



GROWTH AND YIELD OF FLUTED PUMPKIN [*Telfairia occidentalis* (Hook F)] AS INFLUENCED BY TILLAGE PRACTICE AND STAKING METHODS IN THE SUDAN SAVANNAH OF NIGERIA

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ABSTRACT

Field trials were conducted to study the influence of tillage practices and staking methods on the growth and yield of fluted pumpkin, during 2018 rainy session at the Teaching and Research Farm, Bayero University, Kano (Latitude 11°58'N and Longitude 8°25'E), and Kano Institute of Horticulture Bagauda, Kano (Latitude 11°33'N and Longitude 8°34'E) both located in the Sudan savanna of Nigeria. The treatments consisted of three (3) tillage practices (zero tillage, conventional tillage, and conservational tillage) and three (3) staking methods (individual, pyramidal, and non-staked), these were factorially combined to give nine (9) treatments and laid out in a split plot design, replicated four (4) times with tillage practices allocated to the main plot while staking methods were placed in sub-plots. Results indicated that tillage practices had distinct effects on many growth parameters (vine length, number of leaves) depending on the location. In some cases, minimum and conservational tillage practices resulted in more leaves at Bagauda and longer vines at 6 WAS (94.5 cm) and at 12 WAS (160.1cm) at BUK, potentially due to improved soil properties across the locations. Staking methods significantly influenced branching only at Bagauda and later in the growth cycle. Similarly, non-staking (4.091) and pyramidal staking (4.225) encouraged more branching compared to individual staking (3.667), likely due to better support and resource allocation. Tillage and staking methods generally did not significantly impact leaf length across locations, suggesting a potential genetic influence on leaf size in the fluted pumpkin variety used. The combination of tillage and staking methods can influence leaf growth, but the optimal combination depends on the growth stage and location. Therefore, conservational tillage with pyramidal staking could be employed by farmers of fluted pumpkin in the study area to enhance growth and yield.

Keywords: Tillage practices, staking methods, vine length, leaf growth, Bagauda,

INTRODUCTION

Vegetables constitute essential components of human nutrition because they are very rich in vitamins, protein, minerals, oil etc. (Amina *et al.*, 2012; Opazo-Navarrete *et al.*, 2021). Fluted pumpkin (*Telfairia occidentalis* L.) is one of the most popular cucurbitaceous leaf and seed vegetables grown for human consumption. It is a high climbing perennial with partial drought tolerance and penetrating root system (Amina *et al.*, 2012). It is a pot herb cultivated mainly for its young succulent leaves and shoot which are used as vegetables. It originated from East and West Africa and is widely grown and consumed in Nigeria especially in Igbo land. It is also cultivated in various parts of South Western states of Nigeria where the leaves (which produce strong aroma), succulent shoots and seed kernel constitute valuable ingredients in soups (Amina *et al.*, 2012; Sakpere *et al.*, 2019). It is now gradually grown in the northern part of Nigeria.

Fluted pumpkin thrives in various soil tillage conditions, including zero-till, conventional tilling, and mulching (conservational). Okeke *et al.* (2016) observed that in



southern Nigeria, women traditionally cultivate it in home gardens, allowing the vines to climb fences, trees, or other structures. In home gardens, they are grown close to fence or to a tree, wall, and structures on which the shoots are allowed to climb (Akata, 2017). Limited research on tillage and staking methods hinders optimal growth. Furthermore, the soil's rapid nutrient depletion and poor physical condition significantly restrict crop production ((Egun, 2007).

There is lack of standard farming practices for *Telfairia occidentalis* (ugu) in Nigeria, despite its rising demand. While large farms let the crop sprawl on the ground, leading to pest issues and dirty produce, staking the crop can improve yield. Soil moisture is the single most important factor affecting crop growth, development, and ultimately, yield (Chadha *et al.*, 2019; Yang *et al.*, 2021). However, judicious tillage practice and method has been one of cultural practices adopted to ensure optimum soil moisture, aeration, reduction in bulk density, erosion control etc. for better crop growth and invariable optimum crop yield in some agro-ecological zones (Bekele, 2020; Liu *et al.*, 2021).

