

Evaluation of Maize Varieties under Varying Fertilizer Application Rates in Owode-Egba Area of OGUN State Nigeria

Yusuf M.J.^{1*}, Musa U.T.², and Ifeoluwa A. O.³

¹Department of Crop Production, Kogi state University, Anyigba, P.M.B 1008, Kogi State, Nigeria.

²Department of Crop Production, Kogi state University, Anyigba, P.M.B 1008, Kogi State, Nigeria.

³Oyo state College of Agriculture and Technology Igboora, Oyo state, Nigeria.

Corresponding Author's Email: adavize70@gmail.com

Abstract: Field experiment was conducted at Jaeger Blumberg farms Limited, (Latitude 06° 59.033'N and Longitude 003° 28.048'E), Owode-egba, Ogun state, which lies within the tropical humid climatic zone of Nigeria. The study evaluated the effect of different Nitrogen levels (0kgN/ha, 150kgN/ha, 325kgN/ha and 500kgN/ha) on the growth, yield characters and yield of hybrid and open pollinated maize (*Zea mays* L.) varieties Samaz-38 (OPV), Sc-510, Sc-651 and Sc-719. Factorial combination of the treatments gave a total of 16 treatments which was laid in a Randomized Completed Block Design (RCBD) with 3 replications. NPK 15:15:15 fertilizer was applied in 2-split doses first at 3 weeks after sowing and the second dose was applied at the period of tasseling. Characters measured include, Number of leaves/plant, Plant height, Stem girth, Leaf area, Cob length, Number of grains/cob, Number of cobs/plant, Cob weight, threshing percentage, 100 grain weight and grain yield. Fertilizer had no significant influence ($P \geq 0.05$) on all growth characters measured. 150kgN/ha gave the highest yield for 100 grain weight which was significantly different ($P \leq 0.05$) from other application rates. Variety had significant influence ($P \leq 0.05$) on all growth, yield and yield characters measured with Samaz-38 outperforming its hybrid counterparts on Number of leaves (114.64), plant height (3046.04cm) and stem girth (85.67cm) respectively. Sc-719 (hybrid) performed excellently on leaf area (7829.47cm²), Threshing percent (839.28%), 100 grain weight (577.32g) and cob length (209.79cm). Sc-651 gave the highest Number of cobs/plant (12.82), Cob weight (10.83kg) and Number of grains/cob (4151.4). Sc-719 had the highest grain yield (6.35 tons/ha⁻¹). Although, hybrids in general demand increased level of inputs such as fertilizer, plant protection and improved husbandry practices, high cost and yearly replacement of seed which is many times expensive than that of OP. Therefore Samaz-38 is highly recommended for farmers who are not financially buoyant, while the latter can go for Sc-719.

Key words: Open-Pollinated Maize, Hybrid variety, Fall Army Worm (FAW), Yield Characters, Interaction.

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I. Introduction

The ultimate measure of farmers profit is the yield of the crops planted; this yield is dependent on the correct application of production inputs that will sustain the environment as well as agricultural production. These inputs are, inter alia, adapted cultivars, plant population, soil tillage, fertilization, weed, insect and disease control, harvesting, marketing and financial resources. Cultivar and the fertility status of the soil may be considered the primary determinant of a successful crop production. Maize (*Zea mays* L.) is the most important grain crop in South Africa and is produced throughout the country under diverse environments¹. In Africa, maize is used as both human food and animal feeds. It is an important cereal crop belonging to the family Graminae.

In Nigeria it's a versatile crop which ranks third following wheat and rice in world production². Maize is a major component of livestock feed, which is considered palatable to pigs, goats, sheep, cattle and poultry³. In spite of the economic importance and rising demand for maize, local farmers still have not been able to meet demand hence importation of exotic maize produce has been very consistent in the country. More than 70% of maize production is accomplished by resource poor small-scale farmers in Africa with a minimal yield of less than 1.5t/ha resulting from low soil fertility, failure to identify high yielding varieties and negligence of soil amendment materials which have interplayed to decrease yield to as low as 1 t/ha^{3,4}.

