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Genetic Effects of Population Densities on the Growth and Yield of Cowpea Varieties (*Vigna unguiculata(L) Walp*) in Southern Guinea Ecology of Nigeria

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ABSTRACT

A field experiment was conducted at Teaching and Research farm of Landmark University to investigate the influence of three population densities (88,000, 44,000, and 29,000 plants/ha) on the growth and yield of five cowpea varieties (IT97K-461, IT97K-568-18, IT98K-131-2, IT99K-1060 and IT99K-`245). Plant growth parameters such as germination count, plant height, and number of trifoliate leaves per plant, number of branches per plant, flower production dynamics and dry matter determination were measured during growth, and yield components such as harvest index, shelling percentage, number of seeds per pod, see weight pods per plant and grain yield were measured at harvest.

Results showed that there were no constant trends in growth parameters response to population density. Plant height and flower production decreased with increased population density, while number of leaves per plant and dry matter increased with increasing population density. There was no appreciable effect of population density on branching.

All these parameters were significantly affected with variety, while there was no significant interaction effect. Most yield components decreased with increasing population density while grain yield however, slightly increased with increasing population density. All yield parameter and grain yield significantly varied with variety, while there were no appreciable interaction effect.

In concussion, a population density of 88,000 plants /ha gives the highest growth and grain yield. It can therefore be recommended. Also variety, IT97-568-18 gives the higher growth and grain yield than other varieties.

Keywords: *Genetic effects, growth, Vignaunguiculata, population density*

INTRODUCTION

Cowpea (*Vignaunguiculata*(L) Walp) is one of the increasingly cultivated grain legumes of the tropical and subtropical coutries. Cowpea is the most important source of protein for human being and livestock (Ajeigbe *et al*., 2010). Cowpea can be used as a primary source of protein for many poor Africans who cannot afford animal protein (Brader, 2002). In most areas they are grown and eat in various ways either alone or mixed with maize, rice, fish or gaari which supplies 40% of the daily protein (Mulebe et al., 1997). Flour is made into fried or boiled cakes as ‘akara’ or ‘’moinmoin’’ (Onyibe *et al.*, 2006).

Despite the importance of this crop, however, it has been observed that the yield of cowpea in southern guinea savannah of Nigeria has been lower than world average which ranges between 200-600kg/ha. A lot of factors may be responsible for this under production. Ajeigbe*et al* (2006) stated that factors responsible for low yield production include pest infestation, disease and poor management practices. Low yield in cowpea production can also be attributed partly due to inefficient partitioning of dry-matter to the seeds and varietal factors.

A population density of less than 33,000 plants per hectare has been reported on farmers farm (Dugje*et.al*., 2009). At this density the crop does not cover the ground completely, thus allowing the weeds to grow and reducing the efficiency of land utilization. Experiment has reported that cowpea responded very well to inter row spacing of 60 x 30 cm giving a plant population of 55,000 plant per hectare (Kamara *et al*., 2014). In Nigeria, Anonymous, (2008 showed

that a population of 87,000 plants per hectare was ideal for erect and semi erect type. At low densities, competition may not occur at all and resources are not efficiently used. It is therefore the objectives of this present study to investigate the influence of inter row spacing an growth and yield of cowpea varieties in southern guinea savannah of Nigeria and also to determine if cowpea response to increasing density is genotype dependent.

Materials and Methods

Field experiments were conducted at the Teaching and Research (T and R) farm of Landmark University Omu Aran, Kwara State (Latitude 80 28'N, Longitude 40 34'E and annual rainfall of 1005mm) in the southern Guinea savannah of Nigeria. The soil is classified as Typicpaleustalf (United State Department of Agriculture, USDA soil taxonomy). Composite soil samples were collected randomly from the trial site at the depth of 0-15cm with an auger prior to planting. The samples were analysed in the Soil, Water and Material Testing Laboratory of Lower Niger River Basin Development Authority, Ilorin, Nigeria for physic-chemical analysis (Table 1). The collected samples were air-dried and passed through 2mm sieve to remove large particles, debris and stones. The sieved samples were analyzed for pH in 1:1 soil to water ratio using the Coleman pH meter. Organic carbon was determined by Walkley and Black procedure (Nelson Somers, 1992). Total Nitrogen was determined by the micro Kjeldahl method (Bremner 1965), while available phosphorus was extracted by Bray's P1 method (Bray and Kurtz, 1945) and read from the atomic absorption spectrometer. Exchangeable Ca, Mg, K, Na and effective cation exchangeable capacity (ECEC) were analyzed using Atomic Absorption Spectrophotometer (IITA 1989), while textural analysis was by hydrometer method.

