Influence of ridge height, vine orientation and cuttings on growth and yield of sweet potato (*Ipomoea Batatas* L.) in Nigeria

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Abstract

A field study was conducted in Dutse, Sudan Savannah of Nigeria during the 2023 and 2024 rainy seasons to evaluate the effects of ridge height, vine orientation, and vine cuttings on growth and yield of sweet potato. The experiment consisted of five ridge heights (0, 30, 40, 50, and 60 cm), three vine orientations (45°, 90°, and 180°), and three vine cuttings (apical, middle, and base). Results showed that 60 cm ridge height and apical vine cuttings significantly improved growth and yield. Apical vine cuttings outperformed middle and base cuttings in vine length, number of leaves, leaf area, and root yield. Vine orientation had no significant effect on growth and yield. The interaction between ridge height and vine cutting showed 30 cm ridge and apex had higher chlorophyll content, while 50 cm ridge and apex had higher root fresh weight. The study recommends using 60 cm ridge height, apical vine cuttings, and 45° or 90° planting orientation for improved sweet potato yield.

Keywords: Ridge Height, Vine Cutting, Vine Orientation

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is a cheap source of calories and has a long history to stave off famine (Adam, 2005). The relatively high per capita consumption has led to a growing number of farmers producing it for commercial purposes. Sweet potato provides household food security because the crop can be harvested within 3-6 months (Anyaegbunam, *et al*., 2008) and can also remain in the ground for "piece meal" harvesting, a common sweet potato "storage" practice in the tropics (Laban *et al*., 2015). Within the African cropping systems, sweet potato has several advantages. It produces food in a relatively short time, gives reliable yields in sub-optimal growth conditions, requires lower labour inputs (appropriate for vulnerable households) than other staples, serves as an alternative food source for urban populations facing increasing prices of cereals, also provides a potential option to reduce vitamin A deficiency (Andreas *et al*., 2009).

Nigeria is the third largest producer of sweet potato in the world (4.0 million metric tons) with China leading (72 million metric tons) in 2024 (FAOSTAT, 2019). In Africa Nigeria is second following Tanzania (4.2 million metric tons). Despite this high ranking of Nigeria in sweet potato production the world over, the yield obtained in a hectare is which is low compared to that of China and Tanzania (FAOSTAT 2019).

The failure to achieve increased sweet potato production in Nigeria is mainly as a result of the poor agronomic practices. Tewe *et al*. (2003) reported that sweet potato is usually grown in crop mixtures that have negative effect on its output.

The growth and yield performance of sweet potato to different agronomic practices has not received adequate research attention especially in the Sudan Savannah Agro-Ecological Zone. Thus, agricultural management practices that can bring about increase and sustainable food production to meet the present and future nutritional demand of the ever increasing human population which is more than 3% per annum need to be examined (Barzegar *et al*., 2002; Manna *et al*., 2007). Appropriate plant establishment techniques are essential for successful crop growth and yield. Smallholder farmers in different regions of Africa produce sweet potato using their own experience passed on from early generations.

Depending on the experiences and location, farmers use various ridge heights or mound methods and varying vine orientations for planting since they believe these to produce variable yields (Parwada *et al*., 2011). Farmer's propagate sweet potato vegetatively using vine cutting. Cutting from the semi-hard wood cutting (SHWC) and the hard wood cutting (HWC) of the vine can be used, but they usually produce lower yields as well as poor growth performance. In Nigeria, sweet potato farmers plant the crop either horizontally, vertical, at an incline angle or in ring form. The most suitable vine length for propagation and angle of placement for maximum yield has been argued among researchers. Dhliwago and Chiunzi (2004) stipulated that planting at an angle or horizontally produced more yield while Onweme and Sinha (1991) recommends vertical orientation.

These methods make sweet potato a crop with varying yields, creating a void as to the best combination of ridge height, vine cutting as well as vine orientation method to use in order to make suggestions on how to achieve increased production of the crop. There is a need to examine, so as to establish the best ridge height, vine cutting and planting orientation to enhance yields among sweet potato farmers in this agro-ecological zone.

