EFFECT OF PLANT SPACING ON WEED SUPPRESSION AND YIELD OF FLUTED PUMPKIN (*Telfeiria occidentalis* Hook F) IN PORT HARCOURT, NIGERIA

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ABSTRACT

The field study was conducted to evaluate the effect of plant spacing on weed suppression yield and economic benefit of fluted pumpkin (*Telfeiria occidentalis* Hook F). The experiment was carried out at the Department of Crop and Soil Science Demonstration Plot, Faculty of Agriculture, University of Port Harcourt, Nigeria between March and June, 2014. The plant spacing used were; 60 x 60cm, 80 x 80cm, 100 x 100cm and 120 x 120cm. The spacing was arranged in a randomized complete block design (RCBD) replicated six times. The economic analysis of the data were carried out by partial farm budgeting. The weed density differ significantly ($P<0.05$) throughout the sampling periods with plant spacing 120 x 120cm having the highest weed density while the lowest was 60 x 60cm The highest weed fresh weight of 1237.5kg/ha and 927.5kg/ha was recorded at a plant spacing of 120 x 120cm at 4 and 8 weeks after planting respectively. Plant spaced at 120 x 120cm had the highest marketable shoot yield (39, 150kg/ha) whereas the lowest was at 60cm x 60cm (10, 225kg/ha). Plant spaced at 120 x 120cm gave the highest profit of N4723608.48/ha and cost benefit ratio (CBR) of 1:27.76 which implies that it was more profitable to produced fluted pumpkin at a spacing of 120 x 120cm in the area of current study.

Keywords: Fluted pumpkin, plant spacing, weed, cost benefit ratio

INTRODUCTION

Leafy vegetable are essential components of the daily food intake for both the rural and urban dwellers in Nigeria. They provide the much needed materials, vitamins and supplementary protein for majority of the populace that depends largely on starch staples (Tijani-Eniola, 2002). Fluted pumpkin (*Telferia occidentelis* Hook. F) is a member of the curcubitaceae family and is a leafy vegetable that has been widely accepted as a dietary constituent more popular in the south eastern states of Nigeria (Akwaowo *et. al.,* 2000). Its production and utilization however, has gradually spread into other parts of Nigeria. Fluted pumpkin produces for a long periods and it is preferred to short season leafy vegetable such as *Amaranthus spp* which is rarely harvested more than three times in its entire life span. (Mnzara, 1997).

The tender vine and foliage are consumed as potherbs while the seed is consumed as nuts. The leaf finds herbal use in the treatment of anemia and diabetes (Akoroda, 1990). Oyelu (1980) noted that the leaves and edible shoots of fluted pumpkin together contain 85% moisture, whole the dry portion contains 11% crude protein 25% carbohydrate, 3% oil, 11% ash and as much as 700 ppm iron. Despite the usefulness of this vegetable, weeds constitute a significant impediment to its production in Nigeria. In Nigeria, uncontrolled weeds caused yield reduction ranging from 20-78% in other vegetable crops (Awodoyin and Ogunyemi, 2005; Smith and Ayanigbara, 2003). Other researchers have also reported 30-45% of total cost of labour of manual weeding is required for fruit and vegetable production in Nigeria (Chianu and Akintola, 200; Usoroh, 1983).

The minimum weed free period (when the crop must be kept weed-free to prevent yield losses to weed competition) in curcubit crops has been established as the first 4 to 6 weeks after planting (Stall, 2006). Vine forming cultivars usually pass through their minimum weed free period when the vine begins to occupy the inter-row spaces. Population density of a crop determines to a greater extent its performance in terms of growth and yield. If plant population is lower than optimum plant population, then, per hectare production will be low and weeds will also be more (Allard, 1999).

Okhira *et. al.* (1987) observed that plant spacing should be done in such a way not only to ensure that each crop has an equal chance to grow but also to simplify execution of field operation. The rate at which field operations are carried out, weed-crop competition and yield are influenced by the spatial arrangement on the field. Spatial arrangement interacts with other factors to affect competition relationships (Zimdahl, 1980). Also Galanopoulou-Sendouka *et. al.* (1980) showed that increasing plant density reduced individual plant growth, however, per unit land area; there is a higher total dry matter production in close spacing. Also close spacing allows less competition from weeds (Schippers, 2000). Baloch *et. al*. (2002) observed that lowering plant densities increased the nutrient area per plant and this led to increase in morphological characters. Mortley *et. al.* (1992) observed that stem diameter increased linearly as spacing between plants increased and that fresh weight yields are highest at closer within-row spacing.

