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CHARACTERIZATION OF SOME MAIZE VARIETIES IN A GUINEA SAVANNAH AGRO-ECOLOGY

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ABSTRACT

Crop varieties differ in performances and it is on this basis that varieties with economically important agronomic traits should undergo extensive evaluation in order to recommend them for commercial production. 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 maize varieties were laid out in a randomized complete block design (RCBD) with three replications. The result showed that the maize varieties differed significantly ($p<0.05$) in mean husk weight plant^{-1}, cob weight plant^{-1}, seed weight plant^{-1}, number of seeds plant^{-1} and grain yield ha^{-1}. Frequency of better performance than grand mean for traits quantified identified eight varieties having high frequencies (3-5; 5=100%) for traits with significant treatment means. The varieties within this category included: SAMAZ 15, SC651, OBA98, SDM-2, SAMAZ 45, SAMAZ 48, DUPONT P4226 and OBA SUPER 3. These varieties also had high rank scores (90 - 130) and were within the 1st and 8th positions of ranking among the 26 maize varieties. On the bases of the superior cob and grain yield ranking, these varieties were recommended for commercial maize production in the study area.

Keywords: Characterization, grand mean, maize, rank scores, varieties

INTRODUCTION

Maize (Zea mays L.) is a major staple food crop in sub-Saharan Africa. Its high energy content has made it very important in human and animal diets (Akinwale *et al*., 2013). The crop is considered a model system for the study of genetics, evolution, and domestication (Lu *et al*., 2009). In the global context, the genetic improvements in maize, combined with suitable agronomic practices, have allowed increase in grain yield (USDA, 2015).

Maize provides a major source of calories in Nigeria as well as other parts of the world (Ado *et al*., 2013). It is an excellent source of carbohydrate and good quality oil and it is more complete in nutrients when compare with other cereals such as sorghum. The protein content of maize is higher than that of paddy and polish rice. Maize is also a good source of minerals (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.

Crop varieties with outstanding performance should undergo extensive multi-location testing and promotion for adoption for commercial production. Consequently, much work has been done in the characterization of maize germplasm and this has led to continued improvement of the adaptive characteristics in relation to yield (Olaiya *et al*., 2019; Asare-Bediako, 2019), pest and disease resistance (Buso *et al*., 2019; Asare-Bediako, 2019; Craven and Fourie, 2011), striga resistance (Akinwale *et al*., 2013) and other adaptive features. Improved varieties have been developed which are suitable for cultivation in specific ecological zones. Field trials of these varieties have been conducted across several locations. For instance, two test locations, Mokwa and Abuja, both in the southern guinea savannah zones of Nigeria, have been routinely used for the evaluation of maize genotypes in the IITA Maize programmes (Akinwale *et al*., 2013).

The emergence of several seed companies in the West Africa sub-region have necessitated intensified efforts towards hybrid development and extensive testing. This is because the improved varieties vary in performances across locations. Consequently, the evaluation of the performances of cultivars in different ecological zones for adaptability is imperative and should be carried out on a continuous basis (Manggoel and Panwal, 2009). Akinwale *et al.* (2013) also posits that hybrids with outstanding performance should undergo extensive multi-location testing and promotion for adoption for commercial production. This study was aimed at the characterization of 26 maize varieties at Garkawa in the southern guinea savannah agro-ecology and to recommend outstanding varieties for commercial production of the crop in the study area.

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 Ccollection 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. Data were analyzed using Genstat 10.3 DE statistical package and significant treatment means were separated using the least significant difference (LSD) at 5% level of probability (Obi, 2002).

The frequencies of better performance than grand variety means were recorded for significantly different treatment means. This was done by comparing each variety mean with the grand mean. Varietal performances were ranked and scored: 1^{st} = 26 points, 2^{nd} = 25 points…26^{th} = 1 point. The total rank score was plotted by variety (Manggoel and Panwal, 2009).

