



Effects of Variety and Spacing on Growth Characters of Hybrid Maize

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Abstract

This study was carried out in Teaching and Research Farm of Delta State University, Asaba Campus from March, 2008 to June, 2010 to evaluate the effects of variety and spacing on growth characters of hybrid maize. It was a factorial experiment carried out in a Randomized Complete Block Design (RCBD) with three replicates. Three hybrid maize varieties were evaluated under three different plant spacing for such growth characters as plant height, number of leaves, leaf area and stem girth. The results obtained during the 8th week after sowing indicated that hybrid variety 9022-13 which had mean plant height of 170.0cm number of leaves of 13.2, leaf area of 673.2cm² and stem girth of 99.4mm was superior to other varieties investigated. With respect to spacing, plants sown on 75 cm x 15 cm had higher mean height and number of leaves of 176.7 cm and 13.8, respectively while plants sown on spacing of 75 cm x 35 cm had higher mean leaf area of 713.7 cm² and stem girth of 99.4mm, respectively. Results of interaction showed that variety and spacing were significantly ($P < 0.05$) different in 2008 and 2009. Based on the findings of this study, it is recommended that (i) hybrid variety 9022-13 be grown in the study area of enhanced growth characters which interplay to improve grain yield of maize (ii) spacing of 75 cm x 35 cm be used to enhance increased stem girth and leaf area whose photosynthetic activities could positively influence maize yield.

Keywords: Variety and spacing, growth characters, hybrid maize, Asaba, Nigeria

Introduction

Maize (*Zea mays* L) is one of the major cereal crops grown in the humid tropics and Sub-Saharan Africa. It is a versatile crop and ranks third following wheat and rice in world production as reported by Food and Agriculture Organization (FAO, 2002). Maize crop is a key source of food and livelihood for millions of people in many countries of the world. It is produced extensively in Nigeria, where it is consumed roasted, baked, fried, pounded or fermented (Agbato, 2003). In advanced countries, it is an important source of many industrial products such as corn sugar, corn oil, corn flour, starch, syrup, brewer's grit and alcohol (Dutt, 2005). Corn oil is used for salad, soap-making and lubrication. Maize is a major component of livestock feed and it is palatable to poultry, cattle and pigs as it supplies them energy (Iken *et al.*, 2001). The stalk, leaves, grain and immature ears are cherished by different species of livestock (Dutt, 2005).

In spite of the increasing relevance and high demand for maize in Nigeria, yield across the country continues to decrease with an average of about 1 t/ha which is the lowest African yield recorded (Fayenisin, 1993).

The steady decline in maize yield can be attributed to:

1. Rapid reduction in soil fertility caused by intensive use of land and reduction of fallow period as reported by Directorate of Information and Publications of Agriculture (DIPA, 2006).

2. Failure to identify and plant high yielding varieties most suited or adapted to each agro-ecological zone (Kim, 1997).
3. Use of inappropriate plant spacing which determines plant population and final yield (Zeidan *et al.*, 2006).

Tolera *et al.*, (1999) suggested that breeders should select maize varieties that combine high grain yield and desirable stover characteristics because of large differences that exist between cultivars. Odeleye and Odeleye (2001) reported that maize varieties differ in their growth characters, yield and its components, and therefore suggested that breeders must select most promising combiners in their breeding programmes.

Iken and Anusa (2004) recommended an optimum plant population of 53,333 plants/ha for maximum yield of maize. Their report indicated that this is obtainable using a spacing of 75cm x 25cm at 1 plant per stand or 75cm x 50cm at 2 plants per stand. Azam *et al.*, (2007) reported that spacing of 75cm x 35cm resulted in increased grain yield of maize while 75cm x 15cm gave maximum cob weight. Similar report by Alessi and Power (2004) revealed that maize cob weight decreased with increased plant population.