Pandey *et. al*. (1996) noted the highest plant height in narrow spacing in tomato hybrids while wider spacing had the highest number of primary branches per plant. They attributed the higher plant height recorded in narrow spacing to greater competition for and light and thereby forcing the plants to grow taller. Malik *et al*. (1999) also revealed that the closest spacing gave the highest plant height while, number of brandies per plant were highest in the widest spacing in radish. Decreasing planting density significantly increased number of branches plant in soybeans but increasing plant density increased significantly plant height and biological straw (El-Badawy and Mehasen, 2012).

Islam *et al.* (2011) studied the effect of spacing on the growth and yield of sweet pepper (*Capsicum annum* L.) and noted that the yield per plot and yield per hectare were found to be significantly increased with the increases of plant spacing. In cucumber, (*Cucumis sativus*), Lim (1997) indicated that marketable yield ranged from 6.7kg/m^2 at 2.3 plants/m^2 (80cm spacing) to 8.8kg/m^2 at 4.6 plants/m^2 (40cm spacing). In pumpkin (*Curcubita pepo*) increasing plant populations from 2990 to 8960 yields for both the viny-type and semi-bushy cultivars (Reinors and Riggs, 1999). Fluted pumpkin farmers' usually use wider-spacing which encourages weed growth and consequently competition with the crop. Secondly farmers and consumers of this vegetable are skeptical about the use of herbicide in the control of weed in this vegetable. The objective of the present study was to evaluate the effect of plant spacing on weed management and edible leaf yield of fluted pumpkin.

MATERIALS AND METHODS

Description of the Experimental site

The study was carried out between March and June, 2014 at the demonstration site of the Faculty of Agriculture at Abuja Campus, University of Port Harcourt. Port Harcourt is located at latitude 4^0 3" N to 5^0 N and longitude 6^0, 45'E to 70^{0}E, with an average temperature of 27^{0}C, relative humidity of 78% and average annual rainfall between March and November that ranges from 2500 – 4000mm (Nwankwo *et. al*, 2010). The experimental site before cropping was dominated by annual and some perennial weed species such as siam weed (Chromoleana odorata (L)) goat weed (*Ageratum conyzoides* (L.), broom weed (*Sida acuta* burn F), guinea grass (*Panicum maximum Jacq)* and *Cyperus spp.* The site was under continuous cultivation with arable crops such as maize, fluted pumpkin and egusi melon for five years before fallowing for one year.

Land Preparation

The land was cleared and hoe-tilled on 2nd of March 2013 to make seed bed of size 2 x 2m (4m^2)

Source of planting materials

A local variety of fluted pumpkin seeds were purchased from the Faculty of Agriculture Demonstration Farm, University of Port Harcourt, Choba Campus, Rivers State.

Soil sample collection and analysis

Soil samples were taken randomly from 10 spots at (0 – 15cm depth) over the entire field using soil auger of diameter, 8cm before the commencement of the experiment. The samples were bulked and mixed thoroughly for analysis. The sample were air – dried and passed through a 2 – mm mesh sieve before analyzing for physico-chemical properties at Zetta Allied Digital Energy Limited, Port Harcourt, Rivers State, Nigeria. The particle size analysis was done by using hydrometer method (Gee and Bauder, 1986). Soil pH was determined using 1:2 soil distilled water suspension using a pH metre (Maclean, 1982). Available P was determined by Bray P – 1 method (Anderson and Ingram, 1993). Total N was determined by Micro – Kjeldahl method Bremner and Malvancy (1982), organic carbon was determine by Walkley and Black (1934) while Exchangeable bases (Na, K, Ca, Mg) were extracted with IN solution of NH4 oA_c buffered at pH 7.0 and read directly using a flame photometer (Thomas, 1982).

