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Variability Studies for Some Reproductive Traits in Maize (*Zea mays* L.) Genotypes

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Abstract
Successful improvement and high yields of crop depends largely on the genetic variability in existing germplasm. Crop varieties differ in performances and it is on this basis that varieties with economically important agronomic traits are selected. Twenty six maize (Zea mays L.) varieties obtained from National Seed Council of Nigeria were evaluated for cob and seed yields at the Teaching and Research Farm of Plateau State College of Agriculture, Garkawa, Nigeria in 2018 and 2019 cropping seasons. The treatments (maize varieties) were laid out in a randomized complete block design (RCBD) with three replications. Result obtained showed that the maize varieties differed significantly in mean husk weight plant^{-1}, cob weight plant^{-1}, seed weight plant^{-1}, seed weight ha^{-1} and number of seeds plant^{-1}. The varieties SAMAZ 15 and SC651 were outstanding in mean cob weight plant^{-1} (SAMAZ 15 = 669.9g; SC651 = 488.3g) and mean number of seeds plant^{-1} (SAMAZ 15 = 744.0; SC651 = 704.5), hence selected as first class candidates. Eight other varieties (SDM-2, DUPONT P4226, SAMAZ14, SAMAZ48, DUPONT P4063W, OBA98, SAMAZ33 and SAMAZ 45) with cob and seed yields above grand mean (cob=322.0g; seed=462.8) were also recommended as improved varieties for commercial maize production in the study area.
Key words: Maize, seed yield, variability studies, varieties, *Zea mays*

Introduction

Maize (*Zea mays* L.) is the third most important cereal crop in the world after wheat and rice; and base on its agro-economical importance, maize has received tremendous attention from the research communities (Pechanova *et al*., 2013; Renere *et al*., 2009; FAO, 2007). It is widely cultivated throughout the world and a greater weight of maize is produced each year than any other grain. Maize is produced extensively in Nigeria, where it is consumed roasted, baked, fried, pounded or fermented (Agbato, 2003). All parts of maize: the stalks, leaves, grain and immature ears are used as livestock feeds (Dutt, 2005).

Maize provides a major source of calories in Nigeria as well as other parts of the world. It is an excellent source of carbohydrate and good quality oil and it is more complete in nutrients when compared with other cereals such as sorghum. The protein content of maize is higher than that of paddy and polish rice (Ado *et al*., 2013). According to West Africa Agricultural Productivity Programme (WAAPP, 2014) maize is one of the most important staple food crops in Nigeria.

The selection of crops for high yield with the desired traits depends on the genetic variability in existing germplasms; and successful breeding programs need adequate genetic variation for selection and improvement based on necessity (Ibrahim and Dawaki, 2019). Many improved varieties of crops have been developed by breeders for different climatic condition. Manggoel and Panwal (2009) reported that the performances of these improved varieties vary across locations and the need for a continuous evaluation of the performances of cultivars in different agro-ecological zones for adaptability is imperative. This study therefore, was designed to evaluate 26 maize varieties; in order to identify the variability amongst them and to recommend outstanding varieties for commercial maize production.

Material and Methods

Experimental Site and Materials

The field experiments were carried out at the Teaching and Research Farm of Plateau State College of Agriculture, Garkawa, in 2018 and 2019 cropping seasons. The area lies on Latitude 10.11'N and Longitude 8.21'E and an altitude of 1,195m above sea level in the Guinea savanna ecological zone of Nigeria. The experimental site was a sandy loam soil and the climate is characterized by two distinct seasons; wet and dry. The wet season starts by late April and ends in October while the dry season starts in November and ends mid-April. The mean annual rainfall is about 1,450mm and a mean annual relative humidity of 60%. The mean monthly maximum and minimum temperature are 22^0C and 15^0C, respectively; (Da'ar *et al*, 2014).

