EFFECT OF PLANT SPACING AND SOWING DATE ON SESAME *(Sesamum indicum L.)* PRODUCTION IN SOUTHEASTERN NIGERIA

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ABSTRACT

Five plant spacing and four sowing dates were assessed under field conditions for their effects on sesame morphological growth and yield characters in 2004 and 2005 cropping seasons at Obubra, Cross River State, Southeastern Nigeria. The experiment was laid out as split - plot in a randomized complete block design with sowing date as the main plot and plant spacing as the sub-plot treatments with three replicates. The sowing dates were June 24, July 8, July 22 and August 5 while the spacing were 25 cm x 5 cm, 25 cm x 10 cm, 30 cm x 10 cm, 30 cm x 15 cm and 60 cm x 10 cm. On average, wider spacing of 60 cm x 10 cm resulted in significantly ($p < 0.05$) higher number of capsules per plant and number of seeds per capsule, while closer spacing of 30 cm x 10 cm resulted in higher seed yield. The best spacing for higher seed yield was 30cm x 10cm, corresponding to a plant density of 333,333 plants/ha. Delay in sowing to late July resulted in significant increase in plant height, number of leaves per plant and seed yield. For optimum seed yield, sesame should be planted between third and fourth week of July while the best plant spacing recommended is 30 cm x 10 cm.

Key words: Plant spacing, sowing date, sesame and seed yield.

INTRODUCTION

Sesame *(Sesamum indicum L.)* is an important oil crop in Nigeria. It is cultivated for its highly nutritious and edible seeds, which serve as condiment in soup and also as a source of sesame oil. Sesame seed contains 18-23% protein, 48-55% oil and vitamins (Voh, 1998;Riaz et. al.,2002). The semi-drying oil is of high quality and is used as a substitute for olive oil and as salad and cooking oil (Purseglove, 1968). Sesame oil is free from undesirable nutritional or flavour components and is very stable because of the natural anti-oxidants, sesamin and sesamolin which prevent ageing and malfunctioning of the liver (Uzo and Yermanos, 1977). The oil is used in the manufacture of margarine and compound cooking fats and lower grades used in soap and paints production. It is also used as a lubricant, illuminant and in pharmaceutical industry for manufacture of drugs and perfumes and serves as a synergist for pyrethrum in aerosol sprays (Purseglove, 1968). According to Adebisi (2004), sesame cultivation has many advantages as it sets seed and yields relatively well under high temperature and can be grown on residual moisture without any extra rainfall. It readily fits into numerous farming systems as it can be grown in pure stands and also as a companion crop.

The effect of plant spacing on the performance of crops can not be over-emphasized. The optimum plant spacing for

a particular region and level of husbandry must be accurately determined for maximum yields and efficient use of fertilizers and other resources (Lauretti, 1983, Ugbaja *et al.*, 1995; Okpara, 1999). Kalu and Adeyemo (1998) reported that plant population density is a major factor that influences the growth and yield of sesame while Chambi and Taylor (1986) noted that the determinants of optimum plant population density include soil fertility, cultivar and the environment. In Nigeria, research efforts on sesame production have mainly been in the northern parts (guinea savanna) where trials on sesame improvement started as far back as 1964 (Iwo *et al.*, 1998). Although the crop is grown and consumed as condiment in soup in some parts of southeastern Nigeria, information on its agronomy is scanty in the region.

The common production practice in Southeastern Nigeria is to plant major crops such as yam, cassava and maize early in the cropping season in April through June, with the result that other crops are often planted later. In recent times, rainfall patterns have been erratic such that sometimes rains do not stabilize until May/June compared with March/April previously reported by Van Rheenen (1973). The general approach is to relate the planting date to length of rainy season of the region (Akchurst and Screedhavan, 1965). The time of planting in areas of high rainfall is usually determined by the need to avoid flowering periods coinciding with periods of maximum disease or insect pest attacks (Ugbaja, 1995), which are accentuated by high rainfall and temperature regimes. A delay in planting date may result in reduced yields of some crops. Therefore spacing trials should be laid down within this locally established optimum planting time (Deokar *et al.*, 1977).

The objective of this study was to determine the magnitude effect of plant spacing and sowing date on sesame production in southeastern Nigeria.

