



EFFECT OF INTRA ROW SPACING AND VARIETY ON THE GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus* L. Moench) IN BAUCHI, BAUCHI STATE, NIGERIA

¹Abdullahi, S. B., ¹Fagam, A. S., ¹Sabo, U. M., ¹Mohammed, A. and ²Jibrin. M. S.

¹Department of Crop Production, Faculty of Agriculture and Agricultural Technology,
Abubakar Tafawa Balewa University, PMB 0248, Bauchi, Nigeria

²Department of Plant Science, Institute for Agricultural Research,
Ahmadu Bello University Zaria, Nigeria

Corresponding Authors' E-mail: salisuabkurawa10@gmail.com **Tel.:** 08034320624

ABSTRACT

The field experiment was conducted to evaluate the effect of intra row spacing and variety on the growth and yield of okra at the research farm of Abubakar Tafawa Balewa University, Bauchi, Gubi Campus, Bauchi State, Nigeria during the 2016 and 2017 rainy seasons. The treatments consisted of 3 spacing (20, 30 and 40cm) and 3 varieties (Kirikou, Yar-kodom and Clemson spineless) which were factorially combined and laid-down in a randomized complete block design (RCBD) and replicated three times. The result of the experiment revealed significant difference ($P \leq 0.05$) in plant height, number of leaves, and number of pods per plant, pod length, pod girth, and yield per hectare. The use of wider intra row spacing significantly affected most of the parameters measured in the 2016 and 2017 except plant height that showed no significant difference in 2017. Among the varieties, assessed Clemson spineless consistently produced higher result on all measured characters and invariable higher yield. The interaction between intra row spacing and variety showed that the use of wider row spacing in combination with the varieties improved the plant height, stem girth and number of pods significantly. From the result obtained, it can be concluded that the use of wider spacing and improved varieties such as Clemson spineless can be adopted for okra production in Bauchi and its environs. The study recommended that farmers should adopt the use of wider intra-row spacing (30 cm and 40 cm) and Clemson spineless variety in the study area.

Keywords: Growth, Intra row-spacing, Okra, Variety, Yield.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench). Is also known as kubewa, okwuro and ila in Hausa, Igbo and Yoruba languages of Nigeria, respectively. It originated from Ethiopia in Africa, but now widely grown all over the world (Khalid *et al.*, 2005). It is a member of the *malvaceae* family which has about 2,300 species of which cotton (*Gossypium spp.*) and cocoa (*Theobroma cacao*) are inclusive.

It is a nutritious vegetable, which plays an important role in meeting the demand of vegetables in the country when vegetables are scanty (Ahmed, 1995). The green pods are rich sources of vitamins and minerals. The nutritional value of 100 g of edible portion of okra contains 1.9 g of protein, 0.2 g fat, 6.4 g carbohydrate, 0.7 g minerals and 1.2 g fibre (Tiwari *et al.*, 1998). In Nigeria, okra is made into soup with the addition of palm oil, fish and other condiments. It could be boiled as vegetable and served with rice and other foods. Fresh okra fruits may be consumed in the immature stage or they could be sliced, dried and stored for use during the off season. Okra seeds are a source of oil, protein and are also used as a coffee substitute, while ground-up okra seeds have been used as a substitute for aluminium salts in



water purification (Camciuc *et al.*, 1998). Total world production of okra was estimated at 4.99 million metric tons, cultivated from an area of 0.78 million hectares with an average yield of 6.39 t ha⁻¹ (Konyeha and Alatisie, 2013). West and Central Africa region accounts for more than 75% of okra produced in Africa, however the average productivity is very low at 2.5 t ha⁻¹ (Kumar *et al.*, 2010). Production of okra is all year round but more abundant during the rainy season.

Despite the benefits and use of okra its production is constrained by array of biotic and abiotic factors. One major aspect of crop production and management which hamper or limits productivity and yield increase is the poor adoption of improved cultural practices. Cultural practices such as the use of improved varieties, application of appropriate seeding rates and spacing, weed control, fertilizer application among others. Most farmers uses local unimproved varieties that are low yielding and susceptible to pest and diseases.