The experimental materials (treatments) were made up of 26 maize varieties; namely: SDM 2, DUPONT P4226, OBA SUPER 3, SAMAZ 14, OBA SUPER 6, SAMAZ 48, SAMAZ 19, SDM 1, SAMAZ 37, SAMAZ 24, DUPONT P4063W, SC651, DUPONT 30Y87, SAMAZ 40, DUPONTP3 966W, SC719, SC649, SAMAZ 17, OBA SUPER 11, SAMAZ 39, OBA 98, SAMAZ 33, SAMAZ 18, SAMAZ 15, SDM 6 and SAMAZ 45 obtained from the National Seed Council (NSC) of Nigeria.

Land Preparation and Field Layout

The land was ploughed using a disc plough, harrowed and ridged to give a fine tilth. A total of 78 plots were marked out and each plot was made up of a 3m length ridges. Each plot had 4 rows, spaced 75cm apart giving a net plot area of 3m x 3m ($9m^2$). The space between blocks and between plots (discard) was 1m. The total land area used for the research work was 0.125ha (104m x 12m = 1248 m^2).

Experimental Design and Agronomic Practices

The experimental design used was randomized complete block design (RCBD) with three replications. The treatments were randomly allocated in the 26 plots within each replicate. The intra and inter row spacing was 25cm x 75cm. Weeding was done manually at 3 and 6 weeks after sowing (WAS). Fertilizer application was done in two split doses at the rate of 150 kg ha^{-1} NPK (15:15:15) and 100kg ha^{-1} NPK (20:10:10). Harvesting was carried out when the crops reached physiological maturity. This was when the cobs and shoots were dried.

Data Collection and Analysis

The number of cobs produced on five sampled plants were counted and recorded to obtain the mean number of cobs/plant. The cob weight of the sampled plants was obtained using an electronic weighing scale. The husk of each cob was weighed and seed rows per cob counted. The numbers of seeds on each cob of the sampled plants were counted. The shelled seeds on each cob were weighed and recorded as mean number of seeds $plant^{-1}$ and extrapolated to hectare equivalent. The data collected was subjected to analysis of variance using *Genstat discovery* edition software. Means that were found to be statistically significant ($p<0.05$) were separated using the least significant difference (LSD) as described Obi (2002).

Results and Discussion

The mean, range, mean squares and coefficient of variations for the reproductive traits averaged over the two cropping seasons (2018 and 2019) for the 26 maize varieties and presented in Table 1. The analysis of variance showed that the means for the varieties differed significantly ($p<0.05$) for husk weight plant^{-1}, cob weight plant^{-1}, seed weight plant^{-1}, seed weight in tons ha^{-1} and number of seeds plant^{-1}**.** The significant differences in the mean values and wide range for the traits considered implied discernable evidences of inherent genetic variability among the varieties, hence wide scope for improvement of the crop (Manggoel *et al.,* 2012).

Significant statistical differences ($p<0.05$) were recorded among the maize varieties for husk weight plant^{-1} (HW/P) and cob weight plant^{-1} (CW/P), while mean values for number of cobs plant^{-1} (NC/P) were statistically at par. Results obtained for 2018 and 2019 were statistically at par and variety x year interaction were not significant ($p<0.05$); hence the data were averaged over the two cropping seasons (Table 2). The variety SAMAZ 15 recorded the highest mean value for HW/P (112.3g) which was above the grand mean (62.3g); and was statistically at par with the mean husk weight of SDM-2 (106.8g), SC651 (98.3g), OBA98 (91.1g), SAMAZ 48 (86.1g), OBA SUPER3 (83.2g), DUPONT P4226 (79.8g) and SAMAZ 45 (75.8g). The least mean husk weight was recorded by the variety DUPONT P3966W (32.9g) which was below the grand mean value. Mean cob weight plant^{-1} (CW/P) followed a similar trend (Table 2), with the variety SAMAZ 15 being distinct with mean value of CW/P (669.0g) which was above the grand mean (322.0g). The mean value for CW/P was still low for the variety DUPONT P3966W (185.0g), implying that maize varieties with higher husk weight plant^{-1} had corresponding higher cob weight plant^{-1}. The significant treatment effect ($p\leq 0.05$) for husk weight plant^{-1} and the non significant treatment effect for number of cobs plant^{-1} are in agreement with earlier reports by Damiyal *et al.* (2017).

