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Yield response of okra (*Abelmoschus esculentus* L. Moench) at varying sowing depths in Makurdi, Nigeria

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Abstract

Field experiments were conducted from June to August during the years 2009 and 2010 cropping seasons at the University of Agriculture Research Farm, Makurdi, Nigeria, to evaluate the yield response of okra at varying sowing depths and to determine the optimal sowing depth that will maximize yield under Makurdi conditions. Results of the study showed that the least number of days to attain 50 % emergence, greatest number of pods and best yield were obtained when seeds were sown at the depth of 4 cm. The average number of pods produced from seeds sown at 4 cm depth was significantly ($P \leq 0.05$) greater by 53.5 %, 45.4 % and 23.1 % respectively, compared to that obtained from depths of 1 cm, 2 cm, and 3 cm. The average yield obtained from the depth of 4 cm was significantly ($P \leq 0.05$) greater by 33.8 % and 28.6 % respectively, compared to that produced from seeds sown at shallower depths of 1 cm and 2 cm. The implication of study showed that to maximize yield of okra variety 'Dogo', the optimal sowing depth would be 4 cm. This should be recommended for Makurdi location, Nigeria.

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Introduction

Okra *(Abelmoschus esculentus* L. Moench) is an important vegetable crop in tropical and subtropical parts of the world and originated in Asia and Africa (Absar and Siddique, 1992).

In Nigeria, it is one of the foremost vegetable crops in terms of consumption and production area (Iremiren and Okiy, 1999). The immature pods are consumed as boiled vegetable while its dried form is used as soup thickener or in stew (Yadev and Dhankhar, 2002). The green fruits are rich sources of vitamins, calcium, potassium and other minerals (Lee *et al*., 2000).

While planting okra seeds, farmers in Makurdi, Nigeria usually open up the soil, throw in a couple of seeds and cover up the soil without using a specific depth. The potential of the resulting seedlings may not be fully realized since a shallow depth of sowing may lead to lodging of the plant during a light rainstorm later in its life cycle and an excessively deep planting may result in non-emergence of the seedling (Odeleye *et al.,* 2009). Odeleye and Olufajo (2010) reported a progressive decrease in days to emergence as sowing depth increased. Al Amin (2003) reported that the deeper sowing of wheat at a depth of 4 cm increased the number of grains per spike. Abrecht (1989) also reported greatest corn yield at a depth of 4 cm. Depending on soil type, depth of sowing may have varied effects on the performance of different crops. Given the need to optimize okra yield and the desirability to have lodging resistant plants, it therefore became imperative to evaluate the response of okra to varying sowing depths with the objective to determine the optimum sowing depth for okra cultivation.

Materials and methods

This study was carried out at the Research Farm, University of Agriculture, Makurdi, Nigeria, during the planting seasons of 2009 and 2010 to evaluate the yield response of okra at varying sowing depths. The study location (7° 44'N, 8° 35'E) and at an altitude of 228 m above sea level, falls within the Southern Guinea Savanna agroecological zone of Nigeria.

The meteorological information of the area over the trial period (June – August) is provided in Table 1. In the two years of study, the month of July recorded the highest amount of rainfall and number of rainy days. The average monthly temperature over the years ranged from 21.2 °C to 32.2 °C, while the average relative humidity ranged from 77.0 % to 79.0 % (Table 1). The seeds of okra variety 'Dogo' (a local variety) was obtained from the farmers in Makurdi.

The experimental area (198.9 m^2) which consisted of sandy-loam soil, was cleared, ploughed, harrowed, ridged and divided into sixteen plots. Each plot had an area of 6.3 m^2. The plot consisted of three ridges spaced 75 cm apart. The treatments constituted the four sowing depths (1 cm, 2 cm, 3 cm and 4 cm) which were arranged in a randomized complete block design (RCBD) and replicated four times. Three okra seeds were sown at the different sowing depths in a row on top of the ridges. The seeds were sown at an intra-row spacing of 30 cm (Ijoyah *et al*., 2010). Each ridge had 7 plants, making a total of 21 plants per plot (33,333 plants per hectare equivalent). The plots were manually weeded as the need arose. Mixed fertilizer NPK (20:10:10) at the rate of 100 kg per hectare was applied following the recommendation of Ekpete (2000), using the side placement method of application. The fertilizer was applied as a split application at 3 and 6 weeks after sowing (WAS).
Harvesting was done in late August when the tip of pod was observed to break easily when pressed with the finger tip (Usman, 2001).

Data taken included number of days to 50 % emergence, plant height at flowering, number of branches per plant, number of leaves per plant, leaf area at flowering (determined by the length-width method as described by Wuhua, 1985), number of pods per plant, pod length, pod width, pod weight

(g) and yield (t/ha). All data were statistically analyzed using the Analysis of variance (ANOVA) and the Least Significant Difference (LSD) was used for mean separation ($P \leq 0.05$) following the procedure of Steel and Torrie (1980).

