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Effect of Seed Position in Pod on Sex Expression, Vegetable Yield, and Some Related Parameters in Fluted Pumpkin (*Telfairia occidentalis* Hook. f.)

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Abstract

A field experiment was conducted to study the effect of seed position in pod on sex expression, vegetable yield, and some related agronomic parameters in fluted pumpkin (Telfairia occidentalis Hook. f.). Pods obtained from Umuahia, Southeastern Nigeria, were divided into three equal transverse portions, - proximal, middle, and distal. Seeds extracted from the proximal portion were pooled together and tagged Treatment One (T1). Those from the middle portion constituted Treatment Two (T2), and those from the distal portion of the pods were labeled Treatment Three (T3). One hundred and twelve (112) seeds were randomly selected from each of the three pod portions, giving a total of three hundred and thirty-six (336) seeds, one half (168), of which were then planted in two locations, Okigwe and Umudike, both in Southeastern Nigeria, in the 2015 cropping season, in a randomized complete block design (RCBD) experiment that had seven replications. Within each location, the treatments did not differ from each other in respect of emergence count, plant vigour, number of leaves per plant, number of branches per plant, vine length, vine diameter, harvestable vegetable yield, edible vegetable yield, days to opening of first male flower, days to opening of first female flower, and male: female: flowerless plant

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ratio. Umudike plants produced higher edible vegetable yield than Okigwe plants. Male: female: flowerless plants ratio was 3: 3: 1 in Umudike, and 3: 4: 1 in Okigwe. The difference between the performance of the plant in Umudike and Okigwe suggests that environmental factors play significant roles in sex expression and vegetable yield in fluted pumpkin.

Key words: Fluted pumpkin, sex expression, vegetable yield.

Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook f.), a herbaceous plant that climbs by the use of axilary tendrils, belongs to the dicotyledonous family, Cucurbitaceae, and is among three species that make up the genus *Telfairia,* the other two being *T. pedata* (osyter nut), found in East Africa, and *T. batesii* (Okoli, 1987). A native of West Africa, it is a vegetable crop widely cultivated in Southern Nigeria for its nutritious and palatable leaves and seeds which constitute an important component of the diet in many West African countries, notably Nigeria, Ghana, Cameroon and Sierra Leone (FAO, 1992). In Nigeria, fluted pumpkin is cultivated mostly by the Igbos and Ibibios who live in the Southeastern / Niger Delta parts of the country, and who relish it as a pot herb, the Igbos in their "ofe ugu", and the Ibibios in their "edikang ikong" soups. The leaves are used sole or in combination with the leaves, fruits or seeds of other plant species. It is cooked with leaves of waterleaf (*Talinum triangulare*), African gnetum (*Gnetum africanum*), immature fruits of okra (*Abelmoschus esculentus*), seeds of dika (*Irvingia gabonensis*), and seeds of egusi melon (*Cucumeropsis mannii* Naud) in preparing soups used in eating starchy roots, tubers, and cereals. The oil-rich seeds which may be eaten boiled, roasted, or fermented, are high in essential amino acids (except lysine and methionine) and can be compared with soybean meal, with 95% biological value (Girgis and Turner, 1972; Ladeji *et al.,* 1995). Giami (2004) reported that fermenting fluted pumpkin seeds for seven days significantly ($p<0.05$) increased crude protein and in vitro protein digestibility while decreasing the levels of two anti-nutrients, polyphenol and phytic acid.

Fluted pumpkin is dioecious. Flowerless individuals have also been observed. Males, females, and flowerless individuals all look alike during the plant's vegetative phase of growth, and cannot, for now, be differentiated from each other before sexual maturity. Sexually mature male plants produce staminate flowers found on racemous inflorescences that arise from leaf axils beginning from about the 13th week after shoot emergence. Females produce solitary pistilate flowers, also at leaf axils, about three weeks later. Flowerless individuals are rare (Schippers, 2000) and have attracted little attention from researchers. Beginning from flowering, leaves from female plants tend to be broader, greener, and more succulent than those from male individuals. This, together with the fact that it is the female plants that produce the pods that bear the seeds to be used for the following year's planting, makes female plants more desired than the males by fluted pumpkin growers. Harvesting of leaves is usually suspended on female plants as soon as pistillate flowers are observed, to encourage flowering and fruiting. Harvesting of leaves, however, continues on male plants until senescence.