Seed traits assessed in this study averaged over the two cropping seasons (2018 and 2019) are presented in Table 3. Though differences were recorded among the maize varieties in number of seed rows cob^{-1} (SR/C), the differences were not significant ($p<0.05$). Mean values for seed weight plant^{-1} (SW/P), seed weight ha^{-1} (SW/ha) and number of seed plant^{-1} (NS/P) were however, statistically significant ($p<0.05$) and ranged from 157.5g to 479.5g, 1.58 to 4.29t/ha and 341.7 to 744.0, for SW/P, SW/ha and NS/P, respectively. The maize variety SAMAZ 15 was outstanding for SW/P (479.5g), SW/ha (4.29t) and NS/P (744.0), and the mean values were above the grand mean (SW/P=263.91g; SW/ha= 2.65t; NS/P=462.8) for the three traits. The mean values for SW/P, SW/ha and NS/P for this variety (SAMAZ 15) were however at par with that of SC651 (SW/P=418.0g; 4.16t; NS/P=704.5). Eight other maize varieties with seed yields (NS/P) above the grand mean (462.8) included SDM-2 (526.8), DUPONT P4226 (498.8), SAMAZ 14 (412.4), SAMAZ 48 (600.4), DUPONT P4063W (467.4), OBA 98 (590.9), SAMAZ 33 (467.7) and SAMAZ 45 (591.9). The number of seeds plant^{-1} obtained in this study (grand mean= 484; ranged= 341-745) falls within the mean values reported by Damiyal *et al.* (2017) when improved varieties were grown under optimum organic manure (cattle) recommended application of 5t/ha, which gave the highest number of seeds plant^{-1}of 625. The wide range in mean values for cob and seed traits assessed in this study showed that there are enormous genetic variations among the maize varieties. This also implied that the varieties would differ in adaptation to different agro-ecological zones.

Conclusion

On the bases of the superior cob and seed yields, the variety SAMAZ 15 and SC651 were selection as first class candidates. Eight other varieties (SDM-2, DUPONT P4226, SAMAZ14, SAMAZ48, DUPONT P4063W, OBA98, SAMAZ33 and SAMAZ 45) with mean values for cob and seed yields above grand mean were also recommended as improved varieties for commercial maize production in the study area.

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Table 1: Mean, range, mean squares, Fisher's probability and coefficient of variations for 7 reproductive traits in maize averaged over two cropping seasons

Characters	**Mean**	**Range**	**MS**	**F_{pr}**	**CV (%)**
Husk weight/plant(g)	62.3	32.9 - 122.3	41.34**	0.044	18.3
Cob weight/plant(g)	322.0	185.0 - 669.0	123.67**	0.002	10.0
Number of cobs/plant	1.23	1.0 – 1.6	0.89^{ns}	0.825	4.4
Seed row/cob	13.04	12.0 -15.4	1.27^{ns}	0.674	1.8
Seed weight/plant (g)	263.91	157.5 - 479.5	167.40**	<.001	18.4
Seed weight t/ha	2.65	1.58 – 4.29	236.49**	0.029	4.9
Number of seed/plant	462.8	341.7 – 744.0	89.35**	<.001	15.4

Fpr = Fisher's probability; MS = Mean square (Genotype); CV = Coefficient of variation (%), ** = Significant at 1% probability; ns = not significant

Table 2: Mean values for husk weight, cob weight and number of cobs/plant for 26 maize varieties averaged over two growing seasons