Fluted pumpkin, a vital part of the Nigerian diet, faces production challenges in Sudan Savanna soils. Limited research on tillage and staking methods hinders optimal growth. Furthermore, the soil's rapid nutrient depletion and poor physical condition significantly restrict crop production (Aderi *et al.*, 2011). Despite the potential of fluted pumpkin in Sudan Savanna soils of Nigeria, its production suffers due to a lack of suitable tillage and staking methods. These methods can improve nutrient retention and crop growth, but they are rarely practiced in this region. As a result, fluted pumpkin remains a non-viable option for many farmers, despite its economic benefits (Ndo and Dauda, 2013). Low yields of fluted pumpkin in Sudan Savanna are likely due to farmers not using the most effective tillage and staking techniques. These methods are crucial for maximizing crop growth and profitability (Godonu *et al.*, 2023). Further research is needed to determine the best practices for this specific region. This study was however conducted with the aim of evaluating the effect of tillage practices and staking methods on growth and leaf yield of fluted pumpkin in Kano, Sudan savannah ecology of Nigeria.

MATERIALS AND METHODS

The experiment was conducted during 2018 rainy season at the Teaching and Research Farm of the Faculty of Agriculture, Bayero University (Latitude 11°58'N and Longitude 8°25'E) Kano, and Kano Institute of Horticulture Bagauda, Kano (Latitude 1°33'N and Longitude 8°34'E) both in Sudan savanna agro-ecological zone of Nigeria. The soil of the experimental sites was characterized as clay sandy loamy and sandy loamy with a neutral pH (7.12 and 7.34) for Bagauda and BUK, respectively. The soil had medium organic carbon of 7.82 and 13.2 %, total N content of 0.13 gkg⁻¹ and 0.28 gkg⁻¹ and available P of 13.6 mg/kg and 23.20 mg/kg for BUK and Bagauda, respectively. Similarly, the exchangeable cations (Ca, Mg) were medium (3.76, 0.39cmol kg⁻¹) at BUK and high at Bagauda (4.95 and 0.95 cmol kg⁻¹). Whereas K was medium (0.36, 0.18) for BUK and Bagauda, respectively. The sodium (Na) content of both locations was also medium. The CEC of the soil at both locations were medium and ranged between 6.40 cmol/kg and 9.21 cmol/kg for BUK and Bagauda, respectively, in accordance to Esu (1991) as cited by Talha and Mani (2019).

The treatments consisted of three levels of staking methods (individual, pyramidal staking and non-staked) and three levels of tillage methods (Zero tillage, Conservational tillage, and Conventional tillage) these were factorially combined to give nine treatments and laid out in a split plot design with four replications. The tillage method was allocated to main plot while staking methods was placed in sub- plots. Part of the experimental site was cleared, ploughed and harrowed and the other part was cleared with the use of cutlass and hoe. After which, the



plots were mapped out using measuring tape, pegs and ropes, to get a total land area. The gross plot size was 4.0 m x 3.0 m (12 m²), and a net plot size was 2.0 x 3.0 m (6.0 m²). The seeds of *Telfairia occidentalis* were sown manually at a spacing of 1m inter rows and 1m intra row with one seed planted per hole. Large and medium size seeds were used during sowing with the helium facing downward position. The crop received nutrients in the form of blanket application of Poultry manure at 5 t/ha to each plot before sowing. N.P.K fertilizer (15-15-15) was applied at the rate of 45 kg ha⁻¹ at 21 days after sowing by side placement. Weeds were controlled by hoe weeding at 3 WAS and subsequently, hand pulling of weeds was done regularly to keep the field clean of weeds. Insect pests were controlled by spraying with neem leaf extract at rate of 20 ml/L. Staking of vines was done at 6 WAS using the three (3) different staking methods (zero, individual and pyramidal staking). Long bamboo stakes of 2 m were used to make trails for the plants. Thread was used to tie off the plant on the stake. At 8 WAS, the tip of the plant was decapitated using secateurs to avoid apical dominance and this allowed the plant to spread on the trellis and the fruits to hang on it. Data were collected on number of days to seed emergence, germination percentage, vine length, number of leaves, number of branches, leaf length and leaf yield (Kg ha⁻¹). All data collected were subjected to statistical analysis of variance (ANOVA) to test for significant differences among the treatments using SAS statistical package (Version 9.0) and significantly different treatment means were separated using least significance difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Days to Emergence and Germination Percentage (%)

The influence of tillage practices and staking methods on the number of days to seed emergence and germination percentage of fluted pumpkin is presented in Table 1. The result showed that the number of days to emergence and germination percentage were not significantly ($P > 0.05$) influenced by tillage and staking methods at both Bagauda and BUK. This could be attributed to seed quality, encompassing factors like seed maturity, viability, and dormancy characteristics, which might be the primary determinant of germination. Even if tillage or staking methods influenced the soil environment to some extent, high-quality seeds might have overcome these variations. Furthermore, Local climate, particularly temperature and rainfall patterns, could be the most critical factors governing germination timing and success in both locations where tillage and staking practices might have minor effects compared to these prevailing environmental conditions. The findings of this study is in line with that of Reed *et al.* (2022) who reported the role of environmental factors on seed germination and vigor.