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Objectives of the study

The aim of the study is to evaluate the effect of ridge height, vine cutting and vine orientation on the growth and yield of sweet potato.

The specific objectives therefore are to ascertain:

- The effect of ridge height, vine cutting and vine orientation on growth of sweet potato.
- The effect of ridge height, vine cutting and vine orientation on yield of sweet potato.
- The interaction of these factors on the growth and yield of sweet potato.

MATERIALS AND METHODS

Experimental site: The experiment was carried out during the 2023 and 2024 rainy season at Faculty of Agriculture Teaching and Research Farm, Federal University Dutse (11°70' N, 9°34' E, and 460 m above sea level) within the Sudan savannah zone of Nigeria.

Meteorological data: Meteorological data were collected from the National Institute for Oil Palm Research (NIFOR) Dutse sub-station.

Soil sampling: The physico-chemical properties of the soils were determined using standard procedures as described by Black (1965).

Treatments and experimental design: The experiment consisted of ridge heights (flat, 30 cm, 40 cm, 50 cm and 60 cm), vine orientations (45°, 90° and 180°) and vine cuttings (apical, mid and basal portions). The treatments were laid out in a split plot design, with the ridge heights and vine cuttings in the main plot and vine orientations in the sub plot and replicated three times.

Agronomic practices

Variety: The variety used was Dan Izala. Its Skin Colour is purplish cream; Flesh colour is white and has a maturity period of 3 months. All standard agronomic practices like weeding, fertilizer application pest and disease control were observed up to harvest.

Table 1: Physical and chemical properties of the soil 0-30 cm at the experimental site during the 2023 and 2024 rainy season

	2023	2024
Physical Composition (%)		
Sand	67	67
Silt	21	22
Clay	12	11
Textural class	Sandy loam	Sandy loam
Chemical Composition		
pH	6.24	6.22
Acidity (cmol/kg)	0.17	0.15
% Organic Carbon	0.56	0.60
Phosphorus (mg/kg)	17.8	16.5
Total Nitrogen (g/kg)	0.52	0.52
% Organic Matter	0.96	0.94
Exchangeable bases		
Ca (cmol/kg)	3.17	3.21
Mg (cmol/kg)	0.56	0.62
K (cmol/kg)	0.76	0.75
Na (cmol/kg)	0.47	0.50
EC (ds/m)	126	122
ECEC (cmol/kg)	5.12	5.14

Data collected

Four (4) plants were tagged randomly on the sampling rows in each plot and they were used for data collection on growth characters. The 2 inner most rows were used for final yield assessment (net plot). Data were collected for the following:

- Number of branches per plant, vine length per plant, number of leaves per plant;
- Leaf area (LA), chlorophyll content, number of roots per hectare, root fresh weight/hectare (kg) and fodder fresh weight per hectare (kg).

RESULTS

Soil properties

The physico-chemical characteristics of the experimental soil are shown in Table 1. The soil was observed to be sandy loam with an average range 67% sand, 21.5% silt and 11.5% clay. Soil pH ranged from 6.2-6.7 which is slightly acidic. Total N and available P where in moderate quantities. K, Exchangeable Ca, Mg and organic matter contents were low.

Number of branches per plant

No significant difference was observed among the different ridge heights on number of branches per plant during 2023 and 2024 rainy season. However, statistical difference was observed among the different vine cuttings in both the trial periods. The apical portion (apex) had significantly higher number of branches all through the sampling periods in both years. The middle and base were statistically similar and had lower means compared to the apex, except in 2023 where base had the lowest means at 6 WAP.

There was no significant difference among the different vine orientations during all the periods. There was also no significant interaction between all the factors (Table 2).