At present, some farmers in Asaba area sow any maize variety of their choice at such spacings as 90 cm x 30 cm, 90 x 20 cm or 75 cm x 50 cm which do not translate into expected high yield in the study area. Hence, there are no recommended standards taking

into consideration the different combinations of such cultural practices as varietal selection and appropriate plant spacing which interplay to influence yield and optimal performance of maize in Asaba area of Delta State. Against this background, the broad objective of this study, therefore, was to: identify variety of maize most suited or adapted to Asaba area and the appropriate spacing for the variety.

The specific objectives were to:

- (i) identify the best hybrid maize variety for Asaba area, and spacing for the crop.
- (ii) determine the responses of growth characters of hybrid maize to variety and spacing.

Materials and Methods

Site description

The study was carried out in the Teaching and Research Farm of Delta State University, Asaba Campus from March to December 2008 and repeated between March and December, 2009. Asaba is located at latitude 06°14'N and longitude 06°49'N of the equator. It lies in the tropical rainforest zone dominated by mangrove, fresh water, swamps, humid forests and secondary vegetation (NEST, 1991). Its climate is influenced by the movement of the Inter-Tropical Discontinuity (ITD). The ITD is made up of two wind systems namely the moisture-laden South-West monsoon from the Atlantic Ocean and the dry cold North-East trade wind from the Sahara desert. The South-West Trade wind most significantly

determines the climate condition of Asaba area of Delta State. Asaba is characterized by raining season between April and October, with annual mean-rainfall of 1500mm and 2000mm maximum. The distribution is bimodal with peak in July and September, coupled with a period of low precipitation in August. Mean temperature is 23.8°C with 37.3°C as maximum. Relative humidity is 77.2%, the mean monthly soil temperature at 100m depth is 20.3 °C, while sunshine stands at 4.8 bars (Meteorological Office, Asaba, 2003).

Pre-planting Soil Analysis

Representative surface soils (0-20cm) were sampled with a tubular sampling auger. These soil samples were air-dried at room temperature for 5 days and crushed to pass through a 2mm mesh sieve. Sub-samples from the bulked soil sample were further grounded to pieces to pass through 100mm-mesh sieve for the determination of organic matter. The rest samples were then analyzed to determine the physical and chemical properties of the soil. The analysis was done at Delta State University, Asaba campus.

Analytical Procedure

Physical properties

Particle size distribution: Particle size distribution was analyzed using the Bouyoucos hydrometer method in which 0.5 N Sodium hexameta-phosphate was used as dispersant (Landor, 1991).

Bulk density: The bulk density (Bd) was determined by Core-method.

Particle density: This was determined by pycnometer or specific gravity bottle method as described by Bowles (1992).

Chemical Properties

Soil pH: This was determined in soil: water suspension (1:1) using glass electrode pH-meter as described by Mclean (1982).

Organic carbon: This was determined using the wet oxidation method of Walkley and Black (Walkley and Black, 1945).

Total nitrogen: This was determined using the modified K. Jeldah distillation method as described by Landor (1991).

Exchangeable cations (EC) and Effective cation exchange capacity (ECEC):

Exchangeable cations were determined by extracting the cations with IN ammonium acetate (IN, NHOAC) as displacing solution, buffered at pH₇ as described by Brady and Weils (1999). The extract was then determined electrochemically using atomic absorption spectrophotometry. The effective cation exchange capacity (ECEC) was calculated as the sum of exchangeable bases (Ca, Mg, K and Na) and exchangeable Al and H expressed in cmo/kg⁻¹ of soil.

Exchangeable acidity: This was determined by titration method as described by Juo (1981). The exchangeable H⁺ and Al³⁺ were then expressed in cmo/kg⁻¹ of soil

Available phosphorus: This was determined by Bray No.1 method as described by Landor (1991).

Cation exchangeable capacity: This was determined by neutral NH₄ Acetate placement method using the procedure of Anderson and Ingram (1996).