MATERIALS AND METHODS

The study was conducted in 2004 and 2005 at the Cross River State University of Technology Research Farm at Obubra under rain fed conditions. Obubra is situated at longitude 08° 16'E and latitude 05°59'N with an altitude of 184m above sea level. The soil is classified as sandy loam. Some of the soil characteristics and rainfall data are presented in Table 1. The 2004 and 2005 experiments were planted on different field plots within the same location where the plots had been fallowed for 2 and 3 years, respectively. The land used for the experiment was ploughed and harrowed on 26th June, 2004 and 25th June, 2005 while sowing was done on 28th June of 2004 and 2005. Composite soil samples from representative field locations were obtained at a depth of 0-20cm for determination of physico-chemical properties of the soil in 2004 and 2005.

The experiment was a split plot laid out in a randomized complete block design with three replicates. The main plot treatment was four planting dates scheduled at biweekly interval of June 24, July 8, July 22 and August 5 in each of the two seasons whereas the sub plot treatment was five plant spacing 25 cm x 5 cm (800,000 plants/ha), 25 cm x 10 cm (400, 000 plants/ha), 30 cm x 10 cm (333, 333 plants/ha), 30 cm x 15 cm (222, 222 plants/ha) and 60 cm x 10 cm (111, 111 plants/ha). Each plot measured 3 m x 3 m ($9m^2$). A pinch containing 3 to 5 seeds of the Yandev 55 variety was planted per hole at each specified plant spacing and thinning was done 4 weeks after sowing (WAS) to maintain

one plant per stand. Compound fertilizer NPK 15:15:15 was applied using the band placement method at the rate of 50kg/ha. The crop was protected against insect pests in both years by spraying with Thionex insecticide at the rate of 1 L/ha. Manual weeding was carried out at 4, 8 and 12 WAS. Data were taken on plant height, number of branches, shoot dry matter per plant at 7 WAS from ten plants per plot. At full maturity, data were taken on number of capsules per plant, 1000-seed weight (g) and seed yield (kg/ha). The data obtained were subjected to analysis of variance and significant differences among treatment means were detected using Fisher's least significant difference (LSD) as outlined by Gomez and Gomez (1984).

RESULTS

The soil of the experimental site was sandy loam with higher soil pH in 2005 (Table 1). The soil was low in nitrogen but moderate in phosphorus and potassium in both years. The total rainfall for the periods of June through November was 1558.0 mm in 2004 and 1459.9 mm in 2005.

Table 1: Soil properties of the sites and monthly rainfall for the experimental periods

	2004	2005
Mechanical properties of soil		
Sand (%)	63.8	63.80
Clay (%)	12.2	10.20
Silt (%)	24.0	26.00
Texture class	Sandy loam	Sandy loam
Chemical properties of soil		
O.M (%)	2.388	1.772
N (%)	0.098	0.098
P (ppm)	15.68	16.97
K (meq./100g soil)	0.34	0.36
pH(H_2O)	4.73	5.29
Monthly rainfall (mm)		
June	245.8	301.3
July	304.0	269.1
August	250.6	261.9
September	321.7	301.3
October	330.4	264.9
November	105.5	56.4
Total rainfall	1558.0	1459.9

Table 2: Effect of plant spacing and sowing dates on the plant height (cm) of Yandev 55 variety of sesame at 7 WAS

	Sowing Dates				
Spacing	**24th June**	**8th July**	**22nd July**	**5th Aug.**	**Mean**
2004					
25 cm x 5 cm	98.7	143.5	102.1	100.7	111.3
25 cm x 10 cm	95.5	99.8	130.3	104.9	107.6
30 cm x 10 cm	91.3	107.0	80.7	103.3	95.6
30 cm x 15 cm	96.3	128.7	129.5	96.1	112.7
60 cm x 10 cm	88.4	99.2	83.4	71.9	85.7
Mean	94.0	115.6	105.2	95.4	102.6
2005					
25 cm x 5 cm	84.6	99.7	115.7	75.9	94.0
25 cm x 10 cm	89.1	87.3	109.1	88.6	93.5
30 cm x 10 cm	80.4	101.7	125.1	97.9	101.3
30 cm x 15 cm	71.3	109.9	113.5	76.8	92.9
60 cm x 10 cm	68.6	90.6	120.9	78.7	89.7
Mean	78.8	97.8	116.9	83.6	94.3