The experiment was laid out as a randomized complete block in split plot arrangement with the population consisting the main block and varieties subplot. The population density were achieved by planting at inter-row spacing of 30cm, 60 cm and 90 cm equivalent to 88,000, 44,000 and 29,000 plants per hectare respectively. The plot size is 15m2 consisting 2 rows of 5m long. The varieties considered were IT97K-461-4, IT97K-568-18, IT98K-131-2, IT99K-1060 and IT99K-1245 which were collected from the International Institute for Tropical Agriculture (IITA) Ibadan.

Land preparation was carried mechanically using tractor to plough. Ridging was done at 2 weeks after to allow proper decaying of debris. Planting was done on 12th August 2012 at two seeds per hole in double row on a ridge.

Weeds were controlled manually which is the most common method used by farmers in cowpea production. Weeding was twice with hoe, first at 2 weeks after planting and secondly at 4-5 weeks after planting to ensure a clean field. Poor weed control drastic reduction in yield.

At 6 weeks after planting (WAP) all plot were sprayed with insecticide land acyhalothrine 25EC at a rate of 2ml per litre. The spraying continued at interval until pod maturity

Data Collection

Data collection started at 2WAP and the following parameters were recorded

Growth Parameters

Five plants were tagged randomly in each plot for ease growth parameter collection. Growth parameters recorded are:

Plant height: Measurement started from 2 WAP and continues till 7WAP. The measurement was from the soil surface to the last foliage leaf using measuring tape in centimetre. This was carried out weekly.

Number of trifoliate leaves: At each time of height measurement, number of trifoliate leaves was taken and recorded using tagged plants.

Number of branches: At each time of the growth parameter reading, number of branches from main stem was recorded using tagged plants.

Numbers of flowers: The number of flowers produced were taken from tagged plant early in the morning every day and continued until flowering stopped.

Dry matter determination: Dry matters were taken at the commencement of flowering using three samples in a plot which were randomly uprooted. The root was cut from stem, packed separately and oven dried at 100^0c for 48 hours.

Yield Parameters at Harvesting

Harvesting Was Done At 11 WAP When All Pods Had Been Dried. Pods from Tagged Plants Were Harvested According To Their Plot and

Labelled. The Pods From Other Plants Were Harvested And Packed Plot By Plot.

Number Of Pods Per Plant: The Numbers Of Pods In The Five Tagged Plants Of Each Plot Were Counted And Average Was Recorded.

$$\text{Number of pod per plant} = \frac{\text{Total number of pods}}{\text{Number of tagged plants}}$$

Number of seeds per pod: average number of seeds that were contained in each pod per plant was taken. this was done by shelling 10 pods from the tagged plant to remove the seeds. Thereafter the total number of seeds was recorded and divided by the number of pods to obtain number of seeds per pod.

Seed weight: ten seeds were selected from seeds of tagged plants. It is then weighed on electronic balance. Thereafter the total weights of the seeds were taken and the average was calculated by divided by ten.

Pod weight determination: The weight of the pod with grain was recorded plot by plot.

Grain weight: The winnowed grain was weighed ploy by plot in kilogramme and converted to kilogramme per hectare.

Stoffer weight: The remaining plants on the field were uprooted weighed and recorded plot by plot

Shelling percentage: The shelling percentage from each plot was recorded using the expression below:

$$\text{Shelling percentage (SP)} = \frac{\text{Grain weight x 100}}{\text{Pod weight}}$$

Harvest index: the ration of economic yield to that of total biomas is harvest index. Biomas is stoffer weight plus pod weight

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Total biomas}}$$

Data Analysis

All data collected data were subjected to statistical analysis of variance (ANOVA) using SAS Institute (1995). Significant means were separated using Duncans Multiple Range Test at 5% probability level.

