



EFFECT OF PLANT SPACING AND MULCHING MATERIALS ON GROWTH AND YIELD OF FLUTED PUMPKIN (*TELFAIRIA OCCIDENTALIS*) IN SOUTHERN GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT

The effect of mulching materials and plant spacing on the growth and yield of fluted pumpkin (*Telfairia occidentalis*) was studied in a field trial at the Research Farm of the Department of Agricultural Education, Federal College of Education, Eha-Amufu, Enugu state, Nigeria during 2022 cropping season. The aim was to determine the suitable agronomic techniques for optimum yield of fluted pumpkin in Eha-Amufu. The treatments involved three mulching materials (black polythene, rice straw and zero mulch) and three plant spacing (30cm x 30cm, 50cm x 50cm, and 100cm x 100cm). It was a 3 x 3 factorial combination of treatments laid out in Randomized Complete Block Design (RCBD) with three replications. The main plot treatment consisted of plant spacing at three levels designated as S_1 , S_2 , and S_3 while the three levels of mulch materials designated as M_1 , M_2 and M_3 was assigned to the sub-plots. The results obtained from the experiment indicated that while there were no significant ($P > 0.05$) differences among the plant spacings and mulch materials evaluated on the vine length, number of leaves, and fresh leaf weight, planting fluted pumpkin at S_3 and mulching with M_2 consistently gave higher values for these traits. The interaction effect of S_3 plant spacing and M_2 significantly influenced the growth and yield attributes of fluted pumpkin than planting at the rest treatment combinations. For greater productivity of yield and yield components of fluted pumpkin, it is recommended that farmers in Eha-Amufu environment adopt the treatment combination of 100cm x 100cm plant spacing with biodegradable rice straw mulch material.

Key words: Fluted pumpkin, Plant Spacing, Mulching materials, growth, yield

Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook f.) is a leafy vegetable in many African countries such as Nigeria, the Cameroun, Benin Republic, the Republic of Sierra Leone and Angola (Akoroda, 1990). Fluted pumpkin belongs to the family, cucurbitaceous and originated from tropical West Africa (Gregory, 2018). It is a popular and widely accepted as a dietary constituent in the south eastern states of Nigeria (Akwaowo, *et al.*, 2002). It is a herbaceous perennial grown trellised, although it is cultivated as an annual crop especially under the traditional farming system in West Africa. Fluted pumpkin is mostly cultivated in the rainy season but can also be grown in the dry season with irrigation. Fluted pumpkin produces for a long period and it is preferred to short season leafy vegetables such as *Amaranthus spp* which is rarely harvested more than three



times in its life span. The crop can therefore be grown and sold all the year round thus, providing a good source of income to the farmer.

Fluted pumpkin leaves have very high nutritional, medicinal and industrial values. The leaves and tender vines of fluted pumpkin are consumed as potherb while the seeds are eaten as nuts. Due to the soil being silty clay loam, low in nitrogen (0.16 %), total phosphorus (39.11 ppm), Potassium 0.38, Magnesium 2.91, Calcium 7.88. pH 4.91, organic carbon 4.07 while the cation exchange capacity was 11.3 to the hematonic properties with its high levels of protein and iron, extracts from the leaves of fluted pumpkin are used for the treatment of Anemia and diabetes (Akoroda, 1990). The leaves and edible shoots of fluted pumpkin together contains 85% moisture, the whole dry portion contains 11% crude protein, 3% oil, 25% carbohydrate, 11% ash, and as much as 70 ppm iron. Pumpkin leaves also contain magnesium which helps the brain and nervous system, improving cognitive reasoning, memory loss (Dementia) and other health conditions associated to memory health such as Alzheimer's disease (Sharma, 2013).