Treatment application and planting

Poultry manure that had been cured under shade for three weeks and thoroughly mixed and applied uniformity as a basal application to each bed by the use of hand rake on 3rd of March, 2013. 7.5 tonnes/ha of poultry manure which is equivalent to 3kg was applied to each bed. The manure was incorporated into the soil with the use of spade. Seed extracted from the pods were sun – dried for two days to reduce moisture and prevent decay and planting was done one week after application of poultry manure on 10th of March 2013. One seeding was allowed per hole at each plant spacing method. The four plants spacings used were: 60 x 60cm, 80 x 80cm, 100 x 100cm and 120 x 120cm giving approximately by simple proportion plant population of 12 plants/bed (30,000 stands/ha), 9 plants bed (22,500 plants/ha), 6 plants/bed (15,000 plants/ha) and 4 plants/bed (10,000 plants/ha) respectively.

Experimental Design and Layout

The treatments consisted of four spacing methods viz: 60cm x 60cm, 80cm x 80cm, 100cm x 100cm and 120cm x 120cm. The treatments were laid out in a randomized complete block design and replicated six times giving a total of 24 beds. Each bed of 30cm height measure 2 x 2m with 150cm path between beds in order to avoid vines creeping to other plots. Weeding was carried with local hoe at 4 and 8 weeks is after planting (WAP) in all the plots.

Data Collection

Weed Density and Weed Fresh Weight

Two transect quadrat measuring 50cm x 50cm was used to assessed weed density and weed biomass. The weed density was done at four intervals (2WAP, 4WAP, 6WAP and 8WAP) by randomly throwing twice, 50cm x 50cm quadrats per bed.. The weed fresh weight above ground was taken 4WAP and 8WAP by randomly throwing two 50cm x 50cm quadrats per bed. The above – ground parts within each quadrat were clipped with a knife at soil surface and weighed with a top – loading mettler balance (Model P1210) to determine the fresh weight. The weight was later extrapolated to kg/ha.

Marketable Fresh Shoot Yield

Two plants were randomly tagged per bed to determine the fresh vine yield. The vegetable harvest was done by pruning, using sharp knife. Harvesting was done at two weeks interval starting from 52 days after planting. The fresh vine was harvested with a sharp knife and weighed with a weighing balance. The average – fresh shoot weights of the two tagged plants were taken per harvest. Sixteen (16) harvests were carried out throughout the duration of the experiment. The fluted pumpkin fresh shoot (vine) yield was estimated from cumulative fresh weight per plant of the fluted pumpkin harvested at 16 cutting periods. The yield per plant in each treatment was extrapolated to kilogram per hectare (kg/ha) by multiplying by the plant population density of each treatment.

Economic Assessment

Economic evaluation of the different plant spacing was done by partial farm budgeting (Okoruwa *et.al.*, 2005) at prevailing labour and market costs of material to estimate revenue. The variable cost considered were cost of materials (seeds) cost of planting seeds and cost of harvesting, No capital costs such as land and management, charges, interest on operational capital, depreciation of equipment and other over-heads costs were considered. Sale revenue was obtained by multiplying the final shoot (vine) yield (kg/ha) by the market price (N/kg). This is represented below in the following formula.

(i) Revenue = Yf x Pf (where, Yf = fluted pumpkin fresh shoot yield in kilogram per 1ha, Pf = price of fluted pumpkin shoot. The profit was calculated by subtracting the total costs of production from the net such revenue represented as follows:
(ii) Profit (net revenue) = Revenue - Total cost of production
(iii) Simple proportion of total cost of weed control (cost of production and net revenue (profit) were used to determine the cost/benefits as follows.

Cost Benefit Ration (CBR) = Profit (Net revenue)/Total cost of production

Statistical Analysis

All data collected were analyzed statistically and mean separated using least significant difference test ($P = 0.05$)

RESULTS

Some physico-chemical properties of the soil before treatment application

Table 1 shows some physico-chemical properties of the soil before treatment application. The textural classification of the soil was sandy loam. The soil was low in nitrogen (1.14g/kg), available phosphorus 7.33mg/kg, potassium (0.10cmol/kg), magnesium 0.37cmol/kg and calcium 0.10cmol/kg. The pH (6.20) of the soil was slightly acidic, Organic carbon (Oc) (19.90g/kg) was slightly high while the cation exchange capacity (CEC) (0.67cmol/kg) was also low.