Sex expression in the Cucurbitaceae has been reported to be controlled by environmental as well as genetic factors. Unfavourable growing conditions such as water deficit has been known to cause a slowdown in flower production; female sex expression is promoted by low temperature, low nitrogen supply, short photo period and high moisture availability, which influence the level of endogenous hormones (especially ethylene, auxin and gibberellic acid) which in turn influence sex expression (Robinson and Decker- Walters, 1997). The number of female flowers per plant in dioecious species determines the number of fruits the individual plant will bear. In most monoecious cucurbits, the ratio of staminate to pistillate flowers greatly varies when the plants are grown under different environmental conditions, including photoperiod, temperature, nutrient availability, or treated with auxins and plant hormones (Lau and Stephenson, 1993; Swiader *et al.*, 1994; Yin and Quinn, 1995).
Results obtained by Rudich *et al.* (1972) suggest that ethylene participates in the indigenous regulation of sex expression in flowering plants by promoting femaleness in cucumber. Michael *et al.* (1977) indicated that exogenous ethephon treatment on cucumber increases the female tendency in monoecious plants and decreases it

in dioecious ones. According to Kshirsagar *et al.* (1995), plant growth regulators increase the number of female flowers, thereby increasing fruit yields in cucurbits. Akpan and Odejimi (2006) reported that pruning increased the number of edible shoots, percentage of pistillate flowers, and fruit set in the plant.

Agwu and Obiefuna (1987) reported that the distal portion of fluted pumpkin pods produce more female plants than the proximal and middle portions. Similarly, Ogbonna (2009) observed the highest percentage of female plants from the middle portion in one of his pod types. Modupeola *et al.* (2014) reported that seeds from the proximal and distal portions of the pod exhibited the highest and lowest percentage of seedling emergence, respectively. According to these researchers, also, proximal portion seeds germinated to produce plants with the longest vines, compared with seeds from the middle as well as the distal portions of the pod, while middle portion seeds produced the most leafy plants. The present study was conducted to investigate the effect of seed position within the pod on sex expression, vegetable yield, and related parameters in *Telfairia occidentalis*.

Materials and Methods

The study was conducted in the i) Western Farm of the Michael Okpara University of Agriculture, Umudike, Abia State, and ii) Nigeria Institute for Horticultural Research (NIHORT) Okigwe, Imo State, both in Southeastern Nigeria. Umudike is located at latitude 05° 29′ N, longitude 07° 32′ E, at an altitude of 122m above sea level, and NIHORT, Okigwe, lies on latitude 05° 33′ N, longitude 07° 23′ E, and an altitude of 130m above sea level. In both locations, the experimental plot was manually cleared, ploughed and soil samples were collected with a soil auger at the depth of 0 – 15cm, bulked together and a composite soil sample was collected for determination of soil physicochemical properties in the soil laboratory. There are no known (released) varieties of fluted pumpkin. Oval-shaped pods obtained from local markets around Umuahia were cut open to expose the pulp that houses the seeds. For each pod, by use of a metre rule, the pulp holding the seeds was divided into three equal transverse portions. Seeds extracted from each of the three pod portions were pooled together and tagged Treatment One (T1) for seeds extracted from the proximal portion, Treatment Two (T2) for seeds extracted from the middle portion and Treatment Three (T3) for seeds extracted from the distal portion. Seeds extracted from these three pod portions formed the three treatments that were arranged in a randomized complete block design (RCBD) with seven replications. Three treatments over seven replications gave twenty-one plots for the experiment. Eight seeds were planted per plot. One hundred and twelve (112) seeds were randomly selected from each of the three pod portions, giving a total of three hundred and thirty-six (336) seeds planted in the two locations, half of the seeds in each. Data were collected on emergence count, which was obtained as the number of plants that emerged 8 days after planting; plant vigour, which was obtained by visually observing plants and giving them a ranking of 1 to 10, 10 being the most vigorous; number of leaves per plant, which was obtained as the number of fully expanded leaves per plant; number of branches per plant; vine length, obtained as the length of the longest vine in a plant; vine diameter, measured at the base of the plant using venier calipers; harvestable vegetable yield, which was obtained as the weight (kg) of the total vegetable yield of plants, the vine of each sample plant being cut at the length of 1m from the base and weighed; edible vegetable yield, obtained as the weight (kg) of the edible portion of the harvestable yield, made up of the leaves and tender portions of the shoot; days to emergence of first male flower; days to emergence of first female flower, and male: female: flowerless plants ratio.

Data collected were subjected to analysis of variance (ANOVA) method for a randomized complete block design (RCBD) as outlined by Wahua (1999). Means of parameters for the two locations were compared using the Student's t-test. Male: female: flowerless individuals ratios were analyzed by use of the x^2 (chi-square) test.

