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Full Length Research Article

EFFECT OF TILLAGE AND STAKING METHODS ON THE GROWTH AND YIELD OF FLUTED PUMPKIN (*Telfairia occidentalis* L.) IN KAFANCHAN, SOUTHERN GUINEA SAVANNAH, NIGERIA

I.B. Bawa and I.S. *Akos

Department of Crop Science, Faculty of Agriculture, Kaduna State University, Kafanchan Campus, Nigeria

*Corresponding Author Email Address:ibrahim.akos@kasu.edu.ng

ABSTRACT
This study investigated the effects of tillage and staking methods on the growth and yield of fluted pumpkin (*Telfairia occidentalis*) at Kafanchan in southern Guinea Savannah, Nigeria. This was carried out at the Teaching and Research Farm, Department of Crop Science, Faculty of Agriculture, Kaduna State University, Kafanchan Campus. The experiment was a factorial combination of three tillage practices and three stacking methods and was laid out in complete randomized block design and replicated three times on a 3x3 factorial in a Randomized Complete Block Design (RCBD) consisted of three tillage practices (zero tillage, flat tillage, and mound) and three staking methods (zero staking, single staking, and trellis staking). The results showed that Mound tillage (T3) resulted in a 22% increase in vine length (49.12 cm) compared to flat tillage (T2) at 3 WAS. Trellis staking (S3) significantly improved root length (29.05 cm), representing a 43% increase compared to single staking (S2). Zero tillage (T1) resulted in a 51% increase in leaf weight (2.53) compared to flat tillage (T2) and mound tillage (T3). The study suggests that conservation agriculture practices like zero tillage and trellis staking can be beneficial for fluted pumpkin production, potentially reducing soil degradation and promoting soil health. There was no significant interaction in your yield parameters.

Keywords: Phenotypic, Fluted pumpkin, Growth, Tillage, Staking.

INTRODUCTION
Fluted Pumpkin (*Telfairia oocidentalis*) is a member of the family *Cucurbitaceae* and is indigenous to southern Nigeria, and they are distributed all over the warm parts of the world (Okeke et al., 2016). It is named after Charles Telfair (1778-1833), an Irish botanist. It is a perennial woody climber that is grown for its leaves and seeds, known to be very nutritious. Fluted pumpkin is native to West Africa, with Nigeria being its primary center of origin and diversity (Asante *et al.,* 2019). It is widely cultivated and consumed in various regions across Nigeria, especially in the southeastern, southwestern, and parts of the middle belt regions (Eke-Okoro *et al.,* 2020).
This global distribution highlights the adaptability and versatility of Fluted pumpkin as a crop; it has gained recognition on the international market due to its nutritional value and culinary versatility.
Ugu-ala (Calabar Fluted pumpkin) and Ugu-elu (Port Harcourt Fluted pumpkin) are distinguished by their leaf shapes and sizes. Ugu-ala is characterized by broader, more deeply lobed leaves, while Ugu-elu has narrower, less deeply lobed leaves (Nwokocha et al., 2021). Their morphological differences may have implications for their growth patterns and adaptability to different ecological conditions. Both Ugu-ala and Ugu-elu varieties of Fluted pumpkin are known for their high nutritional content.
Recent research has demonstrated that increased fluted pumpkin cultivation and consumption can lead to improvements in household food security and nutrition (Adeyemi *et al.,* 2022). Its cultivation serves as a major source of income for numerous peasant farmers in West Africa. The sale of fluted pumpkin leaves, seeds, and other products provides a substantial portion of household income (Eke-Okoro *et al*., 2020).
Climate plays a significant role, with fluted pumpkin thriving in tropical and subtropical climates characterized by warm temperatures and well-defined wet and dry seasons (Onyeka *et al.*, 2020). Additionally, the availability of suitable soils, adequate water resources, and the presence of traditional knowledge and cultivation practices also influence its distribution. Fluted pumpkin thrives in well-drained, loamy soils with good organic matter content (Onyeka *et al.*, 2020). It is adaptable to a range of soil types, but performs best in soils with a pH ranging from 5.5 to 6.8 (Oyewale *et al.*, 2020). Recent studies have emphasized the importance of soil pH in influencing nutrient availability and uptake by the plant (Egharevba *et al.*, 2021). It is commonly cultivated as an annual crop because the leaves and young shoots dry at the end of growing (rainy) season but at the starting of the rainy season, new shoots regenerate along the main branches, especially in female plants. The female plants can survive for about 4 years when their main stem must have reached a diameter of up to 10cm. Its ligneous branches could be over 30cm long when found high up in trees (Okeke *et al.*, 2016). Soil preparation (tillage) is essential for efficient and maximum productivity, as well as the staking, which also supports their lifespan. This is an indication of the recent high trend in the demand of *Telfairia occidentalis*. The agronomy of Fluted pumpkin, according to Olaniyi and Akanbi (2010) has been neglected because it does not fall into the export category like most other tropical vegetable crops.

