the year and farmers desperately go in search for fodder for the animals. To alleviate the problem of such acute livestock feed scarcity as well as food insecurity during such critical period of the year, farmers have been cultivating sweet potato and cut the vines at some stages of growth as fodder for livestock feeding. Studies have shown that vine harvesting during the growth of sweet potato significantly reduced the tuber yield [20-21]. Farmers must harvest the vines at the appropriate time to avoid damage to the overall production of the crop. Age of forage at harvest is an important management factor that affects sweet potato fodder and tuber yield as well as quality [10,21]. Dumbuya [17] reported that pruning at longer intervals (6 and 8 weeks) significantly ($P < 0.05$) improved forage yield at the expense of tuber yield. Therefore, the demand for improved sweet potato varieties that could be used for both food and fodder production has been on the increase in the area, especially in crop-livestock production areas.

In the light of the aforementioned agronomic conditions, varied seedbed types to cultivate sweet potato and proper time of shoot harvest must be validated to establish suitability for both tuber and forage production. This research was therefore under-taken with the objective of evaluating the effect of seedbed types and vine harvesting dates on tuber and shoot yields of sweet potato in the South-south zone of Nigeria.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

The experiment was conducted at Rivers Institute of Agricultural Research and Training (RIART), Rivers State University, Port Harcourt, Nigeria. The site is located in the South-south geographical region of Nigeria at latitude 4.51$^{o}$North and longitude 7.01$^{o}$East. Rainfall ranges from 2,000–4,500mm per annum with a mean of 2,500mm. The rains begin in late February and continue till early November with peaks in July and September. Relative humidity remains high all year round with mean values of 75% in February, increasing to 86% in the months of July and September. Annual temperatures vary between 26$^{o}$C and 35$^{o}$C while solar radiation /sunshine lasts an average of 4hours daily. The soil is a Typic Paleudult described as Ultisols of sandy loam texture with a pH of 4.8 (1:1 soil:water) and contained 1.5% organic carbon, 0.11% total N, 37ppm available P and 0.24, 0.43, and 0.08me/100g exchangeable K, Ca, and Mg respectively.

### 2.2 Experimental Materials, Design and Treatments

A popular orange-fleshed sweet potato (OFSP) cultivar known as TIS.87/0087/08 was used for the experiment. The cultivar has a spreading growth habit. The treatments consisted of 3 seedbed types (ridge, flat and mound) and four vine harvesting time (harvesting the vines 8, 12, 16 and 20 weeks after planting (WAP) (20 WAP was the final harvest also used as the control treatment – no vine harvesting till final harvest). The treatments were laid out in a 3 x 4 factorial arrangement in a Randomised Complete Block Design (RCBD), replicated thrice. There were 12 treatment combinations with a total of 36 plots. Each plot measured 4m x 3m.

### 2.3 Preparation of Seedbeds and Planting Material

A one-year fallowed land (previously cropped with cassava) was ploughed and harrowed. Thirty-six plots, corresponding to the total treatment combinations, were marked out. Each plot was 4m x 3m in size and separated from one another by a distance of 1.2m within block and 2.0m between blocks. Two of the seedbed types –the ridge and mound were prepared manually using spades and traditional hoes. Each ridge measured a length of 3m, 0.5m width and a height of 0.5m, with a total of four ridges per plot. Mounds were prepared at measurements of 0.6m length by 0.3m width and 0.3m height. The flat seedbed did not require further preparation before planting.

Planting materials were disease and weevil-free fresh vine tips, measuring 0.25 to 0.3m and carrying a minimum of four nodes, obtained from a vine multiplication nursery in RIART. Excess leaves were trimmed off. The cuttings were tied in bundles and placed in an upright position in a bucket (half-filled) with pure water to avoid wilting during planting in the field. Planting space was 0.3m along the row.

## 2.4 Planting and Crop Management

The treatments were randomly assigned to each plot. Vines were planted with two to three nodes inserted into the ground at about 90º to the surface in holes prepared by using sharp-pointed sticks of about 4 cm diameter. Vines were planted by inserting the basal portions into the soil at a spacing of 0.3m between plants along the rows. There were four rows in each plot with each row accommodating 10 plants. Planting was done on 15 March 2019. Weeds were controlled by manual weeding with hoes at 4 and 8 weeks after planting. Fertiliser (20:10:10) was applied two days after the first weeding. No pesticides were applied and the experiment was conducted under rain-fed conditions. Vine harvesting was done based on the design of the experiment at 8, 12, 16 and 20 WAP, respectively. The vines were cut back to about 0.3m above the soil level (providing enough nodes for sprouting) using a sharp kitchen knife. The final harvest including the tubers (both the vines and the tubers) were done on 2 August 2019.