Table 2: Effect of ridge height, vine cutting and vine orientation on number of branches of sweet potato during the 2023 and 2024 rainy season

	2023				2024			
	Weeks after Planting							
Treatment	**6**	**9**	**12**	**15**	**6**	**9**	**12**	**15**
Ridge Height (cm)								
0	19.9	28.8	36.9	41.4	21.6	31.6	39.2	43.0
30	18.6	26.3	33.2	38.7	20.6	28.9	34.9	39.5
40	18.9	27.2	35.3	40.1	20.1	31.3	38.1	42.5
50	18.9	26.3	34.0	39.6	19.6	27.8	35.1	40.5
60	18.9	26.8	35.0	38.5	20.3	29.7	37.3	41.4
SE±	0.67	1.69	1.60	1.67	0.71	1.49	1.80	1.55
Vine Cutting								
Apical	22.8 a	35.5 a	41.7 a	46.5 a	24.4 a	36.3 a	43.3 a	48.1 a
Middle	18.0 b	25.1 b	32.4 b	36.9 b	19.0 b	26.3 b	33.8 b	38.8 b
Base	16.3 c	23.6 b	30.6 b	35.6 b	17.8 b	26.6 b	33.7 b	37.7 b
SE±	0.52	1.52	1.30	1.43	0.55	1.34	1.63	1.34
Vine Orientation (°)								
45	19.2	28.0	34.5	38.6	20.5	29.9	36.1	40.4
90	19.4	27.1	35.2	41.0	21.0	29.6	38.0	42.3
180	18.6	26.2	35.0	39.4	19.8	29.7	36.7	41.4
SE±	0.52	1.52	1.20	1.43	0.55	1.39	1.63	1.34
Interaction								
RH x VC	ns	ns	ns	ns	ns	ns	ns	ns
RH x VO	ns	ns	ns	ns	ns	ns	ns	ns
VC x VO	ns	ns	ns	ns	ns	ns	ns	ns
RH x VC x VO	ns	ns	ns	ns	ns	ns	ns	ns

Means followed by the same letter are not significantly different at 5% level of probability using SNK.

Vine length

Significant differences were observed among the ridge heights in 2023 and 2024 rainy seasons. Flat (0 cm) had the highest mean vine length, while the lowest vine lengths were from 50 cm ridges. In 2023, at 9 WAP, 0 cm had the highest mean vine length and statistically at par with 50 and 60 cm ridges, while 40 cm ridge had the lowest mean and statistically similar with 30 cm ridge. In 2024 at 6 WAP, 0 cm had the highest mean vine length and statistically at par with 40, 50 and 60 cm ridges while 30 cm ridge had lowest mean.

Vine cuttings also showed significant differences in 2023 and 2024. Apex had the highest mean vine length. The base had the lowest.

There was no significant difference among the different vine orientations.

There was no significant interaction between all the factors at both locations (Table 3).

Table 3: Effect of ridge height, vine cutting and vine orientation on vine length (cm) of sweet potato during the 2024 wet season at BUK and DUTSE

	2023				2024			
	Weeks after Planting							
Treatment	6	9	12	15	6	9	12	15
Ridge Height(cm)								
0	112 a	197 a	223 a	244 a	89.6 a	153	176	185
30	104 a	187 a	218 a	239 a	77.1 b	142	171	186
40	85.3 b	157 b	185 b	207 b	89.4 a	142	167	180
50	75.8 b	135 b	160 b	183 b	89.4 a	151	176	191
60	77.8 b	153 b	174 b	196 b	95.7 a	155	173	184
SE±	6.56	9.36	10.2	10.7	6.435	5.57	4.21	4.54
Vine Cutting								
Apical	99.7 a	178 a	205 a	226 a	87.7	166 a	200 a	215 a
Middle	95.5 a	167 ab	194 ab	216 ab	94.6	146 b	167 b	178 b
Base	77.4 b	152 b	177 b	199 b	82.4	133 c	151 c	163 c
SE±	5.48	7.09	8.03	8.54	6.00	4.83	3.38	3.50
Vine Orientation (˚)								
45	89.8	168	195	217	88.0	153	176	189
90	95.4	173	198	220	89.0	147	170	183
180	87.4	156	182	204	87.7	146	171	184
SE±	3.13	5.76	6.13	6.18	6.00	4.83	3.38	3.50
Interaction								
RHxVC	ns	ns	ns	ns	ns	ns	ns	ns
RHxVO	ns	ns	ns	ns	ns	ns	ns	ns
VCxVO	ns	ns	ns	ns	ns	ns	ns	ns
RHxVCxVO	ns	ns	ns	ns	ns	ns	ns	ns

Means followed by the same letter are not significantly different at 5% level of probability using SNK.