A research conducted by IITA, shows that open-pollinated maize varieties are more appropriate to peasant farmers since the seeds obtained from the harvest can be used as planting materials for subsequent cropping season⁵. Ikenet *al.* confirmed this assertion⁶. However, Use of inappropriate plant spacing which determines plant population and final yield, coupled with decline in soil fertility is a major problem contributing to low maize grain yield in Nigeria⁷. Enujeke, in his research to determine the effect of nitrogen fertilizer and

organic manure on maize grain yield, found out that maize plants treated with inorganic fertilizer NPK 20:10:10 at the rate of 450kg/ha gave the highest number of grains/cob. He also found that open-pollinated varieties had higher mean number of cobs/plant than other varieties³.

Report shows that maize varieties differ in their growth characters, yield and its components⁸, and therefore suggested that breeders must select most promising combiners in their breeding programmes. This research seeks to;

- a) Checkmate the relative influence of fertilizers on hybrid and OP varieties of maize.
- b) Evaluate the influence of varieties on the growth characters of maize hybrid and OP Varieties.
- c) Evaluate the influence of varieties on the yield and yield characters of maize hybrid and OP Varieties.
- d) Evaluate the interactions of fertilizers and varieties on the growth, yield and yield characters of maize varieties.

II. Materials and Methods

Site Description: This field experiment was carried out at Jaeger Blumberg farms limited, Akankan village in Owode-egba, Ogun state, in the south western part of Nigeria, during the rainy season of 2018. Ogun state is located at Latitude $06^{\circ} 59.033^{\circ}\text{N}$ and Longitude $003^{\circ} 28.048^{\circ}\text{E}$ of the equator. The state is within the tropical humid climatic zone of Nigeria which generally characterized, by high rainfall and high relative humidity. This is attributable to the prevalence of moisture laden tropical Maritime air mass over the state for about nine months in a year. The mean relative humidity varies from 66.2% in January to 88.4% in July⁹. The rainfall shows a double maxima distribution reaching the peak during the months of June and September. The average monthly rainfall for the state ranges between 7.1mm in the month of January to 208.27mm in the month of June. The mean annual temperature is 26°C ; although with some variations over time. The mean diurnal minimum temperature varies from 21.8°C in December to 24.34°C in April while the mean diurnal maximum temperature varies from 33.92°C to 37.1°C at the onset of the wet season March and April⁹.

Soil preparation and Analysis: Experimental site was firstly bulldozed, ploughed with the mixture of poultry manure, harrowed and prepared into bed while representative surface soil (0-30cm) was sampled with a tubular sampling auger and taken to the University of Ibadan for the determination of its physiochemical properties.

Experimental Design: This was a 4x4 factorial experiment carried out in a Randomized Complete Block Design (RCBD) with three replicates, each containing 16 treatments.

Experimental Materials and Description:

Three Seedco hybrid varieties (Sc-510, 651, 719) were obtained from the Agriseed Company Nigeria Limited while Samaz-38 (OPV) was obtained from a stockiest in Ibadan.

SC-510 is an early maturing, pro vitamin A variety (90days) resistant to most common maize disease, drought and less susceptible to the newly introduced fall armyworm caterpillar. It's an N-Use efficient variety that responds to fertilization and water use efficiency. Sc-651 is a medium maturing type (100-110days), it is tolerant to drought, maize streak virus (MSV) and *Striga* with high yield and double cobs, it's grain is an intermediate size (Semi flint) with white color. Sc-719 is late maturing (120days), a 3-way hybrid universally adapted variety with long and fat cobs and excellent rooting system which makes it tolerant to lodging, resistant to most maize disease including maize streak virus, northern corn leaf blight and grain size is large, adaptable to mechanical planting. Samaz-38 is an open pollinated variety implored to checkmate response to Nitrogen fertilizer, it is early maturing, has yellow coat color, small seeds size with excellent rooting system (Seedco maize catalogue, 2018).

