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Effect of inter-row spacing on some selected Cowpea (*Vigna unguiculata* (L) Walp) varieties in Yola, Adamawa State, Nigeria

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Abstract: *Nigeria is a leading producer of cowpea. However, average yield as obtained by local farmers is far below the yield capacity of the crop. Some of the reasons for this low yield could be attributed to cultivation of low yielding varieties and lack of optimum spacing of specific varieties. Field experiments were conducted during the 2009 and 2010 cropping seasons at the Teaching and Research Farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola ($9^0$10'N, $11^0$14'E and 158,5 above sea level), to evaluate the effects of inter-row spacing on some selected cowpea varieties. The experiment consisted of three row spacing (45 x 25cm, 60 x 25cm and 75 x 25cm) three varieties (IT89KD-288, IT89KD-391 and IT97K-499-35), and were replicated three times with plot size of 4m x 3m. Data collected include number of pods per plant, pod length and pod weight, number seeds per pod, number of seeds per plant, 1000 seed weight, seed yield per plot. The result showed that increasing spacing from 45cm x 35cm to 75cm x 25cm significantly increased number of pods per plant from 12.77 to 15.74 in both 2009 and 2010 rainy seasons. Similarly, number of seeds per pod increased from 10.91 to 12.74. On the other hand, seed yield per plot was higher in spacing of 45cm x 25cm with 1227.9 kg/ha. With respect to the varieties, IT89KD -391 had higher seed yield of 1240.54 kg/ha. Yield increased with decrease in row spacing and hence it is suggested that closer spacing of 45cm x 25cm should be adopted for the erect varieties IT89KD-391 and IT97K-499-35 in the studied area.*

Keywords: *Cowpea, savannah, Yield*

I. Introduction

Cowpea is an important food crop in the dry savannas of West and Central Africa {1}. It is the major source of dietary protein in many parts of the world, particularly in the countries situated along the tropical and subtropical belt, where availability and consumption of animal protein is rather low because of social and economic constraints {2}. It originated in Africa and cowpea dry grains are consumed in several forms (e.g. boiled cowpea, *kosai, moin moin,* etc. Other uses include, seedlings, tender green leaves, immature pods, unripe green seeds are cooked as vegetables whereas immature dry seeds are used in many preparations as pulse. It is also utilised as a fodder plants for hay, silage or pasture and as a quick growing cover crop under wide range of conditions {3}. Increased cowpeas yield from intensified cropping system can play a key role in income generation in West Africa because of the multiple uses of cowpea grain and fodder for human and animal diets respectively {3}.

In Nigeria cowpea is cultivated over a wide range of agro-environments ranging from the forest in the south to the Sahel savannah in the North, although the bulk of the production is in the northern drier part of the country {4}. Adamawa state is one of the major cowpea producing State in Nigeria {5} as evidence by the availability of the produce in most market and also the consumption rate by most household.

Although Nigeria is a leading producer of cowpea in the world, grain yield per hectares is generally low. Some of the reasons for this low yield could be attributed to cultivation of low yielding varieties, lack of optimum spacing of specific varieties, inadequate fertiliser, high incidence of insect pest, disease, weed problems and vagaries of whether condition{6}{7}. In sub-Sahara Africa, {8}reported low cowpea plant population per unit area as a major factor responsible for the low yields obtained from the small holder farming system. They recommended cowpea spacing within such systems to be highly variable (35-90cm). According to {9} cowpea varieties with different plant morphology would require different optimum densities to express their full seed yield potential. {10} also reported that typical pure plant spacing of cowpea (*Vigna unguiculata* (L) Walp) is 30cm between plant and 60cm between rows or 5-12cm between plant and 70-90cm between rows. Cowpea agronomy research {11} had shown that yields increased with increase in plant populations per unit area up to certain limit. At optimal densities, most favourable result was obtained. At narrow spacing between the plants rows, yield was reduced because of the inter plant competition. Other problems of cowpea cultivation are that the local cultivars are photosensitive, indeterminate in growth and posses a prolonged period of pod

development. This makes them less suitable for commercial farming when determinate cultivar which utilises monocroping system is desired [12].