## 2.5 Measurements

### 2.5.1 Fresh and dry weights of shoot

The fresh weight of shoots (vines with leaves) harvested per plot during each harvesting stage was determined using a weighing scale and yield converted to metric tons per hectare (t/ha). The dry weight of the shoot from each plot was determined after subjecting a random sample of about 500 g of the fresh matter to a forced draft oven at 65°C until constant weight was attained. The dry weight was obtained and dry matter (DM) yield calculated to (t/ha).

At final harvest, 20 weeks after planting, whole shoots (vine with leaves) from each plot were cut back to 3 cm at the base of the plant. Fresh and dry weights of shoots obtained were determined (as stated above) and recorded for each plot. The fresh and dry shoot weights at the final harvest were added to the fresh and dry shoot weights obtained at the previous harvests at 8, 12 and 16 WAP, except for the control treatment, 20 WAP, where shoots cut back was done once at the final harvest.

### 2.5.2 Fresh and dry weights and number of root tubers at harvest

At the final harvest (20 WAP), all plants from the net plot area (6 plants from each of the two middle rows excluding two plants at both ends of each row) were harvested per plot. Total number of root tubers (being free from rot, insect or disease damage) and fresh weight were recorded. The root tubers were also graded into 2 categories according to sizes as: marketable tubers (>100g) and unmarketable (<100g) by weighing and each category counted. Yield of each category was computed to t/ha.

The dry matter of the root tubers was determined by taking a random sample of four tubers of each size categories from each plot and their fresh weights determined. They were sliced into thin pieces (2-3 mm thick) and a random composite sample of 400g was dried in a forced draft oven at 65°C until constant weight was attained. Dried samples were weighed and dry matter (DM) yield of each category computed to t/ha.

## 2.6 Data Collection

The following data were collected in course of the study: - fresh and dry weight of vines (shoots), number and fresh and dry weigh of root tubers. The storage roots were graded into 2 categories according to sizes as: marketable tubers (>100g) and unmarketable tubers (<100g), number and fresh and dry weight of each category recorded.

## 2.7 Statistical Analyses

All data collected were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of the statistical analysis system [24] to determine treatment effects. Where there were significant F-test, means were separated by Fisher's protected Least Significant Difference Test at the 0.05 level of probability.

# 3. RESULTS AND DISCUSSION

## 3.1 Results

### 3.1.1 Effect of seedbed types on shoot (vine) yields

Total fresh shoot yield (obtained during the growth stage plus that obtained at final harvest of the crop) of plants planted on flat seedbeds was highest followed by mound seedbed while the ridge seedbed was the least Fig. 1. On the other hand, the total fresh shoot yield from flat seedbed was significantly (P < 0.05) higher than the yield from ridge seedbeds by 23% but statistically similar to the yield from mound seedbed by 12%. In a similar vein, flat seedbed produced significantly higher total dry matter (DM) shoot yield than ridge but statistically similar to mound seedbeds by 24 and 16%, respectively Fig. 1.

### 3.1.2 Effect of time of vine harvesting on shoot (vine) yields

Time of vine cutting during the growth stage of sweet potato had a significant (p<0.05) effect on total forage yield obtained at final harvest of the crop Fig. 2. Harvesting of the vines at 16 weeks after planting (WAP) produced the highest total fresh shoot yield that was significantly (P < 0.05) higher than yields obtained when cutting was done at 8, 12 and 20 WAP, respectively. The yields were in descending order of 16 WAP > 12 WAP > 20 WAP > 8 WAP. Despite the differences observed between the total yields of treatments in which vine cutting took place 12, 20 and 8 WAP, the yields were statistically similar. The trend was also similar for total dry shoot (DM) yield. Treatment in which early vine cutting was done 16 WAP produced total shoot yield that was significantly higher than treatments 8 WAP and 12 WAP but statistically similar to 20 WAP. The DM yield of 16 WAP was greater than 8 WAP, 12 WAP and 20 WAP by 25, 15 and 2%, respectively.