Treatment combination: Treatments which consist of varying levels of Nitrogen fertilizer (NPK 15:15:15) 0kgN/ha, 150kgN/ha, 325kgN/ha and 500kgN/ha coded as F_0, F_1, F_2, F_3 and different varieties Sc-510, Samaz-38, Sc-651 and Sc-719 coded as V_1, V_2, V_3, V_4 were merged into 16 factorial combination.

Note: Sc-510, Sc-651 and Sc-719 are all hybrid while Samaz-38 was open pollinated lines.

Agronomic Practices: The agronomic practices carried out were land preparation and field layout, planting, weeding and insect control.

Land Preparation and Field Layout: The land was ploughed and harrowed using a tractor. three blocks (replicates) consisting of 16 plots each were laid out, each plot measured 2.0m x 2.0m and was separated from one another with a space of 0.5m. Alley pathways of 1m separated one block from the other, and the total number of plots laid out in the entire experiment were 48.

Planting: Maize seeds were sown in the plots at the rate of 1 seed per hole at a depth of 2-3 cm and spacing of 75 cm x 25 cm.

Fertilizer Application: NPK 15:15:15 fertilizer was applied in split doses at the rates of 150kgN/ha, 325kgN/ha and 500kgN/ha as prescribed by Seedco maize hybrid Catalogue¹⁰, firstly to the topsoil within the root horizon at 5cm away from the plants in a ring form at 3WAS, while second doze was applied at 7WAS.

Weeding and Insecticide use: Weeding was done three times using a hoe. Emamectin benzoate was sprayed at the rate of 100-200gms/ha at 5WAS to prevent infestation of FAW.

Data Collection: Observations were recorded on growth characters such as Number of leaves/plant, Plant height, Stem girths were collected at 3, 5 7 and 9WAS. While yield and yield characters such as Cob weight (kg), Cob length (cm), Number of cobs/plant, Number of grains/cob, Shelling percentage(%) and Leaf area (cm²) were collected respectively at harvest. Number of cobs/plant, Leaves/plant, number of grains/cob and were determined by direct counting, Cob length, stem girth, and plant height was measured using tape rule, and grain weight/plot (tonsha⁻¹), cob weight, was measured using a weighing scale while Leaf area was measure using graphical method.

Statistical analysis

Observations recorded, were subjected to Analysis of Variance (ANOVA) test to detect the real differences among the treatment means as described by Snedecor and Cochran¹¹.

III. Results and Discussion

Soil physical and chemical properties are shown in table 1, below. We can deduce that there is relatively high nitrogen in the soil.

Table 1:Physio-chemical properties of soil at the experimental sites

Parameters	Depth
Particle size distribution	0-30cm
Sand %	69.2
Silt %	4.4
Clay %	9.4
Textural class	Sandy
<u>Chemical properties</u>	
pH (H ₂ O)	6.36
Total organic Carbon (g/kg)	22.94
Total Nitrogen (g/kg)	2.37
Av. Mg/kg	15.22
Exchangeable H+	0.80
Calcium [cmol (+) kg ⁻¹]	3.12
Magnesium [cmol (+) kg ⁻¹]	1.12
Potassium [cmol (+) kg ⁻¹]	0.80
Sodium [cmol (+) kg ⁻¹]	0.28
Manganese (mgkg ⁻¹)	7.50
Copper (mgkg ⁻¹)	0.04
Iron (mgkg ⁻¹)	2.20
Zinc (mgkg ⁻¹)	0.22

Influence of Varieties and N-fertilizer on growth characters of maize in Ogun state

Table 2 shows the results obtained for growth characters. Varieties significantly varied ($p \leq 0.05$) on the growth characters measured; these include number of leaves, plant height and stem girth across sampling periods. Sc-651 consistently produced taller plants at 3, 5 and 7WAS. Mean height shows that Samaz-38 produced the tallest plants; these were significantly different ($p \leq 0.05$) from heights of other varieties. Interaction of fertilizer and variety on plant height was significant at 5% level of probability (table 5). Sc-719 responded well to 150kgN thus producing a height of 226.71cm, however this height was not significantly different from those of Samaz-38 at 150kgN, Sc-651 at 325kgN and Sc-719 at 500kgN. This is an indication that at 150kgN application on Sc-719, fertilizer use should stop as further application may result to luxury consumption of Nitrogen resulting in high cost of production through wastage and reduction in yield (fig 1).

