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EFFECT OF CROP SPACING REGIMES ON WEED GROWTH AND PERFORMANCE OF COWPEA (*Vigna unguiculata* (*L.*) IN A HUMID ZONE OF SOUTH-EASTERN NIGERIA

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ABSTRACT
Field experiment was conducted at the Department of Crop and Soil Science Demonstration Plot, Faculty of Agriculture, University of Port Harcourt, Nigeria between August and December 2017 to determine the effect of crop spacing regimes on weed growth and cowpea variety IT90K-277-2 performances in the humid zone of Southeastern Nigeria. The treatments consist of three crop spacing regimes: 75cm x 25cm, 75cmx 30cm and 75cm x 35 cm. The treatments were laid out in a randomized complete block design (RCBD) and replicated four times. Results showed that crop spacing regimes had no significant ($P > 0.05$) effect on weed growth, in all the growth and yield traits of cowpea data assessed, except for stand counts. Therefore, intermediate spacing (75cm x 30cm) or wider spacing (75cm x 35cm) at two stands per hill is recommended to farmers for better weed control and higher grain yield of cowpea in the humid zone of Southeastern Nigeria because either of the spacing tends to be more economical than close spacing, since, no seeds were wasted. However, the study need to the repeated with economic analysis of the crop spacing regime as a variable to revalidate the results obtained from this study.

Keywords: Cowpea, humid zone, spacing, variety IT90K-277-2, and weed growth

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) belongs to family of Fabaceae. It is an annual herb with different growth forms such as bushy, prostrate (creeping) trailing, erect and Semi-erect or climbing. It is an important grain legume in West Africa including Nigeria (Singh *et al.*, 2002). Cowpea is multifunctional crop because it serves several functions. It is used for: human consumption, livestock feed, cover crop, nitrogen fixation and income generation (Ngalamu *et al.*, 2015). However, the volume of production comes from the savannah regions in the North but is steadily being cultivated in the humid zones of Southern Nigeria because of its economic values (Petu -Ibikunle and Smith, 2008). Average yield of cowpea (0.42t/ha) is low in Nigeria (Singh *et al.*, 2002) when compared to achievable average yield that ranged from 1.50 t/ha to 3.00t/ha (Dzemo *et al.*, 2010). Weed infestation as result of inadequate agronomic manipulation/ cultural practices such as crop spacing and among others might be responsible for the low yield of cowpea in Nigeria. Obuo *et al* (1998) reported that poor weed management or poor weed control , delay in weeding and low plant populations contribute to low yield of cowpea in tropics including Nigeria. Many researchers have shown that weeds account for cowpea yield losses under weedy conditions between 25% and 76% subject to the variety and ecology (Osipitan *et al.*, 2016; Ugbe *et al.*, 2016).

Considering the menace value of weeds, it is imperative to control them and as such, farmers used various weed control methods such as hoe weeding and herbicide application. These two methods of weed control have their shortcomings. Hoe weeding is tedious, labour demanding, expensive, especially on a large scale and at times prone farmers to various health hazards due to stress. Herbicides are not easily available; required special skilled operation; might be contaminated and can cause environment pollution. These shortcomings can be addressed through the adoption of agronomic manipulation/ cultural practices, such as proper crop spacing. Farmers abused the crop spacing of cowpea in Nigeria probable because of inadequate knowledge of spacing. This inadequate knowledge of crop spacing often makes them to plant cowpea at a wider spacing that encouraged weed growth. Closer crop spacing suppresses weed growth and increases crop yield, when compared to wider spacing. Closer spacing can cause seed wastage because it requires high seed rate for planting. Several studies have been carried out on the use of manual hoe weeding and herbicide for weed control in cowpea (Chattha *et al*., 2007; Osipitan *et al*., 2013). However, information on the use of proper spacing in controlling weed growth and enhancing cowpea performance is limited especially, for Variety IT90K-277-2 in the humid zone of South-Eastern Nigeria. Hence, the objective of this study was to determine the effect of crop spacing on weed growth and cowpea variety IT90K-277-2 performances in the humid zone of South-Eastern Nigeria.