Different cultivars of okra require different plant spacing. A good cultivar which is sown at an improper spacing will give very poor yield. Proper plant spacing and suitable cultivar is critical to increased productivity of okra. Identifying a suitable cultivar and optimum plant spacing would in no small measure boost the production and income of okra growers. In view of that this research was carried out to determine the effect of variety and intra-row spacing on the growth and yield characters of okra in Bauchi.

MATERIALS AND METHODS

The Study Area

The Field experiment was carried out at the research farm of faculty of agriculture and agricultural technology, Abubakar Tafawa Balewa University, Bauchi, during the 2016 and 2017 rainy seasons. Bauchi is located in 11° 17' North and longitude 9° 47' East 903 m above sea level, in the northern Guinea savanna agro-ecological zone of Nigeria. *The treatments consisted of three okra varieties (Clemson, Yar-kodom and Kirikou) and three intra-row spacings (20, 30 and 40 cm). The treatments were laid out in a Randomized Complete Block Design (RCBD) arranged in 9 treatments combinations and replicated three times.* The plot size was 4m². Each plot had 5 ridges, with intra-row spacing of 20 cm with a total of 9 stands per ridge; 30 cm had 6 stands per ridge and intra row of 40 cm only 5 stands per ridge. The inter row spacing of 70 cm was used. The seeds were treated with seed dressing chemical (Apron star 20% w/w thimethoxan, 20% w/w metalaxyl-m and 2% w/w difenoconazole) at the rate of 10 g per 5 kg of seed against fungal and insect infection. Three seeds were sown per hole and later thinned to one plants per stand at two weeks after sowing (WAS). The P and K were split applied and all other agronomic practices were carried out appropriately as at when due. Five plants were randomly sampled from each plot and tagged for data collection on growth and yield at two weeks intervals. The following parameters were measured; Plant height (cm), Number of leaves per plant, Number of pods per plant, pod length (cm), pod girth (cm) and yield (kg ha⁻¹). The data collected was subjected to statistical analysis of variance to test the significance of treatments effect using the F-test (Snedecor and Cochran, 1967). The means were separated using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of Intra-Row Spacing and Variety on Plant Height (Cm) of Okra

The effect of intra-row spacing and variety on the plant height of okra during 2016 and 2017 rainy seasons in Bauchi showed significant difference as presented in Table 1. During 2016 rainy season, the intra row spacing significantly affected the plant height at 5 WAS and



7 WAS. The intra-spacing of 40 cm recorded the tallest plant height at 5 WAS. It was followed by 30 cm and 20 cm, which are similar. At 7 WAS, 40 cm spacing produced the tallest plant height (69.57) which was statistically at par with 30 cm spacing. The shortest plant height (58.34) was, however, recorded by 20 cm. In 2017 the plant height was not significantly affected by intra-row spacing. However, 20 cm spacing tended to produce taller plants at the different growth stages.

Table 1: Effect of Intra-Row Spacing and Variety on Plant Height (Cm) of Okra during 2016 and 2017 Rainy Seasons in Bauchi

Treatment	2016				2017			
	3WAS	5 WAS	7 WAS	9 WAS	3WAS	5WAS	7 WAS	9WAS
Intra-row spacing (cm)								
20	32.68	55.90b	58.34b	64.86	30.29	65.84	53.57	61.18
30	30.29	56.57b	66.32ab	69.05	28.79	66.05	53.47	60.71
40	30.34	65.89a	69.57a	71.41	24.39	62.68	53.89	60.96
LS	NS	*	*	NS	NS	NS	NS	NS
SE(±)	2.33	3.81	4.05	4.02	3.01	4.83	4.05	3.72
Variety								
Kirikou	26.59b	55.17	58.29b	61.80	26.21	60.79b	53.17ab	59.35b
Yar-kodom	33.69a	54.86	60.59b	63.02	30.64	61.43b	50.64b	57.13b
Clemson spineless	33.02a	59.45	67.63a	69.49	26.63	72.35a	57.12a	66.38a
LS	*	NS	*	NS	NS	*	*	*
SE(±)	2.60	4.50	4.79	4.23	3.47	3.65	4.54	3.80
CV	18.82	12.78	10.96	11.49	22.57	9.01	9.62	6.69
Interaction								
Spacing * Variety	NS	**	NS	NS	NS	NS	**	NS

SE = Standard error, LS = Least significant difference, WAS = Weeks after sowing, NS = Not significant, ** and *Significant at 1 % and 5 %, CV = Coefficient of variation. Means with the same alphabet are not significantly different from each other within column.

