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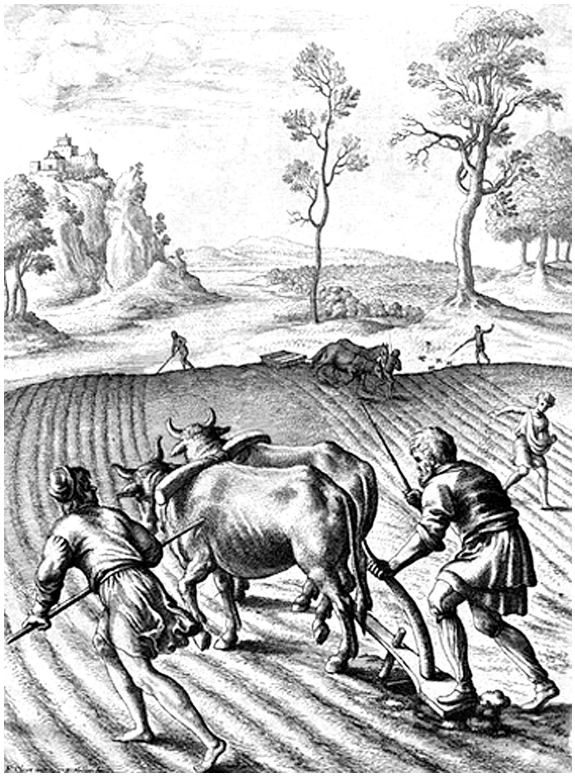

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Effect of Spacing and NPK Fertilizer on the Yield and Yield Components of Okra (*Abelmoschus esculentus* L.) in Mubi, Adamawa State, Nigeria

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Abstract: Field experiments were conducted at the Teaching and Research Farm of the Department of Crop Science, Adamawa State University, Mubi in 2007 and 2008 cropping seasons with the aim of assessing the effect of spacing and NPK fertilizer on the yield and yield components of okra (*Abelmoschus esculentus* L.). Treatments consisted of four spacing (60×30 cm, 90×30 cm, 60×60 cm and 75×45 cm) and four NPK rates (0, 100, 150 and 200 kg ha^{-1}) in a split plot design with plant spacing allocated to main plots and fertilizer in sub plots. The treatments were replicated three times to give a total of forty eight sub plots. Parameter such as number of fruits per plant, length of fruit, fresh weight of fruits per hectare and dry weight of fruits per hectare were measured. Data collected were subjected to Analysis of Variance (ANOVA) as described by Gomez and Gomez and treatment means were separated using Duncans Multiple Range Test (DMRT). Results showed that yield and yield components such as number of fruits per plant and length of fruit were not significantly affected by spacing in 2007. However, significant difference was obtained at 52 DAS in 2008. Number of fruits per plant and length of fruits were significantly affected by fertilizer levels. In 2008, there was significant interaction in respect to fresh weight of fruits per hectare. Also, there was significant interaction between spacing and fertilizer in respect to dry weight of fruits per hectare in 2007 and 2008. The results indicated that spacing of 90x30 cm and application of 150 kg ha^{-1} (22.5 kgN, 22.5 kg P_2O_5 and 22.5 kg K_2O_5) of NPK gave the highest yield of okra in Mubi.