Land Preparation and Plot Layout

The land was ploughed and harrowed using tractor. Three blocks (replicates) consisting of 9 plots each were laid out. Each plot measured 2.6 m x 2.25 m, and was separated from one another with a space of 0.5 m. Alley pathways of 1 m separated one block from the other. The total number of plots laid out in the entire experiment was 27.

Experimental Design

The experiment was a factorial experiment carried out in a Randomized Complete Block Design (RCBD) with three replicates.

Selection of Maize Varieties, Planting and Cultural Practices

Three hybrid varieties of maize were obtained from International Institute of Tropical Agriculture (IITA), Ibadan.

Maize seeds were sown at depth of 2-3cm in plots measuring 2.6m x 2.25m at the rate of one seed per stand using three different spacings:

1. 75cm x 35cm which gave a population density of 38000 plants/ha.
2. 75cm x 25cm which gave a population density of 53, 333 plants/ha.
3. 75cm x 15cm which gave a population density of 88,888 plants/ha.

Weeding: Weeding was done three times using hoe.

Experimental Design

The study was conducted in a factorial layout using a Randomized Complete Block Design (RCBD), and replicated three times.

Data Collection and Statistical Analysis

Fourteen (14) middle maize stands were used as sample in plots evaluated under 75cm x 15cm, 75cm x 25cm and 75cm x 35cm, respectively. Data collected at fortnight intervals starting from the 4th week after sowing included plant height, number of leaves, stem girth, leaf area. Plant height was measured with tape from the base of the plant to the first tassel, leaf area was measured also with tape using non-destructive analysis method (length x breadth by correction factor 0.75, Duke and Duleliar (1993); number of leaves, was obtained by direct counting; stem girth was measured using tape; data collected was subjected to analysis of variance (ANOVA) and treatment means were separated by Duncan Multiple Range Test (DMRT), using SAS (1996).

Results

Soil Physico-chemical Properties of the Experimental Site:

The pre-physico-chemical properties of the experimental site is shown in Table 1. The result showed predominantly sand at the surface and this tends to decrease with depth of profile. Texturally, the soil of the experimental site is classified as sandy loam. The soil is acidic with pH of 6.2 in H₂O and 5.6 in CaCl. The organic matter content and total nitrogen were low with values of 1.22 gkg⁻¹ and 0.113 gkg⁻¹. The available P was high with value of 26.5 mgkg⁻¹. The exchangeable cations (Ca, Mg, Na and K) were equally low in status with values of 2.6cmolkg⁻¹ for Ca²⁺ and 0.9 cmolkg⁻¹ for Mg²⁺. The value obtained for Na⁺ was 0.57 cmolkg⁻¹, which was moderate while that for K⁺ was 0.08cmolkg⁻¹, which was low. The CEC was 4.15, while ECEC was 5.6cmolkg⁻¹, which were generally low. The exchangeable acidity was only trace for Al³⁺ and characteristically low for H⁺ with a value of 1.4 cmolkg⁻¹.

Table 1: Physico-chemical Properties of Experimental Site

Soil Property		Value	Interpretation
Particle Size Distribution (%)			
	Coarse sand	38	
	Fine sand	41	
	Silt	9	
	Clay	12	
	Texture		Sandy loam
pH	H ₂ O	6.2	Acidic
	CaCl	5.6	Acidic
Organic	Carbon gkg ⁻¹	0.71	
Organic	Matter gkg ⁻¹	1.22	Very low
Total	Nitrogen gkg ⁻¹	0.113	Low
Available	P (ppm)	26.5	
Exchangeable bases (cmol/kg ⁻¹)			
	Na ⁺	0.57	Moderate

	K ⁺	0.08	Very low
	Ca ²⁺	2.60	Low
	Mg ²⁺	0.90	Low
Cation Exchange Capacity		4.15	
Exchangeable acidity (cmol/kg ⁻¹)			
	Al ³⁺	Trace	
	H ⁺	1.4	
Effective cation Exchangeable capacity (Cmol/kg ⁻¹)		5.6	