RESULTS AND DISCUSSION

The mean, range, mean squares and coefficient of variations for the traits assessed averaged over two cropping seasons (2018 and 2019) for the 26 maize varieties are presented in Table 1. The analysis of variance showed that the means for the varieties differed significantly ($p<0.05$) for husk weight $plant^{-1}$ (HW/P), cob weight $plant^{-1}$(CW/P), seed weight $plant^{-1}$(SW/P), number of seed $plant^{-1}$ (NS/P), and grain yield (GY)**.** The significant differences in the mean and wide range for the traits considered implied there were discernable evidences of inherent genetic variability among the varieties, hence a wider scope for improvement of the crop (Manggoel *et al.,* 2012).

Results obtained for the two cropping seasons (2018 and 2019) were statistically similar 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 variety mean (62.3g); and was statistically similar to 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 for the variety DUPONT P3966W (32.9g), which was below the grand mean. Mean cob weight plant^{-1} (CW/P) followed the same trend (Table 2), with the variety SAMAZ 15 being distinct for 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 statistical differences in mean husk weight and cob weight obtained in this study are evidence of variations in the yield potentials of the maize genotypes. Damiyal *et al.* (2017) reported significant treatment effect ($p \leq 0.05$) for husk weight plant^{-1} in an earlier report when the authors evaluated some hybrid maize varieties.

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
Number of seed/plant	462.8	341.7 – 744.0	89.35**	<.001	15.4
Grain yield t/ha	2.65	1.58 – 4.29	236.49**	0.029	4.9

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

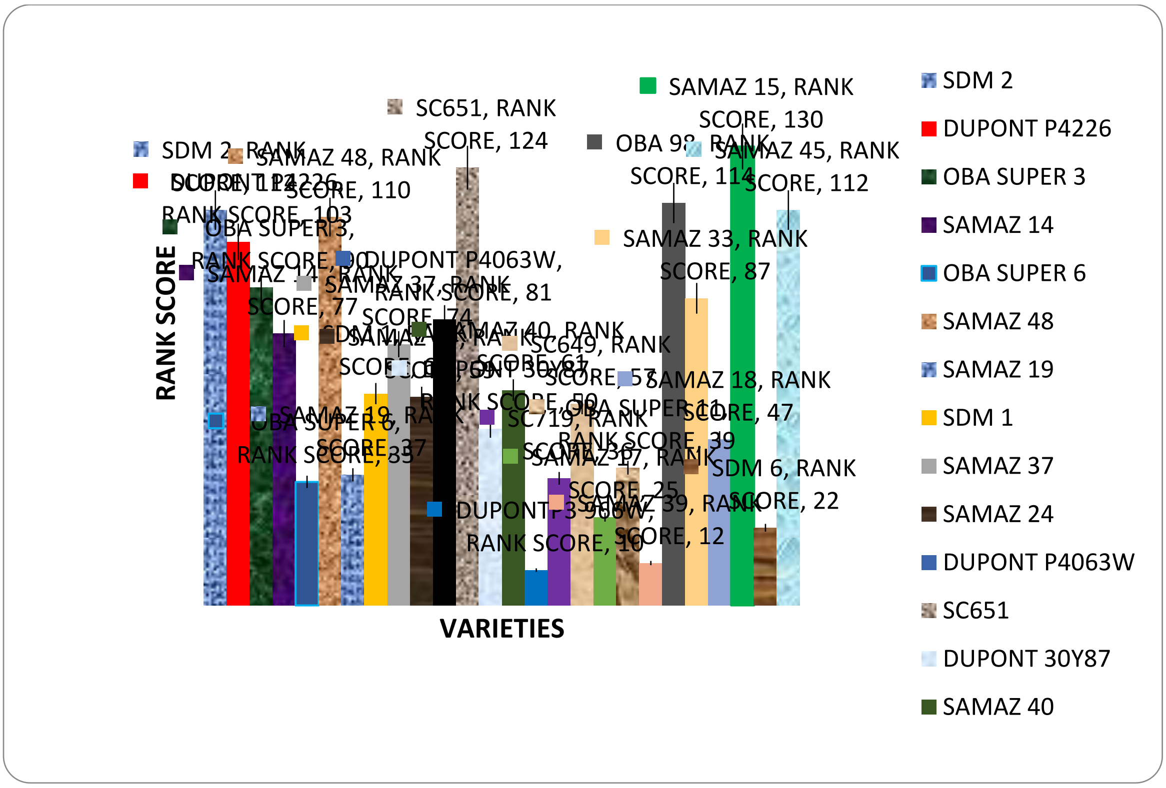

Fig. 1: Rank score summed over cob and seed yields for 26 maize varieties

Table 2: Mean values for husk weight, cob weight and number of cobs/plant for 26 maize varieties averaged over two growing seasons (2018 and 2019)