Results

Soils of the sites for the two locations are sandy loam, low in nitrogen and other micro elements (Table 1).

Effect of Plant Growth Parameters

Effect on Germination Percentage

The result of the analysis of variance for germination shows that both the main effect of population density and variety as well as their interaction were significant (Table 2). The table also show that the effect of population density, variety and the population x variety interaction were generally significant for plant height throughout the measuring periods except at 2 and 3 WAP for population density

Table 3 shows that germination was significantly higher at density of 44,000 plants per hectare, while 88,000 plants per hectare and 29,000 plants per hectare showed similar germination. IT97K-461-4 has significantly lower germination than other varieties. IT98K-131-2, IT99K-1060 and IT99K-1245 have similar germination which was significantly higher in germination than IT97K-568-18. However, significant interaction effect revealed that while population density had no effect in germination of varieties IT97K-568-18, IT99K-1060 and IT99K-1245. Germination in variety IT97K-461-4 and IT98K-131-2 was significantly reduced by the lowest population density (Table 4).

Plant height decreased with increased population density with the plant at the highest population density showing significantly lower heigt than in the other two population densities. Plant height was highest at population density of 29,000, the values however, were not significantly taller than in plans At 44,000 plants per hectare. Plant height was significantly highest with variety IT97K-568-18 and significantly lowest with variety IT97K-461-4 throughout the measurement period (Table 3).

Table1. *Physical and Chemical Properties of Soil in the Experimental Sites*

Properties	Value
Sand %	73.00
Clay %	7.18
Silt %	21.00
Textural class	Sandy loam
pH (H_20)	5.70
Carbon %	0.70
Organic matter %	1.70
Nitrogen %	0.07
Phosphorus (mg/kg)	8.80
Ca^{2+} (cmol/kg)	1.72

Table2. *Mean square from the analysis of variance for germination and plant height*

SV	Df	Germ	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
Density	2	424.09*	0.34ns	2.06ns	13.36**	436.99*	1692.57**	3158.77*
Error (a)	4	49.62	1.61	1.64	0.59	34.32	95.67	49.62
Variety	4	477.37***	6.48	7.79	9.93***	531.10***	1171.16***	477.37**
Density x variety	8	198.70**	2.01**	1.34	3.07***	130.30***	204.30**	198.70**
Error (b)	24	61.71	0.46	0.54	0.5151	24.18	57.20	61.71

Table3. *Effect of population density and variety in germination and plant height*

Treatment	germination	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
88,000	77.9^{b}	9.65^{a}	10.90^{b}	12.99^{b}	21.37^{b}	24.40^{b}	26.45^{c}
44,000	84.4^{a}	9.95^{a}	11.68^{a}	14.43^{a}	31.31^{a}	39.10^{a}	50.15^{b}
29,000	73.9^{b}	9.79^{a}	11.39^{ab}	14.77^{a}	30.00^{a}	45.00^{a}	52.80^{a}
Sed	2.57	0.46	0.47	0.28	2.14	3.57	0.73
variety							
IT97K-461-4	57.1^{c}	9.68^{b}	11.36^{b}	14.44^{b}	21.32^{c}	25.30^{c}	28.00^{c}
IT97-568-18	76.9^{b}	10.27^{a}	11.56^{b}	14.16^{b}	29.60^{a}	51.70^{a}	28.57^{a}
IT98K-131-2	85.1^{a}	9.76^{b}	11.56^{b}	14.28^{b}	30.68^{b}	44.50^{b}	50.36^{b}
IT99K-1060	86.6^{a}	8.5^{c}	9.77^{c}	12.31^{c}	21.94^{c}	27.70^{c}	32.19^{d}
IT99K-1245	87.9^{a}	10.78^{a}	12.29^{a}	15.13^{a}	24.26^{c}	31.60^{c}	36.56^{c}
Sed	3.70	0.32	0.35	0.33	2.32	3.57	1.39