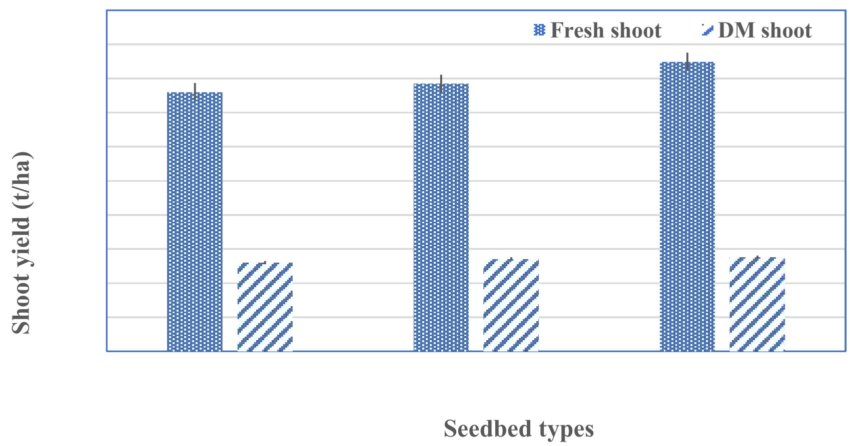


**Fig. 1. Effects of seedbed type on total fresh and dry matter (DM) forage yield of sweet potato**

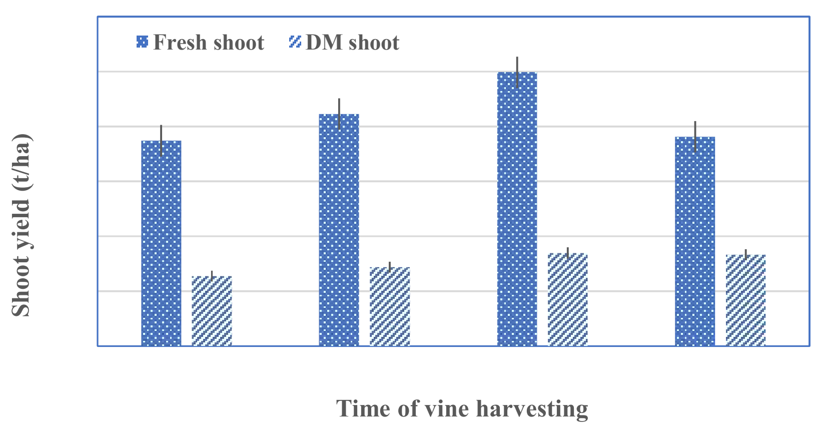


**Fig. 2. Effects of time of forage harvest on total fresh and dry matter (DM) forage yield of sweet potato**

#### 3.1.3 Effect of seedbed type on tuber yields

Planting on different seedbeds significantly influenced total fresh and dry (DM) tuber yield of sweet potato in the study Fig. 3. Planting of the crop on ridge seedbed significantly ($P < 0.05$) increased total fresh tuber yield compared to planting on flat and mound seedbeds. Planting on mound and flat seedbeds reduced total fresh tuber yield by 21 and 15%, respectively, in relation to planting on ridge seedbed. Similarly, the dry matter yield was highest with ridge seedbed and significantly higher than yields of mound and flat seedbed by 23 and 17%, respectively. The yields of mound and flat seedbeds were statistically similar.

#### 3.1.4 Effect of shoot (vine) harvesting time on tuber yields

Time of harvesting the vines during the growth stage of sweet potato significantly ($P < 0.05$) affected total and marketable tuber yields of the crop Fig. 4. Treatment 20 WAP, whose vines were not harvested during growth until final harvest at 20 weeks after planting, produced total fresh tuber yield that was significantly higher than treatments 8 and 12 WAP, whose vines were harvested 8 and 12 weeks after planting by 42 and 32%, respectively. The total fresh tuber yield from treatment 16 WAP (whose vines were harvested 16 weeks after planting) was reduced by 10% in comparison to treatment 20 WAP and they were statistically similar. Similarly, treatment 20 WAP, whose vines were not harvested during growth until final harvest produced significantly higher DM tuber yield that was significantly higher than treatments 8 and 12 WAP by 43 and 35%, respectively. Treatment 16 WAP had the least yield reduction of 14% in relation to treatment 20 WAP and they did not differ significantly from one another.

#### 3.1.5 Influence of seedbed types on the number of root tubers

Seedbed types significantly influenced number of root tubers produced by sweet potato in the study. Planting on the mound seedbed produced significantly higher number of root tubers than the flat seedbed and was statistically similar to ridge seedbed. The reduction in total number of root tuber by flat and ridge seedbeds were 19 and 4%, respectively. Similarly, in terms of number of marketable root tubers, mound seedbed significantly out-yielded ridge and flat seedbeds by 8 and 12%, respectively Fig. 5.

#### 3.1.6 Influence of time of vine harvesting on number of root tubers

Vines harvesting during the growth stage of sweet potato significantly ($P < 0.05$) influenced the number of total and marketable root tubers produced. The control treatment (20 WAP) in which vines were not harvested during growth until final harvest produced the highest number of total root tubers and marketable tubers (Fig. 6). The total number of tubers produced by this treatment significantly out-yielded the treatments whose vines were harvested 8 and 12 weeks after planting by 27 and 14%, respectively and was statistically similar to treatment whose vines were harvested 16 weeks after planting with a total number of tuber reduction of 5%. Similarly, in reference to marketable tuber yield, treatment 20 WAP produced marketable tuber yield that was significantly higher than treatments 8 and 12 WAP by 25 and 19%, respectively. Treatment 16 WAP had the least marketable root tuber yield reduction of 7% in relation to treatment 20 WAP and they did not differ significantly from one another. On the other hand, the number of marketable root tubers produced by treatment 20 WAP out-yielded all other treatments whose vines were harvested during the growth stages.