MATERIALS AND METHODS
Experimental Site
The experimental site is the Teaching and Research Farm of the Department of Crop Science, Faculty of Agriculture, Kaduna State University, Kafanchan Campus (09° 34 'N and 08° 18` E) in the Southern Guinea savannah of Nigeria on some selected parameters of the plant. The average annual rainfall in this region is 1540mm with an average annual temperature of 24.4°C. The experiment was carried out during the rainy season (May - October) of 2024.

Experimental Layout and Design
The experiment was a factorial combination of three levels of tillage (zero tillage, flat tillage, and mound tillage) and three levels of

stacking (Zero staking, single staking, and Trellis staking), laid out in a randomized complete block design (RCBD) and replicated three times.
The experimental plot size was 2 x 2m ($4m^2$) which is 2x2m, which consisted of 3 rows per plot with 9 treatments and 3 replications, with a total of 27 experimental plots.

Data Collection and Statistical Analysis
Three (3) plants were randomly selected and tagged for periodic observations in each plot. Critical observation was taken on the experimental work for the effectiveness of the result. The following parameters were observed for data collection: vine length, number of leaves, number of branches, and leaf area at 3, 5, 7, 9 weeks after sowing (WAS), and leaf weight, number of roots, and root length measured at 12WAS.
The data collected was subjected to analysis of variance (ANOVA) using Statistix version 10. Means were separated using Duncan Multiple Range Test(DMRT) at a 0.05 level of significance.

RESULTS
Effect of Tillage and Staking on Vine Length of Fluted Pumpkin
There were significant differences ($p<0.05$) only at 3 and 5WAS in both tillage practices and stacking. On the effect of tillage and at 3WAS, T3 produced the highest vine length, followed by T2, while T1 produced the least vine length. At 5WAS, T2 produced the highest vine length, followed by T1 and T3 produced the least. On the stacking, S2 supported the highest vine length at 3WAS, followed by S3. However, at 5WAS, S3 supported the highest vine length, followed by S1, while S2 produced the least vine length.

Table 1. Effect of tillage and staking on the vine length (cm) of Fluted pumpkin at 3, 5, 7, and 9WAS during the Rainy Season of 2024.

Treatment	3WAS	5WAS	7WAS	9WAS
Tillage Practices (TP)				
T1	40.03^{ab}	56.89^{b}	74.40	93.71
T2	39.14^{b}	73.67^{a}	86.56	72.62
T3	49.12^{a}	63.15^{ab}	88.25	101.42
SE (±)	6.395	12.269	15.666	35.54
Staking Methods (SM)				
S1	35.73^{ab}	32.69^{b}	60.75	62.01
S2	38.19^{a}	64.67^{ab}	70.44	79.47
S3	29.66^{b}	71.60^{a}	71.40	88.07
SE **(±)**	6.394	12.269	15.666	35.54
Interaction				
TP x SM	NS	NS	NS	NS