Key words: Plots, spacing, fertilizer, okra fruits, replicates, interaction

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is a widely cultivated vegetable crop and can be found in almost every market all over Africa. Okra is an annual vegetable crop, grown from seed and it is widely cultivated in the tropics for the fruits which are used as vegetable both in the green and dried state (Kochhar, 1986). In Africa, there is great diversification of okra with the most important production regions in Ghana, Burkina Faso and Nigeria (Raemaekers, 2001). Okra grows in all types of soils, thriving best in a moist friable well manured soil (Kochhar, 1986). The production and economic importance of okra as vegetable in Nigeria has rapidly increased in recent years. The seasonal supply of this vegetable to a large extent determines how much of it is being consumed by the majority of the people. The fresh and green tender fruits of okra are used as vegetable; it is also sliced and dehydrated, to be conserved for later use (Tindall, 1983). Okra is one of the vegetable that is of great importance in improving the palatability of many dishes in Nigeria. The young tender fruits are mucilaginous; therefore they are often used in the tropics for soups, sauces and stews. According to Kochhar (1986), okra is good source of vitamin A and B and also contain vitamin C and minerals especially iodine. Overcrowding of seedlings or plants in a particular area or spot may lead to competition among the plants for essential growth resources like sunlight, space, water and nutrients; this may thus affect plant performance and yield. Most soils in the tropics, especially in Mubi area are low in plant nutrients which are necessary for plant growth and high yield. It is therefore, necessary to supplement the amount of nutrients present in the soil to meet crop requirement (NAERLS, 1993). If the yield of okra is to be increased, the low fertility soils would require additional nutrients. One of the major causes of low yield in okra in Nigeria is the inadequate information on the application rate of inorganic fertilizer especially compound fertilizers like NPK (Awe *et al*., 2006). Several experiments on crops have generally indicated yield increase due to fertilizer application (Cooke, 1982; Adenala, 1985; Ajari *et al*.,

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2002). Most smallholders of okra farmers produce it at low standard of crop husbandry and rarely care about the spacing and the application of fertilizers to the crop, which resulted, to low yield and much labour. In view of the uses and the economic importance and high demand of this crop, this study was carried out to examine the effect of spacing and NPK fertilizer rates on the yield and yield components of okra in Mubi, Adamawa State Nigeria.

MATERIALS AND METHODS

Field experiments were carried out at the Teaching and Research Farm of the Department of Crop Science, Adamawa State University, Mubi during the 2007 and 2008 cropping seasons. The experiments were designed to study the growth and yield of okra (*Abelmoschus esculentus*) as affected by plant density and NPK fertilizer. Mubi lies within latitude 10° 08'N and 10° 30'N longitude 13°N 11' E and 13°25' E in the Northern Guinea Savannah of Nigeria (Obiefuna *et al*., 1997). The okra seeds were obtained from the local farmers in Mubi. It was a local variety and a dwarf type which grow up to a height of 70 cm and matures in 45 to 50 days. The pods are medium long, green and five ridged, also rough and hairy.

A split plot design was used with four spacing (60x30, 90 x 30, 60 x 60 and 75 x 45 cm) as main plots and the quantity of N.P.K (15:15:15) (0, 100, 150 and 200 kg ha^{-1}) as subplots which were replicated three times. Unit plot size was 4 x 3 m (12 m^2) with 1 and 0.5 m pathway between each replication and the plots, respectively. The four rates of fertilizer were applied as per treatment in two equal split doses at two and four weeks after sowing. Weeding was done as when necessary with a simple hoe. The data collected were number of fruits per plant, length of fruit, fresh weight of fruits and dry weight. The data collected were subjected to Analysis of variance (ANOVA) and means were separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effect of spacing and NPK fertilizer on number of fruits per plant is presented in Table 1 and 2. Results on the number of fruits per plant in 2007 were not influenced by spacing. However in 2008, number of fruits per plant was significantly influenced by spacing treatments. Results showed that higher fruit yield per plant was recorded in wider spacing (75×45 cm) than closer spacing. The possible reason wider spacing produced more healthy plants than closer spacing because of less competition for nutrients. This result is also corroborated by Raemaekers (2001) who reported that optimal plant density should be adjusted to the local condition and the type of varieties to be grown. There was an increase in the number of fruits per plant with increase in the rate of NPK fertilizer. Application of 150 kg ha^{-1} of NPK in both 2007 and 2008 produced the highest number of fruits per plant of 7.7 and 7.7 cm at 52 DAS, respectively, whereas plots that received no fertilizer produced lower number of fruits per plant of 5 and 5.4 in 2007 and 2008, respectively. For the two seasons, application of 150 kg NPK ha^{-1} resulted in the highest number of fruits per plant. The cultivar appear to be more responsive to higher rate of NPK (150 kg ha^{-1}) as it produced significantly higher number of fruits per plant than lower rates of NPK. This is in agreement with the findings of Smith, Smith *et al.* (2001) who reported that, the use of soil amendment (NPK) under a environment significantly influenced the growth and pod yield of okra.