The effect of variety on plant height was significant in both 2016 and 2017 raining seasons. Clemson spineless produced tallest plant in both years of the experiment (Table 1). The interaction between variety and intra-row spacing was significant only at 5 weeks after planting. Plant height is an important growth character that has direct bearing with the production potential in terms of fodder, grain and fruit yield (Omotosho and shittu, 2007). The taller plants obtained at wider spacing of 40 cm over the years could be attributed to less competition for growth factors such as light, nutrient and water, which gave the okra plant access to these factors. The result obtained in this study is in agreement with the findings of



Madisa *et al.* (2014) who reported that taller plant were obtained at wider spacing, which was the result of less competition for resources such as nutrients. Similarly, Ekwu and Nwoku, (2012) reported that plant height increased as the plant spacing increased from 50cm x 25cm to 50cm x 50cm beyond which there was a decrease in plant height. The tallest plants were obtained at 50cm x 50cm while the shortest were at 50cm x 25cm (Ekwu and Nwoku, 2012).

Effect of Intra-Row Spacing and Variety on Number of Leaves of Okra

Table 2 shows the effect of Intra-row spacing and variety on number of leaves of okra, during 2016 and 2017 rainy seasons. In 2016, at 5 and 7WAS, the spacing of 20 and 30cm significantly affected the number of leaves of okra in both year of the experiment at 5 WAS, 30cm spacing produced the highest number of leaves. It was followed by 40cm spacing. At 7 WAS 30 and 40 cm spacing produced statistically similar number of leaves. At 9 WAS no significant difference ($P \leq 0.05$) was observed among the spacing.

The spacing of 30 cm had the highest number of leaves (22.00) that was statistically at par with intra-row spacing of 40 cm in 2017 season. At 7 WAS the number of leaves ranged from 10.00 to 17.00, where, 30 cm and 40 cm spacing significantly ($P < 0.05$) produced more number of leaves as compared to 20 cm spacing.

In 2016, at 3 WAS, the highest number of 9 leaves was recorded by Yar-kodom variety. The lowest number of 7 leaves was recorded by Kirikou and Clemson spineless. Similar trend was observed at 5 and 7 WAS respectively where Yar-kodo consistently had the highest number of leaves. However, at 9 WAS, no significant difference was observed among the varieties on number of leaves. At 3 WAS, Yar-kodom recorded the highest number of leaves (10.00) while the lowest number of leaves (8.00) was recorded by Clemson spineless that was statistically at par with Kirikou variety in 2017. At 5 and 7 WAS similar trend was observed at 3 WAS where Yar-kodom recorded the highest number of leaves and Clemson spineless and Kirikou statistically recorded the lowest number of leaves.

The variety Clemson spineless had the tallest plant height across most of the growth stages. This may be attributed to the genetic differences in the genotypes and Clemson spineless been and improved variety. The result here agreed with the findings of Aliyu and Ajala (2016).

Findings in this study also revealed that the number of leaves was significantly influenced by the treatments. Higher number of leaves recorded by 30 cm and 40 cm spacing could be attributed to availability of sunlight and soil nutrient for better performance of the plant. The availability of these factors aid photosynthesis which translates into bigger plants in terms of number of leaves, branches and others. This is in agreement with the work of (Mehla *et al.*, 2000) who reported that increase in number of leaves and other growth parameters was attributed to less competition. It is observed that the leaves number decreased with time, probably due to senescence. The result here is in agreement with the findings of Madisa *et al.* (2014) and Maurya *et al.* (2013). Across 2016 and 2017 planting season the variety Yar-kodom gave more number of leaves. This can be attributed to varietal differences.