Despite the importance of this vegetable, its demand far exceeds supply, resulting in scarcity which makes it expensive. There is therefore, the need to increase the productivity of the crop by employing agronomic technologies such as mulching and suitable plant spacing that will guarantee optimum yield. Mulch is a coating material spread over the soil surface (Ngouajio, 2012). Mulching is the technique of covering the soil surface around the plant stand with an organic or synthetic mulch to create favorable condition for the plant growth and proficient crop production. It insulates soil to protect organisms and plant roots from different meteorological conditions. Mulching improve soil aeration around the plant, aggregates the soil particles, soil fertility, and drainage over time. Mulch insulates soil, helping to provide better form of heat and cold temperature. The importance of mulching includes reduction of soil water loss, soil erosion, impact of water droplets hitting the soil surface, weed growth, and competition of water and nutrient from the surrounding fields all of which are necessary for optimum crop performance (Anzalone, *et al.*, 2010). Ahmed *et al.*, (2020) reported that mulching was adopted to maintain soil surface coverage, reduce detachment followed by transportation of soil particles by surface run off and minimal losses. Ahmed *et al.*, (2020) further reported that straw mulch conserved higher soil moisture to an extent of 55% more compared to bare soil.

Mulch materials includes organic residues such as grain straw, fresh or old hay, fresh cut forage or cover crops, wood shavings, tree leaves, cotton gin waste, rice or buck wheat hulls and other crop residues. Others are synthetic mulch materials such as plastic sheets, landscape fabrics (geotextiles), stones and rocks etc. Proper Plant spacing provides adequate feeding area for plant to thrive and develop well. When crops are not properly spaced, they tend to compete for growth enhancement parameters like water, nutrients, and air. This competition reduces the growth and potential of the sown crops in terms of both quality and quantity. It reduces the cost of production and helps to achieve optimum utilization of the land. According to Akambi *et al.* (2010), plant spacing is an important agronomic practice that enhances growth, vigor and the overall development of a crop. The importance of using the right spacing for crop production is as crucial as using vigorous planting materials. The practice of adopting a plant spacing that gives the desired



plant density as well as simultaneously conserving resources and optimizing crop yield is an important factor in sustainable crop production. Improper plant spacing may cause either too dense or too sparse crop population resulting in reduced yield. Optimum plant density ensures efficient use of resources to give maximum yield. Some researchers have reported increased above-ground yield of vegetable crops at close spacing (Aslam *et al.*, 1993).

According to Aslam *et al.*, (1993) proper plant spacing is an important agronomic practice which varies from one crop to another. It is a common practice by farmers to ensure good yield and harvest. Good spacing enhances plant development and growth with improved consequential yield. However, farmers in southeast Nigeria, practice different plant spacing on *T. occidentalis* with varying results in terms of shoots, leaf, and pod yield. Islam *et al.*, (2011) studied the effect of spacing on the growth and yield of sweet pepper (*Capsicum annum* L.) and found that the yield per plot and yield per hectare were found to be significantly increased with the increases of plant spacing while El-Badawy and Mehasen, (2012) observed significant increase in the number of branches per plant in soybeans with decrease in plant density but increasing plant density increased significantly plant height and biological straw. In Nigeria, fluted pumpkin is traditionally spaced 100 cm × 100 cm (Nwite *et al.*, 2013), but this is deemed too wide especially under conditions of limiting land for cultivation faced by poor resource farmers.

Production of *T. occidentalis* is predominantly done by poor resource-based farmers while the paucity of documented information on the agronomic technologies suitable for its cultivation have limited the production of the crop among peasant farmers in Eha-Amufu environment. Agronomic practices such as appropriate plant spacing, mulching among other crop production techniques are known to affect crop environment, which influence the yield and yield components. Optimum plant spacing in combination with appropriate mulch materials should be maintained to exploit maximum natural resources, such as nutrient, sunlight, soil moisture and to ensure satisfactory yield (Egbe and Bar-Anyam, 2010). The objectives of this study were to identify the optimum plant spacing, appropriate mulching materials as well as the right treatment combinations of plant spacing and mulching materials that may guarantee the productivity improvement of the crop in Eha-Amufu. Improvement of fluted pumpkin yield in the study area will promote food security through income diversification especially among rural women.