Number of leaves

There was significant difference. Flat (0 cm) had the highest mean number of leaves and was statistically similar to 60 cm ridge, while 30 cm ridge had the least and statistically similar to 40 and 50 cm ridges at 6 WAP. No significant difference was observed subsequently during other sampling periods.

Vine cuttings showed significant differences among means during all periods of sampling in 2023 and 2024. Apex had significantly higher means, except where apex and middle were statistically at par at 6 WAP in 2023 and the base had the lowest means.

No significant difference was observed among the different vine orientations. There were also no significant interactions observed (Table 4).

Table 4: Effect of ridge height, vine cutting and vine orientation on number of leaves of sweet potato during the 2023 and 2024 rainy season

	2023				2024			
	Weeks after planting							
	6	9	12	15	6	9	12	15
Ridge Height (cm)								
0	114 a	190	203	211	123 a	188	209	218
30	89.8 b	171	203	211	96.7 b	181	210	222
40	95.0 b	193	220	221	104 b	201	233	243
50	98.4 b	190	207	220	101 b	195	223	231
60	102 ab	186	209	219	110 ab	187	216	226
SE±	4.69	7.95	8.91	9.71	5.27	8.36	9.33	10.1
Vine Cutting								
Apical	107 a	211 a	229 a	238 a	113	215 a	243 a	252 a
Middle	103 a	182 b	210 b	221 a	108	187 b	219 b	228 b
Base	89.4 b	165 c	185 c	190 b	100	170 b	193 c	204 c
SE±	3.76	6.58	7.23	8.21	3.98	6.79	7.82	8.72
Vine Orientation (˚)								
45	97.3	185	207	218	104	192	216	226
90	104	190	212	221	111	193	224	236
180	97.9	183	206	211	105	186	214	223
SE±	3.76	6.58	7.23	8.21	3.98	6.79	7.82	8.72
Interaction								
RHxVC	ns	ns	ns	ns	ns	ns	ns	ns
RHxVO	ns	ns	ns	ns	ns	ns	ns	ns
VCxVO	ns	ns	ns	ns	ns	ns	ns	ns
RHxVCxVO	ns	ns	ns	ns	ns	ns	ns	ns

Leaf area

There was no significant difference among the ridge. There was significant difference among the vine cuttings. Apex had the highest mean leaf area during 2023 and 2024 rainy seasons. The base had the lowest means even though at some sampling periods were statistically at par with the middle at 9 and 15 WAP in 2023. No significant difference was observed among vine orientations. No significant interaction was observed during the entire period of the experiment (Table 5).

Table 5: Effect of ridge height, vine cutting and vine orientation on leaf area (cm^2) of sweet potato during the 2023 and 2024 rainy season

	2023				2024			
	Weeks after Planting							
	6	9	12	15	6	9	12	15
Ridge Height (cm)								
0	63.4	83.2	98.8	102	63.5	87.3	101	108
30	63.0	86.4	99.0	102	64.6	92.9	103	113
40	61.0	80.9	94.6	97.1	63.4	90.5	99.1	105
50	58.2	78.6	90.6	94.3	61.8	84.0	95.2	106
60	62.2	82.4	95.0	98.9	64.5	87.3	97.2	108
SE±	1.60	3.05	3.31	3.16	2.01	5.90	6.21	6.27
Vine Cutting								
Apical	66.3 a	98.2 a	117 a	120 a	67.3 a	104 a	121 a	128 a
Middle	62.6 b	79.0 b	89.6 b	92.8 b	64.0 a	84.1 b	92.1 b	101 b
Base	55.8 c	69.7 c	80.2 c	83.9 c	59.3 b	77.4 b	84.0 c	95.4 b
SE±	1.35	4.58	5.32	6.12	2.16	5.68	5.98	6.04
Vine Orientation (˚)								
45	62.4	83.3	95.3	98.1	65.4	89.4	99.5	107
90	61.1	80.8	94.8	99.1	62.1	87.6	98.8	109
180	61.2	82.9	96.7	99.1	63.2	88.2	99.4	109
SE±	0.81	1.34	1.27	1.29	2.16	5.68	5.98	6.04
Interaction								
RHxVC	ns	ns	ns	ns	ns	ns	ns	ns
RHxVO	ns	ns	ns	ns	ns	ns	ns	ns
VCxVO	ns	ns	ns	ns	ns	ns	ns	ns
RHxVCxVO	ns	ns	ns	ns	ns	ns	ns	ns

