Agricultural Science
Volume 4, Issue 1 (2016), 01-08
ISSN 2291-4471 E-ISSN 2291-448X
Published by Science and Education Centre of North America

Comparism of Yield Potential of Hybrids and Open Pollinated Varieties of Maize Seeds in Northern Guinea Savanna Alfisols, North-West Nigeria

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Received: October 03, 2015 Accepted: December 03, 2015 Online Published: January 31, 2016

DOI: 10.12735/as.v4i1p01 URL: http://dx.doi.org/10.12735/as.v4i1p01

Abstract

A two year study was conducted on maize (*Zea mays L.*) at the I.A.R farm, Samaru, Zaria, Nigeria, during 2013 and 2014 cropping season. The objective was to investigate the yield potentials of hybrids and OPV maize varieties under the same management condition. The experiment consisted of six maize varieties as the treatments, this includes; four hybrid seeds from some selected seed companies in North-western Region and two open pollinated varieties from I.A.R. The treatments were laid out in a randomized complete block design with four replicates. The results showed that all the six varieties of seeds were good planting materials, with highest disease incidence of 0.5 (mean across treatments) in 2014 for Mr-White from Manoma seed company and highest mean value of off-types (0.75) from the hybrid seeds. Hybrid maize from Maslaha seed company (SDM-1) out yielded all other varieties in both 2013, 2014 and combine (4490.0Kgha^{-1}, 5210.2 Kgha^{-1} and 4850.1 Kgha^{-1}) respectively, while a hybrid seed- NG-Samaru had the least yield in both 2013, 2014 and combine (2586.7Kgha^{-1}, 3632.4 Kgha^{-1} and 3109.6 Kgha^{-1}) compared to open pollinated varieties from I.A.R (Sammaz 14 and Sammaz 34).

Keywords: comparism, hybrids, maize, open pollinated varieties and yield

1. Introduction

Maize is an important and widely acceptable cereal crop. Due to its high yielding, ease of processing, readily digested and cost relatively less than other cereals in production (Jaliya, Falaki,

How to cite this paper: Manasseh, E. A., Abimiku, S. E., Ojo, P. O., Zidafamor, E. J., Ubandoma, H. M., & Ishiak, O. K. (2016). Comparism of yield potential of hybrids and open pollinated varieties of maize seeds in Northern Guinea Savanna Alfisols, North-West Nigeria. *Agricultural Science*, *4*(1), 1-8. http://dx.doi.org/10.12735/as.v4i1p01

Mahmud, & Sani, 2008). It is widely grown throughout the tropics and temperate regions as well as any place man can be found in all the continents of the world. Maize cultivation has immense potential in the tropics and yield of up to 7.7t/ha or more can be obtained if crop is properly managed. Unfortunately yields are still below 5t/ha (FAO, 2007). As a result of these, there has been inadequacy of maize production for its numerous uses. Maize has a very high nutrient requirement and therefore productivity depends largely on nutrients management, as most of the fertility status of tropical soils is tempered and the yield is compromised. Its production has increase over the past two decades in the guinea savanna ecology, owing to the adoption of high yielding and adapted varieties and increased fertilizer use (Fajemisin, 1991). As the first harvested crop in the year, its role in reducing the hunger period has increased (Ado, Abubakar, & Mani, 1999).

The agricultural transformation agenda (ATA) publication of 2011 showed that; maize is one of the commodities in ATA that would be carried out through the value chain of crop, while recognizing roles the stakeholders along the nodes of the chain, input requirements in achieving production targets, reducing all necessary constraints faced to achieve the expected output. The vision in the transformation strategy is to achieve a hunger-free Nigeria through an agricultural sector that drives income growth, accelerates achievement of food and nutritional security, generates employment and transforms Nigeria into a leading player in global food markets to grow wealth for millions of farmers (FGN, 2011).

1.1. Problem Statement

Maize being a staple crop in Nigeria, owing to its important, farmers are more concerns with varieties that are high yielding as a result gives them more revenue. Hybrids were expected to be high yielding compared to OPVs, reverse is the case, where some farmers` buy hybrid seeds from some seed companies, though more expensive than the OPV and yet the yield could not commensurate with the cost of the seeds.

Several works in Nigeria raises this problem of yield difference between hybrids and OPV. This problem may arise as a result of the technicalities involved in hybrid seed production, which some of the companies fails adhered strictly to. This may bring the disparity in yield differences among the varieties.