Materials and Methods

Description of the experimental site

A field experiment was conducted during 2022 cropping season at the Teaching and Research Farm of the Department of Agricultural Education, Federal College of Education Eha-Amufu (Latitude 06° 52'N, Longitude 07° 24'E, Elevation 113m) in Enugu state, located in Southern Guinea Savanna of Nigeria. The experiment was carried out to assess the effect of plant spacing and mulching materials on growth and yield of fluted pumpkin (*Telfairia occidentalis*). The experimental site received a total rainfall of 1700mm in 2022. The soil at the location was analyzed to determine the physical and chemical properties of the soil before planting while the meteorological information of the study area was also sourced.



Experimental design and layout

The experiment was a 3x3 factorial arrangement laid out in Randomized Complete Block Design with three replications. The main plot consisted of plant spacing at three levels (30cm x 30cm, 50cm x 50cm and 100cm x 100cm; designated as S_1 , S_2 , and S_3 respectively), while the mulching materials at three levels (black polyethylene, rice straw, and no mulch (control); designated as M_1 , M_2 , and M_3 respectively) was allocated to the sub plots.

The experimental area measuring 154m² was cleared, pulverized and planting made on beds of dimension 2m x 2m (4 m²) which was constructed using local farm implements. There was a total of 9 treatment combinations for each block giving a total of 27 planting beds and 162 plant stands for the 3 replicates. Weeding was carried out with local hoe at 4 and 8 weeks after planting (WAP) in all the plots. Organic soil amendment (poultry droppings) was incorporated into the soil during bed construction at the rate of 20t/ha. Harvesting of the vegetable crop was done from the inner 2m x 2m and this represented yield per plot. The following agronomic parameters were sampled; stand count, number of leaves per plant, number of branches per plant, vine length (cm) per plant, number of nodes, internode length (cm). The plant parameters were measured at 2, 4, 6 and 8 weeks after planting (WAP) as described by Obiefuna *et al.*, (2012). The fresh leaf and dry leaf weights (kg) were collected at harvest from three randomly selected plants from each plot. Data was subjected to analysis of variance using GenStat Release 10.3 DE (2014) for the main effects and their interactions and where differences existed, Fisher's Least Significant Difference (LSD) at 0.05% level of probability was used to determine the differences (Steel and Torrie, 1980).

Results

The soil was silty clay loam, low in nitrogen (0.16 %), total phosphorus (39.11 ppm), Potassium 0.38, Magnesium 2.91, Calcium 7.88. pH 4.91, organic carbon 4.07 while the cation exchange capacity was 11.3 (Table 1).

Effect of plant spacing and mulching materials on growth parameters of *Telfaria occidentalis*

The result presented in Table 2 and 3 shows the effect of plant spacing and mulching materials on the number of leaves of fluted pumpkin at 2, 4, 6 and 8 WAP.

Plant spacing had no significant effect ($P \geq 0.05$) on the number of leaves per plant (Table 2). Results however indicated that there was a steady increase in the number of leaves as the plant matures. The highest number of leaves (90.4) was obtained from plant spacing of 100cm x 100cm (S_3) followed by 50cm x 50cm (S_2) (52.7) and 30cm x 30cm (S_1) which gave the lowest number of leaves.

Table 3 shows that significant differences existed ($P < 0.05$) among the mulching materials tested on the number of leaves of *Telfaria occidentalis* at 2 and 4 WAP. While there was no difference at 6 and 8 WAP. Result indicate that rice straw (M_2) produced the highest number of leaves (946.20) followed by the standard control (M_3) (41.77), while the lowest was obtained from polythene material (M_1) (37.90).