Effects of Variety and Spacing on Plant Height of Hybrid Maize

The effects of variety and spacing on plant height of hybrid in 2008 and 2009 maize is shown in Table 2. There were gradual increases in plant height of maize from the 4th to the 8th week after sowing. There were significant differences also in the plant height of the maize varieties investigated. In 2008, hybrid variety 9022-13 had the highest plant height of 35.1 cm at 4 weeks after sowing, followed by Oba 98 with height of 33.4cm. among the varieties integrated, Oba super 2 had the lowest plant height (31.9cm) among the varieties evaluated. This trend did not change during the 6th and 8th week of sowing. In 2009, hybrid 9022-13 was superior in plant height during the 6th week (82.6 cm) and 8th week (171.8 cm), followed by Oba 98 which grew up to 73.3 cm at the 6th week and 163.5 cm during the 8 week after sowing.

There was however, little deviation only in week 4 of 2009 when Oba super with height of 36.6 cm and Oba 98 with height of 36.6 cm grew taller than 9022-13 with height of 35.1 cm. Generally, the superiority in plant height based on variety was 9022-13 > Oba 98 > Oba super 2.

With respect to spacing, maize plants sown at 75 cm x 15 cm in 2008 grew taller than

other plants during the 4th week their height was 36.2 cm, at the 6th week their height was 67.7 cm and during the 8th week they grew up to 172.5 cm.

These were followed by plants sown at 75 cm x 25 cm which grew up to 65.3 cm at the 6th week and 58.2 cm at the 8th week after sowing. Plants sown at 75 cm x 35 cm had the lowest plant height in 2008. The trend in plant height of maize as affected by spacing remained the same in 2009 as shown: plants sown at 75 cm x 15 cm > plants sown at 75 cm x 25 cm >, plants sown at 75 cm x 35 cm. The results of interaction (Table 6) showed that variety and space were significantly ($P < 0.05$) different throughout the period of the evaluation and positively affected plant height.

Effects of Variety and Spacing on Number of Leaves of Hybrid Maize

The response of number of leaves of hybrid maize to variety and spacing in 2008 and 2009 is shown in Table 3. Number of leaves of maize gradually increased from the 4th to the 8th week after sowing. There were significant differences in the number of leaves of the hybrid varieties investigated. Hybrid variety 9022-13 had the highest number of leaves of 8.3 at 4 weeks after sowing, followed by Oba super 2 which had

7.4. Oba 98 had the lowest number of leaves (7.2). During the 6th and 8th week of the same year, hybrid variety 9022-13 was also outstanding in the number of leaves with values of 12.3 and 13.8, respectively. Oba super 2 plants had the lowest number of leaves with values of 10.1 and 11.6 in the 6th and 8th weeks of 2008, respectively. In 2009, the mean number of leaves of hybrid variety 9022-13 from the 6th to the 8th week (13.2) indicated that the trend in the number of leaves did not change. The superiority in number of leaves at the end of the 8th week, with respect to variety was 9022-13 > Oba 98 > Oba super 2.

Based on spacing, plants sown at 75 cm x 15 cm had the highest number of leaves from the 4th to 8th week after sowing in both years of evaluation. There were no significant differences in number of leaves of plants sown at both 75 cm x 25 cm and 75 cm x 35 cm. The results of interaction indicated that variety and spacing were significantly ($P < 0.05$) different and positively affected number of leaves of maize.