Therefore, the objective of this study is to identify the variety of maize that perform better among the hybrids and open pollinated varieties in this Region. As this information is very vital to local farmers and will enhance their productivity and results to high return to investment and food security, which is one of the goals of the agricultural transformation agenda.

2. Materials and Methods

Table 1. Source of experimental materials and state

S/NO	Crop	Variety	Seed Source/State	Hyb./Opv.
1	Maize	NG-Samaru	Nagari seeds/Kaduna	Hyb.
2	Maize	Jo-195	DA-allgreen/Kaduna	Hyb.
3	Maize	SDM 1	Maslaha/Zamfara	Hyb.
4	Maize	MR-White	Manoma/Katsina	Hyb.
5	Maize	Sammaz 14	IAR/Zaria-Kaduna	Opv.
6	Maize	Sammaz 34	IAR/Zaria-Kaduna	Opv.

The study was conducted during the wet seasons of 2013 and 2014 at the Research Farm of the Institute for Agricultural Research, Samaru (N11^{0}11.180”E007^{0}36.876”, 686m above sea level)

(GPS) in the Northern Guinea Savanna ecological zone of Nigeria. The annual rainfall for the duration of the study in 2013 and 2014 was 900.4mm and 1083.82mm respectively. The treatments consisted of four hybrids maize varieties and two open pollinated varieties (OPV) of maize (Table 1).

2.1. Experimental Design and Agronomical Practices

The experimental design used was a randomized complete block design (RCBD), replicated four times. Maize seeds were planted with two seeds per hole at a spacing of 25cm on the ridge of 75cm apart. The maize seedlings were thinned to one seed per stand at two weeks after sowing. The experimental plots consisted of six ridges of 4.5m apart and 8m long (Gross plot)) and net plot was 3m × 4m. Two weeks after sowing. N.P.K-15-15-15 was applied by spot placement to the maize with an application rate of (60KgN/Ha, 60KgP_20_5/Ha and 60KgK_20/Ha) and at six weeks after planting, urea was applied to the maize plants to complete the second application for maize with an application rate of 120KgN/Ha, 60KgP_20_5/Ha and 60KgK_20/Ha. Hoe weeding was done at 3 weeks after sowing (WAS) and at 6WAS.

Prior to land preparation, Glyphosate was applied at 4Lha^{-1} in the experimental site, after 14 days of application, the site was ploughed and harrowed to obtain a fine tilth in each season, the field was sub divided into plots and replicated as per the experimental layout. Harvesting was done when the crops reached physiological maturity i.e. when the attachment of the grain to the cob was observed to be black and the leaves turned yellow and brown and kernels were dried in the field. The cob were plucked, dehusked and further sun-dried, weighed, threshed and winnowed to obtained clean seed.

2.2. Data Collection

Data were collected on plant height at 3,6 and 9 WAS, where three tagged plants from each plots were measured using a measuring tape from the ground level to tip of the uppermost leaf prior to tasseling or the tip of the tassel, the average computed and recorded. Leave area was determined by measuring the length and width of the widest part of the leaves for each tagged plants and multiplied by a factor (0.75) as suggested by Lazarov (1965). Three plants outside the net plot were randomly taken and cut at the ground level; the samples were oven dried to a constant weigh using Gallenkamp oven (model OV-420). The dried samples were weighed using Mettle electronic balance (model P. 1200) and the average computed and recorded for each treatment combination for 3, 6 and 9 WAS. Number of diseased plants in each treatment plots was counted and recorded, the off-types of plants in each plots in terms of plants height, leave coloration and arrangement, anthocynanic coloration of the stem, ear position and tassel arrangement were all recorded in each treatment plots. Undehusk cob weight for each net plot was weighed and recorded, seed weight was also recorded. The threshing percentage (%) for each treatment plot was computed and the yield for each net plot was extrapolated to per hectare.

2.3. Statistical Analysis

All data collected was subjected to General Linear Model procedure (GLM) of the Statistical Analysis System (SAS Institute Inc. 1990) and differences between the treatments were compared using Duncan multiple range test as described by Duncan (1955).

3. Results and Discussion

Table 2 showed the effect of varying treatment materials on plant height at 3, 6 and 9 WAS for 2013, 2014 and combine at Samaru. In 2013, at 3, 6 and 9 WAS, MR-White, SDM-1 and NG-Samaru has the least plant height, respectively, compared to the other varieties. In 2014, at 3 WAS, Sammaz 34 recorded a significantly higher plant height, while at 9 WAS, there was no significant difference in plant height between the six varieties, except that SDM-1 from Maslaha ranked highest in plant height followed by other varieties, while Sammaz 34 ranked the least.