Significantly different means existed on mean girth of stems of these varieties tested (table 2); Samaz-38 produced thicker stems (85.67cm), however this was not significantly different from stems of Sc-719 (83.92cm). Sc-510 consistently produced thinner stems during the period of sampling. These variations observed amongst these varieties may have been due to differences in genetic characteristics of the individuals, which have influenced their Nutrient absorption capacity, photosynthetic area accumulation, water use efficiency (WUE) among others.

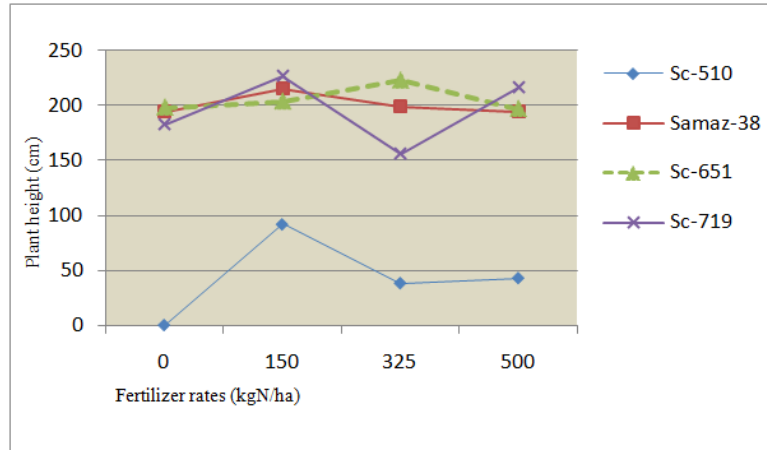


Fig 1: Interaction of fertilizer and variety on heights of plants at 5WAS.

These are functions of rapid growth rates, tallness or shortness of species, thicker stems. This observation is in line with Enujoke and Udoh findings, which attributed the high yield of some improved or open-pollinated maize varieties to differences in genetic make-up disease resistance, and adaptation to environmental condition^{3, 12}.

Mean number of leaves shows that Samaz-38 consistently outperforms other varieties. However this was not significantly different from number of leaves produced by Sc-651.; this is reflected on its photosynthetic activity of leaves, leaf arrangement, chlorophyll content, stomata conductance value and activity of photosynthetic enzymes. This is similar to the findings of Sajjanet *al.*, who reported that growth characters of crops varied because of differences in their genetic make-up¹³.

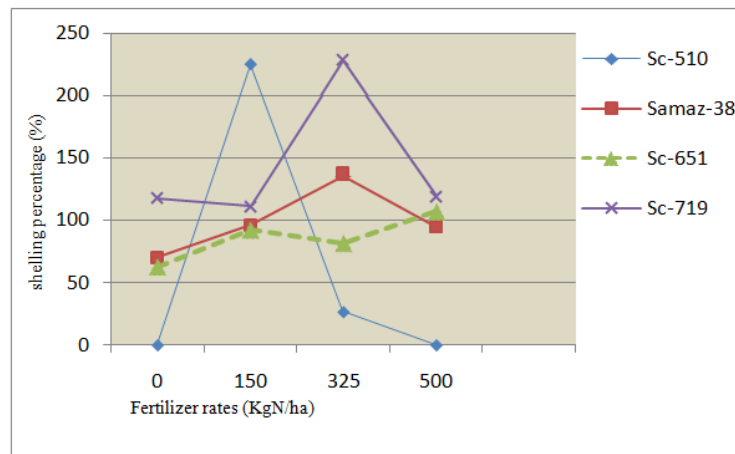


Fig 2: Interaction of fertilizer and variety on 100grain weight of maize

Fertilizer had no significant effect on all the growth characters, however application of 500kgN/ha produced plants with the highest number of leaves, tallest plant and plants with the thickest stems. These were however not statistically significant from other application rate, control plots gave the least yield on these characters across all periods.