Effects of Variety and Spacing on Leaf Area of Hybrid Maize

The response of leaf area of hybrid maize to variety and spacing in 2008 and 2009 is shown in Table 4. Leaf area of maize gradually increased from the 4th to the 8th week after sowing. There were significant differences in leaf area of the hybrid maize varieties evaluated. In the 4th week of 2008, hybrid variety 9022-13 had the highest leaf area (149.0 cm²), followed by Oba 98 which had 361.7 cm². Oba super plants had the

smallest leaf area (331.3 cm²). The mean value with respect to leaf area of hybrid variety 9022-13 (673.2 cm²) indicated that the variety was superior to other varieties tested by the end of the 8th week after sowing. In 2009, hybrid variety 9022-13 was also outstanding in leaf area with values of 161.8 cm² in the 4th week while the mean value of Oba super 2 plants was least (578.5cm²). The order of superiority with respect to leaf area was 9022-13 > Oba 98 > Oba super 2.

Based on spacing, plants sown at 75 cm x 35 cm in 2008 were superior in leaf area with values of 140.3 cm² at week 4, 455.4 cm² at week 6, and 703.5 cm² during week 8. The trend did not change in 2009. The superiority in leaf area based in spacing was 75 cm x 35 cm > 75 cm x 25 cm > 75 cm x 15 cm. The interactions results showed that variety and spacing were significantly ($P < 0.05$) and positively affected leaf area of maize.

Effects of Variety and Spacing on Stem Girth of Hybrid Maize

The effects of variety and spacing in stem girth of hybrid maize in 2008 and 2009 are shown in Table 5. Stem girth of the different varieties investigated gradually increased from 4th – 8th weeks after sowing. There were significant differences in stem girth of the varieties evaluated. In 2008, hybrid variety 9022-13 had the highest stem girth of 50.0 mm, at the 4th week after sowing, followed by Oba 98 which had 38.4 mm. Oba super 2 had the lowest stem girth (36.4 mm). During the 6th week after sowing, variety 9022-13 was also superior with stem

girth of 70.0 mm, followed by Oba 98 with stem girth of 64.4 mm. Oba super 2 plants had the smallest stem girth (63.5mm). At 8 weeks after sowing, variety 9022-13 was also outstanding in stem girth (83.3mm) while Oba super 2 had the lowest stem girth (73.3mm). In 2009, the trend in superiority of stem girth did not change. Hybrid variety 9022-13 plants had the highest stem girth at 4, 6 and 6 weeks after sowing (51.3 mm, 105.6 mm and 115.5 mm, respectively). Oba super 2 plants had the smallest stem girth of 37.1 mm at the 4th week, 77.8 mm at 6th week and 89.8 mm at the 8th weeks after sowing. Based on spacing, maize plants sown at 75 cm x 35 cm in 2008 had the

highest stem girth of 46.0 mm at the 4th week, 75.7 mm at the 6th week, and 87.7 at the 8th week. In 2008 also, plants sown at spacing of 75 cm x 15 cm had the smallest stem girth of 34.8 mm at the 4th week, 55.5 mm at the 6th week, and 67.7 mm at the 8th week after sowing. Stem girth followed similar trend in 2009.

Plants sown at spacing of 75 cm x 35 cm were superior in stem girth while plants sown at spacing of 75 cm x 15 cm had the smallest stem girths. The interaction results showed that variety and spacing were significantly ($P < 0.05$) different and positively affected stem girth of maize.

Table 2: Effects of Variety and Spacing on Plant Height of Maize in 2008 and 2009

	Weeks after sowing								
	4			6			8		
	Plant Height (cm)								
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Variety									
Oba Super 2	31.9 _c	36.6 _a	34.3 _b	58.8 _c	69.3 _c	64.1 _c	146.5 _c	166.1 _b	156.3 _c
Oba 98	33.4 _b	36.6 _a	35.0 _a	60.4 _b	73.3 _b	66.9 _b	163.5 _b	163.5 _c	163.5 _b
9022-13	35.1 _a	35.1 _b	35.1 _a	68.3 _a	82.6 _a	75.5 _a	168.2 _a	171.8 _a	170.0 _a
Spacing (cm)									
75 x 15	36.2 _a	43.1 _a	39.7 _a	67.7 _a	87.3 _a	77.5 _a	172.5 _a	180.9 _a	176.7 _a
75 x 25	31.5 _b	32.9 _b	32.2 _b	65.3 _b	72.9 _b	69.1 _b	158.2 _b	154.8 _c	156.5 _c
75 x 35	32.6 _b	32.3 _b	32.5 _b	59.7 _c	65.1 _c	62.4 _c	147.5 _c	157.9 _b	152.7 _c