Results and Discussion

Table 1. Some physicochemical properties of the experimental site soil

Soil Properties	Umudike	Okigwe
Sand (%)	59.80	62.20
Silt (%)	13.40	17.00
Clay (%)	26.30	28.00
Textural class	Sandy Loam	Sandy Loam
pH (H_2O)	5.90	4.98
Phosphorus (mg/Kg)	42.40	6.80
Total Nitrogen (%)	0.11	0.90
Organic carbon (C mol/Kg)	1.22	1.60
Organic matter (%)	2.10	3.20
Calcium (C mol/Kg)	2.00	3.20
Magnesium (C mol/Kg)	1.20	1.60
Potassium (C mol/Kg)	0.07	0.19
Sodium (C mol/Kg)	0.03	0.06
Exchange Acidity (C mol/Kg)	0.96	1.01
ECEC (C mol/Kg)	4.26	5.75
Base Saturation (%)	77.46	58.00

Table 2. Meteorological data of the experimental site during the 2015 cropping season

Month	Rainfall (mm)		Temperature (^{0}C)		Relative Humidity (%)	
	Umudike	Okigwe	Umudike	Okigwe	Umudike	Okigwe
January	8.4	18.2	33.1	33.4	50	45
February	81.7	0.00	33.8	33.9	78	49
March	130.5	88.3	32.8	33.2	77	67
April	61.7	169.9	33.4	32.2	78	66
May	246.8	202.8	32.7	31.9	81	69
June	346.2	164.2	29.8	30.5	87	74
July	129.2	232.1	27.3	30.0	88	79
August	366.2	282.5	29.0	29.6	87	78
September	276.0	304.0	29.0	29.8	87	79
October	380.2	205.8	31.0	31.0	84	71
November	49.7	150.2	33.0	31.6	80	66
December	0.0	5.40	29.5	32.7	35	47
Total	2076.6	1813.6	===	===	===	===
	173.05	151.1	31.2	31.65	76.00	65.83

Source: National Root Crops Research Institute, Umudike.

Table 3. Means for emergence count, plant vigour, number of leaves per plant, and number of branches per plant, in fluted pumpkin planted in Umudike and Okigwe, Southeastern Nigeria.

Treatment	Emergence Count		Plant Vigour		Number of Leaves / Plant		No. of Branches / Plant	
	Um	Oki	Um	Oki	Um	Oki	Um	Oki
Proximal (T1)	7.57	7.86	6.00	7.86	26.00	21.70	3.37	2.04
Middle (T2)	7.43	7.43	6.86	8.29	27.52	22.27	3.79	2.00
Distal (T3)	7.43	7.43	6.86	7.86	29.72	21.24	3.43	2.29
Mean	7.48	7.57	6.57	8.00	27.75	21.74	3.54	2.11

Table 4. Means for vine length, vine girth, days to emergence of first male flower, and days to emergence of first female flower in fluted pumpkin planted in Umudike and Okigwe, Southeastern Nigeria.

Treatment	VL (cm)		VD (cm)		DTOFMF		DTOFFF	
	Umu	Okig	Umu	Okig	Umu	Okig	Umu	Okig
Proximal (T1)	110.00	108.06	0.32	0.37	110.14	124.14	129.00	157.86
Middle (T2)	130.43	115.59	0.30	0.37	111.29	118.86	128.86	146.86
Distal (T3)	130.57	107.31	0.33	0.33	110.14	125.00	128.57	149.71
Mean	123.67	110.32	0.32	0.36	110.52	122.67	128.81	151.48

Legend: VL: Vine Length; VD: Vine Diameter; DTOFMF:Days to opening of first male flower; DTOFFF: Days to opening of first female flower; Umu: Umudike; Okig: Okigwe

Table 5. Means for harvestable vegetable yield and edible vegetable yield in fluted pumpkin planted in Umudike and Okigwe, Southeastern Nigeria

Treatment	Harvestable Vegetable Yield		Edible Vegetable Yield	
Proximal (T1)	Umudike	Okigwe	Umudike	Okigwe
Middle (T2)	537.50	1037.50	362.50	287.50
Distal (T3)	800.00	1137.50	512.50	262.50
Mean	695.83	1058.33	445.80	279.17

Table 6. X^2 Analysis for ratio of male plants across proximal, middle, and distal pod portions for Umudike and Okigwe

Location	Seed Position in Pod	Number of Female Plants		
		Observed	Expected	X^2
Okigwe	Proximal (T1)	21.00	19.67	0.09
	Middle (T2)	17.00	19.67	0.36
	Distal (T3)	21.00	19.67	0.09
				0.54^{ns}
Umudike	Proximal (T1)	28.00	22.33	1.44
	Middle (T2)	18.00	22.33	0.84
	Distal (T3)	21.00	22.33	0.08
				2.36^{ns}

Legend: ns: Non-significan

Table 7. X^2 Analysis for ratio of female plants across proximal, middle, and distal pod portions for Umudike and Okigwe.