Analysis of basal application of poultry manure

The poultry manure was analyzed to determine the nutrient content as shown in Table 2; nitrogen content was 19.95g/kg; phosphorus 18.40mg/kg; potassium 15.18cmol/kg; magnesium 2.21cmol/kg and calcium, 1.22cmol/kg. The poultry manure was slightly alkaline with a pH of 7.8 and organic carbon of 115g/kg. The C:N of poultry manure had a narrow value of 5.77.

Weed Density and Weed Fresh Biomass

The dry weight of the weed could not be presented in this table because we have the challenge of oven drying and the weather was not conducive enough to sun dry. The effect of the spacing on weed density of fluted pumpkin is presented in Table 3. The results indicated that in all the sampling periods, the 120 x 120cm spacing produced significantly ($P < 0.05$), the highest weed density compared with the other plant spacing. There was no significant difference in weed densities obtained at 100 x 100cm and 80 x 80cm plant spacing at 4 WAP. The least weed density was obtained with the 60 x 60cm at 2, 4 and 8WAP whereas at 6WAP weed densities obtained at 60 x 60cm and 80 x 80cm were their statistically similar (Table 3). The effect of plant spacing on weed fresh biomass of fluted pumpkin is also presented in Table 3. At 4WAP, plant spacing of 120 x 120cm produced significantly the highest weed fresh weight (1237.5 kg/ha) while the lowest was at the spacing of 60 x 60cm (390.0kg/ha). Similarly, at 8WAP, plant spacing of 120 x 120cm had the highest weed fresh weight (927.5kg/ha) and differed significantly ($P < 0.05$) from other spacing. Plant spacing of 80 x 80cm and 100 x 100cm had statistically similar weed fresh weight of 550.0kg/ha and 660.0kg/ha respectively, while the lowest fresh weight 332.5kg/ha was recorded at spacing of 60 x 60cm.

Marketable Fresh Shoot Yield

The effect of plant spacing on marketable fresh shoot yield is presented in Table 3. Plant spaced at 120 x 120cm had the highest fresh shoot yield (39,150kg/ha), followed by 100 x 100cm (24, 522 kg/ha), 80 x 80cm (15, 400kg/ha) while 60cm x 60cm recorded the lowest fresh shoot yield of 10, 225 kg/ha

Economic Assessment

The effect of spacing on production cost of fluted pumpkin is presented in Table 4. The highest production cost was recorded at a plant spacing of 60 x 60cm (N434482.05/ha), - followed by 80 x 80cm (N329058.87/ha), - 100 x 100cm (N3065625/ha) and the lowest was recorded at 120 x 120cm (N4893750/ha).

The highest revenue (Table 4) was recorded at a plant spacing of 120 x 120cm (N4723608.48/ha) with cost benefit ratio of 1: 27.76 followed by 100 x 100cm (N2832556.93/ha) with CBR (1:12.15), 80 x 80cm (N159541.13/ha) while 60 x 60cm (N84362.95/ha) recorded the least yield (1:1.94).

Table 1: Physio-chemical properties of the experimental soil

Property	Value
Sand (g/kg)	718
Silt (g/kg)	148
Clay (g/kg)	134
Textural class	Sandy loam
pH ($H_2$0) 1:1	6.20
OC (g/kg)	19.90
N (g/kg)	1.14
P (mg/kg)	7.33
Ca (cmol/kg	0.10
Mg (cmol/kg)	0.37
K (cmol/kg)	0.10
Na (cmol/kg)	0.10
CEC (cmol/kg)	0.67

Table 2: Analysis of nutrient content of poultry manure

Property	Value
pH	7.8
Oc (g/kg)	115.1
N (g/kg)	19.95
C:N	5.77
P (mg/kg)	18.40
K (cmol/kg)	1518.00
Mg (cmol/kg)	2.21
Ca (cmol/kg	1.22

Table 3: The effect of selected plant spacing methods on weed density (no/m^2) and weed fresh weight (kg/ha) of fluted pumpkin

Plant spacing	Weed density				Weed fresh weight	
	Weeks after Planting				Weeks after Planting	
	2	4	6	8	4	8
60cm x 60cm	38.5	57.0	34.7	50.5	390.0	332.5
80cm x 80cm	42.0	67.0	35.5	53.5	555.75	550.0
100cm x 100cm	43.2	68.0	36.5	59.0	755.0	660.0
120cm x 120cm	48.2	83.2	41.5	63.5	1237.5	927.5
LSD (P = 0.05)	0.99	1.08	0.83	0.72	99.0	161.5