The vine length of *Telfairia occidentalis* was not significantly influenced by plant spacing and mulching materials at 2, 4, 6 and 8 WAP as presented in Tables 4 and 5 respectively. Longest vine length was obtained in S_3 (136.20cm) while S_2 recorded 129.00cm followed by S_1 that recorded 123.30cm (Table 4). The main effect of mulching was significant ($P < 0.05$) for vine length at 2, 6 and 8 WAP (Table 5). M_2 consistently recorded the longest vine length across the 4 weeks measurement. The longest mean vine length (80.98cm) was observed in M_2 followed by M_3 (76.40cm) while the least mean vine length was obtained in M_1 (57.06cm) (Table 5).

The interaction of plant spacing and mulching materials influenced the fresh leaf weight and dry leaf weight of *T. occidentalis*. Planting fluted pumpkin with the plant spacing (30cm x 30cm, 50cm x 50cm and 100cm x 100cm) with rice straw mulch (M_2) produced higher fresh leaf weight than the rest mulch material treatment. This trend was also observed in the dry leaf weight. However, planting fluted pumpkin with 100cm x 100cm spacing and mulching with rice mulch (M_2) recorded the highest fresh leaf weight (FLW) and dry leaf weight value of 1.267kg and 0.170kg respectively (Table 7).

Effect of plant spacing and mulching materials on yield parameters of *Telfaria occidentalis*

Table 6 revealed that plant spacing had no significant ($P \geq 0.05$) effect on dry leaf weight but highly influenced the fresh leaf weight of *T. occidentalis* but this was not statistically significant. Fresh leaf weight was highest in S_3 (1.178kg) followed by S_1 (0.833kg) while the lowest fresh leaf weight was obtained in S_2 (0.689kg). Dry leaf weight of *T. occidentalis* was highest (0.139kg) in S_3 , S_2 ranked second with 0.132kg while S_1 had the least dry leaf weight of 0.106kg (Table 6). The main effect of mulching on the yield of *T. occidentalis* was significant ($P \leq 0.05$) with M_2 recording the highest value, followed by M_3 and lastly M_1 .

The interaction of plant spacing and mulching materials influenced the fresh leaf weight and dry leaf weight of *T. occidentalis*. Planting fluted pumpkin with the plant spacing (30cm x 30cm, 50cm x 50cm and 100cm x 100cm) with rice straw mulch (M_2) produced higher fresh leaf weight than the rest mulch material treatment. However, planting fluted pumpkin with 100cm x 100cm spacing and mulching with rice mulch (M_2) recorded the highest fresh leaf weight (FLW) and dry leaf weight value of 1.267kg and 0.170kg respectively (Table 7).

Discussion

The soil was silty clay loam, low in nitrogen (0.16 %), total phosphorus (39.11 ppm), Potassium 0.38, Magnesium 2.91, Calcium 7.88. pH 4.91, organic carbon 4.07 while the cation exchange capacity was 11.3. It was also observed that mulched plots had higher seedling emergence than in no-mulch plots and could be attributed to the effect of surface mulch in moderating and in making uniform the soil hydrothermal regime (Hochmuth *et al.*, 2015), deemed crucial for seed germination. In this study, it was observed that fluted pumpkin plots mulched with polythene sheet sprouted earlier than the other mulching material used. These might be due to the effect of improved soil micro climate, weed free environment, low evaporation and higher moisture availability in root zone that helped in better nutrient uptake of plants. These results are in agreement with findings of Dinesh and Rishu (2018) in Summer Squash. Similarly, Obalum *et*



al., (2017) reported higher seedling emergence on mulched plots than on un-mulched plots. Elhag and Osman (2013) similarly reported that wider spacing had positive effect on germination and percentage emergence of onion (*Allium cepa* L.) in northern Sudan. However, Asaduzzaman *et al.*, (2012) reported that plant spacing had no effect on germination percentage of some vegetable crops in Bangladesh.

