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Effects of Variety and Spacing on Percentage (%) Emergence and Grain Weight of Maize in Asaba Area of Delta State

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Abstract

This study was carried out in the Teaching and Research Farm of Delta State University, Asaba Campus from March 2008 to December 2009 to evaluate the response of maize varieties to three different plant spacings. It was a factorial experiment carried out in a Randomized Complete Block Design (RCBD) replicated three times. Ten maize varieties were evaluated under three different plant spacings for their percentage emergence and grain weight. The results of percentage emergence showed that open-pollinated variety BR9922-DMRSF$_2$ which had 93.2% in 2008 and 93.8% in 2009 had highest percentage emergence. The results obtained from the grain weights indicated that hybrid variety 9022-13 that was sown at 75cm x 15cm which yielded 6.3 tha^{-1} in 2008 and 6.4 tha^{-1} in 2009 was superior, followed by open-pollinated variety BR9922-DMRSF$_2$ which yielded 4.7tha^{-1} in 2008 and 4.9tha^{-1} in 2009. The effects of interaction showed that variety and space were significantly ($p<0.05$) different and positively affected maize grain weight. Based on the study, it is recommended that (i) Hybrid maize variety 9022-13 which was outstanding in grain weight be grown in the study area. Alternatively, farmers who prefer open-pollinated varieties could grow BR9922-DMRSF$_{2.}$ (ii) Spacing of 75cm x 15cm which resulted in better percentage emergence and highest grain weight be adopted in maize production.

Keywords: Maize variety, Spacing, Percentage emergence, Grain weight, Asaba Delta State

Introduction

Grown in the humid tropics and Sub-Saharan Africa, maize *(Zea mays L)* is the third most important cereal crop after wheat and rice in world production (FAO, 2002). It serves for food and livelihood for millions of people in the world. In Nigeria, it is consumed roasted, fermented, boiled, fried or baked (Agbato, 2003). In developed countries, it provides such industrial products as corn oil, flour, syrup, brewers' grit and alcohol (Dutt, 2005). Maize is cherished by several livestock species, including cattle, pigs, goats, sheep and rabbits as it supplies them energy (Iken *et al*., 2001).

Irrespective of the numerous uses and high demand for maize in Nigeria, yield across the country has declined to as low as 1t/ha due to rapid reduction in soil fertility, failure to identify high yielding varieties adapted to each agro-ecological zone, use of inappropriate plant spacing, and negligence of soil amendment materials (Fayenisin, 1993, Kim, 1997; 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

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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. Other research works done by Enujeke (2013) showed that (i) Dry grain yield of maize could be increased by applying 15 l/ha of liquid organic fertilizer. (ii) Number of grains/cob and grain weight of maize increases by applying 450 kg/ha of N P K 20 : 10 :10. (iii) Choice of appropriate variety and spacing for any agro – ecological zone positively increases grain yield of maize. 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 Allessi and Power (2004) revealed that maize cob weight decreased with increased plant population.

At present, there are no recommended standards taking into consideration the different combinations of such cultural practices as varietal selection and spacing, which interplay to influence yield and optimal performance of maize in Asaba area of Delta State. 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, and their effects on percentage emergence, and grain weight of maize.

The specific objectives were to:

(i) identify the best variety and spacing for the crop.

(ii) determine the effects of variety and spacing on percentage emergence and grain weight of maize.

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 determine 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 pycometer 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 pH_7 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 A1 and H expressed in $cmo1/kg^{-1}$ of soil.

Exchangeable Acidity: This was determined by titration method as described by Juo (1981). The exchangeable H^+ and $A1^{++}$ 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 NH_{4-} Acetate placement method using the procedure of Anderson and Ingram (1996).

Selection of Maize Varieties, Planting and Cultural Practices

Ten varieties of maize were obtained from International Institute of Tropical Agriculture (IITA), Ibadan and Delta Agricultural Procurement Agency (DAPA), Ibusa. These varieties were selected from the following three broad groups:

1. Hybrids (Oba super 2, Oba 98, 9022-13)
2. Open-pollinated (Suwan-1-SR, ACR 97, BR 9922-DMRSRF_2, AMATZBRC_2 WB
3. Local varieties (Asaba local, Agbor local, Kwale local)

   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 was done three times manually as necessary.