Means with the same letter(s) under the same column are not significantly ($P > 0.05$) different using Duncan Multiple Range Test (DMRT)

Table 3: Effects of Variety and Spacing on Number of Leaves of Maize in 2008 and 2009

	Weeks after sowing								
	4			6			8		
	Number of Leaves								
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Variety									
Oba Super 2	7.4 _b	7.5 _a	7.5 _b	10.1 _c	11.1 _c	10.6 _c	11.6 _c	12.8 _a	12.2 _c
Oba 98	7.2 _c	7.3 _b	7.3 _c	10.5 _b	11.3 _b	10.9 _b	13.0 _b	12.7 _b	12.9 _b
9022-13	8.3 _a	7.3 _b	7.8 _a	12.3 _a	11.4 _a	11.9 _a	13.8 _a	12.6 _c	13.2 _a
Spacing (cm²)									

75 x 15	7.8 _a	8.2 _a	8.0 _a	11.3 _a	12.0 _a	11.7 _a	13.4 _a	14.2 _a	13.8 _a
75 x 25	7.9 _a	7.2 _b	7.6 _b	10.7 _b	10.9 _b	10.8 _b	12.4 _b	12.0 _b	12.2 _b
75 x 35	7.7 _A	7.0 _b	7.4 _b	10.9 _b	10.9 _b	10.9 _b	12.5 _b	11.9 _b	12.2 _b

Means with the same letter(s) under the same column are not significantly ($P > 0.05$) different using Duncan Multiple Range Test (DMRT)

Table 4: Effects of Variety and Spacing on Leaf Area of Maize in 2008 and 2009

	Weeks after sowing								
	4			6			8		
	Leaf area (cm ²)								
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Variety									
Oba Super 2	108.8 _b	121.2 _b	115.0 _b	331.3 _c	314.1 _b	322.7 _c	563.5 _b	589.4 _c	576.5 _c
Oba 98	98.6 _c	117.6 _c	108.1 _c	361.7 _b	287.9 _c	324.8 _b	596.2 _a	626.4 _b	611.3 _b
9022-13	149.0 _a	161.8 _a	155.4 _a	483.5 _a	500.5 _a	492.0 _a	559.3 _c	787.1 _a	673.2 _a
Spacing (cm²)									
75 x 15	110.7 _b	112.1 _c	111.4 _c	290.2 _c	288.0 _c	289.1 _c	567.7 _c	606.8 _c	587.3 _c
75 x 25	105.4 _c	130.8 _b	118.1 _b	389.9 _b	377.6 _b	383.8 _b	656.2 _b	675.8 _b	666.0 _b
75 x 35	140.3 _a	157.6 _a	148.9 _a	455.4 _a	436.9 _a	446.2 _a	703.5 _a	723.8 _a	713.7 _a

Means with the same letter(s) under the same column are not significantly ($P > 0.05$) different using Duncan Multiple Range Test (DMRT)