Table4. *Interactive effects of population and variety on germination*

Variety	88,000	44,000	29,000	Variety means
IT97K-461-4	61.7	72.0	37.7	57.1
IT97-568-18	69.7	80.7	80.3	76.9
IT98K-131-2	86.0	88.3	81.0	85.1
IT99K-1060	87.0	83.7	87.0	86.6
IT99K-1245	85.0	95.3	83.3	87.9
Population means	77.9	84.4	73.9	

s.e.d. for population=2.57

s.e.d. for variety=3.7

s.e.d. for population x variety = 6.29

Effect on Leaf Production

Analysis of variance for number of trifoliate leaves show that the effects of population density were significant from 4 WAP to 7 WAP, while the effects of variety were significant throughout the measurement period except at 2 WAP. Population density x variety effect were also significant throughout the period except at 2 WAP and 5 WAP (Table 5). Table 6 shows that number of leaves increases with increase in days of planting. Number of trifoliate leaves increased with increasing population density throughout the measurement period with leaves production at population density 88,000 plants/ha significantly higher than at both 44,000 and 29,000 plants/ha which showed similar leave production. IT97K-568-18 and IT99K-1245 gave significantly higher number of leaves more than in the other varieties throughout the measurement period.

Table5. *Means square from the analyses of variance for number of trifoliate leave per plant*

plant height (weeks after planting (WAP)							
SV	df	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
Density	2	0.022ns	7.27ns	37.96*	90.82***	190.16**	224.47***
Error (a)	4	0.01	2.37	4.49	0.79	6.92	2.56
Variety	4	0.08ns	23.61	17.80***	34.03	55.19***	61.42***
Density x variety	8	0.08ns	3.04***	5.90**	3.52	15.91**	19.19*
Error (b)	24	0.10	0.5	1.75	3.24	4.86	7.00

*Ns denotes effect not significant, *Denotes effect significant (P<0.05)*

Table6. *Effect of population density and variety on number of trifoliate leaves per plant*

plant height (weeks after planting (WAP)

Treatment	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
88,000	2.07[a]	6.47[a]	13.53[a]	23.47[a]	29.80[a]	30.67[a]
44,000	2.13[a]	5.33[b]	11.27[b]	20.40[b]	23.67[b]	24.73[b]
29,000	2.07[a]	5.20[b]	10.47[b]	18.60[c]	23.60[b]	23.40[b]
Sed	0.11	0.56	0.78	0.32	0.96	0.59
Variety						
IT97K-461-4	2.11[a]	8.56[a]	13.56[a]	22.67[a]	27.33[a]	28.11[a]
IT97-568-18	2.00[a]	5.11[b]	11.67[bc]	21.33[a]	25.22[b]	5.78[b]
IT98K-131-2	2.22[a]	4.89[b]	10.00[d]	22.56[a]	26.89[a]	26.56[a]
IT99K-1060	2.11[a]	5.00[b]	12.67[ab]	19.00[b]	21.56[c]	22.11[c]
IT99K-1245	2.00[a]	4.78[b]	10.89[cd]	18.56[b]	27.44[a]	28.78[a]
Sed	0.14	0.32	0.62	0.85	1.08	1.25

Means having the same letter in a column are not significantly different by DMRT ($p<0.05$)

Effect on Branches Production

The result of analysis of variance for branches (Table 7) shows that both the effects of population density and variety as well as their interaction were not significant throughout the period of data collection with the exception of 4 WAP for variety and interaction. Table 8 show that branches initially increase with increase in days of planting until a constant number is recorded at 4WAP till 7 WAP. Numbers of branches were neither affected by population density nor by variety. There was also no significant effect.