Table 1: Influence of Tillage Practices and Staking Methods on the Days to Emergence and Germination Percentage (%) of Fluted Pumpkin

Treatment	Bagauda		BUK	
	Days to seed emergence	Germination percentage (%)	Days to seed emergence	Germination percentage (%)
<u>Tillage Practices (TP)</u>				
Minimum	11.58	94.92	11.83	94.22
Conservational	10.08	95.70	11.08	95.35
Conventional	12.50	93.91	11.66	93.91
LSD (0.05)	1.389	3.622	1.322	3.641
<u>Staking Methods (SM)</u>				
Individual	10.92	94.41	11.92	95.25
Non- staked	11.92	95.75	11.08	94.08
Pyramidal	11.33	94.41	11.58	94.83
LSD (0.05)	1.391	4.764	1.673	4.191
<u>Interaction</u>				
TP x SM	0.607	0.575	0.751	0.184

Vine Length

Table 2 shows the influence of tillage practices and staking methods on the vine length of fluted pumpkin. Results indicated that vine length was not significantly ($P < 0.05$) influenced by tillage practices and staking methods across the sampling periods at Bagauda. However, at BUK, tillage practices significantly ($P < 0.05$) influenced the vine length of fluted pumpkin, where the minimum tillage significantly produced the longest vine at 6 WAS, while conservational tillage resulted in significantly longer vines at 12 WAS compared with other tillage practices. The variation in terms of location might be due to soil composition, climate, and rainfall patterns which could all influence how fluted pumpkins respond to tillage and staking. For instance, minimum tillage might be more beneficial in drier regions (Bagauda) to conserve moisture, while conservational tillage might offer advantages in areas with heavier rainfall (BUK) by improving drainage and aeration. This finding concurred with that of Okporie *et al.* (2012) and Okeke *et al.* (2016), who reported that tillage of the soil alters the moisture content of the upper soil, which impacts seed emergence and germination. A higher concentration of nutrients encourages crop development and growth, which may result in a noticeable rise in the amount of biomass that fluted pumpkin accumulates.



Table 2: Influence of Tillage Practices and Staking Methods on the Vine Length (cm) of Fluted Pumpkin

Treatments	Bagauda				BUK			
	Weeks After Sowing (WAS)							
	6	8	10	12	6	8	10	12
<u>Tillage Practices (TP)</u>								
Minimum	86.70	104.7	126.2	143.9	94.5 ^a	111.3	132.9	154.5 ^b
Conservational	87.64	108.3	128.2	158.1	90.4 ^b	111.5	131.1	160.1 ^a
Conventional	95.48	115.9	135.7	150.8	87.4 ^b	107.9	135.6	155.8 ^b
LSD	9.504	15.02	15.50	16.07	8.484	10.04	10.44	12.66
<u>Staking Methods (SM)</u>								
Individual	87.75	105.1	125.2	145.7	85.7	105.3	129.2	157.8
Non staked	88.14	111.7	132.3	152.3	92.6	111.8	133.5	150.4
Pyramidal	93.92	112.1	132.4	154.7	94.0	113.5	136.9	162.2
LSD	9.327	11.819	13.66	17.35	5.176	7.646	7.326	10.85
<u>Interaction</u>								
TP x SM	0.660	0.568	0.696	0.301	0.113	0.467	0.270	0.402

Means following different superscript in a column are significantly different at 5% LSD.



Number of Leaves

Table 3 shows the influence of tillage practices and staking methods on the number of leaves at Bagauda and BUK. The result indicated no significant effect of the tillage method on the number of leaves per plant at both locations except at 12 WAS at Bagauda, where conservational tillage significantly resulted in a higher number of leaves than other tillage practices. On the other hand, the staking method had a significant effect on number of leaves at Bagauda only, where the pyramidal staking methods significantly ($P < 0.05$) produced more leaves than other staking methods at 6, 8, and 10 WAS. This outcome might be related to the soil conditions at Bagauda which was influenced by conservational tillage due to its relative dryness which suggest that conservational tillage practices can improve soil structure and nutrient availability. This, in turn, could have benefited leaf production at Bagauda during the later growth stage (12 WAS) when plants require more resources for photosynthesis. This finding corroborates that of by Eze *et al.* (2020) who showed that Conservation Agriculture increased total soil porosity by 14–49 % and fine water storage pores by 33–171 %. Similarly, Mhlanga *et al.* (2024) discovered the interactions of genotype with environment and management to maize productivity where conservation practices boosted the yield of the companion crops than the non-conservational practices.