Materials and Methods

Description of the experimental site

The experiment was conducted at the Department of Crop and Soil Science Demonstration Plot, Faculty of Agriculture, University of Port Harcourt, Nigeria between August and December 2017 on latitude 04° 54´ 538'Nand longitude 006° 55´ 329'E. The experimental site has an average temperature of 27^0C, relative humidity of 78%, and average annual rainfall between March and November that ranges from 2500 – 4000 mm (Nwankwo and Ehirim, 2010).The site was under continuous cultivation of fluted pumpkin and maize for four years. The common weed species present in the experimental site and their levels of infestation were identified with a weed handbook (Akobundu *et al*., 2016).

Soil analysis

Prior to the experimentation, soil samples were taken randomly from the experimental site at uniform depth of 0-15cm at 15 points with an auger of 8cm diameter. The soil samples were bulked and air dried and a representative was taken and processed for laboratory analysis. The sample was analyzed for some physicochemical using standard procedure.

Cowpea variety used for the experiment

The cowpea variety used was IT90K-277-2. It was obtained from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. It has small sized seeds that are white rough in color, medium maturing (80–89 days) and semi erect.

Treatments and Experimental Design

The treatment consisted of three levels of crop spacing regimes viz: 75cm x 25cm, 75 x 30 cm; and 75cm x 35cm. The treatments were laid out in a Randomized Complete Block Design (RCBD) replicated four times. Experimental land area of 13m x 18m ($234m^2$) of approximately 0.023ha was cleared manually, stumps and debris were packed. The experimental area was divided into four blocks while each block was further divided into three (3) plots making it 12 plots. Each plot size was 3m x 3m. The plots were separated by 2m while the blocks were separated with alleyway of 2m. Three seeds of cowpea were planted on per hole on 30^{th} August 2017 and later thinned to two seedlings at two weeks after planting to give plant population of 96 stands/plot (106,667 /ha) for 75 x 25cm,80 stands /plot(88, 889/ha) for 75 x 30cm and 64 stands/plot (71,111/ha) for 75cm x 35cm. All the plots were hoe weeded once at 3weeks after planting (3WAP).

Weed growth characteristics

Weed density and weed biomass

Weed density was done at harvest by using two quadrats of 50cm x 50cm and placing them diagonally in each plot, the weeds inside the quadrats were uprooted, counted and expressed in no. /m^2.

Weed dry weight

Weed dry weight was determined by cutting off the root form each weed species within each quadrat remaining only the shoots, which were sun dry to constant weight and expressed in g/m^2

Cowpea growth and yield characteristics

Stand count at 100% podding

This was carried out by counting the number of stands in each gross plot per treatment and later expressed in plant population per hectare

Canopy volume

The canopy diameters were determined at harvest by stretching measuring tape across diagonally from the beginning of one edge of the plot to the end of the other edge. Five plants were randomly selected from both diagonal points. The longest vine was selected from each of the plant and measured from the soil surface to the tip of the apical bud. The average of five plants was taken as length of vine per plant and was used to calculate canopy volume with the formula as:

$$Canopy\ volume = \frac{D1 + D2}{2} \times \text{Vine length} \qquad (1)$$

Where D_1 = first canopy diameter and D2 = second canopy diameter

Shoot dry weight (biomass without pods)

The shoots cut with cutlass from the soil surface when the pods have turned brown and leaves were about to senesce. The pods were picked from each per plots and the shoots (without pods) were tied into bundles and sundried to constant weight and measured with a weighing scale. Bundle weight of the shoot per plot was later converted to kilograms per hectares (kg/ha) by using the following formula as:

$$Shoot\ dry\ weight\ \left(\frac{Kg}{ha}\right) = \frac{\frac{\text{Shoot dry weight (kg)/gross plot}}{\text{gross plot}}}{Area\ of\ \text{gross plot}} \qquad (2)$$

Pod length per plant

Ten pods form each plot was used to determine the pod length. The pods were measured from the base to the tip of apical bud with a meter rule and their averages were taken as length of pod per plant.