Table7. *Means square from the analyses of variance for branch per plant*

plant height (weeks after planting (WAP)							
SV	**Df**	**2 WAP**	**3 WAP**	**4 WAP**	**5 WAP**	**6 WAP**	**7 WAP**
Density	2	0.56ns		0.09ns	0ns	0ns	0ns
Error (a)	4	0.29	0.73	0.02	0	0	0
Variety	4	0.14ns	0.37ns	0.09**	0ns	0ns	0ns
Density x variety	8	0.19ns	0.97ns	0.09**	0ns	0ns	0ns
Error (b)	24	0.33	0.88	0.02	0	0	0

*Ns denotes effect not significant, *Denotes effect significant ($P<0.05$)*

Table8. *Effect of population density and variety on number of branches per plant*

Treatment	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
88,000	0.60[a]	2.20[b]	4.00[a]	4.00[a]	4.00[a]	4.00[a]
44,000	0.27[a]	2.87[a]	3.87[b]	4.00[a]	4.00[a]	4.00[a]
29,000	0.27[a]	2.13[b]	4.00[a]	4.00[a]	4.00[a]	4.00[a]
Sed	0.20	0.31	0.05	0.00	0.00	0.00
Variety						
IT97K-461-4	0.56[a]	2.44[a]	3.78[b]	4.00[a]	4.00[a]	4.00[a]
IT97-568-18	0.33[a]	2.33[a]	4.00[a]	4.00[a]	4.00[a]	4.00[a]
IT98K-131-2	0.22[a]	2.44[a]	4.00[a]	4.00[a]	4.00[a]	4.00[a]
IT99K-1060	0.33[a]	2.67[a]	4.00[a]	4.00[a]	4.00[a]	4.00[a]
IT99K-1245	0.44[a]	2.11[a]	4.00[a]	4.00[a]	4.00[a]	4.00[a]
Sed	0.27	0.43	0.07	0.00	0.00	0.00

Means having the same letter in a column are not significantly different by DMRT ($p<0.05$)

Effect on Dry Matter Production

Dry matter was not significantly affected by both density and density by variety interaction, while it is significantly influenced by the variety (Table 9)Table 10 show that dry matter was higher with population density of 88,000 plants/ha and least with 44,000 plants /ha. However, the differences were not significant. IT97K-568-18 has the highest dry matter which was significantly higher from those of other varieties. IT98K-131-2 was significantly lower from other varieties.

Table9. *Means square from the analyses of variance for dry matter per plant*

SV	Df	DM
Density	2	10.64ns
Error (a)	4	4.40
Variety	4	399.84***
Density x variety	8	2.01ns
Error (b)	24	0.92

*Ns denotes effect not significant, *Denotes effect significant (P<0.05)*

Table10. *Effect of population density and variety on dry matter per plant*

Treatment	DM
88,000	25.13[a]
44,000	23.60[a]
29,000	23.75[a]
Sed	0.766
Variety	
IT97K-461-4	23.52[c]
IT97-568-18	33.60[a]
IT98K-131-2	15.33[d]
IT99K-1060	23.33[c]
IT99K-1245	25.00[b]
Sed	0.46

Means having the same letter in a column are not significantly different by DMRT (p<0.05)

Effect of Flower Production Dynamics

Analysis of variance for flower production show that that effect of population density were generally not significant throughout the period of flower counting with the exception of days 3 and 4. However, the effects of variety were generally significant with the exception of days 3 and 4. However, the effect of variety was generally significant with the exception of days 7.8.9 and 15. Density x variety effect was only significant on few occasions during measurement (Table 11).

Flower production increased with decrease in population density with production at the highest population density significantly lower than in the two lower densities which showed similar flower production from day 1 to day 7. Thereafter flower production was similar for all the three varieties. IT97K-461-4 and significantly lowest with variety IT98K131-2 throughout the measurement period (Table12)

Table11. *Mean squarefrom the analyses of variance for flower production*

SV	df	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Density	2	11.82ns	15.26ns	20.69**	26.6**	4.95ns	4.42**	6.82ns	0.42ns	0.96ns	0.36	0.00ns	1.42	5.07ns	2.49 ns	0.87ns
Error (a)	4	1.92	2.57	1.32	1.87	0.86	0.55	2.29	1.16	1.39	1.79	0.40	1.06	1.97	0.75	1.43
Variety	4	60.33***	59.86***	63.61***	34.37***	16.91***	4.03**	0.81ns	0.86ns	2.37ns	9.86	5.57**	3.81**	3.26**	2.36 ns	0.24ns
Density x variety	8	7.93***	1.49ns	3.07**	3.43ns	3.51**	1.28ns	2.46ns	3.172***	2.57**	3.44***	2.52ns	1.97**	1.37ns	1.74**	1.06ns
Error (b)	24	0.71	1.56	0.94	1.61	1.18	0.73	1.11	0.51	0.60	0.89	1.098	0.80	0.83	0.54	0.66