Table 3: Influence of Tillage Practices and Staking Methods on the Number of Leaves per Plant of Fluted Pumpkin

Treatment	Bagauda				BUK			
	Weeks After Sowing (WAS)							
	6	8	10	12	6	8	10	12
<u>Tillage Practices (TP)</u>								
Minimum	25.83	45.7 ^{ab}	72.8	103.6 ^b	30.58	49.75	69.2	97.08
Conservational	26.83	48.1 ^a	71.2	113.0 ^a	35.58	29.83	70.2	96.42
Conventional	26.58	44.2 ^b	73.8	104.6 ^b	35.58	53.28	69.5	96.92
LSD	2.804	2.936	6.990	13.89	5.399	6.624	3.346	5.522
<u>Staking Methods (SM)</u>								
Individual	23.36 ^b	42.65 ^b	70.2 ^b	104.2	30.42	46.85	66.81	94.08
Non-staked	25.00 ^b	46.74 ^b	70.8 ^b	105.1	31.58	53.87	72.40	98.42
Pyramidal	31.17 ^a	48.88 ^a	79.9 ^a	112.0	34.00	51.83	68.63	97.92
LSD	2.749	4.795	6.516	5.120	4.727	6.937	6.538	3.974
<u>Interaction</u>								
TP x SM	0.334	0.545	0.237	0.265	0.685	0.778	0.546	0.504

Means following different superscript (s) in a column are significantly different at 5% LSD.



Number of Branches

Number of branches per plant of fluted pumpkin as influenced by tillage practices and staking methods is presented in Table 4. The result revealed that tillage practices had no significant ($P < 0.05$) effect on number of branches of fluted pumpkin across the sampling periods at both locations. This suggests that factors other than soil disturbance through tillage might play a more prominent role in fluted pumpkin branching. Research by Adeyemo and Tijjani (2018) and Aworunse *et al.* (2022) points towards genetic predisposition and plant density as crucial determinants of branching in cucurbits like fluted pumpkin. Staking methods vary significantly at 12 WAS at Bagauda only, where the non-staked and pyramidal significantly ($P < 0.05$) produced more branches than the individual staking. The ability of zero staking and/or pyramidal staking to produce more branches could be linked to support and energy allocation, where the non-staked and pyramidal staking offer more balanced support, hence the plants might expend less energy on maintaining vine structure. This could allow them to allocate more resources towards lateral branch development, especially at a later stage (12 WAS), when branching might be advantageous for maximizing light interception and yield.

Individual staking, by providing a central support, might inadvertently promote apical dominance, where the main vine receives a larger share of resources, potentially suppressing lateral branch development, compared with individual staking, where a central support was provided, which might inadvertently promote apical dominance, where the main vine receives a larger share of resources, potentially suppressing lateral branch development. Studies like that of Liu *et al.* (2020) discuss the concept of apical dominance and its influence on branching patterns in plants. Furthermore, Beveridge *et al.* (2023) stated that the process of apical dominance, by which the apical bud or shoot tip of the plant inhibits the outgrowth of axillary buds, is influenced by some growth hormones.



Table 4: Influence of Tillage and Staking Methods on the Number of Branches per Plant of Fluted Pumpkin

	Bagauda				BUK			
	Weeks after sowing (WAS)							
Treatments	6	8	10	12	6	8	10	12
<u>Tillage Practices (TP)</u>								
Minimum	2.333	3.192	3.583	4.042	2.700	3.108	3.475	4.141
Conservational	2.716	3.742	3.641	5.941	2.700	3.058	3.550	4.266
Conventional	2.558	3.117	3.516	4.000	2.516	3.191	3.600	3.958
LSD	0.305	5.008	00.388	0.490	0.553	0.583	0.392	0.711
<u>Staking Methods (SM)</u>								
Individual	2.191	5.350	3.233	3.667 ^b	2.350	3.941	3.308	4.008
Non-staked	2.750	3.325	3.683	4.091 ^a	2.701	3.200	3.591	4.125
Pyramidal	2.667	3.375	3.825	4.225 ^a	2.850	3.216	3.725	4.234
LSD	0.394	4.265	0.347	0.316	0.506	0.399	0.232	0.309
<u>Interaction</u>								
TP x SM	0.563	0.379	0.924	0.334	0.860	0.772	0.275	0.554

Means following different superscript in a column are significantly different at 5% LSD.