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 were percentage emergence after 7 days from date of sowing and grain weight of maize after harvesting and sherling at the end of the 16^{th} week. Data collected was subjected to analysis of variance (ANOVA) according to Wahua, (1999) and treatment means were separated using Duncan Multiple Range Test (DMRT).

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 H_2O 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 Ca^{2+} and 0.9 $cmolkg^{-1}$ for Mg^{2+}. 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 Al^{3+} 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_2O	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 % Emergence of Maize

The response of percentage emergence of maize varieties to different plant spacings is shown in Table 2. There were significant differences in percentage emergence of maize varieties studied. Open-pollinated variety BR 9922 – DMRSF$_2$ had the highest % emergence of (93.2) in 2008 and 93.8 in 2009, followed by hybrid variety 9022-13 (91.7) in 2008 and 91.9 in 2009 and AMATZBRC$_2$WB variety had the lowest % emergence of 60.2 in 2008 and 62.5 in 2009. This trend was observed in 2009 experimental year in which open-pollinated variety BR9922-DMRSF$_2$ also obtained the highest % emergence of 93.8, followed by hybrid variety 9022-13 (91.9). AMATZBRC$_2$WB had the lowest % emergence of 6.25 among the varieties investigated. With respect to spacing, 15cm-spaced plants had the highest % emergence of 86.8 in 2008 and 86.4% in 2009, followed by plants sown on 25cm intra row spaces (84.0) in 2008 and (84.2) in 2009 and 35cm-spaced plants had the lowest % emergence (77.9) in 2008 and 78.5 in 2009. The order of superiority in % emergence based on plant spacing (cm) was 15 > 25 > 35. The trend was the same in 2008 and 2009.

The interaction effect (Table 3) indicated that apart from variety x space interaction in 2008, other parameters (variety and space) were significantly ($P < 0.05$) different in both years of evaluation.

Effects of Variety and Spacing on Grain Weight of Maize

The effects of variety and spacing on grain weight of maize is shown in Table 2. There were significant differences in grain weight of maize. In 2008, hybrid variety 9022–13 had the highest grain weight of 6.3 t/ha among the varieties tested, followed by open-pollinated variety BR9922-DMRSRF$_2$ (4.7 t/ha). Kwale local and Asaba local varieties had the lowest grain weights of 2.8 t/ha and 2.5 t/ha, respectively. With respect to spacing, maize plants sown on 15cm spacing had the highest grain weight in 2008 (4.7 t/ha) and 2009 (4.8 t/ha), followed by plants sown on 25cm spacing (3.8 t/ha and 4.0 t/ha, respectively). Maize plants sown at 35cm spacing had the lowest grain weights of 2.9 t/ha in 2008 and 3.2 t/ha in 2009. The superiority in grain weight based on spacing was 75cm x 15cm > 75cm x 25cm > 75cm x 35cm. Grain weight followed the same trend in 2009. The effects of interaction of variety and spacing on grain weight of maize (Table 3) showed that except variety * space interaction other parameters, such as variety, space were significantly ($P < 0.05$) different and affected changes in grain weight of maize in 2008 and 2009.

Table 2: Effects of Variety and Spacing on % Emergence and Grain Weight of Maize in 2008 and 2009

	-----------% Emergence-----------			Grain weight of maize (t/ha)		
	2008	**2009**	**Mean**	**2008**	**2009**	**Mean**
Variety						
Oba Super 2	81.8_c	79.4_d	80.6_d	3.2_f	3.8_e	3.5_e
Oba 98	81.5_c	79.6_d	80.6_d	3.0_f	3.1_{ef}	3.1_f
9022-13	91.7_a	91.9_a	91.8_a	6.3_a	6.4_a	6.4_a
Suwan-1-SR	87.2_b	85.6_c	86.4_c	4.2_{bc}	4.3_{bc}	4.2_{bc}
ACR 97	89.3_b	88.5_b	88.9_b	3.7_c	4.1_c	3.9_c
BR9922-DMRSF$_2$	93.2_a	93.8_a	93.5_a	4.7_b	4.9_b	4.8_b
AMATZBRC$_2$ WB	60.2_d	62.5_e	61.4_e	3.5_d	3.7_d	3.6_d
Asaba Local	81.8_c	83.8_c	82.8_d	2.5_g	2.7_f	2.6_g
Agbor Local	81.4_c	82.9_c	82.2_c	4.2_{bc}	4.4_{bc}	4.3_{bc}
Kwale Local	80.5_c	83.5_c	82.0_c	2.8_g	2.9_f	2.9_g
Spacing (cm)						
75 x 15	86.8_a	86.4_a	86.6_a	4.7_a	4.8_a	4.8_a
75 x 25	84.0_b	84.2_b	84.1_b	3.8_b	4.0_b	3.9_b
75 x 35	77.9_c	78.5_c	78.2_c	2.9_c	3.2_c	3.1_c