		2004	2005
LSD$_{(0.05)}$ for sowing date (D) mean	=	NS	32.26
LSD$_{(0.05)}$ for plant spacing (S) means	=	NS	NS
LSD$_{(0.05)}$ for S x D Means	=	NS	NS

At 7 weeks after sowing (WAS), plant spacing did not influence plant height in 2004 and 2005 seasons but sowing date significantly ($P<0.05$) affected this character in 2005 (Table 2). Delaying sowing in 2005 to late July resulted in significant increase in sesame plant height (116.9 cm) but beyond this date there was reduction in height. The late July sowing date which gave tallest plants was greater than the late June, early July, and early August sowings by 48, 20, and 40%, respectively. Interactions between spacing and sowing date did not affect plant height.

The number of leaves per plant at 7 WAS increased significantly ($P<0.05$) with delay in sowing up to early July in 2004 with 60.7 number of leaves and late July in 2005 with 50.2 number of leaves (Table 3). However, further delay in sowing date to early August resulted in significant ($P>0.05$) reduction in leaf production in both years. Similar to the result obtained in plant height, plant spacing and sowing date and interaction of plant spacing and sowing date did not influence the number of leaves per plant. From the results in Table 4, the number of branches per plant at 7 WAS was significantly ($P<0.05$) reduced from 5.7 or 5.3 to 4.5 or 3.4 when planting was delayed to late July or early August in 2005. In both years, plant spacing and interaction of plant spacing x sowing date did not affect branching.

As presented in Table 5, shoot dry matter at 7 WAS was significantly ($P<0.05$) reduced from 22.5 or 25.8 g/plant to 13.8 or 9.5 g/plant when sowing was delayed to late July or early August of 2004. In 2005, however, shoot dry matter per plant was significantly reduced from 19.2 or 14.0 g/plant to 18.7 or 10.8 g/plant when

Table 3: Effect of plant spacing and sowing date on the number of leaves/plant of Yandev 55 variety of sesame at 7 WAS.

	Sowing Dates				
Spacing	**24th June**	**8th July**	**22nd July**	**5th Aug.**	**Mean**
2004					
25 cm x 5 cm	40.4	65.5	45.3	48.1	49.8
25 cm x 10 cm	33.6	73.0	42.9	36.9	46.6
30 cm x 10 cm	33.5	48.5	53.7	40.8	44.1
30 cm x 15 cm	36.0	53.5	59.5	30.6	44.9
60 cm x 10 cm	39.2	62.8	47.5	40.2	47.4
Mean	36.5	60.7	49.8	39.3	46.6
2005					
25 cm x 5 cm	36.3	46.5	42.9	48.1	43.5
25 cm x 10 cm	31.3	39.9	55.5	36.9	40.9
30 cm x 10 cm	34.3	43.6	49.7	41.2	42.2
30 cm x 15 cm	33.9	43.1	54.1	30.6	40.4
60 cm x 10 cm	36.5	40.6	48.7	40.2	41.5
Mean	34.5	42.7	50.2	39.4	41.7

		2004	2005
LSD ($_{0.05}$) for sowing date (D) means	=	15.96	7.42
LSD ($_{0.05}$) for plant spacing (S) means	=	NS	NS
LSD ($_{0.05}$) for S x D means	=	NS	NS

Table 4: Effect of plant spacing and sowing date on the number of branches per plant of Yandev 55 variety of sesame at 7 WAS.

	Sowing Dates				
Spacing	**24th June**	**8th July**	**22nd July**	**5th Aug.**	**Mean**
2004					
25 cm x 5 cm	4.9	4.8	5.9	6.5	5.5
25 cm x 10 cm	4.0	5.8	4.6	3.5	4.5
30 cm x 10 cm	3.9	3.5	5.6	4.9	4.5
30 cm x 15 cm	3.2	4.0	4.7	4.0	4.0
60 cm x 10 cm	4.3	4.0	5.0	4.5	4.5
Mean	4.1	4.4	5.2	4.9	4.7
2005					
25 cm x 5 cm	5.3	6.0	4.5	3.1	4.7
25 cm x 10 cm	5.3	5.9	4.3	3.1	4.7
30 cm x 10 cm	6.4	4.7	5.2	3.8	5.0
30 cm x 15 cm	5.7	5.3	3.2	3.4	4.4
60 cm x 10 cm	5.7	4.7	5.1	3.7	4.8
Mean	5.7	5.3	4.5	3.4	4.7

		2004	2005
LSD $(_{0.05})$ for sowing date (D) mean	=	NS	0.95
LSD $(_{0.05})$ for plant spacing (S) means	=	NS	NS
LSD $(_{0.05})$ for S x D means	=	NS	NS

Table 5: Effect of plant spacing and sowing date on the shoot dry matter (g/plant) of Yandev 55 variety of sesame at 7 WAS.