Table 1: Means of yield parameters on okra grown in 2007 cropping season in Mubi

	Number of fruit per plant		Fruit length (cm)			
Treatment	48 DAS	52 DAS	48 DAS	52 DAS	Fruit fresh weight (kg ha^{-1})	Fruit dry weight (kg ha^{-1})
Spacing						
60×30 cm	3.7a	6.5a	6.4a	9.3a	6595.8a	793.3a
90×30 cm	3.8a	6.8a	6.5a	8.8a	6608.6a	828.2a
60×60 cm	3.5a	7.4a	5.9a	8.5a	5887.8a	720.4a
75×45 cm	3.5a	7.3a	6.6a	9.1a	5190.4a	625.0a
SE±	0.219	1.105	0.378	0.845	1516.2	213.5
Fertilizer N P K (15:15:15)						
0 kg ha^{-1}	2.9ab	5.2b	5.3b	7.7c	4469.2b	546.2b
100 kg ha^{-1}	3.6a	7.4a	6.6a	8.8ab	5949.7a	735.1a
150 kg ha^{-1}	4.0a	7.7a	6.5a	9.6a	7002.8a	849.9a
200 kg ha^{-1}	3.9a	7.7a	7.1a	9.6a	6861.0a	835.8a
SE±	0.299	0.434	0.424	0.465	854.2	113.5
Interaction						
Spacing×fertilizer	NS	NS	NS	NS	NS	NS

DAS: Days after sowing, NS: Not significant. Means with the same letters in the same column are not significantly different using Duncan's multiple range test

Table 2: Means of yield parameters on okra grown in 2008 cropping season in Mubi

	Number of fruit per plant		Fruit length (cm)			
Treatment	48 DAS	52 DAS	48 DAS	52 DAS	Fruit Fresh weight (kg ha^{-1})	Fruit dry weight (kg ha^{-1})
Spacing						
60×30 cm	4.0a	6.3c	6.4a	9.1a	6574.8a	778.5a
90×30 cm	4.4a	6.8a	6.9a	8.7a	6687.3a	800.7a
60×60 cm	4.3a	6.6b	6.3a	8.6a	5380.3a	706.2ab
75×45 cm	4.1a	7.6a	7.1a	7.3a	5365.4a	618.2b
SE±	0.451	0.414	0.924	0.294	1432.9	166.5
Fertilizer (N P K 15:15:15)						
0 kg ha^{-1}	3.5b	5.4c	5.1b	7.5c	4362.8b	539.6c
100 kg ha^{-1}	4.3a	6.4b	6.9a	8.5b	6073.4a	698.9b
150 kg ha^{-1}	4.7a	7.7a	6.9a	9.9a	7255.5a	871.7a
200 kg ha^{-1}	4.3a	7.7a	7.5a	9.86a	6316.1a	703.5ab
SE±	0.401	0.372	0.347	0.335	572.4	154.2
Interaction						
Spacing×fertilizer	NS	NS	NS	NS	NS	NS

DAS: Days after sowing. NS: Not significant. Means with the same letters in the column are not significantly different using duncan's multiple range test

Table 1 and 2 show the Effect of spacing and NPK fertilizer on fruit length. There was no significant difference in fruit length as a result of spacing and NPK fertilizer application in 2007. However, significant difference was observed in fruit length at 52 DAS in 2008. Plants spaced closely (60×30 cm) produced longest fruits of 9.1 cm. There was significant influence in the combined analysis from the two cropping season's results due to spacing treatments. This was contrary to the findings of Christo and Onuh (2005) who reported that, fruit length were found higher in plants when grown in wider spacing than those at closer spacing. However, in agreement with the findings of this study Gorachand and Mondal (1990) found that spacing influences the yield of crops. There were significant influences in the combined analysis from the two cropping seasons results (Table 3) due to spacing treatments. Spacing of 60×30 cm produced the longest fruits at 52 DAS. The lengths of fruit were influenced by the rate of NPK fertilizer. NPK increased the length of fruits when 200 kg NPK ha^{-1} was applied giving the longest fruits at 48 DAS in both 2007 and 2008 whereas at 52 DAS, the longest fruits were obtained from 150 kg NPK ha^{-1}. Significant influence of NPK was also recorded from the two years on the length of fruits. Application of 200 kg NPK ha^{-1} produced the longest fruits at 52 DAS. This is accounted for by the adequacy of NPK fertilizer received.