T. occidentalis planted at 30cm x 30cm (S₁) and 50cm x 50cm (S₂) produced fewer fresh and dry leaf yields while plant spacing of 100cm x 100cm (S₃) produced the highest fresh and dry leaf yield of 1.178 and 0.139 kg respectively. The lowest fresh leaf weight (0.689kg) was obtained in 50cm x 50cm plant spacing. The result of this study validates the recommendation of 100cm x 100cm as the standard plant spacing for *T. occidentalis* production and optimum yield as reported by NIHORT (2010). The superior performance of *T. occidentalis* planted at 100cm x 100cm could be attributed to the fact that well-spaced plants had more favorable biological environment for growth and development. It could also be attributed to lack of intra-specific competition and the ability to spread to capture more environmental resources, while the low yields recorded at closer spacing could be ascribed to intra-specific competition of individual plants for growth resources such as available water, light and nutrients in addition to weed competition. This finding is in agreement with Uwalaka *et al.*, (2019) who observed that good growth invariably led to high yield at a wider spacing and attributed this to less competition for water and nutrients. Morrison *et al.* (1990) also explained that well-spaced plants receive more solar radiation and therefore are more photo-synthetically active.

Mulching highly influenced the performance of the yield parameters of fluted pumpkin in this study. Among the mulch materials tested, rice straw gave the best performance as indicated by the fresh and dry leaf weight yields of 1.022kg and 0.148kg respectively. Increases in fresh and dry yields of vegetable crops have been attributed to mulch-induced high soil moisture and the associated optimal transpiration, nutrient uptake and increased photosynthesis required for plant growth (Aniekwe, 2015).

Plant spacing x Mulch (interaction) influenced the fresh leaf weight and dry leaf weight of *T. occidentalis*. Planting fluted pumpkin with the plant spacing (30cm x 30cm, 50cm x 50cm and 100cm x 100cm) with rice straw mulch (M₂) produced higher fresh and dry leaf weight than the rest mulch material treatment. This finding validates the report of Obalum *et al.*, (2017) that seedling emergence was highest and lowest under mulched and wide spacing and no-mulch and close spacing respectively. In this study, fluted pumpkin planted with 100cm x 100cm spacing and mulched with rice straw (M₂) recorded the highest fresh leaf weight (FLW) and dry leaf weight value of 1.267kg and 0.170kg respectively. However, these yields were not significant thus, highlighting the equal strengths of mulching and spacing in the interaction (Table 7).

Conclusion

T. occidentalis expressed more productive potentials when planted at 100cm x 100cm spacing and mulched with rice straw as indicated by the yield of 1.267kg and 0.170kg of fresh leaf weight (FLW) and dry leaf weight (DLW) respectively. This treatment combination also produced the



highest mean number of leaves and vine length as compared to other plant spacing and mulch materials used for the experiment. This suggests that good planting distance in combination with biodegradable organic mulch such as rice straw should be used to obtain bumper yield of *T. occidentalis*. Eha-Amufu is a predominantly rice growing community with large accumulation of rice straw which is usually abandoned in the field after paddy harvest. Farmers in the community do not put rice straw to any meaningful use other than to burn them in the field to introduce ash to the soil. The superior performance of rice straw mulch relative to the rest mulch treatments in this study indicates that the organic rice straw mulch being left to waste in the study area will no longer constitute waste burden to the farmers but will be profitably recycled for crop production purposes. In this regard, the biodegradable rice straw mulch material can now find niche within the cropping system while supporting large scale fluted pumpkin production in Eha-Amufu environment especially among women farmers.

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APPENDICES

Table 1: Physical and Chemical Properties of the Experimental Site

Parameter	Value
Physical	
Clay (%)	15.48
Silt (%)	31.28
Sand (%)	53.24
Textural class	Silty clay loam
Chemical properties	
pH (kcl)	4.91
Organic carbon (%)	4.07
Organic matter (%)	7.02
Total nitrogen (%)	0.16
Available phosphorus (ppm)	39.11
Exchangeable cations (meg/100g soil)	
Exchangeable Na ²⁺ (cmol kg ⁻¹ soil)	0.57
Exchangeable K ⁺ (cmol kg ⁻¹ soil)	0.38
Exchangeable C ²⁺ (cmol kg ⁻¹ soil)	7.88
Exchangeable Mg ²⁺ (cmol kg ⁻¹ soil)	2.91
ECEC (cmol kg ⁻¹ soil)	11.3
Exch.acidity (cmol kg ⁻¹ soil)	0.28

Source: Soil Science Laboratory, Federal University of Agriculture, Makurdi

Table 2: Effect of plant spacing on the number of leaves of *T. occidentalis* at 2, 4, 6 and 8 WAP.

