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INFLUENCE OF VARIETY AND SPACING ON THE GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus* L. Moench) IN MUBI, NORTHERN GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT

Yield of Okra (*Abelmoschus esculentus* L. Moench), one of the most important vegetables grown in Nigeria depends on variety and spacing among others. Farmers are yet to adopt new varieties that posses such characteristics. Thus, field experiments were conducted at the FAO/TCP farm, Faculty of Agriculture, Adamawa State University, Mubi (10^0 15' N, 13^0 16'E and 696 above sea level), to study the Influence of variety and spacing on the growth and yield of okra. Treatments consisted of three okra varieties (L*ong pod local, Yarkwadon and Clemson spineless,*) with three inter and intra spacing (60 cm x 30 cm, 60 cm x 45 cm and 60 cm x 60 cm). The experiment was laid out in a split plot design with the varieties assigned to the main plots and spacing assigned to the subplots; these were then replicated three times. Data were collected on: Number of branches per plant, Days to 50% flowering, Number of fruits per plant, Fruit length, Fruit diameter and fresh fruit weight. Data generated were then subjected to analysis of variance. Means showing significant F- test were separated using DMRT. Result showed that Yarkwadon had the highest number of branches, highest number of fruits per plant and fresh fruit weight, likewise spacing at 60 cm x 60 cm. Based on the results, yarkawadon at a spacing of 60 cm x 60 cm should be adopted in Mubi and similar environment since it manifested the highest effect on the major parameters measured.

Keywords: variety, spacing, growth, yield.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is one of the important vegetable crops grown in Nigeria (Eligiator *et al*., 2015). Okra is cultivated mainly for its immature fresh fruits which are used as vegetables in making soup or dried and milled to powder for use as flavouring (Phillip *et al.*, 2010). The stems and leaves of okra are used as animal feed; the seed are dried and ground for making coffee. Okra contains high amount of dietary fiber which includes large spectrum of molecules such as cellulose, non – starch polysaccharides and lignin; this protects the body against certain types of cancer, like colon cancer, regulates transit and lowers blood cholesterol (Phillip *et al.*, 2010). Okra fruit is also useful against genitor-urinary disorders and chronic dysentery. Okra contains carbohydrates, proteins and vitamin C in large quantities and also essential and non-essential amino acids which are comparable to that of Soybean (Adebayo and Oputa, 1996). One of the major limitations of okra production is improper crop spacing (Mogapi *et al.*, 2014). Spacing okra optimally reduced plant competition for light, moisture and nutrient; wider or narrow spacing may lead to reduction in yield (Youdeowe *et al.*, 1999). For example closer spacing will produce taller plants with less number of branches. Some varieties of okra are taller in height, while others are dwarf, because of this there is variation in their performance (Dikwahal *et al.*, 2006). Farmers cultivate okra without efficient knowledge on the appropriate spacing for optimum yield. Furthermore, local varieties whose characteristics are long duration, seasonal and low in yield are still on use. New varieties that withstand stress, give high yield among other advantages are now available and need to be adopted.

This study therefore, was design to evaluate the best performing and high yielding variety and optimum spacing for okra in Mubi with the view of improving farmers yield and income.