Chlorophyll content

There was significant difference (P<0.05) among means at 6 WAP in Dutse during 2023 rainy season. 30 cm ridge height had the highest mean chlorophyll content in 2023, and was at par with 60 cm, 40 and 50 cm ridge heights. 0 cm (flat) had the lowest mean chlorophyll content all through the trials.

Significant differences were observed among the vine cuttings in 2023 and 2024. The apex had the higher means during all the sampling periods at all locations. The middle and the base had lower means and were statistically at par. Vine orientations had no significant differences (Table 6).

Table 6: Effect of ridge height, vine cutting and vine orientation on chlorophyll content of sweet potato during the 2023 and 2024 rainy season

	2023				2024			
	Weeks after Planting							
	6	9	12	15	6	9	12	15
Ridge Height (cm)								
0	46.4	49.8	57.1	58.0 c	46.5 b	51.6	59.3	59.5
30	51.0	55.1	60.8	62.9 a	53.8 a	57.1	63.0	63.2
40	48.4	53.0	57.6	59.5 a-c	50.5 ab	54.5	60.3	60.3
50	49.9	53.5	59.4	58.9 bc	53.8 a	54.7	62.1	61.2
60	50.7	53.2	61.5	62.6 ab	48.8 b	56.1	63.4	63.8
SE±	1.91	2.05	1.60	3.00	2.39	2.86	2.91	1.47
Vine Cutting								
Apical	52.1 a	56.6 a	66.7 a	65.9 a	55.0 a	57.6 a	68.7 a	67.4 a
Middle	49.6 a	51.4 b	56.8 b	58.2 b	50.2 b	53.9 b	58.8 b	59.9 b
Base	46.2 b	50.7 b	54.4 b	56.9 b	46.9 c	52.8 b	57.3 b	57.5 b
SE±	2.54	2.64	2.47	2.86	2.21	2.67	2.77	1.14
Vine Orientation (˚)								
45	49.1	52.3	58.5	59.2	50.6	54.4	60.6	60.8
90	49.5	52.7	59.6	60.9	51.5	54.8	62.2	62.0
180	49.2	53.7	59.7	60.9	50.0	55.2	62.0	62.0
SE±	0.97	0.92	0.94	1.12	2.21	2.67	2.77	1.06
Interaction								
RHxVC	ns	ns	ns	*	ns	ns	ns	*
RHxVO	ns	ns	ns	ns	ns	ns	ns	ns
VCxVO	ns	ns	ns	ns	ns	ns	ns	ns
RHxVCxVO	ns	ns	ns	ns	ns	ns	ns	ns

Means followed by the same letter are not significantly different at 5% level of probability using SNK.

There was significant interaction between ridge height and vine cutting at both locations in 2023 and 2024 at 15 WAP. Thirty (30 cm) ridge height and apex had the highest means, however was statistically similar with 0 cm (flat) and apex. Flat (0 cm) and middle had the lowest means in 2024 (Tables 7 and 8).

Table 7: Interaction between ridge height and vine cutting on chlorophyll content of sweet potato at 15 WAP during the 2023 rainy season

	Vine Cutting		
Ridge Height (cm)	**Apical**	**Middle**	**Base**
0	67.8 ab	53.2 f	52.9 f
30	72.6 a	58.2 c-f	57.9 d-f
40	60.4 c-e	59.3 c-f	58.9 c-f
50	64.5 b-d	55.5 ef	56.6 ef
60	64.4 b-d	65.0 bc	58.4 c-f
SE (±)	2.26		

Means followed by the same letter are not significantly different at 5% level of probability using SNK.