* Means following different superscript in a column are significantly different at 5% LSD; Not significant (NS); Not significant (NS); Zero tillage(T1); Flat tillage (T2); Mound tillage (T3); Zero staking (S1); Single staking (S2); Trellis staking (S3)

Effect of Tillage and Staking on the Number of Leaves of Fluted Pumpkin.
There were no significant differences at 3 and 9WAS in both tillage and stacking practices. However, the parameters showed significant differences at 5 and 7WAS. At 5 and 7WAS, T2 produced the highest number of leaves, then T1, and lastly, T3 in that order. Similarly, at 5 and 7WAS, S3 gave the highest number of leaves, followed by S2, while S1 produced the least.
There was no significant interaction between tillage and staking.

Table 2. Effect of Tillage and Staking on the Number of Leaves of Fluted Pumpkin at 3, 5, 7, and 9WAS During the Rainy Season of 2024.

Treatment	3WAS	5WAS	7WAS	9WAS
Tillage Practices (TP)				
T1	7.56	13.22^{b}	28.57^{b}	39.56
T2	8.68	18.56^{a}	38.40^{a}	43.44
T3	8.83	14.66^{ab}	29.72^{ab}	47.81
SE (±)	1.413	2.856	6.186	
Staking Methods (SM)				
S1	7.56	12.82^{ab}	24.07^{ab}	33.36
S2	5.38	9.41^{b}	23.20^{b}	32.84
S3	5.88	14.86^{a}	28.87^{a}	36.36
SE **(±)**	1.413	2.856	6.186	8.97
Interaction				
TP x SM	NS	NS	NS	NS

* Means following different superscript in a column are significantly different at 5% LSD; Not significant (NS); Zero tillage(T1); Flat tillage (T2); Mound tillage (T3); Zero staking (S1); Single staking (S2); Trellis staking (S3)

Effect of Tillage and Staking on the Leaf Area (cm^2) of Fluted pumpkin.
The effect of tillage and stacking on the leaf area of fluted pumpkin is shown in Table 3. The parameters remained at par throughout the sampling period, except at 9WAS in both factors. At 9WAS, T1 produced the highest leaf area, which differed significantly from its counterparts. It was followed by T2, then T3. During the same period, S2 produced the highest leaf area, followed by S1, and S3 produced the least leaf area. There were no significant interactions between tillage and staking method on leaf area.

Table 3. Effect of Tillage and Staking on the Leaf area (cm^2) of Fluted pumpkin at 3, 5, 7, and 9WAS During the Rainy Season of 2024

Treatment	3WAS	5WAS	7WAS	9WAS
Tillage Practices (TP)				
T1	44.08	48.88	55.64	55.70^{a}
T2	37.36	47.86	50.72	37.64^{b}
T3	37.69	41.67	49.74	49.68^{ab}

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SE (±)	9.977	18.922	21.364	11.810
Staking Methods (SM)				
S1	36.98	58.98	53.44	54.50[b]
S2	47.66	58.16	61.37	68.49[a]
S3	33.24	69.32	77.14	65.28[ab]
SE **(±)**	9.977	18.922	21.364	11.810
Interaction				
TP x SM	NS	NS	NS	NS

* Means were not significantly different at 5% LSD; Not significant (NS); Zero tillage(T1); Flat tillage (T2); Mound tillage (T3); Zero staking (S1); Single staking (S2); Trellis staking (S3)

Effect of Tillage and Staking on the Number of Branches of Fluted Pumpkin

The effects of tillage and stacking practices are presented in Table 4. Based on the table, tillage and stacking did not have a significant influence on the number of branches of fluted pumpkin at 5, 7, and 9WAS. The interaction between tillage and stacking was not significant.