Table 2: Influence of variety and fertilizer on some growth characters of ScMaize (hybrid) and Samaz (Opv) variety in Ogun state.

Treatments	Number of Leaves/plant				Mean NOL	Heights of plants (cm)				Mean PH
	3was	5was	7was	9was		3was	5was	7was	9was	
Sc-510	23.00 ^c	32.00 ^d	42.33 ^c	47.66 ^b	36.25 ^c	50.0 ^c	173.33 ^c	729.5 ^d	1217.0 ^c	542.46 ^c
Samaz-38	80.81 ^a	107.98 ^a	129.67 ^a	140.11 ^a	114.64 ^a	278.66 ^b	803.01 ^a	2315.5 ^b	8787.0 ^a	3046.04 ^a
Sc-651	79.82 ^a	99.10 ^b	133.09 ^a	141.11 ^a	113.28 ^a	296.09 ^a	821.67 ^a	2418.95 ^a	8293.0 ^b	2957.43 ^b
Sc-719	71.38 ^b	92.51 ^c	122.96 ^b	141.94 ^a	107.19 ^b	272.44 ^b	728.53 ^b	2104.64 ^c	8645.0 ^a	2937.65 ^b
Significance	**	**	**	**	**	**	**	**	**	**

F-LSD _{0.05}	2.39	3.39	4.26	4.79	3.71	6.96	22.56	72.83	149.55	62.98
Fertilizer										
0kgN/ha	62.11	71.27	97.95	107.97	84.83	218.25	575.95	1622.69	6213.0	2157.47
150kgN/ha	68.97	72.54	115.54	127.25	96.08	226.11	737.41	2037.66	6757.0	2439.55
325kgN/ha	60.96	78.25	102.31	112.05	88.39	227.74	616.37	1855.74	6842.0	2385.46
500kgN/ha	62.97	89.53	112.25	123.55	97.08	225.09	650.82	2052.52	7130.0	2514.61
Significance	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Interaction V x F										
Significance	ns	ns	ns	ns	ns	ns	*	ns	ns	ns
F-LSD _{0.05}							22.56			
SED±		0.35	0.44	0.25			2.35	7.59	15.58	
CV (%)	32.5	35.5	34.5	35.3		6.96	30.28	33.3	149.5	

Means followed by the same letter(s) within agronomic characters are not significantly different at 5% level of probability using N-DMRT

Yield characters of maize as influenced by fertilizer and variety in Ogun state

Table 3 shows the influence of fertilizer and variety on yield characters of maize. While fertilizer had no significant effect on the all growth and some yield characters measured, 150kgN/ha application gave the highest yield throughout the sampling periods. This result coincides with Hafez and Abdelaalwho reported that maize hybrid variety increases yield indices, crude fat %, fresh forage yield and protein % with N-application up to 150kg¹⁴. According to Huber *et al.*, there are four general characteristics which determine the response of maize grain yield to N availability: root uptake; vegetative storage capacity; recycling efficiency from vegetative tissues to developing kernels; dynamics and strength of the kernel sink¹⁵.

The insignificant effect of fertilizer on the growth and some yield characters may be attributed to the high nitrogen level of the soil resulting from the application of poultry manure at the time of ploughing. Further supply of nitrogen may have equalized the available soil nitrogen to blanket; however, excessive nitrogen may reduce grain yield and enhance plant growth. This result corroborates with those of Hussainiet *al.*, Mani, Sharifalet *al.*, and Namakkaet *al.*, respectively^{16, 17, 18 & 19}. Sharifalet *al.*, had also reported that poultry manure supplies essential nutrients and micronutrients for crop production. They are also valuable sources of soil organic matter. Organic matter improves soil structure; increases water holding capacity of soil and are source of slow-release nutrient. Soil organic matter also contributes to greater efficiency of fertilizer use²⁰.