Leaf Length

Table 5 shows the influence of tillage practices and staking methods on leaf length of fluted pumpkin at 6, 8, 10 and 12 WAS at Bagauda and BUK. Results reveals that tillage practices and staking methods had no significant ($P < 0.05$) effect on leaf length across all sampling periods and at both locations. The fluted pumpkin variety used in the study might have an inherent genetic tendency toward a specific leaf size, regardless of tillage or staking methods. Wang *et al.* (2024) and Ren *et al.* (2020) delve into the influence of genetics on leaf size traits in cucurbit crops and *Populus simonii* \times *P. nigra*, respectively. The interaction between tillage practices and staking methods revealed that, combination of non-staked with conventional tillage significantly ($P < 0.05$) resulted in longer leaves. In the absence of staking (non-staked), the plants might be allocating more resources towards leaf growth to capture sunlight for photosynthesis, especially during the crucial early stages (6 WAS). Conventional tillage, by potentially improving soil aeration and nutrient availability, could further support this enhanced leaf growth. This aligns with research by Vallotton (2018) on the positive effects of conservational tillage (which might be similar to conventional tillage in some aspects) on soil properties and nutrient availability.

On the other hand, at 12 WAS at BUK, the combination of individual staking with conventional tillage significantly resulted in longer leaves, which was also comparable with the rest of the interaction (Table 7). At this later growth stage (12 WAS), individual staking might provide the most balanced support for the developing vines, allowing them to invest more energy in leaf expansion. Conventional tillage, by potentially improving soil aeration and nutrient availability, could further support this enhanced leaf growth. This aligns with the concept of support influencing resource allocation discussed previously. The fact that the longer leaves produced by individual staking and conventional tillage were also comparable to other interaction effects suggests that the differences in leaf length between various combinations might be relatively small at this stage. Perhaps other environmental factors like rainfall or sunlight intensity will become more influential on leaf size at BUK during this later period. This finding agrees with that of Lili *et al.* (2023).



Table 5: Effect of Tillage and Staking on the Leaf Length (cm) of Fluted Pumpkin

Treatment	Bagauda				BUK			
	Weeks After Sowing (WAS)							
	6	8	10	12	6	8	10	12
<u>Tillage Practices (TP)</u>								
Minimum	28.45	39.98	67.95	98.95	32.71	51.75	88.90	119.58
Conservational	35.34	49.06	96.96	133.12	29.40	51.75	88.67	125.14
Conventional	33.59	53.20	94.20	140.00	34.77	55.53	90.51	133.16
LSD	8.439	12.671	16.408	24.071	8.326	6.036	9.263	23.147
<u>Staking Methods (SM)</u>								
Individual	29.84	50.54	91.98	128.80	33.41	54.53	93.28	129.39
Non-staked	34.46	46.32	80.47	121.53	33.02	54.53	88.67	126.01
Pyramidal	33.08	44.36	85.65	121.63	30.45	49.97	86.13	122.47
LSD	5.067	8.396	13.48	15.88	5.210	8.774	8.841	12.974
<u>Interaction</u>								
T x S	0.027	0.067	0.269	0.334	0.395	0.857	0.571	0.006



Table 6: Interaction between Tillage Practices and Staking Methods on Leaf Length of Fluted Pumpkin

Staking Methods	Tillage Practices		
	Minimum	Conservational	Conventional
6 WAS Bagauda			
Individual	26.56 ^b	36.60 ^{ab}	26.79 ^b
Non-staked	29.78 ^{ab}	31.42 ^{bc}	42.16 ^a
Pyramidal	29.01 ^{ab}	37.92 ^{ab}	32.32 ^{ab}
12 WAS BUK			
Individual	109.35 ^b	138.59 ^{ab}	140.25 ^a
Non-staked	133.79 ^{ab}	102.04 ^{ab}	131.59 ^{ab}
Pyramidal	115.61 ^{ab}	134.81 ^{ab}	127.64 ^{ab}

Means following different superscript (s) across row and column are significantly different at 5% LSD.

CONCLUSION AND RECOMENDATION

The results of this investigation showed that conservation tillage techniques promise to have a good impact on a variety of growth indices, including vine length and leaf count, possibly through enhancing the aeration and nutrient availability of the soil. In a similar vein, pyramidal staking promotes greater branching than other staking techniques, which may be advantageous for optimizing light interception and, eventually, yield. Consequently, pyramidal staking and conservation tillage appear to work well together, especially when it comes to vine length and leaf production. This implies that the development and leaf output of fluted pumpkins can be maximized by combining these two techniques.

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