Number of pods per plant
This was done by using the formula below:

$$Number\ of\ pods\ /plant\ = \frac{number\ of\ harvested\ pods\ /gross\ plot}{number\ of\ plants/\ gross\ plot} \quad (3)$$

Weight of dry pods/plant
The pods removed from the shoot were sun dried to constant weight for two weeks and weight was taken with sensitive electronic scale. The weight of pods/plant was calculated as:

$$Weight\ of\ pods\ /plant\ = \frac{weight\ of\ harvested\ pods\ (g)/gross\ plot}{number\ of\ plants/gross\ plot} \quad (4)$$

Grain yield
After sun drying the pods to constant weight for two weeks, the pods were shelled and the grains were winnowed. The grains in each gross plot were weighed with weighing balance and the weight recorded. The yield per gross plot was extrapolated to kilograms per hectare (kg/ha) by using the following formula as:

$$Grain\ yield\ (Kg/ha)\ = \frac{\text{Grain weight (kg)/gross plot}}{\text{Area of gross plot}} \quad (5)$$

Statistical analysis
Data generated were subjected to statistical analysis of variance (ANOVA) and significant treatment means were compared using least significant difference (LSD) at 5% probability level.

Results and Discussion
Soil physico-chemical properties
Physiochemical properties of the soil before planting are presented in Table1. The result showed that soil was sandy by texture and acidic with a low pH. The soil has moderate organic carbon and Phosphorus (P) but low in calcium (Ca), and magnesium (Mg), potassium (K), sodium (Na) according to the criteria for soil fertility classes of Ibude *et al*. (1988)

Weed growth characteristics
Weed species composition
Table 2 shows the common weeds species found at the experimental site and their levels of infestation. Thirteen weeds species belonging to 12 genera and 7 families were found in the experimental site before the experiment. About 31 % of all the weed species belonged to the Poaceae (4), 23% Cyperaceae (3) and 15% Asteraceae (4) 15%, Rubiaceae (1), 8% Cleomaceae (1) and 8% Euphorbiaceae (1). About 46% of the weeds were broadleaved species, 31% were grasses while 23% were sedges. Annual weed species recorded 77% while perennial weed species recorded 23%. The most dominant weed species at the experimental site were *Ageratum conyzoides* Linn *Mitracapus villosus* (Sw.) DC. *Oldenlandia corymbosa* Linn and *Digitaria horizontalis* Willd.

Weed density and weed dry weight
The effect of crop spacing on weed density and weed dry weight of cowpea is presented Table 3. There were no significant differences (P> 0.05) among the different spacing regimes on weed density and dry weight. The probable reason for the non-significant differences in weed density and weed dry weight might be due to growth habit of the cowpea used in the study, which is semi-erect with profuse creeping vines that spread in different directions to occupy spaces that could have caused weed growth. Thus, both spacing (inter mediate, 75cm x 30 cm and wider, 75cm x 35cm) had similar weed suppressive ability with that of closer spacing (75cm x 25cm). However, the slight decrease recorded in weed density and weed dry weight at a closer spacing of 75cm x 25cm could be attributable to its high plant population density, which allows speedy and superior canopy cover of the crop. This finding is in consonance with that of Adigun *et al.* (2014) who noted that closer spacing results to low weed density and weed dry weight of cowpea.

Vegetative growth characteristics of cowpea
Stand count (no/ha) at 100% podding
The effect of crop spacing regimes on stand count per hectare of cowpea is presented in Table 4. There were significant differences (P< 0.05) among the crop spacing regimes on stand counts of cowpea at 100% podding. However, cowpea spaced at a closer spacing of 75cm x 25cm gave the highest number of plants per hectare when compared to other crop spacing regimes. The probable reason for this might be due to differences in crop spacing regimes. This finding agrees with that of (Malami and Sama'ila, 2012) who reported similar response that closer spacing of cowpea resulted in high plant population of cowpea (variety Kanannado) in in the Semi-Arid North-Western Nigeria.

Canopy volume
The effect of crop spacing regimes on canopy volume of cowpea is presented in Table 4. There were no significant differences (P > 0.05) among the crop spacing regimes on canopy volume probably because the cultivar was able to spread to different directions to occupy the empty space that were in the intermediate (75cm x 30cm) and wider spacing (75cm x 35cm). Although not-significant, cowpea spaced at a closer spacing of 75cm x 25cm gave the highest canopy volume than other spacing probable due to its higher number of plants.