### 3.2 Discussion

#### 3.2.1 Effect of seedbed type on shoot (vine) yields

The high total fresh and dry shoot yields obtained from plants grown on flat seedbed in relation to those obtained from mound and ridge seedbeds could be assumed as a result of effective lateral spread of the feeding root system in the top soil, resulting to effective utilization of available nutrients for growth and development. It is also possible that where the compact soil in flat seedbed would hinder root tuber penetration and bulking, the energy thereof could be redirected to foliage production, thereby producing higher amount of shoot than other seedbeds. This report is in agreement with that of Busha-Ababu [25] that sweet potato plants grown on flat seedbeds grew excess foliage at the expense of storage roots yields. This they attributed to flat seedbed depression of penetration and bulking of tuberous roots due to less optimal tilth compared to the situation in ridge seedbed. The

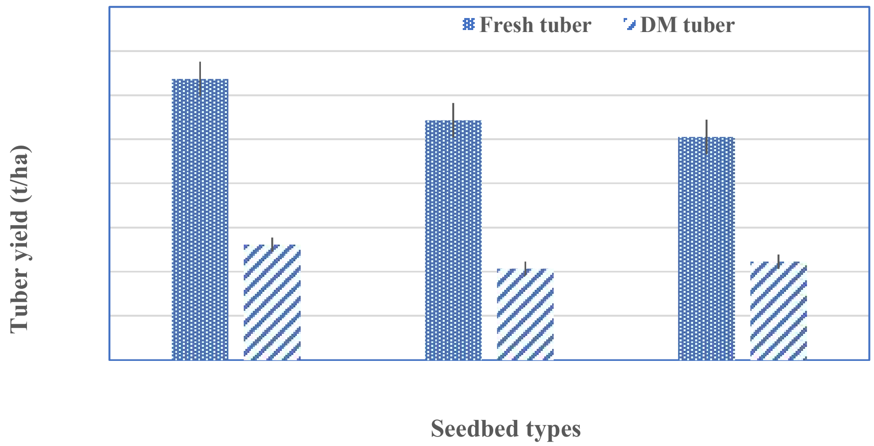


**Fig. 3. Effects of seedbed type on tuber yield of sweet potato**

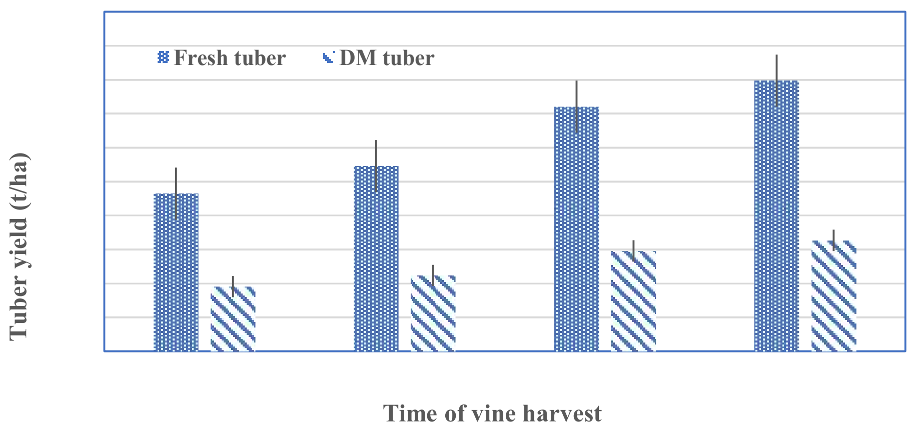


**Fig. 4. Effects of time of vine harvesting on tuber yield of sweet potato**

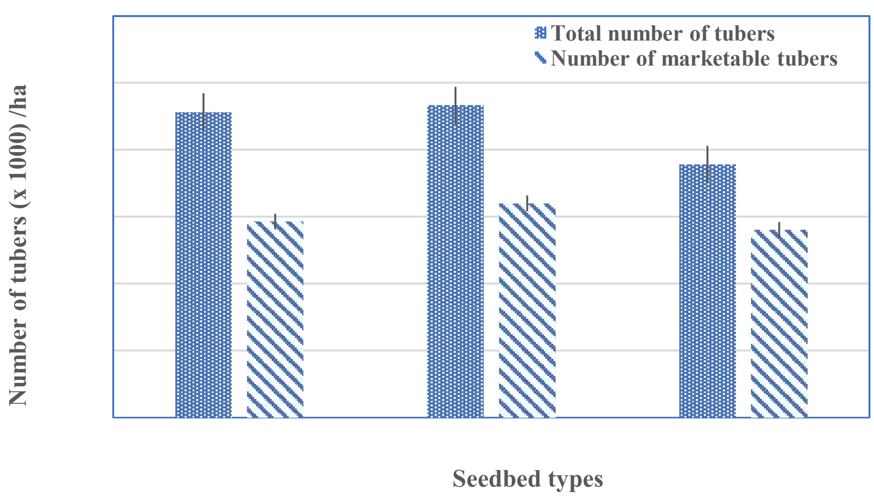


**Fig. 5. Number of tubers of sweet potato as influenced by seedbed type**

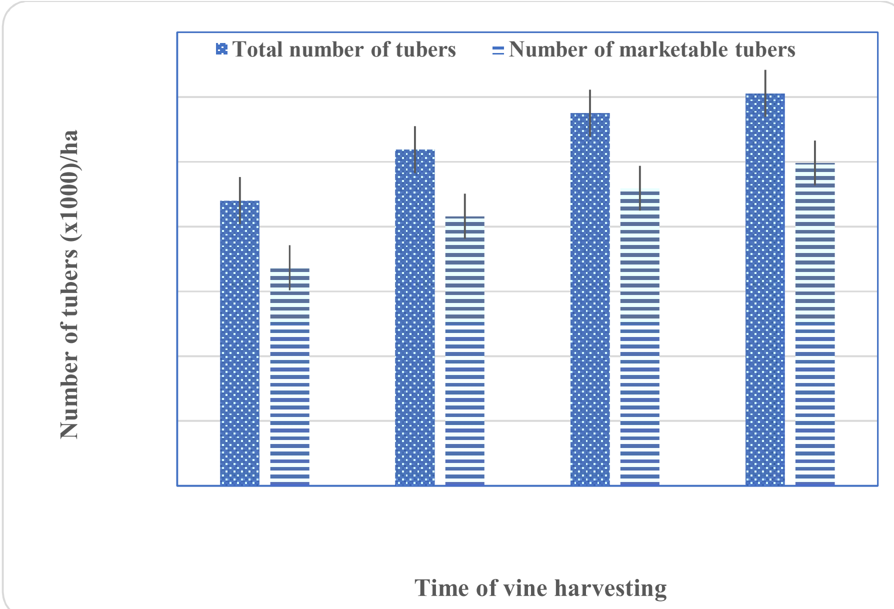


**Fig. 6. Number of tubers of sweet potato as influenced by time of vine harvest**

report is on the other hand not in agreement with Nedunchezhiyan et al. [26] who observed higher green fodder yields in conventional tillage compared to minimum tillage treatment.

### 3.2.2 Effect of time of vine harvest on vine (shoot) yields

In this study, management of the vegetative phase of the sweet potato cultivar played a great role in determining the overall shoot (vine) yield of the crop. Results obtained show that the fresh as well as dry shoot yields of plants were significantly high in treatment 16 WAP, whose vines were harvested 16 weeks