Table 2: Effect of Intra-Row Spacing and Variety on Number of Leaves of Okra during 2016 and 2017 Rainy Seasons in Bauchi

Treatment	2016				2017			
	3WAS	5 WAS	7 WAS	9 WAS	3WAS	5 WAS	7WAS	9WAS
Intra-row spacing (cm)								
20	8.00	19.00b	12.00b	18.00	9.00	17.00b	10.00b	14.00
30	8.00	24.00a	18.00a	15.00	9.00	22.00a	17.00a	16.00
40	8.00	19.00b	18.00a	21.00	9.00	19.00ab	17.00a	20.00
LS	NS	*	*	NS	NS	*	*	NS
SE(±)	0.37	1.86	2.65	3.89	0.37	1.52	2.65	3.89
Variety								
Kirikou	7.00b	16.00b	15.00b	18.00	8.00b	15.00b	13.00b	17.00
Yar-kodom	9.00a	28.00a	19.00a	18.00	10.00a	27.00a	17.00a	17.00
Clemson spineless	7.00b	16.00b	14.00b	18.00	8.00b	16.00b	13.00b	16.00
LS	*	*	*	NS	*	*	*	NS
SE(±)	0.22	1.41	1.86	3.84	0.22	1.36	1.86	3.86
CV	11.38	23.02	25.00	49.27	9.48	23.24	25.30	54.10
Interaction								
Spacing*Variety	NS	*	*	*	NS	NS	NS	NS

SE = Standard error, LS = Least significant difference, WAS = Weeks after sowing, NS = Not significant, ** and *Significant at 1 %, and 5 %, Means with the same alphabet are not significantly different from each other within column.

Effect of Intra-Row Spacing and Variety on Pod Number

Table 3 shows the effect of intra-row spacing and variety on pod number in the 2016 and 2017 seasons. The 30 cm row spacing had the highest number of pods (38.00) and the lowest number of pod was recorded by 40 cm which is statistically at par with 20 cm spacing during the period of the experiment. However, in both seasons variety was not significantly affected by intra row spacing. Intra-row spacing had no significant effect on pod length in both years of the study. The effect of variety on pod length showed that Clemson spineless had the longest pod length (9.72 cm), followed by Yar-kodom (8.10 cm) and the shortest pod length (6.32 cm) by Kirikou in 2016. Clemson spineless recorded the longest pod length (8.52 cm), followed by Yar-kodom (6.90 cm) and the shortest pod length (5.12 cm) was recorded by Kirikou in 2017. The intra row spacing and variety interaction was not significant.



Table 3: Effect of Intra-row Spacing and Variety on Yield and Yield Components of Okra during 2016 and 2017 Rainy Seasons in Bauchi

Treatment	Pod number		Pod length		Pod girth		Yield (kg)	
	2016	2017	2016	2017	2016	2017	2016	2017
Intra-row spacing (cm)								
20	29.00b	24.00b	8.48	7.28	2.45b	2.68	4641.00b	4591.25b
30	38.00a	34.00a	7.89	6.69	3.19a	2.48	5993.00ab	5867.00ab
40	29.00b	24.00b	7.77	6.57	3.39a	2.42	8415.75a	8364.75a
LS	**	**	NS	NS	*	NS	**	**
SE(±)	3.92	4.06	0.57	0.57	0.21	0.20	312.76	780.05
Variety								
Kirikou	30.00	26.00	6.32c	5.12c	2.80c	2.23	6064.25ab	6013.25ab
Yar-kodom	34.00	30.00	8.10b	6.90b	3.29b	2.72	4158.75b	4109.00b
Clemson spineless	31.00	27.00	9.72a	8.52a	3.95a	2.64	8826.75a	8775.75a
LS	NS	NS	**	**	*	NS	**	**
SE(±)	4.97	4.77	0.55	0.55	0.14	0.28	337.76	842.05
CV	24.31	29.09	15.51	18.23	14.36	27.42	43.90	44.25
Interaction								
Spacing*Variety	**	**	NS	NS	NS	NS	NS	NS

Means with the same alphabet are not significantly different from each other within column, SE = Standard error, LS = Least significant difference, WAS = Weeks after sowing, NS = Not significant, *Significant at 1 %, **Significant at 5 %.

Effect of intra-row spacing on pod diameter during 2016 rainy season as presented in Table 3 showed that wider row spacing (30 cm and 40 cm) recorded the widest diameter and the shortest diameter was recorded by 20 cm. On the effect of variety on pod diameter showed that Clemson spineless had the widest diameter (3.95 cm), and the shortest diameter (2.80 cm) was recorded by Kirikou. The pod diameter was not affected by both the intra-row spacing and variety during 2017 rainy season.