MATERIALS AND METHODS

Field experiments was conducted in 2014 and 2015 rainfed cropping seasons at the FAO/TCP farm, Faculty of Agriculture, Adamawa State University, Mubi (10^0 15' N, 13^0 16'E and 696 above sea level), to study the Influence of variety and spacing on the growth and yield of okra. Treatments consisted of three okra varieties (Long pod local, Yarkwadon and Clemson spineless) with three inter and intra row spacing (60 cm x 30 cm, 60 cm x 45 cm and 60 cm x 60 cm). The experiment was laid out in a split plot design with the varieties assigned to the main plots and the spacing assigned to the subplots and was replicated three times. Gross plot and net plot sizes were 10.8 m^2 and 4.86 m^2, respectively. Alleyways of 1 m between replications and 0.5 m between plots were created. Weeds were controlled manually using hand hoes at 2, 4 and 8 weeks after sowing (WAS). At land preparation 200 kg ha^{-1} NPK 15 – 15 – 15 fertilizer was applied, this was supplemented by 10 kg N ha^{-1} at 6 WAS. Pest was controlled using Lambda (*Cyhalothrin* 15g/L) weekly at flowering using 20 L knapsack sprayer. Data were collected on: Number of branches per plant at harvest by counting the number of branches of 5 tagged plants, their average computed and recorded. Days to 50% flowering; constant observation of plots was done from the first flower opening until 50 % flowers were observed days taken and recorded. Number of fruits per plant: number of fruits of the 5 tagged plants was counted their mean determined and recorded. Fruit length; length of 10 fruits from each plot was measured, mean determined and recorded. Fruit diameter; diameter of ten fruits were measured using digital veneer caliper graduated in millimeter mean taken and recorded. Weight of fresh pod; weight of ten fresh fruits from each plot was determined, average taken and recorded. Data generated were subjected to analysis of variance using SAS system for windows (SAS v8, 2000). Means showing significant F- test were separated using DMRT.

RESULTS

The effects of variety and spacing on number of branches per plant of okra in 2014 and 2015 rainfed cropping seasons and combined is presented in Table 1. Highly significant ($P \leq 0.01$) variation exist among varieties on number of branches per plant, yarkwadon had the highest branches in the seasons and combined, average number of branches recorded in the combined seasons was 7.56 branches this was followed by Clemson spines with 6.39 branches in the combined seasons and least in long pod local variety (5.46). Spacing of okra at 60 cm x 60 cm had the highest number of branches per plant in the seasons with an average of 7.28 branches in the combined seasons, followed by 60 cm x 45 cm (6.38 branches) and least number of branches was recorded at a spacing of 60 cm x 30 cm (5.68). No significant interaction was recorded between varieties with spacing on number of branches per plant (Table 1). Also presented in Table 1 is the effect of variety and spacing on days to 50 % flowering of okra. Highly significant differences ($P \leq 0.01$) was recorded between varieties on days to 50 % flowering; long pod local had shorter days to 50 % flowering in the seasons and combined with an average of 54.94 days in the combined seasons, yarkwadon followed with 56.39 days in the combined. Longer days to 50 % flowering were in Clemson spineness with an average of 68.06 days in the combined seasons. There were no significant effect of spacing on days to 50 % flowering and no interaction between varieties with spacing on days to 50 % flowering (Table 1).

Table 1: Effect of Variety and Spacing on Number of branches per plant and Days to 50 % flowering of Okra (*Abelmoschus esculentus* L. Moench) in 2014 and 2015 rainfed cropping seasons and combined.

Treatment	Number of branches per plant			Days to 50% flowering		
Variety (V)	**2014**	**2015**	**Combined**	**2014**	**2015**	**Combined**
Long pod local	6.54^{b}	4.27^{c}	5.46^{c}	55.22^{c}	54.67^{b}	54.94^{c}
Yarkwadon	7.84^{a}	7.18^{b}	7.56^{a}	56.89^{b}	55.89^{b}	56.39^{b}
Clemson spineless	6.48^{b}	6.22^{b}	6.39^{b}	62.33^{a}	73.78^{a}	68.06^{a}
Level of probability (LP)	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001
SE	0.201	0.157	0.175	0.693	0.456	0.543
Spacing (S)						
60 cm x 30 cm	6.23^{c}	5.14^{c}	5.68^{c}	58.22	61.44	59.83
60 cm x 45 cm	6.98^{b}	5.78^{b}	6.38^{b}	58.44	61.11	59.78
60 cm x 60 cm	7.67^{a}	6.79^{a}	7.28^{a}	57.78	61.78	59.78
Level of probability	< .0001	0.0001	0.006	0.58	0.79	0.4782
SE	0.201	0.157	0.175			
V X S (LP)	0.4560	0.2035	0.4370	0.1899	0.4601	0.5740

Means in the same column followed by the same letter are not significantly different at 5 % level of significant using DMRT.