after planting compared to low fresh and dry matter shoot yields obtained in treatments 8 WAP and 12 WAP, whose vines were harvested at 8 and 12 weeks after planting, respectively, earlier than 16 weeks after planting. The high fresh and dry shoot yields reported in treatments 16 WAP, may have emanated from the relatively longer duration of leaf growth for enhanced photo-assimilation which was not the case in treatments in which vines were harvested 8 and 12 weeks after planting that recorded low fresh and dry matter shoot yields. This is in agreement with Ahmed et al. [16], who reported that harvesting the vines of sweet potato at 105 days after planting led to optimum production of herbage for fodder without compromising yield of tuberous roots. Thus, when vine harvesting was delayed up to 16 weeks after planting, it is speculated that the accumulated carbohydrate in the developed tuber may have been partitioned to the shoots for recuperation to enhance regeneration of new leaves, thereby resulting in a high total shoot yield at the final harvest. Similarly, Ruiz et al. [27] had earlier reported increments in foliage dry matter yield amounting to 26 and 17% for plants on which defoliation was practiced two and three months respectively, compared to those on which defoliation was not performed at all. In this study, earlier vine cutting at 8 and 12 weeks after planting resulted to reduced total fresh and dry shoot yield compared to when harvesting was delayed up to 16 WAP and beyond. Olorunnisomo [28] had reported similar observation of low and high biomass and dry matter yields of sweet potato harvested at 4 and 8 weeks after planting, respectively, indicating low yield with early harvest and high yield when harvest was delayed during growth. Harvesting of vines at 20 WAP decreased forage yield compared to 16 WAP. This also agrees with Larbi et al. [10] who stated that maturity of tubers decreased yield and quality of fodder due to allocation of photosynthate to the root tubers.