Results and discussion

Okra seeds sown at deeper depth of 4 cm recorded the least number of days to attain 50 % emergence (Table 2). The delay in emergence at lower depths could probably be attributed to lack of moisture, promoted by heat stress during the period of germination (Webb *et al.,* 1987). This result agreed with that of Odeleye and Olufolaji (2010) who reported a progressive decrease in the days to emergence as sowing depth increased. The result, however contradict that of Tayo (1983) who reported that deeply planted pigeon pea delayed emergence and that of Allessi and Power (1981) who also reported that one additional day was required for corn emergence for each 2.5 cm increase in depth of sowing. The difference in results might be due to variation in the environmental conditions of the different locations of study and the genetic potential of the different crops used.

Table 2. Yield response of okra at varying sowing depths at Makurdi, in year 2009 and 2010.

Depth of sowing	Days to 50% emergence		Plant height at flowering (cm)		Number of branches per plant		Number of leaves per plant		Leaf area (cm^2)		Number of pods per plant		Pod length (cm)		Pod width (cm)		Pod weight (g)		Yield (t/ha)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
1cm	6.2	6.5	29.6	28.4	12.4	13.5	10.3	11.5	342.3	364.4	12.4	13.0	8.3	9.0	5.2	6.4	19.3	20.4	5.1	5.0
2cm	6.3	6.7	28.8	27.4	11.6	12.0	10.8	11.9	344.2	348.0	14.6	15.1	9.8	10.2	4.2	5.4	21.0	21.0	5.5	5.0
3cm	5.3	5.3	31.0	29.4	12.5	13.7	11.2	12.6	346.3	350.1	20.1	21.3	11.3	12.3	4.1	5.1	20.5	21.8	6.3	6.2
4cm	4.0	4.3	30.2	30.4	13.0	14.3	11.8	12.9	348.5	352.1	26.7	27.8	11.6	12.8	4.0	5.1	31.8	29.9	7.7	6.4
mean	5.5	5.8	29.9	28.9	12.4	13.4	11.0	12.2	345.3	349.2	18.6	19.3	10.3	11.1	4.4	5.5	22.9	23.0	6.1	5.7
LSD(0.05)	0.55	0.62	ns	ns	ns	ns	ns	ns	ns	ns	0.99	0.85	0.80	0.60	0.20	0.42	4.65	5.24	2.15	1.24
Cv (%)	6.79	7.52	7.20	9.71	10.2	12.4	11.9	10.2	21.7	19.6	3.32	5.40	4.90	6.0	2.83	4.20	12.7	15.2	21.9	19.8

ns: not significant

Although plant height, number of branches per plant, number of leaves per plant and leaf area were not significantly different at all depths, however, in both years, seeds sown at deeper depths of 3 cm and 4 cm produced taller plants, greater number of leaves and larger leaf area compared to those produced from lower depths of 1 cm and 2 cm (Table 2). Seeds sown at 4 cm depth produced plants with the greatest number of pods, significantly ($P \leq 0.05$) greater than the rest treatments. This view supports Al Amin (2003) who reported that the deeper sowing of wheat at a depth of 4 cm increased the number of grains per spike.

The average number of pods produced over the years from okra seeds sown at 4 cm depth was significantly ($P \leq 0.05$) greater by 53.5 %, 45.4 % and 23.1 % respectively, compared to that obtained from depths of 1 cm, 2 cm and 3 cm.

Similarly, pod length, pod weight and yield were significantly greater for seeds sown at deeper depth of 4 cm compared to those sown at lower depths of 1cm and 2cm (Table 2).

Table 2. Meteorological information for Makurdi Nigeria (June-August) 2009, 2010.

Months	Average monthly rainfall (mm)	Average monthly temperature (°c)		Average relative humidity (%)
2009		Max.	Min.	
June	224.0 (13)+	32.2	23.0	77.0
July	230.2(18)	30.0	22.4	77.2
August	221.5 (16)	30.1	23.2	79.0
2010				
June	220.1(11)+	31.4	22.0	77.3
July	245.3 (16)	31.2	21.2	77.0
August	198.5(15)	30.3	22.1	77.4

Source: Air Force Base, Makurdi Meteorological Station.

+Values in parenthesis indicate number of rainy days

Although the greatest yield was obtained at the depth of 4 cm, however, yields obtained from seeds sown at the depth of 3 cm and that produced from 4 cm depth showed no significant difference. The greatest yield obtained from okra seeds sown at 4 cm depth (Table 2) could be attributed to the greater number of branches, larger leaf area and greater number of pods produced compared to the rest treatments. This result agreed with that of Tayo (1983) in pigeon pea, Gupta *et al.,* (1989) and Abrecht (1989) in corn.

The average yield of okra obtained when seeds were sown at depth of 4 cm, was significantly ($P \leq 0.05$) greater by 28.2 % and 25.4 % respectively, compared to that produced from seeds sown at 1 cm and 2 cm.

Conclusion

From the results obtained, it can be concluded that in Makurdi, Nigeria, the optimal sowing depth for okra was found to be 4 cm. This is associated with the least number of days to attain 50 % emergence, greater number of pods and yield respectively. It is however, recommended that further investigation be evaluated with other okra varieties and across different locations with varied environmental conditions within the Southern Guinea Savanna agro ecological zone of Nigeria.

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