Shoot dry weight
Table 4 shows the effect of crop spacing regimes on shoot dry weight of cowpea. There were no significant differences among the crop spacing regimes. The non-significant different might be attributed to of

differences in plant population. However, crop spaced at closer 75 cm x 25 cm produced slightly higher shoot dry weight than other spacing probably because it has higher plant population. This finding is similar to that Malami and Samaila (2012) who noted that spacing had no significant effect on dry shoot weight of cowpea.

Yield and yield components of cowpea

Pod length

The effect of crop spacing on pod length of cowpea is presented in Table 5. There were no significant differences (P>0.05) among the crop spacing regimes on pod length of cowpea. The probable reason while plant spaced at a wider and intermediate spacing had similar pod length with that of closer spacing might be due to the creeping nature of the cowpea vine to different directions to fill up the empty spaces left at both crop spacing regimes. The result of this finding is in agreement with that of Yohanna (2017) who noted that length of pods of three genotypes namely: Iron, Kanannado and IAR- 00 – 1074 of cowpea were similar at the different cowpea spacing (75 x 15cm, 75 x 30cm, 75 x 45cm, 75 x 60cm, 75 x 75cm). The author attributed the identical length of cowpea pod to their growth habits. However, crop spaced at a closer spacing of 75cm x 25cm produced slight longer pod than other crop spacing regimes probable as result of intra specific competition of plants for growth resource due to high density.

Number of pods/plant

The effect of crop spacing regimes on the number of pods of cowpea is presented in Table 5. There were no significant differences (P>0.05) among the crop spacing regimes on number of pods at 100% podding. This may be attributed to the cowpea growth habit and plasticity. However, highest number of pods was recorded on spacing of 75cm x25cm probably as result of high plant population while the lowest pod numbers was recorded on a spacing of 75cm x 35cm probably as result of low plant population. This finding is also similar to that of Kawooya (2014) who reported that elite cowpea varieties spaced at 45×30cm, 60×30cm and 75×30cm were not significantly different on number of pods produced per plant. In the same vein, higher yield per hectare in higher populated plots (closer spacing) and lower plant population plots (wider spacing) have been reported (Nwofia and Ekeleme, 2005)

Weight of pods/plant

The effect of crop spacing regimes on weight of pods/plant of cowpea is presented in Table 5. There were no significant differences (P>0.05) on weight of pods per plant of cowpea among the crop spacing regimes probable as result of the growth habit of the cowpea. Although there were no significant differences among the crop spacing regimes, cowpea spaced at 75cm x 25cm appeared to have slightly heavier pod weight per plant than the other crop spacing regimes probable as result of more number of plants. Osipitan *et al.* (2013) reported identical findings that closer spacing produced heavier pods weight than intermediate and wider crop spacing.

Grain yield

The effect of crop spacing regimes on grain yield of cowpea is presented in Table 5. There were no significant differences (P > 0.05) among the crop spacing regimes. The probable reason while the intermediate, wider spacing had identical yield with closer spacing might be due to the growth habit of the cowpea variety used for this study. The cowpea variety used for the study has the ability to produce profuse creeping vines that can spread to different directions. The creeping vines filled the gap left at wider spacing, cover the weeds and prevent solar radiation from stimulating weed growth. This finding is in conformity with that of Yohanna (2017) who noted the yield of cowpea at different spacing was similar probable as result of growth habit. Although there were similarities in grain yield among the crop spacing regimes cowpea spaced at closer spacing of 75cm x 25cm appeared to perform slightly better than the other spacing regimes probable of more number of pods. Osipitan *et al.* (2013) have noted similar findings on high yield of cowpea due to closer spacing.