To improve the production and yield of cowpea in Nigeria, a continuous study must be undertaken on the factors affecting the production and yield of cowpea. It is against this background, that a study was conducted on varieties and inter-row spacing with the objectives of evaluating the effect of inter-row spacing of some selected cowpea varieties in Yola, Adamawa State.

II. Materials And Method

The experiment was conducted during the raining seasons of 2009 and 2010 at the Teaching and Research Farm of the Department of Crop Production and Horticulture, Modibbo Adamawa University of Technology, Yola ($9^0$10'N, $11^0$14'E and 158.5 above sea level). Three cowpea varieties were obtained from Biu Zonal Office, Borno State Agricultural Development Programme. The three varieties used were improved and characterized as follows:

i. **Variety – IT89KD-288:** The plant is semi-erect and medium size seed, medium maturity and photosensitive. It is excellent for intercropping with cereals and requires 2-3 sprays with insecticide.
ii. **Variety –IT89KD-391:** It is improved, early maturing, non-photosensitive, erect, and medium sized brown seeds. It has some level of resistance to aphids, thrips, viruses and several diseases. It requires 2-3 sprays with insecticide for good grain yield.
iii. **Variety –IT97K-499-35:** The plant is erect, medium-maturing and photo-sensitive. Medium sized seeds and required at least 2-3 sprays with insecticide.

The experimental design was split plot design and consisted of three inter-row spacing, 45 x 25cm, 60 x 25cm and 75 x 25cm as the main plot treatments and three varieties (IT-89KD-288, IT89KD-391 and IT97K-499-35) as sub-plot treatment and was replicated three times with plot size 4m x 3m. The soil physiochemical properties were analyzed and rainfall data collected. Fertilizer was applied according to agronomic recommendations and the experimental plots were kept weed free by manual weeding.

Data were collected on establishment count, number of leaves and branches, plant height, number of pods per plant, length of pod per plant, number of seeds per pod/plant, and 1000 seed weight. The data collected were subjected to analysis of variance (ANOVA), using the 'F' test as described by Gomez and Gomez (1984). Differences between the means were partitioned using Duncan's Multiple Range Test [13].

Table 1:Some physicochemical properties and monthly rainfall of the experimental site during the 2009 and 2010 cropping season

Soil properties	2009	2010
Soil pH (H_2O)	6.5	6.4
Organic carbon (g kg^{-1})	1.4	1.1
Total N (g kg^{-1})	0.04	0.04
Available P (mg Kg^{-1})	0.09	0.09
C.E.C (cmol kg^{-1}) 0.22		0.21
Exchangeable K (cmol kg^{-1})	0.3	0.54
Exchangeable Na (coml kg^{-1})	0.09	0.08
Exchangeable Ca (coml kg^{-1})	2.54	2.65
Exchangeable Mg (coml. kg^{-1})	1.25	1.45
Textural class	Sandy loam	Sandy loam
Monthly rainfall (mm)		
March	0.00	1.6
April	69.8	4.0
May	18.95	48.5
June	31.8	157.9
July	80.4	88.0
August	161.7	151.0
September	176.6	116.0
October	38.2	77.1
Total	577.45	644.10
Mean	82.49	86.51

III. Results

3.1 Number of Pods per Plant

Table 2 shows the mean values of number of pods per plant in 2009 and 2010 rainy season. In 2009, the highest number of pods per plants in spacing 75 x 25cm was 17.04 followed by 60 x 25cm with 16.11 while 45 x 25cm was the least 12.81 pods per plant. In 2010 season, higher mean values were recorded in 75 x 25cm which was 14.43 and the lowest in 60 x 25cm with 11.27. Similarly, the mean varieties of 15.74, 14.18 and 12.77 pods per plant were recorded for spacing 75 x 25cm, 60 x 25cm while 45 x 25cm respectively. The mean variation in respect of inter-row spacing was not significant ($p \leq 0.05$).