Table 8: Interaction between ridge height and vine cutting on chlorophyll content of sweet potato at 15 WAP during the 2024 rainy season

	Vine Cutting		
Ridge Height (cm)	**Apical**	**Middle**	**Base**
0	69.3 a	54.8 e	54.5 e
30	71.5 a	60.2 c-e	57.9 de
40	62.1 b-d	59.6 c-e	59.2 c-e
50	69.2 a	57.6 de	56.8 de
60	65.0 a-c	67.2 ab	59.0 c-e
SE (±)	3.72		

Number of roots per hectare

There was significant difference among ridges in 2024. Fourty (40 cm) ridge had highest number of roots and was statistically similar to 60 cm ridge, while 30 cm had the lowest means. There was no significant difference among means at both locations in 2023.

There was significant difference (P<0.001) among vine cuttings. The Apex had the highest mean number of roots per hectare all through, even though statistically similar with the middle in 2023. The base had lower means There was no significant difference among the vine orientations (Table 9).

Table 9: Effect of ridge height, vine cutting and vine orientation on number of roots per hectare of sweet potato during the 2023 and 2024 rainy season

	2023	2024
Ridge Height (cm)		
0	69,300	52,539 b
30	75,885	52,960 b
40	83,621	68,807 a
50	85,844	55,399 b
60	85,432	63,231 ab
SE±	6,477	4,345
Vine Cutting		
Apical	104,346 a	69,244 a
Middle	90,617 a	59,196 b
Base	45,086 b	47,321 c
SE±	5,589	3,555
Vine Orientation (˚)		
45	80,741	57,133
90	80,198	60,871
180	79,111	57,756
SE±	5,589	3,555
Interaction		
RHxVC	*	ns
RHxVO	ns	ns
VCxVO	ns	ns
RHxVCxVO	ns	ns

There was significant interaction between ridge height and vine cutting in 2023. Fifty (50) cm ridge and apex had the highest mean and was statistically similar to 40 cm ridge and apex, while 30 cm ridge and the base had the lowest mean and similar to flat (0 cm) and base, 40 cm ridge and base, and 50 cm ridge and base (Table 10).

Root Fresh Weight per Hectare

There was significant difference among the ridge heights in 2023 and 2024. 60 cm ridge had the highest root fresh weight per hectare, even though statistically similar with 50 cm, 40 cm, while flat (0 cm) had the lowest fresh weight per hectare though at par with 30 cm.

Table 10: Interaction between ridge height and vine cutting on number of roots per hectare during the 2023 rainy season

	Vine Cutting		
Ridge Height (cm)	**Apical**	**Middle**	**Base**
0	80,741 cd	86,667 cd	40,494 ef
30	94,568 bc	102,963 bc	30,124 f
40	115,309 ab	90,124 bc	45,432 ef
50	128,642 a	80,988 cd	47,901 ef
60	102,469 bc	92,346 bc	61,482 de
SE (±)	9,775.3		

Means followed by the same letter are not significantly different at 5% level of probability using SNK.

Mean root fresh weight as affected by vine cuttings showed significant differences ($P<0.05$) in 2023 and 2024. Apical cutting had significantly higher root fresh weight per hectare, while base had the lowest in 2024. In 2023, apical cutting was statistically at par with the middle. No significant differences were observed among the vine orientations (Table 11). Significant interaction was observed between ridge height and vine cutting at in 2023. Fourty (40) cm ridge and apex had statistically higher means but similar to 30 cm ridge and middle, 50cm ridge and apex, and 60 cm ridge and apex, while the lowest mean was from flat (0 cm) and base but statistically similar to 30 cm ridge and base, and 40 cm ridge and base (Table 12).