The yield of the four varieties tested shows that Sc-719 (hybrid) performed excellently among others. This observation supports Luis *et al.*, findings who reported that hybrids varieties enhanced their grain yield linearly when the N dose was raised from 0 to 200kg/ha¹ accordingly²¹. Sc-719 (hybrid) performed excellently when compared with its counterpart on Cob length (209.79cm) and Leaf area (7829.47cm²). Sc-651 gave the highest Number of cobs/plant (12.82), Cob weight (10.83kg) and Number of grains/cob (4151.4). Sc-510 gave the lowest yield on all the yield characters. This result may have emanated from the fact that hybrid maize varieties have yield advantage over other maize varieties.

Abayomiet *al.*, reported that hybrid maize possess such special qualities as high yield, disease resistance, and early maturity, uniformity in flowering and ear placement, higher leaf growth, leaf area duration and effective leaf area than the OPVs²². Tollenaar and Lee, had confirmed that hybrids have been characterized to have high yield potentials due mainly to higher assimilatory surfaces and high leaf angle that could facilitate diffusion of light into the lower portion of the canopy²³. This report is also in line with Duncan *et al.*, findings²⁴.

Genetic improvements in conjunction with good management practice have played a fundamental role on this increase²³. Hammer *et al.*, reported that the physiological basis which underpins this genetic improvement has been attributed to both canopy and root architecture, especially under high population density²⁵. Other physiological basis has been reported to be linked to stay green leaf at the most critical stage of maize growth and increased duration of grain filling period.²⁵ This assertion directly supports the higher number of grains/cobs obtained from Sc-651.

Table 3: Influence of variety and fertilizer on stem girth and some yield characters of Sc maize hybrid and Samaz (OPV) variety in Ogun state.

Treatments	Stem girth			Yield characters				
	7was	9was	Mean girth	Leaf area (cm ²)	Cob length (cm)	Number of grains/cob	Number of cobs/plant	Cob weight
Variety								
Sc-510	33.95 ^c	51.85	42.90 ^c	2242.81 ^c	47 ^d	1043 ^c	6.0 ^d	0.8 ^d
Samaz-38	84.74 ^a	86.60	85.67 ^a	6723.54 ^b	179.42 ^b	3728.2 ^b	11.86 ^b	9.16 ^c
Sc-651	81.3 ^b	83.31	82.31 ^b	6693.74 ^b	163.92 ^c	4151.4 ^a	12.82 ^a	10.83 ^a
Sc-719	80.67 ^b	87.16	83.92 ^{ab}	7829.47 ^a	209.79 ^a	4053.8 ^a	10.1 ^c	9.93 ^b
Significance	*	ns	*	*	**	**	*	**
F-LSD _{0.05}	3.24		3.24	213.92	5.15	153.14	0.61	0.38

Fertilizer								
0kgN/ha	55.53	65.11	60.32	4952.44	129.17	2834.9	7.97	5.72
150kgN/ha	76.63	80.11	78.37	6358.24	173.81	3792.4	12.4	8.33
325kgN/ha	71.25	84.88	78.07	5872.21	160.53	3181.4	9.39	7.7
500kgN/ha	77.25	78.82	78.04	6303.67	136.62	3167.7	11.02	8.97
Significance	ns	ns	ns	ns	ns	ns	ns	ns
Interaction V x F								
Significance	ns	ns	ns	ns	ns	ns	ns	ns
SED±	0.34	0.54		22.28	0.536	15.95	0.064	0.039
CV (%)	39.9	58.0	48.9	31.5	29.7	40.8	51.7	43.07

Means followed by the same letter(s) within agronomic characters are not significantly different at 5% level of probability using N-DMRT

Grain yield, threshing percentage and 100grain weight as influenced by fertilizer and variety

Combined analysis of data for grain yield, threshing percentage and 100grain weight between hybrid and OPV revealed significant results (Table 4). Samaz-38 was found comparable for some yield attributes (threshing % and 100grain weight). This explains that Samaz-38 can compete or even be superior to other hybrid for obtaining increased yield. Overall performance of these attributes remained higher throughout the period of sampling.