In 2009 rainy season, variety IT89KD-391 recorded the highest mean value with 18.73 numbers of pods per plant followed by IT97K-499-35 and IT89KD-288 with 14.11 and 13.12 pods per plant, receptively. In 2010 rainy season, IT89KD-391 had the highest number of pods with 15.20 while IT89KD-288 the lowest having 11.29. In the combined analysis of both years, IT89KD-391 had 16.97 pods gave the highest means while the lowest of 12.21 pods was recorded in IY89KD-288. The mean difference among the varieties was significance ($p \leq 0.05$).

3.2 Length of pods per plant

Table 2 shows the effects of inter-row spacing and variety on length of pods per plant in 2009 and 2010 rainy season. In 2009 season, the mean values of the length of pods per plant was significantly ($P \leq 0.01$) higher in spacing 75 x 25cm with 15.83cm than in spacing 45 x 25cm which was the lowest with value of 13.61cm. In 2010 season, 60 x 25cm had the highest mean value of 16.24 followed by 75 x 25cm and the 45 x 25cm with 16.20, 15.63 and 13.88centimers respectively. In combined mean of the years, pod length in 75 x 25cm was the longest recording 15.73cm followed by 60 x 25cm with 15.46 while 45 x 25cm was the least (13.61cm). The mean variation was significant ($P \leq 0.05$). There was significant difference ($P \leq 0.05$) in 2009 with respect to the variety; IT97K-499-35 recorded the highest mean value of 15.48cm followed by IT89KD-391 (15.10cm) while IT89KD-288 was the least with the mean values of 13.26cm.

Table 2: Mean effects of spacing and variety on number of pod per plant and length of pod per plant in 2009 and 2010 rainy season

	Number of pods per plant			Length of pods per plant (cm)		
Treatment	2009	2010	Combined	2009	2010	Combined
Spacing						
S_1	12.81b	12.72	12.77b	13.33c	13.88	13.61b
S_2	16.11ab	11.26	14.18ab	14.68b	16.24	15.44a
S_3	17.04a	14.43	15.74a	15.82a	15.63	15.73a
Variety						
V_1	13.12b	11.29b	12.21b	13.26b	13.96	13.63b
V_2	18.73a	15.20a	16.97a	15.10a	17.06	16.08a
V_3	14.11b	12.92ab	13.52b	15.48a	14.70	15.09ab
Interaction						
S x V	NS	NS	NS	**	NS	NS

Means in a column followed by the same letter(s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT)

Key:

S_1 = 45 x 25cm V_1 = IT89KD-288
S_2 = 60 x 25cm V_2 = IT89KD-391
S_3 = 75 x 25cm V_3 = IT97K-499-35
NS = Not Significant ** = significant at 1%

Similarly in 2010 season, IT89KD-391 had 17.06cm which had the longest pods while IT89KD-288 the shortest pod length of 13.96cm. In the combined years, IT89KD-391 mean value was the highest with 16.08cm while IT89KD-288 was the least in terms of pod length with the mean value of 13.63cm.

3.3 Number of seeds per pod

The mean effects of inter-row spacing and variety on number of seeds per pod for 2009 and 2010 rainy seasons and the combined years are presented in table 2. In 2009 season, spacing 75 x 25cm had the highest number of seeds per pod recording 12.69 while 45 x 25cm was the least having 10.58 number of seeds per pods. Similarly, in 2010 rainy season, spacing 75 x 25cm had the highest number of seeds per pod with the mean

value of 12.80 followed by 60 x 25cm with 12.61 and 45 x 25cm being the least with the mean value of 11.24. In the combined years, 75 x 25cm was also the highest with 12.74 numbers of seeds per pod while 45 x 25cm had 10.91 seeds per pod. The difference in inter-
row spacing was significant ($p \leq 0.05$) in 2009. In 2010 season and the combined years, no significant difference was observed.