Table 11: Effect of Ridge Height, Vine Cutting and Vine Orientation on root fresh weight per hectare (kg) plant of sweet potato during the 2023 and 2024 rainy season

	2023	**2024**
Ridge Height (cm)		
0	11,177 b	8,994 c
30	14,004 a	9,360 c
40	15,741 a	12,251 ab
50	14,709 a	11,300 b
60	16,082 a	13,352 a
SE±	858	606
Vine Cutting		
Apical	18,020 a	13,555 a
Middle	16,036 a	11,485 b
Base	8,973 b	8,114 c
SE±	626	439
Vine Orientation (˚)		
45	14,440	10,781
90	14,579	11,515
180	14,010	10,858
SE±	626	439
Interaction		
RHxVC	*	ns
RHxVO	ns	ns
VCxVO	ns	ns
RHxVCxVO	ns	ns

Table 12: Interaction between ridge height and vine cutting on root fresh weight per hectare of sweet potato during the 2023 wet season at DUTSE

	Vine Cutting		
Ridge Height (cm)	**Apical**	**Middle**	**Base**
0	13,124 de	14,234 c-e	6,173 h
30	16,358 b-d	18,815 ab	6,840 gh
40	21,074 a	17,877 a-c	8,272 f-h
50	20,407 ab	12,610 d-f	11,111 e-g
60	19,136 ab	16,642 a-d	12,469 d-f
SE (±)	1,568		

Fodder fresh weight per hectare

No significant difference was observed on ridge heights during the trial periods.

Significant difference was observed on vine cutting in 2023. Middle had the highest fodder fresh weight per hectare and also at par with the apical cutting. The base had the lowest fodder fresh weight per hectare.

There was also significant difference among the vine orientations (Table 13).

Table 13: Effect of Ridge Height, Vine Cutting and Vine Orientation on fresh fodder weight per hectare (kg) of sweet potato during the 2023 and 2024 rainy season

	2023	**2024**
Ridge Height (cm)		
0	13,486	9,623
30	13,415	7,786
40	11,988	9,016
50	12,872	8,938
60	12,518	9,556
SE±	907	624
Vine Cutting		
Apical	13,109 a	9,091
Middle	14,454 a	8,942
Base	11,005 b	8,919
SE±	747	482
Vine Orientation (˚)		
45	12,323	8,662
90	12,854	9,652
180	13,390	8,638
SE±	747	482
Interaction		
RHxVC	ns	ns
RHxVO	ns	ns
VCxVO	ns	ns
RHxVCxVO	ns	ns

Means followed by the same letter are not significantly different at 5% level of probability using SNK.

DISCUSSION

Growth of sweet potato

Number of branches was not significantly influenced by ridge height, however the vine cuttings showed that apex had higher number of branches as compared to the middle and the base. Cuttings from the shoot apex give more branches due to the fact that they establish quickly in the soil by initiating more roots and thereby encourage subsequent production of branches and greater number of root tubers than semi hardwood and hardwood cuttings (Tewe *et al.*, 2003). This finding is in agreement with Belehu (2003) who reported that middle and basal stem cuttings can be planted when there is shortage in supply of planting material causing a slight decrease in expected yield. The highest vine length was observed from no ridging, while 60 cm ridge had the lowest vine length. This result concurred with Dhliwayo and Chiunzi (2004) but contradicts with Gomes (1999) who postulated that, vine growth tends to be higher on high ridges where there is increased root penetration and ample soil from which nutrients are extracted. This is conflicting with Edmond (2001) who noted that, ridge height and planting angle affect vine length of sweet potatoes at all growth stages. The apex also resulted in the longest vines with the base having the shortest vine length as apical cuttings may ensure better rooting and establishment and faster shoot growth and therefore early closure for weed suppression (Eronica *et al.* 1984). Vine length was not affected by the different vine orientations. This finding agrees with Zanele *et al.* (2018), who reported that vine orientation had no significant effect on vine length.

Differences in number of leaves was only observed at early growth stages, but subsequently no differences were observed among the ridge heights leading to the conclusion that ridge height did not significantly affect number of leaves. The apex had higher number of leaves, showing that it performed better in cell division, while the base which was semi-woody to woody had lowest number of leaves. This result is in agreement with the findings of Eronica *et al. (*1984), and Tewe *et al.* (2003).