Plant spacing	2 WAP	4 WAP	6 WAP	8 WAP	Mean
S ₁ (30cmx30cm)	4.46	16.40	50	78.8	37.42
S ₂ (50cmx50cm)	5.13	15.88	58	82.70	40.43
S ₃ (100cmx100cm)	5.26	19.07	65.6	90.40	45.08
F-LSD (p=0.05)	NS	NS	NS	NS	

WAP= Weeks after planting; NS= Not significant

Table 3: Effect of mulching materials on the number of leaves of *T. occidentalis* at 2, 4, 6 and 8 WAP

Mulch	2WAP	4WAP	6WAP	8WAP	Mean
M ₁ (Polythene sheet)	4.13	15.67	64.4	67.4	37.90
M ₂ (Rice straw)	5.74	19.47	65	94.6	46.20
M ₃ (No mulch)	4.98	16.21	56	89.9	41.77
F-LSD (p=0.05)	1.231	3.130	NS	NS	

WAP= Weeks after planting; NS= Not significant

Table 4: Effect of plant spacing on the vine length of *T. occidentalis*

Plant spacing	2WAP	4WAP	6WAP	8WAP	Mean
S ₁ (30cmx30cm)	8.36	42.90	98.50	123.30	68.27
S ₂ (50cmx50cm)	9.17	43.90	99.30	129.00	70.34
S ₃ (100cmx100cm)	9.92	47.10	108.00	136.20	74.56
F-LSD (p=0.05)	NS	NS	NS	NS	

WAP= Weeks after planting; NS= Not significant



Table 5: Effect of mulching materials on the vine length of *T. occidentalis*

Mulch	2WAP	4WAP	6WAP	8WAP	Mean
M ₁ (Polythene sheet)	6.25	38.40	81.50	102.10	57.06
M ₂ (Rice straw)	12.32	48.10	116.80	146.70	80.98
M ₃ (No mulch)	9.09	47.30	107.40	139.80	76.40
F-LSD (p=0.05)	2.778	NS	18.95	18.74	

WAP= Weeks after planting; NS= Not significant

Table 6: The effect of plant spacing and mulching materials on yield of *T. occidentalis*

Plant spacing	FLW(kg)	DLW(kg)	Mulch	FLW(kg)	DLW(kg)
S ₁	0.833	0.106	M ₁	0.667	0.096
S ₂	0.689	0.132	M ₂	1.022	0.148
S ₃	1.178	0.139	M ₃	1.011	0.143
F-LSD (p=0.05)	0.209	NS	F-LSD (p=0.05)	0.209	NS

Key: FLW= Fresh leaf weight; DLW= Dry leaf weight; NS= Not significant

Table 7: Interaction effect of plant spacing and mulching materials on *T. occidentalis*

PLANT SPACING	Mulches	DLW (KG)	FLW (KG)
S ₁ (30cmx30cm)	M ₁ (Polythene) 0.093	0.600	
	M ₂ (Rice straw)	0.113	0.900
	M ₃ (No mulch) 0.110	1.000	
S ₂ (50cmx50cm)	M ₁ (Polythene) 0.063	0.267	
	M ₂ (Rice straw)	0.160	0.900
	M ₃ (No mulch) 0.147	0.900	
S ₃ (100cmx100cm)	M ₁ (Polythene) 0.100	1.133	
	M ₂ (Rice straw)	0.170	1.267
	M ₃ (No mulch) 0.147	1.133	
F-LSD (p=0.05)		NS	NS

KEY: NS = not significant, DLW= Dry leaf weight; FLW= Fresh leaf weight.