With respect to the varieties, in 2009 season, IT97KD-499-35 had the highest mean value of number of seeds per pod with 13.38 while IT89KD-288 had the least with the mean value of 10.38. And in 2010 weight of seed per pod of 10.55g, 9.29g and 8.39g respectively. The combined seasons similarly had 75 x 25cm as the highest with 9.60g while 45 x 25cm recorded the least mean value of 8.33g. The mean variation was significant ($p \leq 0.05$) for the year 2009 and the combined analysis for the two seasons. In 2010 growing season, the mean variation was not significant ($p \leq 0.05$).

Table 3: Mean effects of inter-row spacing and variety on number of seeds per pod in 2009 and 2010 rainy season

	Number of seeds per pod		
Treatment	2009	2010	Combined
Spacing			
45 x 25cm	10.58b	11.24b	10.91b
60 x 25cm	11.82ab	12.61a	12.02a
75 x 25cm	12.69a	12.80a	12.74a
Variety			
IT89KD-288	10.38b	11.59b	10.79c
IT89KD-391	11.33b	12.53b	11.93b
IT97K-499-35	13.38a	12.53a	12.96a
Interaction			
S x V	*	NS	**

Means in a column followed by the same letter(s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT)
NS = Not Significant * = significant at 5% ** = significant at 1%

Growing season, IT89KD-391 and IT97K-499-35 had the same mean value of 12.53 followed by IT89KD-288 with the mean value of 11.53. Similarly, in the combined mean of the two years, IT97K-499-35 had the highest number of seeds per pod with 12.96 while IT89KD-288 had the least with 10.79. The mean variation with respect to the varieties in 2009 and combined years was significant ($p \leq 0.05$) and not significant ($p \leq 0.05$) for 2010.

Table 5: Mean effects of spacing and variety on weight of seeds per pod, weight of pod per plant and seed weight of 1000 seeds in 2009 and 2010 rainy season

	Weight of seeds per pod (g)			**Weight of pods per plant (g)**			**1000 seed weight (g)**		
Treatment	2009	2010	Combined	2009	2010	Combined	2009	2010	Combined
pacing									
S_1	8.28	8.39c	8.33b	15.07b	28.17ab	21.62b	137.49b	157.76	147.62b
S_2	7.58	9.29b	8.47b	18.63ab	27.28b	23.68b	145.02a	142.58	151.74ab
S_3	8.66	10.55a	9.60a	23.97a	32.61a	28.29a	149.22a	165.01	157.12a
SE±	0.27	0.65	0.77	4.33	4.22	3.90	5.51	25.10	8.65
Variety									
V_1	7.46b	9.47	8.50b	14.14b	26.29b	20.95c	144.93	153.81	149.37a
V_2	8.18ab	9.19	8.69ab	23.94a	32.67a	28.31a	141.96	153.97	147.96b
V_3	8.87a	9.56	9.21a	19.58ab	29.09ab	24.33b	144.84	157.57	151.21ab
SE±	0.27	0.65	0.77	4.33	4.22	3.90	5.51	25.10	8.65
Interaction									
S x V	NS	NS	NS	NS	NS	NS	**	NS	NS

Means in a column followed by the same letter(s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT)
Key:
S_1 = 45 x 25cm V_1 = IT89KD-288
S_2 = 60 x 25cm V_2 = IT89KD-391
S_3 = 75 x 25cm V_3 = IT97K-499-35
NS = Not Significant ** = significant at 1%

3.4 1000 seed weight

The mean weight of 1000 seeds for 2009 and 2010 rainy seasons is presented in table 3. In 2009 season, the mean weight of 1000 seeds is highest in 75 x 25cm followed by 60 x 25cm while 45 x 25cm is the lowest with the value of 149.22g, 145.02g and 137.49g respectively. In 2010 rainy season, similar result was obtained with 75 x 25cm having the highest mean weight of 165.01g while 60 x 25cm the lowest with 142.58g. In the combined seasons, 75 x 25cm similarly, had the highest 1000-seed weight followed by 60 x 25cm while 45 x 25cm had the lowest with the value of 157.62g 151.74g and 147.62g. The means for 2009 rainy season was highly significant ($p \leq 0.01$) and not significant in 2010 rainy season.