### 3.2.3 Effect of seedbed type on tuber yield

The higher tuber yields from ridge followed by mound seedbeds in relation to the flat seedbed could be linked to the effectiveness of soil tillage in ridge and mound seedbeds, creating a loose top soil in which the storage roots penetrated with ease and developed profusely in size. The loosed soil medium equally created an enhanced supply of plant nutrients and moisture as well as good drainage and aeration for the growth and yield of the crop. This result agrees with those of Busha-Ababu [24] and Ahmed et al. [16] who reported that sweet potato plants grown on ridges produced significantly higher tuberous root yields than those grown on flat and furrow seedbeds. The result also confirms earlier work of Agbede and Adekiya [18] who reported that ridge planting of sweet potato increased the yield of tuberous roots by about 64% compared to flat planting with just manual clearing of the land. Similarly, Anikwe et al. [28] report high yield and quality of cocoyam planted on ridge seedbed compared to planting on flat seedbed which they attributed to enhanced soil penetration and aeration at the early stages of crop development. The decrease in the total and marketable root tuber yields of sweet potato plants planted on flat seedbed compared to ridge seedbed might be attributed to the relatively compact soil in the flat seedbed which could limit root tuber penetration and bulking. This report is in agreement with that of Busha-Ababu [24] that sweet potato plants grown on flat seedbeds grew excess foliage at the expense of storage roots resulting in low yields. This may signify that flat seedbed depresses bulking of tuberous roots due to less optimal tilth for growth and bulking of tuberous roots than ridge seedbed. Also, in agreement with our finding, Nedunchezhiyan et al. [25] reported that tillage practices had significant impact on root yield. They observed that planting sweet potato under conventional tillage produced higher root yield than minimum tillage due to higher growth and yield attributes as well as reduced soil penetration resistance in the conventional tilled plot. Number of total and marketable tubers were also high with ridge seedbed than flat seedbed. This was in agreement with report of Ahmed et al. [16] who recorded high number of both total and marketable root tubers on ridge seedbed than on flat and sunken seedbeds. Similarly, in another study, Chagonda et al. [17] noted that planting on ridges recorded longer mean storage root length and higher yields while those from mounds had shorter root length and lower yields. Dumbuya et al. [18] reported that plant growth was not significantly affected by tillage, but root yield was affected significantly with ridging produced the highest root tuber yield. Contrary to our observation, Mu'azu [19] reported that planting sweet potato on the mound performed better than planting on the ridges or on the flat with no significant differences between ridges and flats.

#### 3.2.4 Effect of time of vine harvest on root tuber yields

Time of harvesting the vines during the growth phase of sweet potato crop significantly influenced root tuber yield. Treatments in which vines were not harvested during the active vegetative growth phase of the crop produced the highest total and marketable root tubers. This was noticed in treatment 20 WAP (whose vines were not harvested until final harvest at 20 weeks after planting) followed by treatment 16 WAP (whose vines were harvested at 16 weeks after planting). The high tuber yield of 16 WAP comparing statistically similar with 20 WAP is based on the assumption that at 16 weeks after planting the tubers may have been almost fully developed and that any encroachment on the shoot at this stage may insignificantly affect tuber yield. This observation agrees with the finding of Ahmed et al. [16] that harvesting the vines 105 days after planting (when about 60% of the growth phase of the plant was completed) led to optimum production of herbage for fodder without compromising yield of tuberous roots. The significant reduction in total and marketable root tuber yields of treatments 8 WAP and 12 WAP, whose vines were harvested at 8 and 12 weeks after planting, respectively, during the very active growth phase may be attributed to disruption of growth and development processes. The cutting off of vines at such active vegetative growth periods of the crop could cause disruption in growth and development of leaves which may have reduced total number of leaves produced as well as total leaf surface area available for photosynthesis during the growth phase, contributing to the suboptimal synthesis and partitioning of carbohydrates to the tubers. Nwinyi [29] had earlier reported that removal of sweet potato vines during growth reduced the supply of photosynthate in the remaining period of growth of the plant with an eventual reduction in tuberous root yield. Similarly, Stathers et al. [30] reported that tuberous root weight of sweet potato was significantly reduced when cuttings were taken from young plants during early growth for propagation. Corroborating the results of this study, Kiozya et al. [22] and Nguyen and Bautista [31] also reported that harvesting the vines of sweet potato reduced yields of tuberous roots. In agreement with this work was the report of Etela et al. [32] and Larbi et al. [10], working on sweet potato varieties and maturity time found that tuberous root yields were not depressed when vine harvesting was done 140 days after planting and recommended that vine harvesting should be delayed up until this duration of growth to attain optimum tuberous root yields for use as human food. Similarly, Lebot [11] also recommends that vines should be harvested late (90 to 120 days after planting) after the storage cells in the tuberous roots have developed and accumulated sufficient starch in order to avoid suppression in growth and development of tuberous roots. In agreement with the results of this study.

Reduction in the number of root tubers noted with early vine-harvesting at 8 and 12 weeks after planting may be attributed to minimal partitioning of carbohydrate to the root tubers thereby reducing their numbers. These results agree with those of Lugojja et al. [33] who reported mean number of sweet potato root tubers per hectare following early vine harvesting

The report of this study shows that age of plant at which vines are harvested during growth is an important management factor affecting sweet potato leaf fodder and tuberous root yields.