Conclusion

This study validates the effect of crop spacing regimes on weed growth and cowpea variety IT90K-277-2 performance in the humid zone of Southeastern Nigeria. Results of this study showed that: the lack of significant differences in weed density, weed dry matter yield, and cowpea grain yield among the crop spacing regimes implies that the crop spacing regimes were similar. From agronomic point of view, any of the crop spacing is recommendable; but in terms of economic, 75cm x 30cm (intermediate spacing) or 75cm x 35cm (wider spacing) is recommended to farmers in the humid zone of South-Eastern Nigeria because either of the spacing involves waste of seeds when compared to closer spacing. However, the study needs to be repeated by inclusion of economic analysis of the crop spacing regimes as a variable to revalidate the results obtained from this study.

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Table 1: Physiochemical properties of the experimental site before planting

Soil properties	Value
Physical characteristics	
Sand(%)	95.70
Silt(%)	3.2
Clay(%)	1.10
Textural class	Sandy
Chemical characteristics	
pH ($H_2$0)	4.89
Organic Carbon	1.45
Organic Matter	2.5
Total nitrogen (%)	0.09
Available P (mg/kg)	18.00
Ca	2.00
Mg	0.20
Na	0.04
K	0.12
CEC (cmol/kg)	2.36
Exchange acidity (cmol/kg)	0.20
ECEC (cmol/kg)	2.56
Base saturation (%)	92.19

CEC= Cation exchange capacity ; ECEC= Effective cation exchange capacity

Table 2: Common weeds species found at the experimental site and their level of infestation before planting

Weed species	Family	Growth form	Level of infestation
Broadleaves			
Ageratum conyzoides Linn.	Asteraceae	ABL	+ + +
Aspilia Africana (Pers.) C.D. Adams	Asteraceae	ABL	+ +
Cleome rutidosperma DC.	Cleomaceae	ABL	+ +
Mitracapus villosus (Sw.) DC.	Rubiaceae	ABL	+ + +
Oldenlandia corymbosa Linn.	Rubiaceae	ABL	+ + +
Phyllanthus amarus (Schumach. & Thonn.) Learndri	Euphorbiaceae	ABL	+ +
Grasses			
Digitaria horizontalis Willd.	Poaceae	AG	+ + +
Echinochloa colona (Linn.) Link	Poaceae	AG	+ +
Eleusine indica Gaertn.	Poaceae	AG	+
Eragrostis tenella (Linn.) P.Beauv. Ex Roem	Poaceae	AG	+
Sedges			
Cyperus esculentus Linn.	Cyperaceae	PS	+ +
Cyperus tuberosus Rottb.	Cyperaceae	PS	+
Kyllinga bulbosa P.Beauv.	Cyperaceae	PS	+

Key

ABL	=	Annual broad leaf
AG	=	Annual grass
PS	=	Perennial sedge
+ ++	=	Higher infestation (60 – 90% occurrence)
++	=	Moderate infestation (30 –59% occurrence)
+	=	Low infestation (1 – 29% occurrence)

Table 3: Effect of crop spacing regimes on weed density and weed dry weight of cowpea at harvest

Spacing (cm)	Weed density (no/m^2)	Weed dry weight (g/m^2)
75 x 25	41.00	11.00
75 x 30	53.25	22.75
75 x 35	92.25	38.71
LSD (P = 0.05)	82.207NS	38.705NS

NS = Not Significant

Table 4: Effect of crop spacing regimes on vegetative traits of cowpea

Spacing (cm)	Stand count at100%podding (no/ha)	Canopy volume at harvest (cm^3)	Shoot dry weight at harvest (kg/ha)
75 x 25	106,666	9.17	2347.22
75 x 30	88,888	9.12	2291.67
75 x 35	71,111	8.01	2194.44
LSD (P = 0.05)	0.577	2.059NS	1831.121NS

NS = Not Significant

Table 5: Effect of spacing regimes on yield and yield components of cowpea

Spacing (cm)	Length of pod (cm)	No. pods / plant	Weight of pods/plant (g)	Grain yield (kg/ha)
75 x 25	11.60	3.60	4.87	269.44
75 x 30	12.60	3.03	4.58	234.17
75 x 35	13.35	2.60	3.85	198.29
LSD (P = 0.05)	3.198NS	2.813NS	3.534NS	129.298NS

NS = Not Significant