With respect to the varieties, in 2009 season, IT89KD-288 had the highest weight of mean value of 144.93g while IT89KD-391 had the lowest value of 141.96g. In 2010 rainy season, IT97K-499-35 had the highest mean value followed by IT89KD-391 and IT89KD-288 the lowest with the values of 157.57g, 153.97g and 153.81g respectively. In the combined years, IT97K-499-35 gave the highest mean value of 151.21g and IT89KD-391 the least with 147.96g. The mean variation for 2009 and 2010 seasons was not significant ($p \leq 0.05$) in respective of the varieties but the combined seasons was significant ($p \leq 0.05$).

IV. Discussion

Yield in cowpea have been reported to consist of three primary components viz: number of pods per plant, number of seeds per pod and 100 seeds weight [14]. Other components include length of pods per plant, weight of pods per plant and weight of seeds per pod. The response of the three varieties of cowpea to spacing indicated that the number of pods per plant were not significantly ($p \leq 0.05$) affected by spacing in 2010 but were significant ($p \leq 0.05$) in 2009 and the combined seasons. In the combined seasons, increasing spacing from 45 x 25cm to 75 x 25cm significantly increased the number of pods per plant from 12.77 to 15.74. Similarly, length of pods per plant significantly increased from 10.91 to 12.74. Similarly, [15] reported that increasing population density decreased number of pods per plant and the seed yield per plant. They further stated that plant population had a significant effect on most yield components. With respect to the varieties, IT89KD-391 had significantly higher number of pods per plant, length of pods per plant and number of seed per pod followed by IT97K-499-35 while IT89KD-288 recorded the lowest numbers. [15] also reported that difference in growth attributes observed among cultivars may be due to the growth habit and the genetic potential of each genotype.

Weight of seeds per pod, weight of pods per plant and 1000 seed weight all increased significantly with increase in spacing or decrease population density. Plant spaced 75 x 25cm (165.01g) gave the highest 1000 seed weight in 2010 on individual plant while 45 x 25cm had the least with 137.49g in 2009. Furthermore, [15] reported that decreased plant population had a significant increase on most yield components and increased 100-seed weight. This may be due to better availability of nutrients and better translocation of photosynthates from source to sink and may be due to higher accumulation of photosynthates in the seeds. With respect to varieties, IT97K-499-35 was found to have higher weight of seed per pod and 1000 seed weight while IT89KD-391 higher weight of pod per plant. This is because IT89KD-391 produced more number of pods per plant. IT89KD-288 was found to have lower values for weight of seeds per pod, weight of pod per plant and 1000 seed weight. The variation among varieties might be due to genotype. However, the overall seed yield per hectare was found to be higher in spacing 45 x 25cm with 1227.9kg/ha followed by 60 x 25cm had 1194.8kg/ha while 75 x 25cm had the least with 1055.6Kg/ha. This observation is in line with the findings of [16] that high planting densities reduce yield of individual plants though the production per unit area might increase. The findings of [17] also stated that, semi-erect and erect cowpeas respectively responded positively to plant population of 100,000 plants/ha which correspond to a row spacing of 50 x 25cm or 75 x 20cm for semi erect indeterminate, high branching type. [11] had shown that yields are increased with increase in plant population per hectare up to certain limit.

V. Conclusion

From the results of the studies, decreasing plant population or increasing spacing from 45 x 25cm to 75 x 25cm significantly increase the number of pods per plant from 12.77 to 15.74. Similarly, length of pods per plant significantly increased from 13.61cm to 15.73cm and number of seeds per pod increased from 10.91 to 12.74. However, on the overall, seed yield per plot and seed yield per hectare was found to be higher in spacing 45 x 25cm with 1227.9Kg/ha followed by 60 x 25cm have 1194.8Kg/ha while 75 x 25cm was the least with 1055.6Kg/ha. With respect to the varieties, overall yield results revealed that IT89KD-391 had higher seed yield of 1240.54Kg/ha. Yield increased with decrease inter row spacing and hence it is suggested that closer spacing of 45cm x 25cm should be adopted for the erect varieties, IT89KD-391 and IT97K-499-35 in the studied area.

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