S/N	Varieties	HW/P(g)			CW/P (g)			NC/P		
		2018	2019	**Mean**	2018	2019	**Mean**	2018	2019	**Mean**
1	SDM 2	107.0	106.5	106.8	428.3	430.4	429.4	1.2	1.0	1.1
2	DUPONT P4226	79.3	80.2	79.8	417.0	416.3	416.7	1.4	1.2	1.3
3	OBA SUPER 3	83.3	83.0	83.2	364.6	361.3	363.0	1.0	1.2	1.1
4	SAMAZ 14	59.0	59.2	59.1	295.7	294.1	294.9	1.4	1.4	1.4
5	OBA SUPER 6	57.3	57.5	57.4	245.2	244.5	244.9	1.0	1.4	1.2
6	SAMAZ 48	86.3	85.9	86.1	389.0	388.6	388.8	1.2	1.0	1.1
7	SAMAZ 19	42.3	45.0	43.7	272.3	270.7	271.5	1.2	1.4	1.3
8	SDM 1	60.0	61.2	60.6	273.3	275.0	274.2	1.4	1.2	1.3
9	SAMAZ 37	45.7	45.5	45.6	299.0	300.3	299.7	1.4	1.4	1.4
10	SAMAZ 24	45.7	45.4	45.6	282.6	281.7	282.7	1.0	1.0	1.0
11	DUPONT P4063W	51.3	50.9	51.1	306.6	305.4	306.0	1.4	1.0	1.2
12	SC651	98.7	97.9	98.3	489.3	487.3	488.3	1.2	1.4	1.3
13	DUPONT 30Y87	37.7	39.3	38.5	261.0	260.5	260.8	1.6	1.2	1.4
14	SAMAZ 40	59.7	60.1	59.9	279.6	278.3	279.0	1.0	1.4	1.2
15	DUPONTP3 966W	32.7	33.1	32.9	185.3	184.6	185.0	1.0	1.0	1.0
16	SC719	45.0	46.0	45.5	254.0	254.2	254.1	1.2	1.0	1.1
17	SC649	62.0	62.3	62.2	269.6	268.6	269.1	1.4	1.4	1.4
18	SAMAZ 17	57.3	58.4	57.9	225.3	224.9	225.1	1.6	1.4	1.5
19	OBA SUPER 11	39.7	39.9	39.8	256.0	257.0	256.5	1.0	1.0	1.0
20	SAMAZ 39	39.3	40.5	39.9	212.0	213.5	212.8	1.2	1.2	1.2
21	OBA 98	91.7	90.5	91.1	417.3	418.9	418.1	1.2	1.0	1.1
22	SAMAZ 33	59.7	60.6	60.2	381.5	380.5	381.0	1.4	1.4	1.4
23	SAMAZ 18	50.3	51.3	50.8	273.9	272.1	273.0	1.0	1.2	1.1
24	SAMAZ 15	113.7	110.9	112.3	669.6	668.4	669.0	1.6	1.6	1.6
25	SDM 6	34.7	36.3	35.5	215.3	217.0	216.2	1.4	1.0	1.2
26	SAMAZ 45	77.3	74.3	75.8	413.3	412.5	412.9	1.2	1.0	1.1
	GRAND MEAN			**62.3**			**322.0**			**1.23**
	F-LSD (p<0.05)									
	Varieties (V)			**37.23**			**107.6**			**NS**
	Year (Y)			**NS**			**NS**			**NS**
	V x Y			**NS**			**NS**			**NS**

HW/P (g) = Hush weight/plant,
HW/P (g)= Husk weight/plant, CW/P (g) = Cob weight/plant, NC/P = Number of cobs/plant, NS = Not significant (p<0.05)

Table 3: Mean seed yields of 26 Maize varieties averaged over two growing seasons (2018 and 2019)