Varieties		HW/P(g)			CW/P (g)			NC/P		
		2018	2019	**Mean**	2018	2019	**Mean**	2018	2019	**Mean**
SDM 2	1	107.0	106.5	106.8	428.3	430.4	429.4	1.2	1.0	1.1
DUPONT P4226	2	79.3	80.2	79.8	417.0	416.3	416.7	1.4	1.2	1.3
OBA SUPER 3	3	83.3	83.0	83.2	364.6	361.3	363.0	1.0	1.2	1.1
SAMAZ 14	4	59.0	59.2	59.1	295.7	294.1	294.9	1.4	1.4	1.4
OBA SUPER 6	5	57.3	57.5	57.4	245.2	244.5	244.9	1.0	1.4	1.2
SAMAZ 48	6	86.3	85.9	86.1	389.0	388.6	388.8	1.2	1.0	1.1
SAMAZ 19	7	42.3	45.0	43.7	272.3	270.7	271.5	1.2	1.4	1.3
SDM 1	8	60.0	61.2	60.6	273.3	275.0	274.2	1.4	1.2	1.3
SAMAZ 37	9	45.7	45.5	45.6	299.0	300.3	299.7	1.4	1.4	1.4
SAMAZ 24	10	45.7	45.4	45.6	282.6	281.7	282.7	1.0	1.0	1.0
DUPONT P4063W	11	51.3	50.9	51.1	306.6	305.4	306.0	1.4	1.0	1.2
SC651	12	98.7	97.9	98.3	489.3	487.3	488.3	1.2	1.4	1.3
DUPONT 30Y87	13	37.7	39.3	38.5	261.0	260.5	260.8	1.6	1.2	1.4
SAMAZ 40	14	59.7	60.1	59.9	279.6	278.3	279.0	1.0	1.4	1.2
DUPONTP3 966W	15	32.7	33.1	32.9	185.3	184.6	185.0	1.0	1.0	1.0
SC719	16	45.0	46.0	45.5	254.0	254.2	254.1	1.2	1.0	1.1
SC649	17	62.0	62.3	62.2	269.6	268.6	269.1	1.4	1.4	1.4
SAMAZ 17	18	57.3	58.4	57.9	225.3	224.9	225.1	1.6	1.4	1.5
OBA SUPER 11	19	39.7	39.9	39.8	256.0	257.0	256.5	1.0	1.0	1.0
SAMAZ 39	20	39.3	40.5	39.9	212.0	213.5	212.8	1.2	1.2	1.2
OBA 98	21	91.7	90.5	91.1	417.3	418.9	418.1	1.2	1.0	1.1
SAMAZ 33	22	59.7	60.6	60.2	381.5	380.5	381.0	1.4	1.4	1.4
SAMAZ 18	23	50.3	51.3	50.8	273.9	272.1	273.0	1.0	1.2	1.1
SAMAZ 15	24	113.7	110.9	112.3	669.6	668.4	669.0	1.6	1.6	1.6
SDM 6	25	34.7	36.3	35.5	215.3	217.0	216.2	1.4	1.0	1.2
SAMAZ 45	26	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, CW/P (g) = Cob weight/plant, NC/P = Number of cobs/plant, NS = Not significant (p<0.05)