Table 2 shows the effect of variety and spacing of okra on fruit length and fruit diameter in 2014 and 2015 rainfed cropping seasons. Clemson spineless recorded longest fruit lengths in 2014 and combined seasons, 17.61 cm and 15.49 cm, respectively. Shortest fruit lengths in the seasons and combined was in yarkwadon; 11.12 cm, 8.58 cm and 9.84 cm in 2015, 2015 and combined seasons, respectively. Similarly, in Table 2 spacing at 60 cm x 60 cm had the longest fruit lengths in 2015 and combined seasons, 14.37 cm and 14.97 cm, respectively. Shorter fruits were at a spacing of 60 cm x 30 cm. No significant effect of spacing was recorded in 2014 rainfed cropping season. There was no interaction between varieties with spacing on fruit length of okra. The effect of variety and spacing on fruit diameter of okra in the seasons and combined is also presented in Table 2. There was a highly significant difference between varieties on fruit diameter; yarkwadon had the widest fruit diameter in the combined seasons (23.88 mm) and least clemson spineless (18.28 mm). There was no significant effect of spacing on fruit diameter as well as interaction.

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Table 2: Effect of Variety and Spacing on Fruit length (cm) and Fruit diameter (mm) of Okra (*Abelmoschus esculentus* L. Moench) in 2014 and 2015 rainfed cropping seasons and combined.

Treatment	Fruit length (cm)			Fruit diameter (mm)		
Variety (V)	**2014**	**2015**	**Combined**	**2014**	**2015**	**Combined**
Long pod local	16.84[a]	13.95[a]	15.48[a]	28.82[b]	8.40[b]	18.61[b]
Yarkwadon	11.12[b]	8.58[b]	9.84[b]	35.81[a]	11.86[a]	23.88[a]
Clemson spineless	17.61[a]	13.35[a]	15.49[a]	27.94[b]	8.64[b]	18.28[b]
Level of probability (LP)	< .0001	< .0001	0.014	< .0001	< .0001	0.0027
SE	0.384	0.528	0.452	0.389	0.85	0.617
Spacing (S)						
60 cm x 30 cm	14.49[a]	10.26[b]	12.37[c]	29.59	8.98	19.28
60 cm x 45 cm	15.66[a]	11.29[b]	13.47[b]	31.32	9.89	20.56
60 cm x 60 cm	15.48[a]	14.37[a]	14.97[a]	31.67	10.19	20.98
Level of probability	0.280	< .0001	0.0019	0.220	0.085	0.7681
SE	0.384	0.528	0.452			
V X S (LP)	0.7201	0.1040	0.1842	0.6375	0.0801	0.1252

Means in the same column followed by the same letter are not significantly different at 5 % level of significant using DMRT.

The effect of variety and spacing on number of fruits per plant of okra in 2014 and 2015 rainfed cropping seasons and combined is presented in Table 3. There was a highly significant difference ($P \leq 0.01$) between varieties on number of fruits per plant. Yarkwadon had the highest number of fruits per plant in the seasons and combined; 42.39, 49.41 and 45.89, respectively. Least number of fruits per plant was recorded in Clemsonspineless in the seasons and combined (Table 3). Also presented in Table 3 was a significant effect of spacing on number of fruits per plant, plants spaced at 60 cm x 60 cm had the highest number of fruits per plant (50.49 fruits in the combined seasons), followed by spacing at 60 cm x 45 cm (42.17 fruits in the combined seasons). Least number of fruits per plant was recorded in 60 cm x 30 cm (37.66 fruits in the combined seasons). There was no interaction between spacing with varieties on number of fruits per plant. Similarly, the effect of variety and spacing on weight of fresh fruit in 2014 and 2015 rainfed cropping seasons and combined is recorded in Table 3.Highly significant differences ($P \leq 0.01$) among varieties was observed in 2015 and combined seasons. Yarkwadon recorded the highest fresh fruit weight with an average fruit weight of 112.34g in the combined seasons and Clemsonspineless recorded the lowest fresh fruit weight of 93.17 g in the combined seasons.

There was no significant effect of spacing on weight of fresh fruits as well as interaction between varieties with spacing on fresh fruit weight (Table 3).

Table 3: Effect of Variety and Spacing on Number of fruits per plant and Weight of fresh fruit (g) of Okra (*Abelmoschus esculentus* L. Moench) in 2014 and 2015 rainfed cropping seasons and combined.