Table 2. Plant height (cm) at 3, 6 and 9 WAS for 2013, 2014 and combined

	2013			2014			Combine		
Treatments	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS
NG-Samaru	23.08	117.58	206.57	29.03	133.23	200.39	26.05	125.41	203.48
JO-195	24.29	130.78	218.17	31.30	129.30	183.83	27.80	130.04	201.00
SDM 1	22.79	109.96	210.96	28.83	133.75	196.69	25.81	121.85	203.83
Mr White	21.58	117.89	215.37	29.43	132.42	198.30	25.50	125.15	206.83
Sammaz 14	22.96	112.45	217.34	28.60	126.06	193.68	27.78	119.26	205.51
Sammaz 34	22.86	106.03	208.64	34.75	135.84	188.43	28.82	120.94	198.54
SE±	0.70	3.19	2.95	1.31	3.55	5.20	0.84	2.51	3.36

Note: Within treatment group, means in a column followed by the same letter (s) are not significantly difference at 5% probability according to DMRT

The variation in leaf area (cm^{-2}) at 3, 6 and 9 WAS in 2013, 2014 and combine among the treatments combination showed that, in 2013 at 3 WAS, JO-195 and SDM-1 hybrids varieties recorded highest leaf area (Table 3) and at 6 and 9 WAS, N-G Samaru and Sammaz 34 had the least value of leaf area. Similar trend in leaf area was observed in 2014 and combine, where Sammaz 34 recorded the least value of leaf area at 6, 9 WAS and combine at 6 and 9 WAS respectively.

Table 3. Leaf area (cm^2) at 3, 6 and 9 WAS for 2013, 2014 and combined

	2013			2014			Combine		
Treatments	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS
NG-Samaru	25.97ab	392.96c	699.31a	57.48b	432.69e	668.81c	41.72b	412.82d	684.06b
JO-195	27.04a	469.13a	692.07a	59.88b	546.94b	710.08b	43.46b	508.03b	701.07b
SDM 1	27.05a	445.63b	689.95a	51.94c	616.20a	767.86a	39.49bcd	530.92a	728.91a
Mr White	23.12c	460.77a	671.79ab	59.47b	556.23b	682.52c	41.29bc	508.50b	677.18bc
Sammaz 14	26.62ab	384.21c	662.44ab	52.79c	477.42d	655.08cd	39.70bcd	430.81c	658.76bc
Sammaz 34	23.48c	346.78d	621.10c	77.53a	520.44c	639.22cde	50.50a	433.61c	630.16d
SE±	1.20	22.16	20.66	3.56	19.54	25.28	1.80	17.07	19.73

Note: Within treatment group, means in a column followed by the same letter (s) are not significantly difference at 5% probability according to DMRT

There was also a significant difference in shoot dry matter (Table 4) in 2013, 2014 and combine at 3, 6 and 9 WAS respectively. In 2013 at 3 WAS, MR-White variety recorded the least shoot dry matter (0.26g) compared to other varieties, while at 6 and 9 WAS, NG-Samaru and Sammaz 14 had the highest mean values (13.08g and 80.15g) for shoot dry matter. Considering the combine analysis at 3 WAS, there was a significant difference in shoot dry matter, while NG- Samaru and JO-195 were at par and recorded higher values compared to the other hybrids and open pollinated varieties of maize, and at 6 and 9 WAS, NG-Samaru and Sammaz 14 had the highest mean values of shoot dry matter (13.17g and 80.67g) compared to the other varieties at those period.

Table 4. Shoot dry matter (g) at 3, 6 and 9 WAS for 2013, 2014 and combined

	2013			2014			Combine		
Treatments	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS
NG-Samaru	0.43a	13.08a	65.68c	0.43b	13.25a	66.53c	0.43a	13.17a	66.10c
JO-195	0.45a	10.64b	61.80c	0.46a	10.78bc	62.60c	0.45a	10.71b	62.20c
SDM 1	0.30bc	11.22b	62.40c	0.31cd	11.37b	56.36d	0.30c	11.30b	59.38cd
Mr White	0.26d	11.10b	71.07b	0.26d	11.24b	71.99b	0.26d	11.17b	71.53b
Sammaz 14	0.33b	9.83c	80.15a	0.34c	9.96c	81.19a	0.34b	9.90c	80.67a
Sammaz 34	0.33b	9.76c	54.77a	0.34c	9.88c	55.48d	0.34b	9.82c	55.12d
SE±	0.03	0.74	4.98	0.03	0.74	4.21	0.03	0.74	4.16