Seed parameters 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), number of seed cob^{-1} (NS/C) and grain yield (GY) were however, statistically significant (p<0.05) and ranged from 157.5g-479.5g, 341.7-744.0 and 1.58 - 4.29t/ha, in that order. The maize variety SAMAZ 15 was outstanding for SW/P (479.5g), NS/C (744.0) and GY (4.29t/ha), and was above the grand variety mean (SW/P=263.91g; NS/C=462.77; SW/ha= .65t/ha) for the three traits. The mean values of these traits for this same variety (SAMAZ 15) were however statistically similar to that of SC651 SW/P=418.0g; NS/C=704.5; GY=4.16t). Other maize varieties with SW/P, NS/C and GY above the grand variety mean included SDM-2, DUPONT P4226, OBA SUPER3, SAMAZ48, OBA98, SAMAZ15, and SAMAZ 45. The number of seeds plant^{-1} obtained in this study (Grand mean= 462.8; ranged 341.7-744.0) falls within that obtained 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 (Damiyal *et al*., 2017). The mean grain yield obtained in this study (1.58-4.29t/ha) is similar to the grain yield (1.84-3.48t/ha) reported by Sorsa and Kassa (2015). A recent study (Goshime *et al*., 2020) however, reported higher values (8.10-10.10t/ha) for grain yield of maize for some new selected maize hybrids under sole and inter crop systems in Ethiopia. The differences in yield obtained in these studies are obviously due to variations in the environmental conditions and genetic potentials of the maize genotypes used for the studies.

Frequency of better performance than grand means for parameters quantified (Table 4) identified eight varieties having high frequencies (3-5) for the five traits considered. Varieties within this category included: SAMAZ 15, SC651, OBA98, SDM-2, SAMAZ 45, SAMAZ 48, DUPONT P4226 and OBA SUPER3. These varieties also had high rank scores of between 90 and 130 (Fig. 1) and were within the 1st and the 8th position of ranking (Table 5). These varieties were regarded to have performed better (adapted) at the Garkawa agro-ecology. Three other varieties (SAMAZ 33, SAMAZ 14 and DUPONT P4063W) had moderate frequencies (1-2) of better varietal performance than grand mean as well as moderate rank scores (77-87). Frequencies of better performance than grand mean was used by Manggoel and Panwal (2009) to recommend seven elite varieties of cowpea within the Makurdi agro-ecology.

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

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

*Parameters quantified	**Grand variety means
Hush weight/plant (g)	62.30
Cob weight/plant (g)	322.00
Seed weight/plant (g)	263.91
Seed weight (t/ha)	2.65
Numbers of seed/plant	462.77

Table 4: Frequency of better performance than grand variety mean** for parameters quantified*

5	4	3	2	1	0
SAMAZ 15	-	OBA SUPER 3	SAMAZ 33	SAMAZ 14	SAMAZ 37
SC651			DUPONT	P4063W	SAMAZ 40
OBA 98					SDM 1
SDM 2					SAMAZ 24
SAMAZ 45					SC649
SAMAZ 48					DUPONT 30Y87
DUPONT P4226					SAMAZ 18
					OBA SUPER 11
					SAMAZ 19
					SC719
					OBA SUPER 6
					SAMAZ 17
					SDM 6
					SAMAZ 39
					DUPONTP3 966W

Table 5: Rank score and position for better performance than grand variety mean

S/N	VARIETY	RANK SCORE	POSITION
1	SDM 2	112	4th
2	DUPONT P4226	103	7th
3	OBA SUPER 3	90	8th
4	SAMAZ 14	77	11th
5	OBA SUPER 6	35	22nd
6	SAMAZ 48	110	6th
7	SAMAZ 19	37	20th
8	SDM 1	60	14th
9	SAMAZ 37	74	12th
10	SAMAZ 24	59	15th
11	DUPONT P4063W	81	9th
12	SC651	124	2nd
13	DUPONT 30Y87	50	17th
14	SAMAZ 40	61	13th
15	DUPONTP3 966W	10	26th
16	SC719	36	21st
17	SC649	57	16th
18	SAMAZ 17	25	25th
19	OBA SUPER 11	39	19th
20	SAMAZ 39	12	25th
21	OBA 98	114	3rd
22	SAMAZ 33	87	10th
23	SAMAZ 18	47	18th
24	SAMAZ 15	130	1st
25	SDM 6	22	24th
26	SAMAZ 45	112	4th

CONCLUSION

Eight (8) varieties had mean cob and grain yields above grand variety mean and these varieties included: SAMAZ 15, SC651, OBA98, SDM-2, SAMAZ 45, SAMAZ 48, DUPONT P4226 and OBA SUPER3. The varieties also had high rank scores (90 - 130) and were within the 1st and the 8th positions of ranking among the 26 maize varieties. On the bases of the superior cob and grain yields these varieties were recommended for commercial maize production in the study area.

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