Table 5: Effects of Variety and Spacing on Stem Girth of Maize in 2008 and 2009

	Weeks after sowing								
	4			6			8		
	Stem girth (mm)								
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Variety									
Oba Super 2	36.4 _c	37.1 _c	36.8 _c	63.5 _c	77.8 _c	79.8 _b	73.3 _c	89.8 _b	81.6 _c
Oba 98	38.4 _b	37.7 _b	38.1 _b	64.4 _b	78.8 _b	71.6 _c	76.6 _b	88.9 _c	82.8 _b
9022-13	50.0 _a	51.3 _a	50.6 _a	70.0 _a	105.6 _a	87.8 _a	83.3 _a	115.5 _a	99.4 _a
Spacing (cm²)									
75 x 15	34.8 _c	33.9 _c	34.4 _c	55.5 _c	74.2 _c	64.9 _c	67.7 _c	85.5 _c	76.6 _c
75 x 25	43.8 _b	44.4 _b	44.1 _b	66.6 _b	131.6 _b	98.9 _b	77.7 _{cb}	97.5 _b	87.6 _b
75 x 35	46.0 _a	46.4 _a	46.2 _a	75.7 _a	180.0 _a	127.9 _a	87.7 _a	111.1 _a	99.4 _a

Means with the same letter(s) under the same column are not significantly ($P > 0.05$) different using Duncan Multiple Range Test (DMRT).

Discussion

Physico-chemical Properties of the Experimental Site

The sandy loam texture of the experimental site may be attributed to the parent material (PM) from which the soil was formed and the climate of the area. The soil might be

formed from sandstone and quartz parent materials. These impart sandy texture to the soils. The high sand content of the soil could be attributed to high content of quartz in the parent material (Brady and Weils, 1999).

The weakly acid nature of the soil of the area may be traced to the marked leaching of exchangeable bases resulting from the high rainfall associated with the environment and

the dissociation of strong and functional group in the organic matter. This is in harmony with the findings of Esu (2001). The low organic matter status of the experimental site could be attributed to the rapid decomposition of organic matter due to high solar radiation and moisture, these favour optimum microbial activities in the soil. It could also be attributed to the annual seasonal bush burning which tend to deplete organic matter accumulation in the soil (Landor, 1991). The low level of total nitrogen could be possibly due to low organic matter content of the soil which contributes about 90-95% of soil nitrogen (Nnaji *et al.*, 2002). It could also be attributed to leaching of nitrate by torrential rainfall prevalent in the environment (Olatunji *et al.*, 2007). The high level of Phosphorus may be attributed to either of these reasons: (i) History of land use and cultural practices associated with the land use (that is, cropping of crops that do not take much P nutrient from the soil and the application of P organic or inorganic fertilizers (Nnaji *et al.*, 2002 and Nnaji, 2008). (ii) The parent material from which the soil was formed may be rich in P minerals (Brady and Weils, 1999). (iii) The soil may not be highly acidic as to cause high level of P fixation (Brady and Weils, 1999; Omokri *et al.*, 2007). The low values of exchangeable cation may be attributed to the leaching of bases from the solum due to the high rainfall characteristics of the area. The low cation exchange capacity could be attributed to the PM from which the soil was formed, and low organic matter (OM) content of the soil. The PM from which the

soil was formed may be poor in basic nutrients. FMANR (1990) noted that soils of the study area were dominated by Fe oxide and kaolinites. These clay minerals are low in basic cations (Esu, 2001). The exchangeable acidity was low possibly because of leaching of basic cations by torrential rainfall. The results generally are in harmony with the findings of Osaretin *et al.*, (2006), Olatunji *et al.*, (2007) and the results of soil fertility evaluation in the region. It is also consistent with the findings of Nnaji *et al.* (2002 and 2008) which reported that the history of landuse and cultural practices affect soil conditions and crop productivity.

Effect of Variety and Spacing on Plant Height of Maize

The differential growth with respect to plant height observed among the varieties may be attributed to differences in genetic characteristics of the individual varieties, including rapid growth rates, tallness or shortness of species. This is similar to the findings of Majambu *et al.*, (1996) and Ibrahim *et al.*, (2000) that attributed the differences in growth indices of crops to genetic constitution. Maize plants spaced 15cm grew taller than other plants possibly because of increased competition for space, sunlight and available nutrients. This is similar to the findings of Teasdale (1995), Widdicombe and Thelen (2002), and Dalley *et al.* (2006) who attributed the increased growth rates and earlier canopy closure of narrow row spaced crops to quest for increased light interception as well as increased availability of soil moisture

because of equidistant distribution of crop plants. It is also consistent with the reports of Al-Rudha and Al-Youmis (1998) that maize sown at 15cm had maximum plant height compared with their counterparts sown at wider intra-row spacing.