Note: Within treatment group, means in a column followed by the same letter (s) are not significantly difference at 5% probability according to DMRT

Considering the distinct, uniformity and stability of the six varieties of seeds used for this study, the six varieties are good in terms of free from disease condition, with the highest mean value (0.25) for combine of Mr-White variety from Manoma (Table 5). The hybrid varieties recorded highest off-types value compared to the two open pollinated varieties from I.A.R, with the highest mean values of 0.75. This may be as a result of inadequate isolation, either in terms of times, space and barriers that might have allowed the pollination of unwanted pollen from a different field to pollinate the seed field (Ado, Usman, & Abdullahi, 2007). This problem can be ameliorated by maintaining proper isolation both in terms of space, barriers and time, rogueing of the seed fields and after harvest, the cobs should be sorted out to remove non uniform ones before threshing, as this will minimize the level of contaminants of the seeds that resulted to highest off-types value in hybrid seed fields. This finding is in agreement with the report of Ado and Usman (2008).

The yield attributes in Table 5 for undehusk cob weight, weight of seed, threshing % and yield per hectare for the treatment materials showed a steady trend in 2013, 2014 and combined, with SDM-1 hybrid variety from Maslaha having a significantly higher mean values compared to other treatments, while the two open pollinated varieties from I.A.R out-yielded a hybrid variety from Nagari (NG-Samaru) and was at par with JO-195 from Da-allgreen. The variation in yield comparism between the four hybrids used and two open pollinated varieties used may be as a result of recycling of the hybrids seeds, which may not allow the seeds to exert its full genetic potential, as such results to decrease in yield.

Table 5. Seed quality (DUS) and yield attributes for 2013, 2014 and combine

	Diseased Plants			Off-Typrs			Unthreshed Cob Weight(g)			Seed Weight (g) only			Threshing %			Yield/Ha(Kg)		
Treatment	2013	2014	Combine	2013	2014	Combine	2013	2014	Combine	2013	2014	Combine	2013	2014	Combine	2013	2014	Combine
NG-Samaru	0.25a	0.00c	0.13b	0.75a	0.50b	0.50b	177.83b	167.86d	172.84c	129.75c	110.20cd	119.97c	72.81c	66.78b	69.79b	2586.7d	3632.4d	3109.6e
JO-195	0.25b	0.00c	0.13b	0.75a	0.50b	0.50b	142.84d	178.30c	160.57d	109.79f	114.74c	112.26e	77.24a	65.67b	71.45a	2848.5c	3874.7c	3361.6d
SDM 1	0.00c	0.00c	0.00c	0.50b	0.75a	0.75a	201.18a	213.58a	207.38a	148.76a	149.15a	148.96a	73.93c	70.29a	72.11a	4490.9a	5210.2a	4850.6a
Mr White	0.00c	0.50ca	0.25a	0.50b	0.75a	0.75a	159.58c	190.60b	175.09c	114.72e	133.90b	124.31c	71.00d	70.26a	70.63b	3366.5b	4396.9b	3881.7
Sammaz 14	0.00c	0.00c	0.00c	0.25c	0.25c	0.25c	183.64b	192.65b	188.14b	141.83b	114.79c	128.31b	77.06a	60.32d	68.68c	3315.9b	3315.9c	3596.6b
Sammaz 34	0.00c	0.25b	0.13b	0.25c	0.25c	0.25c	157.88c	180.99c	169.44cd	118.82d	113.39c	116.10d	75.74b	63.88c	69.61c	3035.1c	3035.1c	3418.9c
SE±	0.075	0.12	0.07	0.14	0.14	0.09	6.17	6.15	3.77	4.88	3.79	3.30	1.14	1.46	0.96	246.90	114.86	132.21d

Note: Within treatment group, means in a column followed by the same letter (s) are not significantly difference at 5% probability according to DMRT

4. Conclusion

All the six varieties of seeds used for this study were good planting materials with very little problems of disease and off-types conditions that can be ameliorated through continuous rogueing of the seed fields and sorting of the cobs before threshing. Hybrid maize variety SDM 1 from Maslaha out-yielded all the other varieties in both the two years and combined while NG-Samaru performs least.

5. Recommendation

All seed companies producing hybrid seed should adhere to all technicalities involved in hybrids seed production and the selection of their inbred lines. This will enable hybrids to exerts its full potential when planted and farmers will be encourage to buy hybrid seeds, not considering the cost of the seeds.

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