	Sowing Dates				
Spacing	**24th June**	**8th July**	**22nd July**	**5th Aug.**	**Mean**
2004					
25 cm x 5 cm	18.0	33.0	13.0	7.7	17.9
25 cm x 10 cm	28.1	21.7	15.2	8.6	18.4
30 cm x 10 cm	19.1	16.7	10.5	9.2	13.9
30 cm x 15 cm	22.9	31.4	19.5	10.2	21.0
60 cm x 10 cm	24.5	26.1	11.0	11.9	18.4
Mean	22.5	25.8	13.8	9.5	
2005					
25 cm x 5 cm	17.5	12.4	16.3	10.3	14.1
25 cm x 10 cm	32.1	30.7	27.0	9.8	24.9
30 cm x 10 cm	21.2	6.0	17.3	11.3	14.0
30 cm x 15 cm	14.2	10.2	17.3	13.2	13.7
60 cm x 10 cm	10.8	10.5	15.5	9.4	11.6
Mean	19.2	14.0	18.7	10.8	

		2004	2005
LSD $(_{0.05})$ for sowing date (D) mean	=	6.28	5.27
LSD $(_{0.05})$ for plant spacing (S) means	=	5.05	5.70
LSD $(_{0.05})$ for S x D means	=	NS	NS

sowing was delayed to early July or early August. In 2004, shoot dry matter of 21.0 g/plant was significantly higher at the wider spacing of 30 cm x 15 cm compared to 30 cm x 10 cm. On the other hand, in 2005, higher shoot dry matter of 24.9 g/plant was obtained with the closer spacing of 25 cm x 10 cm than other spacing. Interaction between plant spacing and sowing date did not significantly ($P>0.05$) affect shoot dry matter in both years.

In Table 6, the number of capsules harvested per plant was significantly reduced from 52.9 to 44.9 as sowing was delayed till August in 2004, but there was no significant reduction in 2005. Averaged over two years, the highest number of capsules produced per plant (65.5) was obtained at the widest spacing of 60 cm x 10 cm while the least value (33.3) was obtained with the closest spacing of 25 cm x 5 cm . In 2004, the number of capsules per plant obtained at the June 24 sowing date was 4, 7, and 18% higher than the values obtained at July 8, July 29, and August 5 plantings, respectively. Significant differences occurred between the late June and early August sowing dates in 2004. The number of capsules produced with the closest spacing (25 cm x 5 cm) was about 49% lower than that with widest spacing (60 cm x 10 cm). There was no sowing date x plant spacing interaction effect on number of capsules per plant in both years.

The number of seeds per capsule was significantly ($P<0.05$) increased with the wider spacing of 25 cm x 10 cm (49.6) and 60 cm x 10 cm (48.1) than at the closest spacing of 25 cm x 5 cm in 2004 and 2005 (Table 7). Sowing date and

Table 6: Effect of plant spacing and sowing date on the number of capsules per plant in Yandev 55 variety of sesame

	Sowing Dates				
Spacing	**24th June**	**8th July**	**22nd July**	**5th Aug.**	**Mean**
2004					
25 cm x 5 cm	26.6	35.6	38.3	31.2	32.9
25 cm x 10 cm	51.3	48.7	42.7	39.2	45.5
30 cm x 10 cm	54.4	52.4	47.9	48.0	50.7
30 cm x 15 cm	63.9	55.0	56.0	48.7	55.9
60 cm x 10 cm	68.3	62.0	63.3	57.4	62.8
Mean	52.9	50.7	49.6	44.9	
2005					
25 cm x 5 cm	29.9	30.5	37.7	36.1	33.6
25 cm x 10 cm	48.9	40.7	45.5	44.3	44.9
30 cm x 10 cm	57.1	60.5	57.0	55.7	57.6
30 cm x 15 cm	69.4	58.5	72.2	64.7	66.2
60 cm x 10 cm	75.5	64.9	63.3	69.1	68.2
Mean	56.2	51.0	55.1	54.0	

		2004	2005
LSD ($_{0.05}$) for sowing date (D) mean	=	5.07	NS
LSD ($_{0.05}$) for plant spacing (S) means	=	5.17	7.20
LSD ($_{0.05}$) for S x D means	=	NS	NS

Table 7: Effect of plant spacing and sowing date on the number of seeds per capsule of Yandev 55 variety of sesame.