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

Table 3: Effects of Interaction of Variety and Spacing on % Emergence and Grain Weight of Maize in 2008 and 2009

		% emergence			Grain Weight (tha^1)	Grain Weight (tha^1)	
		2008	**2009**	**Mean**	**2008**	**2009**	**Mean**
Variety	**Spacing (cm)**						
	75 x 15	86.0	83.3	84.7	4.3	4.6	4.45
Oba Super 2	75 x 25	83.0	80.3	81.7	2.9	4.1	3.50
	75 x 35	76.6	74.6	75.6	2.4	2.6	2.50
	Mean	**81.8**	**79.4**	**80.6**	**3.2**	**3.8**	**3.50**
	75 x 15	87.6	86.0	86.8	3.8	3.9	3.85
Oba 98	75 x 25	81.6	80.0	80.8	3.1	3.2	3.15
	75 x 35	75.3	73.0	74.2	2.1	2.3	2.3
	Mean	**81.5**	**79.6**	**80.6**	**3.0**	**3.1**	**3.1**
	75 x 15	95.6	94.3	94.9	7.1	7.2	7.2
9022-13	75 x 25	93.3	92.6	92.9	6.5	6.6	6.6
	75 x 35	86.3	89.0	87.7	5.2	5.4	5.4
	Mean	**91.7**	**91.9**	**91.8**	**6.3**	**6.4**	**6.4**
	75 x 15	94.3	91.6	92.9	5.1	5.1	5.1

Suwan-1-SR	75 x 25	87.6	87.0	87.3	4.6	4.7	4.7
	75 x 35	79.6	78.3	78.9	2.9	3.0	3.0
	Mean	**87.2_b**	**85.6**	**86.4**	**4.2**	**4.3**	**4.3**
	75 x 15	62.3	64.6	63.4	4.7	4.8	4.8
AMATZBR C_2WB	75 x 25	60.0	64.3	62.2	3.6	3.7	3.7
	75 x 35	58.3	58.6	58.5	2.8	2.6	2.6
	Mean	**60.2**	**62.5**	**61.4**	**3.7**	**3.7**	**3.7**
	75 x 15	97.3	97.6	97.5	5.7	5.9	5.9
BR9922-DMRSF$_2$	75 x 25	95.0	95.3	95.2	4.8	4.9	4.9
	75 x 35	87.3	88.6	87.9	3.7	3.8	3.8
	Mean	**93.2**	**93.8**	**93.5**	**4.7**	**4.9**	**4.9**
	75 x 15	94.0	91.6	92.8	4.6	5.1	5.1
ACR 97	75 x 25	92.0	91.0	91.5	3.6	3.8	3.8
	75 x 35	82.0	83.0	82.5	2.4	3.4	3.4
	Mean	**89.3**	**88.5**	**88.9**	**3.5**	**4.1**	**4.1**
	75 x 15	85.0	84.0	84.5	2.8	2.9	2.9
Asaba Local	75 x 25	85.0	84.0	84.5	2.5	2.7	2.7
	75 x 35	75.3	76.3	75.8	2.2	2.5	2.5
	Mean	**81.8**	**83.8**	**82.8**	**2.5**	**2.7**	**2.7**
	75 x 15	83.0	84.3	83.7	5.3	5.4	5.4
Agbor Local	75 x 25	81.0	83.0	82.0	4.1	4.3	4.3
	75 x 35	80.3	81.6	80.9	3.2	3.5	3.5
	Mean	**81.4**	**82.9**	**82.2**	**4.2**	**4.4**	**4.4**
	75 x 15	82.3	85.0	83.7	3.4	3.5	3.5
Kwale Local	75 x 25	81.3	84.0	82.7	2.6	3.0	3.0
	75 x 35	78.0	81.6	79.8	2.3	2.4	2.4
	Mean	**80.5**	**83.5**	**82.0**	**2.8**	**2.9**	**2.9**
Variety		*	*	*	*	*	*
Space		*	*	*	*	*	*
Variety x space		*	Ns	*	Ns	Ns	Ns