## 4. CONCLUSION

Results of this study reveals that smallholder farmers who produce sweet potato mainly to obtain tubers for food would adopt planting on ridge seedbed for optimum root tuber yield while prospective pastoralists who produce sweet potato mainly to obtain the shoot as fodder may not need to labour to prepare ridge or mound seedbeds but plant on the flat which gave the highest shoot yield in the study. Nevertheless, when such planting is of a dual purpose, the shift goes to planting sweet potato on ridges and harvesting the vines at a later stage of growth by which time the root tubers may have developed and bulked sufficiently (when about 70% of the growth phase of the plants has been achieved), thereby enhancing the production of high amount of herbage for animal feed without compromising yield of root tubers as human food. As every sweet potato cultivar varies from the other in terms of genetic characters, the right time to harvest vines for optimizing yields of root tubers and herbage may vary depending on maturity time and other characteristics of the sweet potato cultivars. This study has revealed that harvesting sweet potato vines during early and active stages of vegetative growth drastically reduced fresh and dry root tuber yields and the number of root tubers, shoot fresh and dry matter yield. However, harvesting the vines 16 WAP (weeks after planting) led to insignificant reduction in the production of dry matter yield and number of tuberous roots.

Therefore, research should be done further on other sweet potato cultivars to compliment the determination of appropriate vine harvesting stages on growth of cultivars for optimum production of both root tubers for food and shoot for fodder.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Mbanaso EO. Adoption and dis-adoption of sweet potato Production and processing technologies by farmers in South-Eastern Nigeria. Ph.D thesis, department of agricultural extension, University of Nigeria, Nsukka. 2010;1-104.
2. Laban TF, Peace K, Robert M, Maggiore K, Hellen M, Muhumuza J. Participatory agronomic performance and sensory evaluation of selected orange-fleshed sweet potato varieties in south western Uganda. Global Journal of Science Frontier Research. 2015;15:25-30.
3. Gonzalez C, Diaz I, Vecchionacce H, Ly J. Performance traits of pigs fed sweet potato (*Ipomoea batatas* L.) foliage ad libitum and graded levels of protein. Livestock research for rural development. 2003;9-15.
4. Giang HH, Ly LV, Ogle B. Digestibility of dried and ensiled sweet potato roots and vines and their effect on the performance and economic efficiency of FI cross bred fattening pigs. Livestock Research for Rural Development. 2004;6-7.
5. Getachew A, Roger CM, Tilahun S. Increasing food security through improved goat production: a progress report of a UNICEF funded International Development Psartnership between Langston University and Alemaya University. In: R.C. Merkel, G. Abebeand A.L. Goetsh (eds). The opportunities and challenges of enhancing goat production in east Africa. Proceedings of a conference held at Debub University, Awassa, Ethiopia from November 10-12 E (Kika) de la Garza institute for goat

research, Langston University, Langston, Ok. 2000;118-126.