Spacing	Sowing Dates 24th June	8th July	22nd July	5th Aug.	Mean
2004					
25 cm x 5 cm	41.4	43.4	39.5	44.1	42.1
25 cm x 10 cm	41.3	47.8	45.3	47.7	45.5
30 cm x 10 cm	44.5	47.4	51.5	48.4	48.0
30 cm x 15 cm	43.9	52.5	43.1	42.1	45.4
60 cm x 10 cm	54.0	52.3	52.2	62.1	55.2
Mean	45.0	48.7	46.3	48.9	
2005					
25 cm x 5 cm	41.3	43.8	43.6	37.1	41.5
25 cm x 10 cm	51.3	48.0	50.9	48.2	49.6
30 cm x 10 cm	50.6	44.8	44.3	51.9	47.9
30 cm x 15 cm	44.3	48.3	50.9	46.4	47.5
60 cm x 10 cm	53.8	43.5	44.4	50.5	48.1
Mean	48.3	45.7	46.8		

		2004	2005
LSD $(_{0.05})$ for sowing date (D) mean	=	NS	NS
LSD $(_{0.05})$ for plant spacing (S) means	=	4.09	5.78
LSD $(_{0.05})$ for S x D means	=	NS	NS

sowing date x plant spacing interaction did not clearly influence the number of seeds per capsule in both years.

From the data in Table 8, seed yield obtained at the spacing of 30 cm x 10 cm (484 kg/ha) and 30 x 15 cm (452 kg/ha) were statistically similar but significantly higher than the yield values at the widest spacing of 60 cm x 10 cm (258 kg/ha) and closest spacing of 25 cm x 10 cm (380 kg/ha) and 25 cm x 5 cm (291 kg/ha) in 2004. However, in 2005, the closer spacing of 30 cm x 10 cm(680 kg/ha) produced significantly higher seed yield than other spacings. Averaged over the two years, the closer spacing of 30 cm x 10 cm gave seed yield that was higher than the yields obtained at 60 cm x 10 cm, 30 cm x 15 cm, 25 cm x 10 cm and 25cm x 5 cm by 110, 18, 45 and 73%, respectively. On the other hand, seed yield increased significantly with delay in sowing date up to late July in 2004 and 2005. Further delay in sowing date to early August resulted in significant reduction in yield. The late July 22 sowing date which gave the highest seed yield, was higher than the yields in late June, early July and early August plantings by 109, 62 and 44% respectively on average. The interactions between plant spacing and sowing date were significant in both years, with the highest yield produced at the closer spacing of 30 cm x 10 cm (680 kg/ha) and (1148 kg/ha) in 2004 and 2005, respectively in the late July sowing date.

Table 8: Effect of sowing date and plant spacing on the seed yield (kg/ha) of Yandev 55 variety of sesame.

	Sowing Dates				
Spacing	**24th June**	**8th July**	**22nd July**	**5th Aug.**	**Mean**
2004					
25 cm x 5 cm	215	268	383	298	291
25 cm x 10 cm	257	287	573	402	380
30 cm x 10 cm	303	473	680	480	484
30 cm x 15 cm	222	415	612	560	452
60 cm x 10 cm	194	238	296	302	258
Mean	238	336	509	408	373
2005					
25 cm x 5 cm	295	360	472	389	379
25 cm x 10 cm	325	378	560	422	421
30 cm x 10 cm	450	537	1148	586	680
30 cm x 15 cm	380	428	843	478	532
60 cm x 10 cm	213	307	415	236	293
Mean	333	402	688	422	461

		2004	2005
LSD ($_{0.05}$) for sowing date (D) mean	=	41.2	35.3
LSD ($_{0.05}$) for plant spacing (S) means	=	36.9	31.6
LSD ($_{0.05}$) for S x D means	=	82.4	70.7