Table 4. Effect of Tillage and Staking on the Number of Branches per Plant of Fluted pumpkin at 3, 5, 7, and 9WAS During the Rainy Season of 2024**.**

Treatment	5WAS	7WAS	9WAS
Tillage Practices (TP)			
T1	0.60	1.94	2.62
T2	0.74	2.04	2.78
T3	0.06	1.53	3.73
SE (±)	0.559	0.917	1.714
Staking Methods (SM)			
S1	0.65	1.59	1.72
S2	0.09	0.94	1.88
S3	0.21	1.48	2.73
SE **(±)**	0.559	0.917	1.714
Interaction			
TP x SM	NS	NS	NS

* Means were not significantly different at 5% LSD; Not significant (NS); Zero tillage(T1); Flat tillage (T2); Mound tillage (T3); Zero staking (S1); Single staking (S2); Trellis staking (S3)

Table 5 shows the effects of tillage and stacking on leaf weight/plant, number of roots/plant, and root length/plant. Tillage practices had no significant effect on root length. However, there were significant differences in leaf weight and the number of roots/plant. T1 gave the highest number of leaves/plant, while T2 and T3 produced results that are at par. T3 produced the highest number of roots, followed by T2, then T1. Conversely, stacking had no significant effect on leaf weight and the number of roots/plant. However, stacking had a significant influence on root length, with S3 being superior to other stacking methods by producing the highest root length, followed by S2, and S1 supported the least root length. There was no significant interaction between Tillage practices and stacking methods

Table 5. Effect of Tillage and Staking on the Yield Parameters of Fluted Pumpkin at 12WAS During the Rainy Season of 2024.

Treatment	Leaf Weight(kg)	No of Root	Root Length(cm)
Tillage Practices (TP)			
T1	2.53[a]	6.95[ab]	22.07
T2	1.68[b]	6.63[b]	26.07
Mound tillage **(T3)**	1.68[b]	9.10[a]	26.80
SE (±)	0.248	0.808	2.705
Staking Methods (SM)			
S1	2.22	8.12	25.37[ab]
S2	1.90	7.43	20.52[b]
S3	1.78	7.13	29.05[a]
SE **(±)**	0.248	0.808	2.705
Interaction			
TP x SM	NS	NS	NS

* Means following different superscript in a column are significantly different at 5% LSD; Not significant (NS); Zero tillage(T1); Flat tillage (T2); Mound tillage (T3); Zero staking (S1); Single staking (S2); Trellis staking (S3).

DISCUSSION

The study evaluates the effect of tillage and staking methods on the growth of *Telfairia occidentalis* (fluted pumpkin), analyzing parameters such as plant height, number of leaves, leaf area, number of branches, root weights, number of roots, and root length. Akos et al. (2019ab); Akos et al. (2021); Akos (2023) used similar parameters for growth and yield evaluation.

The significant difference in vine length observed at 3 and 5 WAS for both tillage and staking methods underscores the importance of these agronomic practices in promoting vertical growth. Mound tillage (T3) and trellis staking (S3) performed better, likely due to improved light capture and reduced competition. This finding is consistent with previous studies by Akande et al. (2020); Oluwasegun et al. (2019), and Adekiya et al. (2019); Faloye et al. (2019), who highlighted the benefits of staking in enhancing photosynthesis and reducing lodging. The increased vine length observed in T3 and S3 may be attributed to the better utilization of resources such as light, water, and nutrients, which are essential for plant growth and development.

The superiority of T2 and S3 observed at 5 and 7WAS for flat tillage (T2) and trellis staking (S3) suggests that these treatments facilitate better leaf development. This may be attributed to improved aeration and reduced pest/disease pressure associated with staked systems. This is in consonant with the finding of Ibeawuchi et al. (2018). The statistical similarity between T3 and S1 are not statistically similar, it is just that both were superior to their counter parts in producing the highest number of leaves/plant and it is only at 3WAS. It indicates that mound tillage and zero staking may also promote leaf growth, potentially due to reduced soil disturbance and improved soil moisture conservation. Improved leaf development in T2 and S3 may be due to the increased exposure to sunlight, which is essential for photosynthesis (Lawal et al., 2020).