S/N	**Varieties**	**SR/C**			**SW/P (g)**			**SW/HA (t)**			**NS/P**		
		2018	2019	**Mean**	2018	2019	**Mean**	2018	2019	**Mean**	2018	2019	**Mean**
1	SDM 2	13.0	12.3	12.7	343.5	341.6	342.6	3.43	3.42	3.43	523.3	530.2	526.8
2	DUPONT P4226	12.0	12.3	12.2	341.2	344.0	342.6	3.41	3.40	3.41	498.4	499.1	498.8
3	OBA SUPER 3	12.3	13.0	12.7	293.4	295.7	294.6	2.93	2.89	2.91	411.1	413.6	412.4
4	SAMAZ 14	13.3	13.0	13.2	246.6	247.8	247.2	2.46	2.46	2.46	465.4	469.0	467.2
5	OBA SUPER 6	13.3	13.0	13.2	193.1	195.8	194.5	1.93	1.94	1.94	400.9	403.8	402.4
6	SAMAZ 48	13.3	12.3	12.8	344.2	347.1	345.7	3.44	3.45	3.45	599.4	601.3	600.4
7	SAMAZ 19	13.3	12.3	12.8	219.7	220.2	220.0	2.19	2.20	2.20	375.8	377.2	376.5
8	SDM 1	14.3	12.0	13.2	221.4	225.3	223.4	2.21	2.21	2.21	428.3	430.2	429.3
9	SAMAZ 37	12.7	13.0	12.9	252.5	253.5	253.0	2.52	2.53	2.53	445.5	448.3	446.9
10	SAMAZ 24	12.3	12.0	12.2	243.1	243.9	243.5	2.43	2.44	2.44	379.2	378.9	379.1
11	DUPONT P4063W	13.0	13.3	13.2	262.9	260.3	261.6	2.62	2.61	2.62	465.4	469.3	467.4
12	SC651	16.0	14.7	15.4	416.5	419.5	418.0	4.16	4.15	4.16	708.4	700.5	704.5
13	DUPONT 30Y87	15.3	15.0	15.2	226.6	229.0	227.8	2.26	2.27	2.27	437.3	440.4	438.9
14	SAMAZ 40	12.3	12.0	12.2	225.0	227.6	226.3	2.25	2.27	2.26	411.3	412.9	412.1
15	DUPONTP3 966W	13.0	13.3	13.2	154.8	160.1	157.5	1.55	1.60	1.58	382.4	389.1	385.8
16	SC719	14.7	13.7	14.2	213.3	218.4	215.9	2.13	2.14	2.14	404.5	401.6	403.1
17	SC649	13.3	13.3	13.3	228.6	229.5	229.1	2.28	2.28	2.28	375.8	376.4	376.1
18	SAMAZ 17	13.3	13.0	13.2	179.3	180.1	179.7	1.79	1.78	1.79	350.6	356.2	353.4
19	OBA SUPER 11	12.5	12.3	12.4	214.6	216.4	215.5	2.14	2.15	2.15	441.5	443.0	442.3
20	SAMAZ 39	12.0	12.0	12.0	170.8	185.4	178.1	1.70	1.72	1.71	341.1	342.2	341.7
21	OBA 98	13.0	13.3	13.2	352.5	354.7	353.6	3.52	3.52	3.52	591.3	590.4	590.9
22	SAMAZ 33	11.3	13.7	12.5	234.4	237.2	235.8	3.34	3.30	3.32	468.5	466.9	467.7
23	SAMAZ 18	12.7	12.6	12.7	224.6	229.5	227.1	2.24	2.25	2.25	361.2	365.4	363.3
24	SAMAZ 15	14.3	13.3	13.8	478.4	480.6	479.5	4.28	4.30	4.29	746.6	741.4	744.0
25	SDM 6	12.3	12.0	12.2	184.7	185.5	185.1	1.84	1.79	1.82	410.3	409.3	409.8
26	SAMAZ 45	12.7	13.7	13.2	363.7	365.4	364.6	3.63	3.64	3.64	592.3	591.5	591.9
	GRAND MEAN			**13.04**			**263.91**			**2.65**			**462.77**
	F-LSD (p<0.05)												
	Variety (V)			**NS**			**63.25**			**1.01**			**159.62**
	Year (Y)			NS			NS			NS			NS
	V x Y			NS			NS			NS			NS

SR/C = Seed row/cob, SW/P (g) = Seed weight/plant (g), SW t/ha = Seed weight/ha, NS/P = Numbers of seed/plant, NS = Not significant