Leaf area was not affected by ridge height. However, there was difference among the vine cuttings whereby the apex had plants with higher leaf area. The base and middle had lower leaf areas. This might be due to the presence of leaves on vine cuttings which greatly increased adventitious root production, presumably due to the presence of active endogenous root promoting substances (Fadl *et al.*, 1977; Fadl *et al.*, 1978). Oliveira (2000) also stated that leaf diameter decreased in the hard wood cutting (base) compared to the soft wood cutting (apex) that resulted in lager leaf diameter. This finding is also supported by Nkambule and Ossom (2010). Vine orientations did not have any significant effects on leaf area as no difference was observed among the different vine orientations.

Differences in chlorophyll content was only observed at early growth stage of sweet potato and as such the conclusion that there was not much difference among the ridge heights. The apex however, resulted in highest chlorophyll content while the middle and the base had lower chlorophyll content; this is in agreement with the findings of Hall (1987), Eronica *et al.* (1984), and Tewe *et al.* (2003) as apical cuttings may ensure better rooting and establishment and faster shoot growth due to faster cell division.

Yield and Yield Components of Sweet Potato

Ridge height did not significantly affect number of roots. However, the apex and middle vine cutting had higher number of roots per plant than the base, this is due to the fact that apex is a better planting material than the middle or base as stated earlier. This is in agreement with Zaag *et al.* (1998).

Root fresh weight per hectare was influenced more by 60 cm ridge height and 0 cm (flat) had the least influence. There was increase in root fresh weight by 4.1- 48.5% as the ridge height was increased with 60 cm ridge having the highest percentage increase. The finding is in conformity with that of Ennin *et al. (*2003), Dhliwayo and Chiunzi (2004), who reported ridging to result in increased sweet potato yields by up to 38 %. The apex had higher root fresh weight per hectare (up to 122 %) as compared to the middle (up to 78.7) and base which had lower yield. Vine orientation showed no significant influence on root fresh weight per hectare. This result conflicts the findings of Idoko *et al.* (2017), where saleable root weight decreases with increase in angle of planting while unsalable root weight increases with increase in angle of planting This might be due to better light interception by the inclined cuttings which most have resulted in production of more photosynthates to the sink.

Fodder fresh weight was higher with no ridging and less by higher ridges. This can be attributed to the fact that ridging influenced more dry matter accumulation which was translated to the storage roots, hence higher root yield and as such reduction in fodder yield. Apex vine cutting resulted in higher fodder fresh weight and the base was having the lowest and in conformity with the findings of Tewe *et al.* (2003). Vine orientations at 45° and 90° had higher fodder fresh weight per hectare. Boote and Loomis (1992) reported that light interception efficiency was higher for inclined arranged leaves but lower for vertical leaves arrangement which allows for rapid reallocation of resources between the shoot and the root system as was also observed by Chiunzi and Dhliwayo (2004).

Interactions

Interaction between ridge height and vine cutting showed 30 cm ridge and apex as having higher chlorophyll content. This can be attributed to the better cell division and elongation properties of the shoot apex. This is supported by the works of Ennin *et al.* (2003) and Chagonda *et al.* (2014).

Number of roots per hectare was higher with 60 cm ridge, and apex, while 50 cm ridge and apex had the highest root fresh weight per hectare. This can be explained by the fact that loose soil and higher ridges promotes better root formation than compacted soil. This result is corroborated by the findings of Edmond (2001) who noted that, ridge height and planting angle affect storage root of sweet potatoes, also Cuttings from apical shoot grow more vigorously and produce larger storage roots compared with cuttings from middle and basal portions. Tewe *et al.* (2003) reported that apical cuttings of sweet potato had significantly higher marketable and total tuber yield than the middle followed by the basal cuttings. Chagonda *et al.*, (2014) reported that higher yields will be obtained if sweet potato is planted at an angle or horizontally. Parwada *et al.(*2011) reported that there were interaction effects of ridge height and planting angle on final root yield.

CONCLUSION

In conclusion it can be recommended that for better plant establishment and subsequent root yield 60 cm ridge height, apical vine cuttings and 45° or 90˚ planting orientations should be employed.

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