The production of the highest leaf area by T1 and S2 suggests that these treatments promote leaf expansion. This may be due to optimal light exposure and minimized mechanical damage. Similar, findings have been reported by Oluwasegun et al. (2019) and Adebayo et al. (2018). Also, Egun (2007) recommended that *Telfairia occidentalis* be staked with bush sticks or raised platform for good exposure to sunlight and better photosynthetic activities to promote high leaf yield. Statistical similarity occurs within levels of the same factor; T1 and S2 are statistically similar with T3 and S3, which indicates that they (mound tillage and trellis staking) also enhance leaf area, potentially due to improved soil aeration and reduced soil-borne diseases. According to Lawal et al. (2020), leaf area is a critical factor in determining plant productivity, and any factor that promotes leaf expansion can lead to increased yields. Furthermore, the larger leaf area in T1 and S2 at 9WAS may be attributed to the reduced competition for resources, allowing the plants to allocate more energy to leaf growth, confirming the earlier report by Faloye et al. (2019).

The lack of significant difference in the number of branches among treatments suggests that branching is influenced more by genetic factors than environmental factors. This finding is consistent with previous report by Opeña et al. (2011); and Sanni et al. (2017) which highlight the importance of genotype and plant density in determining branching in vining crops. According to Eifediyi et al. (2019), branching in crops like fluted pumpkin is often influenced by intrinsic factors, and environmental factors may play a secondary role. However, the numerical variation among treatments, with T3 and S3 at 9WAS showing higher values, may indicate that mound tillage and trellis staking can still influence branching, potentially due to improved light capture and reduced competition.

The significantly higher leaf weight observed in Zero tillage(T1) value (2.53) suggests that minimal soil disturbance may promote better leaf growth and development. This could be due to reduced soil compaction, improved soil structure and aeration, and enhanced microbial activity. Flat tillage (T2) and Mound tillage (T3) with the lower leaf values might be attributed to Soil compaction and disruption of root growth, increased soil erosion or waterlogging. Similar results were reported by Akata et al. (2017). Trellis staking (S3) with significantly longer root length (29.05cm) indicates that providing vertical support can enhance root growth and penetration, increase exposure to sunlight and air circulation, and reduce disease and pest pressure. Zero staking (S1) and Single staking (S2), the varying effects on root length and leaf weight might be due to limited support and structure, increased competition for resources (light, water, nutrients). This is confirmed by the recommendations of Borget (1992) and Okonmah (2011) that climbing species such as *Telfairia occidentalis*, water hyacinth, water melon, cucumber, and beans be staked to promote reception of sunlight and enhance both leaf and fruit yield.

Conservative agriculture practices (zero tillage) can be beneficial for fluted pumpkin production, potentially reducing soil degradation and promoting soil health. Awonubi (2019) suggests that this difference in results may be due to the climatic and soil characteristics of the study area. Accordingly, Nabayi et al. (2021), also stated that conservation tillage practices can improve soil fertility and structure, leading to increased leaf production. Trellis staking can be an effective method for improving root length and potentially increasing yields.

Conclusion

This study demonstrated the importance of tillage and staking methods on the growth and yield of fluted pumpkin. The results showed that different tillage and staking practices can impact vine length, number of leaves, leaf area, number of branches, leaf weight, number of roots, and root growth. However, the only parameters that were significantly different and or with similarity at 9WAS are leaf area (T1 and S2), leaf weight (T1 and S1), with number of roots showing no significant difference for T3 but significant difference and similarity with S1, while T3 was statistically higher but significantly different with statistical similarity at S3 on root length. These findings have implications for sustainable agricultural practices, particularly in regions where fluted pumpkin is an important crop. By adopting conservation agriculture practices like zero tillage and trellis staking, farmers can potentially reduce soil degradation, promote soil health, and improve crop yields in the study area.

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