DISCUSSION

The use of optimum plant spacing is a very important agronomic practice employed to maximize the yield of crops. Data obtained in this study showed that plant spacing had significant effects on number of capsules per plant , number of seeds per capsule and seed yield. The observed decrease in number of capsules per plant, and number of seeds per capsule, as the plant density increased indicates that the yield attributes were dictated primarily by competition with neighbouring plants for light, nutrients or both. Adams (1967) observed that when inter-plant competition became intense in field bean (Phaseolus vulgaris) and hence limiting the availability of environmental resources to the individual plant, it ultimately leads to high intra-plant competition for assimilates resulting in a compensatory variation among the yield components.

With interplant competition for light and nutrients reduced with wider spacing, greater number of capsules per plant and number of seeds per capsule occurred at low populations (60 cm x 10 cm). Similar increase in yield components of sesame as spacing between plants increased has been reported (Delgado and Yermanos, 1975; Jadhav et. al; 1992; Majumdar and Roy; 1992 and Caliskan et. al; 2004). On the basis of seed yield per hectare, more benefits accrued due to closer spacings. Maximum yield was obtained at the closer spacing of 30 cm x 10 cm, corresponding to 333, 333 plants/ha. However, when compared to the wider spacing of 30 x 15 cm and 60cm x 10 cm or the closest spacings of 25 cm x 10 cm and 25 cm x

5 cm, yield reductions ranged between 18 and 110%. Holliday (1960) similarly reported that as plant density increases, the yield of seed increases to a maximum, and then declines as the population pressures increase still further; even when moisture and nutrients are not limiting. The superior yields obtained at high plant population have been attributed to better water utilization, as a result of less evaporation, better weed control through canopy shading, better radiant energy utilization, increased photosynthesis and improved leaf distribution (Obasi, 1989; Funnah and Matsebula; 1984). The results of this investigation would therefore favour the adoption of 30 cm x 10 cm spacing for Yandev 55 variety of sesame in south eastern Nigeria.

Sowing date had significant effects on some Yandev 55 morphological characteristics and seed yield and yield components. While plant height and number of leaves were increased, number of branches and shoot dry matter were decreased with delay in sowing to July or August. Similar reduction in shoot dry matter of African yambean and soybean have been reported following delay in planting date (Okpara, 1999 and Okpara et al., 2005). The results of the present investigation showed that sowing sesame in late July significantly increased seed yield. Generally, seed yield declined as sowing date was extended from late July to early August. In a study involving sesame cultivars in the guinea savanna, Adeyemo and Ogunwolu (1996) attributed the decline in seed yield following delay in sowing to reduced seed filling duration (shorter flowering period), reduced pod production and lighter weight of seed while Busari and Ajewole (1993) reported earlier flowering and reduced number of capsules/plant in late plantings made in September. Seed yield obtained in the late July planting was higher than the yields of late June, early July and early August sowing dates by 109, 62 and 44 %, respectively. Weiss (1971) reported that environmental influences especially rainfall determine the extent to which the genetic potential of a variety of sesame is expressed or suppressed while Yayock et al. (1988) indicated that sesame requires five months of rainy season and 500 mm of rain, conditions which can be met by planting in the fourth week of July in areas of high rainfall and long duration as in southeastern Nigeria.

The highest seed yields of 680.0kg/ha in 2004 and 1148.0 kg/ha in 2005 obtained at 30 cm x 10 cm spacing in late July, were much higher than the highest seed yield of 400 kg/ha reported by Adeyemo and Ogunwolu (1996) in the guinea savanna. The disparities in response reported could be related to differences in the plant population used, as well as differences in weather (rainfall) and edaphic factors which vary from region to region. The total rainfall recorded during the period (1558.0 mm in 2004 and 1459.9 mm in 2005 from June to November) was much higher than the rainfall of 992.0 mm in 1989 and 913.9 mm in 1990 for the same period as reported by Adeyemo and Ogunwolu (1996). From this study, it appeared that high sesame seed production could be obtained by planting in the fourth week of July and at a spacing of 30 cm x 10 cm. Sowing before or after this period and below or above this population resulted in substantially lowered yields under Obubra conditions in southeastern Nigeria.

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