Effect of Variety and Spacing on Number of Leaves of Maize

The differences observed in the number of leaves of maize may be attributed to differences in growth characters which are being influenced by genetic make-up of the plants. This is similar to the findings of Sajjan *et al.*, (2002) who reported that growth characters of crops varied because of differences in their genetic make-up. Maize plant sown on 15cm spacing had higher number of leaves than their counterparts which were sown at wider spacing possibly because of increased growth rate in search for space, sunlight and other environmental resources. This is consistent with the findings of Al-Rudha and Al-Youmis (1998) and Ali *et al.* (2003) that made similar reports on 15cm-spaced maize plants.

Effect of Variety and Spacing on Leaf Area of Maize

The differences observed in leaf area of the varieties of maize sown could be attributed to the differences in leaf arrangement, photosynthetic activities of leaves, differences in chlorophyll content and activity of photosynthetic enzymes. This is similar to the findings of Gwizdek (1989) who attributed the differences between the leaf area and other growth characters of maize genotypes to differences in

photosynthetic activity of leaves, leaf arrangement, chlorophyll content, stomatal conductance value and activity of photosynthetic enzymes. The differences observed in leaf area is also similar to the findings of Akinfoesoye *et al.*, (1997); Odeleye and Odeleye (2001) who suggested that since maize varieties differ in leaf area, other growth characters as well as in yield and its components, breeders must select most promising combiners in their breeding programmes. Increased intra-row spacing resulted in larger leaf area possibly because there was a reduction in competition for space, sunlight and nutrients within the wider spaced plants. This is similar to the findings of Ali *et al.*, (2003) who reported that competition between maize plants for light, soil fertility and other environmental factors were markedly increased with highest population but decreased with lower plant population.

Effect of Variety and Spacing on Stem Girth (Mm) of Maize

The superiority of hybrid variety 9022-13 over other varieties with respect to stem girth may be attributed to the special qualities credited to hybrids, including disease resistance, early maturity, uniformity in flowering and ear-placement, and very high yield. This is similar to the findings of Obi (1999), Kim (1997), Olakojo *et al.* (1998) and Udoh (2005) who reported that some hybrid maize varieties have yield advantage over other maize varieties because they possess such special qualities as high yield, disease resistance, and early maturity, uniformity in flowering and ear placement,

and ease of harvesting using combined harvester. Maize plants sown at spacing of 35cm were superior in stem girth over those sown at narrower or smaller spacing possibly because the plants obtained more soil moisture and nutrients than narrower-spaced plants. This is similar to the findings of Barbier *et al.* (2000); Hamayan (2003); Dalley *et al.* (2006) and Azam *et al.* (2007) who reported that wider-spaced maize plants obtained more soil moisture and nutrients than narrower plants.

Conclusion and Recommendations

The study was carried out to evaluate the effects of variety and spacing on growth characters of hybrid maize. Three hybrid maize varieties were evaluated under three different plant spacings for such growth characters as plants height, number of leaves, leaf area and stem girth. It was a factorial experiment carried out in a Randomized Complete Block Design (RBCD) with three replicates. Results obtained indicated that hybrid variety 9022-13 was outstanding in growth characters while spacing of 75 cm x 35 cm had highest leaf area and stem girth. Based on the findings of the study, it is recommended that hybrid variety 9022-13 be grown in the study area for enhanced growth characters. Also, spacing of 75 cm x 35 cm is recommended to enhance increased stem girth and leaf area since their photosynthetic activities could positively improve maize yield.

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