The effect of spacing and NPK fertilizer on fresh weight of fruits is presented in Table 1 and 2. Fresh weight of fruits in 2007 and 2008 showed no significant difference as a result of spacing. The component of yield in terms of fresh and dry weight of fruits were however significantly influenced by rates of NPK fertilizer application. NPK rates increased the fresh weight of fruits per hectare with 150 kg ha^{-1} giving the highest fresh weight of 7,002 and 7,255 kg ha^{-1} in both 2007 and 2008 whereas plots that received 0 kg ha^{-1} produced lower

Table 3: Interaction between spacing and fertilizer on fresh weight of Fruits kg ha^{-1} in 2008

	Fresh weight			
Fertilizer	60×30 cm	90×30 cm	60×60 cm	75×45 cm
Spacing				
0 kg ha^{-1}	5193.7	4744.8	6138.7	7701.1
100 kg ha^{-1}	4697.3	7365.2	7093.3	7417.4
150 kg ha^{-1}	4183.5	6636.6	8763.9	5880.8
200 kg ha^{-1}	3591.2	5282.3	6300.5	5939.6
Prob. of F	NS	*	*	NS
LSD (0.05)		2343.7	2343.7	

NS: Not significant, *Significant (p = 0.005)

fresh weight of fruits of 4469.2 and 4362.8 kg ha^{-1} in 2007 and 2008. This indicates a positive response to fertilizer as increase in yield was obtained with the fertilizer rate up to the 150 kg ha^{-1} rates in both the two years. In 2008, a significant interaction between spacing and fertilizer in terms of fresh weight of fruits per hectare was recorded, these could have resulted from interaction effect between spacing and fertilizer; meaning that spacing and NPK rates combined more favorably during 2008 cropping season. The result obtained agreed that nitrogen as well as phosphorus plays an important role in fruit, seed and development of okra.

In this study, dry weight of fruits per hectare Table 1 and 2 was influenced by spacing. Spacing at 90 x30 cm produced plants with greater dry weight per hectare of 828.2 kg and 800.7 kg ha^{-1} in 2007 and 2008, respectively. Youdeowei *et al.* (1999) reported that, adequate spacing of crops is important for high yield. Application of 150 kg NPK/ha in both 2007 and 2008 produced heavier fruits of 849.9 and 871.7 kg whereas 0 kg ha^{-1} produced lower dry weight of fruits ha^{-1} (546.2 and 539.6 kg), respectively. The means for the two cropping seasons also differ significantly due to NPK from 0 to 150 kg ha^{-1} produced heavier fruits of 860.0 kg ha^{-1}. The results indicated that higher dosage application of NPK up 150 kg ha^{-1} have potentials of increasing okra yield. This

was contrary to the findings of Obi *et al*. (2005) who reported no significant increase in both fresh and dry weight of okra plants with increasing NPK fertilizer treatment. However, in this study okra yield and yield components were lower without the application of NPK as results showed increase in rate of NPK increases yield of okra. Thus, agreeing with the findings from some earlier studies in Nigeria which showed that application of these nutrients is important for enhanced yield of okra (Adediran and Banjoro, 2003).

CONCLUSION

The study has provided useful information on the effect of spacing and fertilizer on the growth and yield of okra at Mubi. It is very clear from the results obtained in this study that the local okra cultivar can perform well under different spacing and different levels of NPK fertilizer, but the optimum spacing of 90x30 cm with an application of 150 kg NPK ha^{-1} fertilizer gave the highest yield of the local okra cultivar at Mubi; as such, it is concluded that from the results obtained spacing of 90x30 cm and application of 150 kg NPK ha^{-1} appeared optimum for maximum growth and yield of the local okra cultivar in Mubi.

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