Yield obtained with Sc-719, on grain weight (6.35tonsha⁻¹), threshing percentage (839.28%) and 100grain weight (577.32g) was higher than other varieties. This result corroborates with Pearl, who reported that hybrids record high yield advantages over OPVs with increasing fertilizer rates²⁶. Min’s found insignificant variation between hybrid and open pollinated maize varieties. In his findings, he found OPV’s and hybrid comparable for grain yield and yield related attributes and that they are agronomically and physiologically similar in maturity, and yield attributes²⁷.

The significant interaction of fertilizer and variety on 100 grain weight shows that 325kgN/ha had positively increased the biomass of the forage of Sc-719 which is reflected in higher starch accumulation on the grain (i.e higher grain weight), (fig 2). Table 6 also explains the effect of fertilizer on 100 grain weight, as Samaz-38 responded well at 325kgN/ha. Geremewet *al.*, Kolawole and Joyce had reported that application of either N or P fertilizers alone did not have significant difference in biomass production from the non-fertilized treatments but increased with an increase in the application of N or P fertilizers^{28, 29}.

Table 4: Influence of variety and fertilizer on yield and yield characters of Sc maize hybrid and Samaz (Op) variety in Ogun state.

	Grain weight/plot (tonsha ⁻¹)	Threshing percentage (%)	100grain weight (g)
Treatments			
Variety			
Sc-510	1.4 ^d	180 ^d	251.49 ^d
Samaz-38	4.9 ^c	655.21 ^b	399.904 ^b
Sc-651	5.85 ^b	646.66 ^c	344.553 ^c
Sc-719	6.35 ^a	839.28 ^a	577.32 ^a
Significance	**	**	*
F-LSD _{0.05}	0.294	27.917	30.062
Fertilizer			
0kgN/ha	3.45	493.46	251.433 ^d
150kgN/ha	5.05	603.02	525.554 ^d
325kgN/ha	4.30	651.86	474.5 ^b
500kgN/ha	5.70	572.81	321.78 ^c
Significance	ns	ns	*
F-LSD _{0.05}			30.062
Interaction V x F			
Significance	ns	ns	*
F-LSD _{0.05}			30.062
SED±	0.03	2.908	3.13
CV (%)	55.07	41.66	66.19

Means followed by the same letter(s) within agronomic characters are not significantly different at 5% level of probability using N-DMRT

Table 5: Interaction of fertilizer and variety on the heights of plant at 5WAS

	0kgN/ha	150kgN/ha	325kgN/ha	500kgN/ha
Sc-510	0 ^h	92 ^f	38.33 ^e	43 ^e
Samaz-38	194.55 ^{cd}	214.99 ^{abc}	198.78 ^{cd}	194.7 ^{cd}
Sc-651	198.13 ^{cd}	203.71 ^{bc}	222.99 ^{ab}	196.85 ^{cd}
Sc-719	183.27 ^d	226.71 ^a	156.28 ^e	216.27 ^{abc}
F-LSD _{0.05} 22.56				

Means followed by the same letter(s) within agronomic characters are not significantly different at 5% level of probability using N-DMRT

Table 6: Interaction of fertilizer and variety on the 100 grain weight of maize varieties

	0kgN/ha	150kgN/ha	325kgN/ha	500kgN/ha
Sc-510	0 ^e	224.82 ^a	26.67 ^e	0 ^e
Samaz-38	70.49 ^{ef}	96.604 ^{cde}	137.68 ^b	95.13 ^{cde}
Sc-651	62.963 ^f	92.65 ^{cdef}	81.84 ^{def}	107.1 ^{cd}
Sc-719	117.98 ^{bc}	111.48 ^{bcd}	228.31 ^a	119.55 ^{bc}
F-LSD _{0.05} 30.062				

Means followed by the same letter(s) within agronomic characters are not significantly different at 5% level of probability using N-DMRT

Conclusion

From this research, hybrids have yield advantages over composite varieties of maize. However, hybrids in general demand increased level of inputs such as fertilizer, high cost of yearly replacement of seed which is many times expensive than the of OPVs, plant protection and improved husbandry practices. Farmers within this geographical location are therefore advised in accordance to select Samaz-38 for planting in preponderance to its economic advantages over its hybrid counterparts. However those who have financial capabilities may choose Sc-719 (hybrid).

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