Table12. *Effect of population density and variety on flower production*

Treatment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
88,000	6.27[b]	6.67[b]	6.87[b]	7.40[b]	6.13[b]	5.47[b]	5.20[b]	5.40[a]	4.67[a]	4.40[a]	3.53[a]	2.27[a]	1.40[b]	1.20[b]	0.53[a]
44,000	7.47[a]	8.13[a]	8.93[a]	9.60[a]	7.27[a]	6.47[b]	6.40[a]	5.60[a]	5.13[a]	4.40[a]	3.53[a]	2.80[a]	2.33[b]	2.00[a]	1.00[a]
29,000	8.00[a]	9.60[a]	8.87[a]	7.20[b]	6.53[ba]	5.60[b]	5.27[b]	5.73[a]	5.07[a]	4.14[a]	3.53[a]	2.80[a]	2.47[a]	1.73[ab]	0.87[a]
Sed	0.51	0.59	0.42	0.50	0.34	0.27	0,55	0.40	0.43	0.49	0.23	0.38	0.51	0.32	0.43
Variety															
IT97K-461-4	9.56[a]	10.78[a]	11.78[a]	10.11[a]	8.00[a]	6.22[ab]	5.67[a]	5.67[ab]	5.22[ab]	5.56[a]	4.67[a]	2.89[a]	2.33[a]	2.33[a]	0.89[a]
IT97-568-18	7.44[b]	5.78[c]	6.67[c]	6.78[b]	6.67[b]	6.56[a]	5.44[a]	5.11[b]	4.67[c]	4.56[b]	3.78[ab]	3.00[a]	2.33[a]	1.67[ab]	0.78[a]
IT98K-131-2	2.89[c]	4.56[d]	4.78[d]	5.33[c]	4.44[c]	4.89[c]	5.22[a]	5.78[ab]	4.33[c]	2.89[c]	2.56[c]	1.11[b]	1.00[b]	1.00[b]	0.56[a]
IT99K-1060	8.78[a]	9.44[b]	9.33[b]	9.11[a]	7.56[ab]	6.11[ab]	6.00[a]	5.89[a]	5.67[c]	4.89[ab]	3.56[b]	3.33[a]	2.44[a]	1.89[a]	1.00[a]
IT99K-1245	7.56[b]	8.44[b]	8.56[b]	9.00[a]	6.56[b]	5.44[bc]	5.78[a]	5.44[ab]	4.89[c]	3.67[bc]	3.11[bc]	2.78[a]	2.22[a]	1.33[b]	0.78[a]
Sed	0.40	0.50	0.46	0.60	0.51	0.4	0.50	0.33	0.37	0.44	0.49	0.43	0.43	0.34	0.38

Effect on Yield Components and Grain Yield

Effect on Yield Component

Analysis of variance for yield and yield component shows that the effect of population except seeds per pod. Similarly, the effects of variety were only significant for number of seeds per pod and seed weight. While the interaction effect of density x variety were only significant for shelling percentage and number of pods per plant (Table 13).

Table 14 show that harvest index was highest at 29,000 plants/ha and least at 44,000 plants/ha, even though the IT98K-131-2 and IT99K-1245 had similar harvest index which was significantly higher than those of IT97K-461_4 and IT99K-1060.

Table13. *Mean square from the analyses of variance for flower production*

SV	df	HI	SP	SEEDPOD	PODS	SEEDWT	YIELDKg/ha
Density	2	0.01ns	42.68ns	6.00***	47.76ns	0.01ns	170336ns
Error (a)	4	0.01	45.53	0.49	13.29	0.01	119326
Variety	4	0.02ns	97.42ns	6.70***	24.58ns	4.01***	76916ns
Density x variety	8	0.01ns	125.30a	1.23ns	40.06**	0.01ns	27656ns
Error (b)	24	0.01	47.89	0.84	10.97	10.97	43037

*Ns denote effect not significant ** denote effect significant (P<0.05)*

Shelling percentage was not significantly different with all density even though it increased with increasing density. IT99K-125 showed significantly higher shelling percentage than other varieties.