6. Tesfaye K, Tesfaye L, Estifanos T, Mieso G. Effect of level of substitution of sweet potato (*Ipomoea batatas* L.) vines for concentrate on body weight gain and carcass characteristics of browsing Arsi-Bale goats. J. Cell Anim. Biol. 2008;2(2): 036-042.
7. Okonkwo JC, Amadi CO, Nwosu KI. Potato production, storage, processing and utilization in Nigeria. National Root Crops Research Institute, Umudike, Nigeria. 2009;67-69.
8. Udemezue JC. Profitabilities and Constraints to Sweet Potato Production in Nigeria. Current Trends Biomedical Engineering & Bioscience. 2019;19(2): 556007.
DOI: 10.19080/CTBEB.2019.19.556007.
9. Adeyonu A, Balogun O, Ajiboye B, Oluwatayo IB, Otunaiya AO. Sweet potato production efficiency in Nigeria: Application of data envelopment analysis. AIMS Agriculture and Food. 2019;4(3):672-684. DOI: 10.3934/agrfood.2019.3.672
10. Larbi A, Etela L, Nwokocha HN, Oji UI, Anyanwu NJ, Gbaraneh LD, Anioke SC, Balogun RO, Muhammad IR. Fodder and Tuber yields and Fodder quality of sweet potato cultivars at different maturity stages in the West African humid forest and savanna zones. Animal. Feed. Sci. Technol. 2007;135:126-138.
11. Lebot V. Tropical root and tuber crops: cassava, sweet potato, yams and aroids CAB International publishers. 413p. Leon-Verlarde CU. Using competing traits to select dual-purpose sweet potato in native germplasm. International Potato Centre (CIP), Lima, Peru. 2009;89-294.
12. Aina PO. Effect of tillage, seed bed configuration and mulching on soil physical properties. Journal of Agriculture Sciences. 2002;10:26-31.
13. Lal R. Managing the soils of sub-Saharan Africa. Science. 1987;236:1069-1076.
14. Agbede TM, Adekiya AO. Tillage effects on soil properties and performance on an alfisol in south-western Nigeria. American – Eurasian J. Sustain. Agric. 2009;3(3): 561-568.
15. Van Vugt D, Franke AC. Exploring the yield gap of orange-fleshed sweet potato varieties on smallholder farmers' fields in Malawi. Field Crops Research. 2018; 221:245–256.
16. Ahmed M, Nigussie-Dechassa R, Abebie B. Effect of planting methods and vine harvesting on shoot and tuberous root yields of sweet potato [*Ipomoea batatas* (L.) Lam.] in the Afar region of Ethiopia. African Journal of Agricultural Research. 2012;7(7):1129-1141.
DOI: 10.5897/AJAR11.894
17. Chagonda I, Mapfeka RF, Chitata T. Effect of Tillage Systems and Vine Orientation on Yield of Sweet Potato (*Ipomoea batatas* L.). American Journal of Plant Sciences. 2014;5:3159-3165.
Available;http://dx.doi.org/10.4236/ajps.2014.521332
18. Dumbuya G, Sarkodie-Addo J, Daramy MA, Jalloh M. Growth and yield response of sweet potato to different tillage methods and phosphorus fertilizer rates in Ghana. Journal of Experimental Biology and Agricultural Sciences. 2016;4(5):475.483
19. Mu'azu A. Growth and development of sweet potato as influenced by NPK fertilizer rates intra-row spacing and seed bed types in the northern guinea savanna. Gashua Journal of Irrigation and Desertification Studies. 2016;2;1:109-115.
20. Ravindran CS, Mohankumar CR. Effect of method of land preparation and depth of planting on yield of sweet potatoes. In: Ramanujam, T., S. P. Ghosh, J. S. Jos, S. M. Morrthy and R. G. Nair (Eds.), Tropical Tuber Crops Production and Utilization. In: Proceedings of the National Symposium on Production and Utilization of Tropical Tuber Crops, 27-29 November, Central Tuber Crops Research Institute, Trivandrum, India. 1985;129-133.
21. Midmore DJ. Potato production in the tropics. In: P.M. Harris (Ed.). The potato Crop. The Scientific Basis for Improvement, second edition. Chapman and Hall, in Press; 1991.
22. Kiozya HC, Mtunda K, Kapinga R, Chirimi B, Rwiza E. Effect of leaf harvesting frequency on growth and yield of sweet potato in the Lake Zone of Tanzania. African Crop Science Journal. 2001;9(1): 97-103.
DOI:10.4314/acsj.v9i1.27629
23. An LV, Frankow-Lindeberg BE, Lindeberg JE. Effect of harvesting interval and defoliation on yield and chemical composition of leaves, stems, and tubers of sweet potato (*Ipomoea batatas* (L) Lam) cultivars. Field crops Research. 2003; 82(1):49-85.

24. Busha A. Effect of N and P Application and Seedbed Types on Growth, Yield and Nutrient Content of Sweet Potato [*Ipomoea batatas* L. (Lam)], Grown in West Wollega. M.Sc. Thesis presented to the School of Graduate Studies of Haramaya University. 2006;87.
25. Nedunchezhiyan M, Byju G, Ray RC. Effect of Tillage, Irrigation, and Nutrient Levels on Growth and Yield of Sweet Potato in Rice Fallow. International Scholarly Research Notices; 2012. Available:https://doi.org/10.5402/2012/291285
26. Ruiz ME, Pezo D, Martinez L. The use of sweet potato [*Ipomoea batatas* (L) Lam] in animal feeding. I. Agronomic aspects. Trop. Animal Prod. 1980;5(2):144-151.
27. Olorunnisomo OA. Yield and quality of sweet potato forage pruned at different intervals for West African dwarf sheep. Livestock Research for Rural Development. 2007;19(3).
28. Anikwe MAN, Mbah CN, Ezeaku PI, Onyia VN Tillage and plastic mulch effects on soil properties and growth and yield of cocoyam (*Colocasia esculenta*) on an ultisol in south-eastern Nigeria. Soil & Tillage Research. 2007;93:264–272.
29. Nwinyi SCO. Effect of age of shoot removal on tuber and shoot yields at harvest of five sweet potato (*Ipomoea batatas* (L) Lam.) cultivars. Field crops Research. 1992;29(1):47-54.
30. Stathers T, Namanda S, Mwanga ROM, Khisa G, Kapinga R. Manual for Sweet Potato Integrated Production and Pest Management for Farmer Field Schools in Sub-Saharan Africa. International Potato Centre, CIP, Kampala. 2005;31. ISBN: 9970-895- 01-x.
31. Nguyen BL, Bautista OK. Extent and mechanism of yield reduction in sweet potato grown for tops and roots. Philos. Agric. 1999;82:137–150.
32. Etela I, Oji UI, Kalio GA, Tona GO. Studies on sweet potato forage and dried brewers' grains as supplements to green panic for Bunaji cows. Tropical Grasslands. 2008; 42:245-251.
33. Lugojja F, Ogenga-Latigo MW, Smith NEJM. Impact of defoliation on the agronomic performance of sweetpotato in Uganda. Afri. Crop Sci. J. 2001;9:103-108.



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