Table 4: The effect of spacing on shoot fresh yield of fluted pumpkin

Plant spacing	Yield (kg/ha)
60cm x 60cm	10,225
80cm x 80cm	15,400
100cm x 100cm	24,522
120cm x 120cm	39,150
LSD (P = 0.05)	3,105

Table 5: Effect of plant spacing on shoot yield and Economic Assessment of fluted pumpkin production

Plant spacing	Labour cost for planting ₦/ha	Cost of planting material (seeds) ₦/ha	Labour cost for weeding * ₦/ha	Labour cost for harvesting ** ₦/ha	Total cost of production ₦/ha	Shoot yield kg/ha	Revenue ₦/ha	Net revenue profit ₦/ha	Cost benefit ratio (CBR)
60cm x 60cm	6771.00	400,000.00	21,600.00	6,111.05	434482.05	10,225	1278125	843642.95	1 :1.94
80cm x 80cm	5242.80	292,500.00	26,400.00	4,916.07	329058.87	15,400	1925000	1595941.13	1 :4.85
100cm x 100cm	2952.00	195,000.00	31,200.00	3,916.07	233068.07	34,525	3065625	2832556.93	1 :12.15
120cm x 120cm	1804.50	130,000.00	36,000.00	2,337.02	170141.52	39,150	4893750	4723608.48	1 :27.76

1kg of fluted pumpkin edible shoot = ₦125

*** Labour cost for two weedings**

**** Average cost for 16 harvests**

DISCUSSION

Basal application of poultry manure was to supplement the deficient nutrients in the soil as indicated by the soil test results. Though there was significance difference in weed density, the weed density increased from 2WAP to 4WAP. This could be attributed to the inability of the fluted pumpkin vine to smother weed effectively at its earlier stage of establishment. Results obtained from weed density in this study indicated that closer spacing of 60 x 60cm had more weed suppressive ability than the other spacing. The probable reason for this could be as a result of high plant population and non-penetration of light energy to the ground to activate weed growth. The result of this finding is in conformity with that of Aulkalmene *et.al*. (2010) who noted that weed suppression increased with crop density.

The value of weed fresh weight recorded in this study could be attributed to wider spacing and inability of the fluted pumpkin to smother weeds at this wider spacing when compared with other plant spacing. This wide space gave opportunity for the crop and weeds to compete for nutrients, light, water and carbon dioxide which gave the weeds the advantage to supersede the crop and utilized resources at its (fluted pumpkin) detriment thereby giving all the weeds in all plots under the 120 x 120cm undue advantages over others; hence, there was a higher biomass production in plant spaced at 120x120cm. The outcome of competition between crop and weeds depends on the competitive ability of the species, if the weed is a good competitor, reduced row distance could be a disadvantage for the crop (Olsen *et .al.*, 2005)

The high yield recoded at a spacing of 120 x120cm could be attributed to lack of intra-specific competition and the ability to spread to capture more environmental resources. The low yield recorded at closer spacing could be attributed to intra-specific competition of individual plant for growth resources such as available water, light and nutrient in addition to weed competition. Our findings are also in agreement with Philip *et.al*. (2010) who observed that good growth invariably leads 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 plant received more solar radiation and therefore are more photosynthetically active.

Despite the fact that weeds were not well suppressed by 120 x120cm, its attracted higher monetary value from the market to the farmers than other spacing which had low yields. This finding is in agreement with that of Ibeawuchi *et.al*. (2005) who noted that plant spaced at a wider spacing had a higher monetary yield than other with narrower spacing. In this current study, plant spaced at 120 120cm recorded the highest profit (₦4723608. 48/ha) coupled with its' high cost benefit ratio when compared with other spacing. This further showed that for every (₦) invested on fluted pumpkin production, a profit ₦ 1:27.77 will be realized.

CONCLUSION

The highest weed growth attributes were recorded at a spacing of 120 x 120 cm while the lowest was 60 x 60cm. Although, plant spaced at 120 x120cm gave the highest monetary value from the market to the farmer than others under this preliminary investigation; there is need to carry out more studies to validate the results obtained under this current study before a clear cut recommendation could be made.

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