Number of seeds was highest at 29,000 plants/ha although this was not significantly higher than 44,000 plants /ha. Number of seeds per pod decreased with increasing density. IT97K-568-18 has significantly higher number of seeds per pod than the other varieties. Number of seeds per pod was significantly lowest in IT97K-461, although the value was not significantly lower than in IT99K-1245.

Pod per plant decrease with increased population with significant difference between 88,000 pants /ha and 29,000 plants/ha. Number of seeds per plant at 44,000 plants/ha was neither significantly lower than in 29,000 plants/ha higher than 88,000 plants/ha. IT97K-461 and IT99K-1060 was not significantly different but significantly higher than other varieties.

Seed weight shows no significant difference but a close look show that 29,000 plants/ha has the highest seed weight. IT97K-461-4 ha the highest seed weight and value was significantly higher than in other varieties which showed similar seed weight.

Grain yield slightly increased with increasing density even though the differences were significant. IT97K-568-18, IT98K-131-2, IT99K-1245 and IT99K-1060 had significantly higher grain yield which was however not significantly lower in IT99K-1060.

DISCUSSION

Growth Parameter Response

Response per Plant Height

Population density of 29,000 plants/ha resulted in taller plant from other plant population densities. This agrees with Kamara *et al.,(*2003) who stated that increase in number of plant per hectare was associated with increase in plant height. This decreased of plant height to increase in population density can be attributed to increase in moisture stress (Sing 2007) and competition for limited available nutrient. This means that the greater the plant density the lower the plant highest.

Response of Leaf Production

The leaf production increased with increased in plant population density especially at 4WAP-7WAP with 88,000 plants/ha having the highest lead production. This observation agree with Xiaolei and Zhifeng (2002) who stated that widely spread plants at low density, never completely cover the ground with their leaves and radiation interception is less efficient that at high population. The reason is that the increased competition at high density result in excessive leaf growth at the expense of the roots

Response of Dry Matter

The response on dry matter production in this study agreed with the observation of Purcell *et al*, 2002) that dense sowing increased dry matter weight. The result from this research work showed that 88,000 plants/aha gives the highest dry matter weight which in turn gives the highest yield as compared to other densities.

Response of Flower Production

Flower production was positively affected by population density with 88.000 plants/ha gave the highest flower production. This showed that dense sowing gave more flower production. This statement disagree with (Xiaolei and Zhifeng, 2002) who stated that higher plant density decreased flower formation and increased abortion of reproductive structure due to plant competition for space, light and other growth factors.

Response of Yield and Yield Components

Response of Pod Production

Results of this study with a significant decrease in pod formation with increased population density disagree with Purcell *et al*. (2002) who stated that with decreasing plant population density, there were increase in the number of pods per stem and number of seed per M^2 . This is because the resources needed for the pod formation are less competed for at low densities

Response of Seed per Pod

In this study, number of seeds per pod increased with decreasing population density. This is in agreement with Chiezey (1990) who reported that higher density plant lead to decreased yield of individual plants. This is attributed to lesser competition for light, moisture and nutrient.

Response to Grain Yield

The result of rain yield response to the effect of population densities showed that as population level increases, grain yield increases. This agrees with the results of Ismail and Hall (2000) who stated that higher density planting resulted in increased yield per unit area. Also it agree with Kamara *et al*., 2014who reported that yield increased with increasing number of plant per stand although individual plants yield was reduced because the lower half of the stem produced fewer pod. The best spatial distribution and density and plant population are those which maximize yield hence a population of 88,000 plants/ha is the best.

CONCLUSION AND RECOMMENDATION

From the experiment, it could be observed that population of 88,000 plants/ha gives the highest yield and this can be recommended for farmers' usage. Any farmer that is interested in any of cowpea varieties in Southern Guinea Savannah should go for IT97K-568-18 because it gives highest seed per pod and yield.

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