Legend: * = significant at 0.05 level of probability, ns = not significant

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, this 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 (Amalu, 2001). 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, Nnaji, *et al*., 2002). (iii) The soil may not be highly acidic as to cause high level of P fixation (Isirimah *et al* 2003 and 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 was dominated by Fe oxide and kaolinites. These clay minerals are low in basic cations (Brady and Weils., 1999). 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 FMANR (1990), and Nnaji *et al*. (2002) and Nnaji (2008), who reported that most soils of the Southern Nigeria are poor in nutrients due to intense rainfall, soil erosion, nutrient depletion through leaching and continuous cultivation of land without adequate application of fertilizer or other amendments.

Effects of Variety and Spacing on % Emergence of Maize

Open-pollinated variety BR9922-DMRSF$_2$ had the highest % emergence among the maize varieties studied possibly because Asaba ecological zone where the study was made and optimum management of resources provided favoured its genetic potential for expression of high % emergence. This is similar to the findings of Sukanya *et al.* (1998); Iken and Anusa (2004) who reported that because of the differences in yield potential of ecological zones, high yielding maize varieties can only express their full genetic potentials when offered optimum management resources, which starts with the right choice of site through timely and appropriate establishment, nutrition, disease and pest control to proper harvesting procedure, and produce disposal and/or storage. Plants sown on 75cm x 15cm spacing obtained highest % emergence compared to other plants sown on wider spacings. This could be attributed to increased competition for soil nutrients and other natural resources. This is similar to the findings of Olufajo (1992); Muoneke *et al.* (2007) and Enujeke (2013) who reported increased number of cobs and higher grain yield obtained from higher plant density due to narrow spacing.

Effects of Variety and Spacing on Grain Weight of Maize

Hybrid maize variety 9022-13 was superior or highest in grain weight over other varieties tested. This may be attributed to special qualities associated with hybrid varieties such as high yield, disease resistance, adaptability to environmental stresses, and early maturity. This is similar to the findings of Kim (1997) and Udoh (2005) who attributed the high yield of hybrid varieties of maize to their special qualities, including disease resistance, early maturity, adaptation to environmental conditions, uniformity in flowering and ear placement and ease of harvesting by combined harvester. Grain weight of maize obtained from plants sown at 75cm x 15cm spacing was higher than those sown at wider spacing possibly because more number of cobs were obtained from the increased plant population. This is similar to the findings of Olufajo (1992) and Muoneke *et al.* (2007) who reported increased number of cobs and higher grain yield obtained from higher plant density due to narrow spacing. It is also consistent with the findings of Alford *et al.* (2008) who reported that growing crops in narrow rows reduces weed biomass and increases the interception of light which could lead to increase in yield. It is also similar to the findings of Azam *et al.* (2007) and Enujeke (2013) who reported that spacing of 75cm x 15cm resulted in maximum cob weight of maize.

Conclusion and Recommendations

The study was carried out to evaluate the effects of variety and spacing and percentage emergence and grain weight of maize in Asaba area of Delta State. Ten varieties were sown in three different plant spacings. The results showed that though open-pollinated variety BR9922-DMRSF$_2$ had the highest percentage emergence, hybrid variety 9022-13 sown at 75cm x 15 cm was superior in grain weight while Asaba local variety had the lowest percentage emergence and grain weight. Based on this study, it is recommended that hybrid maize variety 9022-13 which was outstanding in grain weight be grown in the study area. Also, spacing of 75 cm x 15 cm which resulted in higher percentage emergence and grain weight be adopted in maize production.

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