Treatment	Number of fruits per plant			Weight of fresh fruit (g)		
Variety (V)	**2014**	**2015**	**Combined**	**2014**	**2015**	**Combined**
Long pod local	42.39[b]	49.41[b]	45.89[b]	170.03	33.84[b]	101.99[ab]
Yarkwadon	54.21[a]	59.58[a]	56.99[a]	157.72	66.97[b]	112.34[a]
Clemson spineless	19.71[c]	35.12[c]	27.44[c]	161.35	24.88[c]	93.17[b]
Level of probability (LP)	< .0001	< .0001	0.0151	0.47	< .0001	0.0002
SE	1.736	1.606	1.690		7.120	5.325
Spacing (S)						
60 cm x 30 cm	35.66[b]	39.57[c]	37.66[c]	156.52	32.89	94.69
60 cm x 45 cm	37.08[b]	47.17[b]	42.17[b]	168.08	42.69	105.36
60 cm x 60 cm	43.68[a]	57.38[a]	50.49[a]	164.51	50.15	107.33
Level of probability	0.0066	< .0001	0.0245	0.51	0.501	0.5445
SE	1.736	1.606	1.690			
V X S (LP)	0.4541	0.112	0.1509	0.8503	0.1107	0.6113

Means in the same column followed by the same letter are not significantly different at 5 % level of significant using DMRT.

DISCUSSION

The significant effect of varieties on number of branches per plant may be attributed to the morphological nature of the plants. Varieties that grow taller may have their auxiliary buds that were dormant to become active and grow into branches as the plants increased in height. On the other hand dwarf varieties may not have that characteristic. Similarly, the more the number of leaves more photosynthetic area may be created. Consequently, more assimilates may be accumulated by the plant. This will then be translocated to developing regions of the plant such as branches. Earlier, Muhamman *et al.* (2009) reported that the larger the leaf area of a plant the maximum photosynthesis that will be achieved; this will in turn facilitate growth and thus, increase in the number of branches. The significant effect of spacing on number of branches could be attributed to different spacing used in the experiment. Some were optimally spaced to utilized maximum environmental factors. This result is in line with the findings of Saha *et al.*

(2005) who reported a greater number of branches at wider intra-row spacing. Similar trend was also reported by Ijoyah *et al.* (2010) that number of branches per plant decreased as intra-row spacing reduced. Also, Mogapi *et al.* (2014) reported a significant effect of spacing on number of branches per plant and they attributed that to less intra-plant competition for light and nutrient.

The significant effect of variety on days to 50% flowering might be due to the differences in the plants life cycle; some varieties mature earlier than others. Similarly, growth resources might have been utilized differently by the okra varieties.

The significant effects of varieties on number of fruits per plant may be due to increased in the number of branches and leaves, which might have contributed to increased in the photosynthetic ability of the plants, consequently, more assimilates, some of which might have been partitioned to fruits for their development. The significant effect of spacing on number of fruits may be as a result of greater availability of growth factors more especially at a wider spacing. The result of this study agreed with the earlier report of Moniruzzaman *et al.* (2007) that more healthy plants were recorded at a wider spacing.

The non-significant effect of spacing on fruit diameter may be due to the varietal differences. The result agreed with Ijoyah *et al.* (2010) that fruit diameter of okra was not affected by intra row spacing. In the other hand, contradicted the report of Moniruzzaman *et al.* (2007) fruit diameter of okra significantly reduced at closer intra-row spacing.

The significant effect of variety on weight of fresh fruit may be due to the significant effect on fruit length and diameter. The result is in agreement with Jamala *et al.* (2011) who reported a significant effect of variety on weight of fresh fruit of okra. The significant effect of spacing on weight of fresh fruit could be attributed to the ability of some plants to accumulate more assimilates than others probably due photosynthetic leaf area.

CONCLUSION

Results of this study showed that Yarkwadon manifested the highest effect on the major parameters measured; fruit diameter, number of fruits per plant and weight of fresh fruit, Likewise inter and intra row spacing of 60 cm x 60 cm. Thus, should be adopted in Mubi and similar environments.

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