Pod yield was equally affected by the intra-row spacing during 2016 rainy season as presented in Table 3. The maximum and minimum pod yield was recorded by 40 cm (8415.75 kg) and 20 cm (4641.00 kg), respectively. During 2017 rainy season Pod yield was significantly affected by intra-row spacing also as presented in Table 3. Intra-row spacing of 40 cm gave the highest pod yield (8364.75 kg) that is statistically at par with 30 cm intra-row spacing and the lowest (4591.25 kg) was recorded by 20 cm intra-row spacing.

Clemson spineless variety had the weightiest pod yield (8826.75 kg) that is statistically at par with Kirikou variety. The lowest pod yield (4158.75 kg) was recorded by Yar-kodom variety. The variety Yar-kodom gave the highest pod weight per plot (8775.75 kg) which is at par with Kirikou statistically in 2017. The smallest pod weight (4109.00 kg) was recorded by Clemson spineless.



The spacing of 30 cm consistently recorded the highest number of pod in both years. This can be attributed to availability and utilization of growth factors (water, sunlight and soil nutrients), because of less competition. These results agreed with the findings of Moniruzzaman *et al.* (2007) who reported lower number of mature pods with closer spacing. They maintained that the lower number of pods obtained from the closer spacing might be due to competition for nutrients and space among the plants owing to high plant population. Ijoyah *et al.* (2010) also obtained similar results.

The pod length was not influenced by the intra-row spacing for 2016 and 2017 rainy season. The result here contradicts the findings of Moniruzzaman *et al.* (2007) and Aliyu and Ajala, (2016) who reported significant difference in pod length as influenced by spacing. However, in respect of variety Clemson spineless an improved variety produced longer pods in comparison to Kirikou and Yar-kodom varieties. This can be attributed to the difference in genotype, more Clemson spineless is an improved variety, as indicated in the taller plants and wide leaf area. These results are in agreement with the findings of Jamala *et al.* (2011) in their work with local and improved varieties of okra where they reported that local variety had the shortest pod length.

The results on pod diameter also followed a similar trend as in pod length in 2016. Wider spacing had wider diameter as compared to 20 cm intra-row spacing also. This can also be connected with more number of leaves, larger leaf area and bigger stem girth at wider spacing that all translates into larger pods. Similarly the result on pod diameter shows that Clemson spineless had okra with bigger pod size as compared to Kirikou and Yra-kodom. However, Clemson spineless performed better at wider intra-row spacing. This may be attributed to less competition at wider spacing. This result agrees with the work of Aliyu and Ajala (2016) who reported that; the highest number of pods obtained by Clemson spineless at 40cm intra-row spacing could be because it is an improved variety planted at a wider spacing, causing minimum competition. These results agree with the findings of Ijoyah *et al.* (2010) as the two varieties they worked on have their highest weight at wider spacing. They stated that plants grown at wider intra-row spacing might have received more nutrition and light for optimal growth and development thereby producing the highest pod number.

The pod yield was significantly influenced by the intra-row spacing in 2016 and 2017. Pod yield depends on growth and yield parameters. The result showed an increase in pod weight with increase in intra-row spacing in both years. This can be attributed to less competition for growth factors (water, soil nutrient and solar radiation) that resulted in taller plants, more number of leaves, wider stem girths, high number of pods and ultimately high yield. The result could be as a result of less competition between plants that have been relatively widely spaced. This agrees with the findings of Moniruzzaman *et al.* (2007); Ijoyah *et al.* (2010); and Hossain *et al.* (2001).

The variety Clemson spineless also superseded the other two varieties, a condition that can be attributed to the improved nature of the Clemson spineless variety. This agrees with the work of Aliyu and Ajala (2016), who reported that; the high pod yield obtained from Clemson spineless variety could be due to its improved nature which gave it the ability to produce more branches consequently more fruits by Ojo *et al.* (2012) reported similar findings.

CONCLUSION AND RECOMMENDATIONS

It can be concluded that Clemson spineless out yielded Kirikou and Yar-kodom varieties of okra. Sowing of okra at 30 and 40cm intra row spacing gave highest pod yield of okra under the conditions of Bauchi. Based on the results of the study farmers should adopt the



use of wider intra-row spacing (30 cm and 40 cm) and Clemson spineless variety in the study area.

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