Location	Seed Position in Pod	Number of Female Plants		
		Observed	Expected	X^2
Umudike	Proximal (T1)	20.00	25.33	1.12
	Middle (T2)	30.00	25.33	1.12
	Distal (T3)	26.00	25.33	0.02
				2.26^{ns}
Okigwe	Proximal (T1)	28.00	28.33	0.00
	Middle (T2)	29.00	28.33	0.02
	Distal (T3)	28.00	28.33	0.00
				0.02^{ns}

Legend: ns: Non-significant

Table 8. X^2 Analysis for male plants: female plants: flowerless plants ratios for Umudike and Okigwe.

Location	Seed Position in Pod	Number of Individuals		
		Observed	Expected	X^2
Umudike	Males	67.00	51.33	4.78
	Females	76.00	51.33	7.54
	Flowerless Individuals	16.00	51.33	24.32
				36.64**
Okigwe	Males	59.00	55.00	0.29
	Females	85.00	55.00	16.36
	Flowerless Individuals	23.00	55.00	18.62
				35.15**

Legend: **: Highly significant ($p<0.01$)

Table 9. Summary of X^2 results comparing ratios between Umudike and Okigwe.

Description	X^2 Value
Number of male individuals (Umudike): Number of male individuals (Okigwe)	0.56^{ns}
Number of female individuals (Umudike): Number of female individuals (Okigwe)	0.50^{ns}
Number of flowerless individuals (Umudike): Number of flowerless individuals (Okigwe)	1.26^{ns}
Number of male individuals (Umudike): Number of female individuals (Umudike)	0.56^{ns}
Number of male individuals (Okigwe): Number of female individuals (Okigwe)	4.20*
Number of males (Okigwe + Umudike): Number of females (Okigwe + Umudike)	4.26*

Legend: ns: Non-significant; *: Significant ($p<0.05$)

Table 10. Summary of t-test results comparing values between Umudike and Okigwe.

Parameter	t-Value
Emergence count	ns
Plant vigour	ns
Number of leaves per plant	5.78*
Number of branches per plant	18.44*
Main vine length	Ns
Vine diameter	4-0*
Harvestable vegetable yield	3.02*
Edible vegetable yield	2.22*

Legend: ns: Non-significant; *: Significant ($p<0.05$)

Analysis of variance conducted on the treatment means showed that there was no significant difference among the three treatments for emergence count, plant vigour, number of leaves per plant, number of branches per plant, vine length, vine diameter, harvestable vegetable yield, edible vegetable yield, days to opening of the first male flower, and days to opening of the first female flower, for Umudike and for Okigwe. Umudike plants had significantly more branches and leaves per plant, than Okigwe plants ($p<0.05$). Main vine length was the same in Umudike as well as in Okigwe. Okigwe plants, however, had thicker vines ($p<0.05$) than Umudike plants.

The number of males across the three treatments did not differ in Okigwe and in Umudike. There were, however, more males ($p<0.05$) in Umudike (67) than in Okigwe (59). Equally, the number of females across the three treatments did not differ in Okigwe and in Umudike, but there were more females ($p<0.05$) in Okigwe (85) than in Umudike (76). In Okigwe, out of a total of 167 plants, there were 59 males, 85 females, and 23 flowerless individuals, the ratio of male: female: flowerless individuals being approximately 3: 4: 1. Similarly, in Umudike, out of a total of 159 plants, there were 67 males, 76 females, and 16 flowerless individuals, the ratio of male: female: flowerless individuals being approximately 3: 3: 1. In both locations, the frequency of females was higher than that of males ($p<0.05$), and the least frequent class was that of the flowerless individuals. The difference between the number of male plants (67) and that of females (76) in Umudike, was, however, not significant statistically, representing a 1:1ratio. It was, however, significant ($p<0.05$) in Okigwe, where there were 59 males to 85 females, representing a male: female ratio of 3: 4.

The difference between the performance of the plant in Umudike and Okigwe suggest that location (which is made up of environmental factors) play prominent roles in sex expression and vegetable yield in fluted pumpkin. This is in tandem with the report of several workers such as Robinson and Decker- Walters (1997) who reported that in the Cucurbitaceae, sex expression is controlled by environmental as well as genetic factors. It is also a possible explanation for the different results obtained by different researchers like Agwu and Obiefuna (1987), Ogbonna (2009), and the present ones.

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