World Journal of Agricultural Sciences 15 (6): 396-401, 2019
ISSN 1817-3047

DOI: 10.5829/idosi.wjas.2019.396.401

Evaluation of Maize Population for Growth and Yield Performance

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Abstract: The objectives of the experiment were to evaluate the magnitude of genetic variability of ten maize populations for growth and yield performance. This experiment was carried out at the Teaching and Research Farm of the Federal University of Technology Akure. The research was subjected to Randomized Complete Block Design with three replicates. Results obtained showed that there was considerable variation ($p \leq 0.05$) among the genotypes for all characters studied. POOL18-SR1/ARC94DMR-ESR had 50 days to 50% tasseling and 52 days to 50% silking and TZE/COMP3WCT 50 days to tasseling and 52 days to 50% silking. The two varieties were the earliest in maturity. SUWAN1-SR-QPM had the highest field weight of 2042g. Days to tasseling and days to silking, ear height, field weight and kernel row all had moderate heritability estimates (20-50%) while other traits studied had low heritability estimate (0-20%). There were strong and positive correlations between plant height and field weight (0.22). Ear height had a strong positive correlation with field weight (0.235) and number of cobs (0.115) which is highly significantly different. Also field weight had a strong positive correlation with 500 grain weight (0.422). As the characters can be further improved, there was reciprocal selection against some characters that are significant and negative. The result shows that maize varieties that had high earliness trait are not high yielding. The tall maize varieties (SUWAN1-SR-QPM) with moderate earliness had high field weight and had the highest yield while POOL18 SR1 ARC94 DMR ESR was the earliest in maturity.

Key words: Maize · Population · Variability · Yield · Varieties

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereals broadly adapted worldwide [1]. It is the third most important cereal after wheat and rice [2].

The importance of maize crop cannot be over-emphasized. It is cultivated worldwide on more than 160 million hectares every year and production was put at 785 million tons [3]. The crop is commonly cultivated in the tropics and warm sub-tropics for food, livestock and industrial uses.

In Nigeria, maize is an important food, fodder and industrial crop grown both commercially and at subsistence level. Maize is not only an important cereal crop produced in Nigeria on the basis of output but also on the basis of number of farmers that produced it, as well as for its economic value [4].

Nigeria was the tenth largest producer of maize in the world and the largest maize producer in Africa [5] but recently according to FAO [6] world maize production and yield statistics, Nigeria is the fifteenth largest producer of maize in the world and second largest producer in Africa producing about 6.9 million metric tons.

It was estimated that seventy percent of farmers are smallholders accounting for 90 percent of total farm output [7].

Despite an increasing area of land which has been dedicated to cultivate maize since the mid- 2000s, production per hectare is still (1.3 t/ha) compared to 8.6 t/ha in developed countries [6]. However, the yield of maize in recent years has increased significantly due to several breeding program as response to striga, pest and diseases such as American rust [8] and tolerance to linked abiotic stresses (drought, erratic rainfall, low nitrogen).

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Maize production is limited by several factors including drought, which affects maize grain yield to some degree at almost all the stages of crop growth [9].

One way to alleviate this constraint is through development of higher yielding hybrids which give stable yield across the environments [10]. Grain yield stability is influenced by the capacity of a genotype to react to environmental conditions, which is determined by the genotype's genetic composition [11].

Efforts aimed at obtaining high yield of maize would necessitate the augmentation of the nutrient status of the soil and the climatic requirements of the crop for optimum productivity and to maintain soil fertility [12]. The recent achievements by breeders in the development and release of superior maize varieties with higher yield potentials and better resistance to insect pests and diseases has played a central role in increase maize production in the country [13].

Hence, the need to assess parent material of maize to identify promising hybrids that can be used for hybrid seed production led to the objectives of this study.

MATERIALS AND METHODS

Study Area: The present study was conducted to evaluate maize populations for genetic variability in yield and yield component, at the teaching and research farm of the federal university of technology, Akure (Latitude 7°16' N, Longitude 5°12'E), tropical rainforest of southern Nigeria. The location is characterized by bimodal pattern of rainfall with an annual mean of 1300 mm with a mean temperature of 27°C and climate of sub-humid type.

The Experiment Layout: Ten early maturing maize populations which were obtained from the International Institute for Tropical Agriculture (IITA) Ibadan, Nigeria was used for the experiment. The experiment was laid out in randomized complete block design with three replications.

The seeds were grown in two row plots, with row length of 5 m, having row to row and plant to plant distance of 0.75 and 0.25 m, respectively. Two seeds per hill were planted, which were thinned to one plant per hill at 4-5 leaf stage. NPK (15:15:15) fertilizer applied at the same rate at third week after planting while urea was applied week before flowering. Standard cultural practices were followed from sowing till harvesting during the entire crop season.

Data was recorded on five competitive plants from each plot for yield related traits viz; cob length (cm), grains rows cob^{-1}, fresh cob weight (kg), grain moisture content (%), 500-grains weight and grain yield (kg ha^{-1}) was calculated for the entire plot, converted into yield ha^{-1}. Data were statistically analyzed using analysis of variance appropriate for randomized complete block design. Means were compared using Tukey test at 0.05 level of probability when the F values were significant [14].

RESULTS

Means and Ranges of Fourteen Characters in the Maize Varieties: Days to tasselling varied from 46 days to 66 days with the overall mean of 54.7. Days to silking varied from 50 days to 77 days with the overall mean of 58.53. Plant height varied from 114 cm to 173 cm with the overall mean of 145.3 cm. Ear height varied from 42 cm to 79 cm with the overall mean of 56.97 cm. Number of cobs varied from 5 to 24 with the overall mean of 11.4. Length of cobs varied from 12 cm to 19 cm with the overall mean of 15.13 cm. Girth of cobs varied from 14 to 17 with the overall mean of 14.7. Field weight varied from 151g to 2160 g with the overall mean of 1206.07 G. Five hundred grain weight varied from 88 g to 127g with the overall mean of 103.73 g. Kernel row varied from 20 to 30 with the overall mean of 23.83. Plant girth varied from 6 cm to 8 cm while average cob weight varied from 20c m to 30 cm (Table 1).

Mean Performance of the Varieties: Table 2 shows that the mean number of days to 50% tasselling ranged from 49.667 to 64.33. $IWDC_3SYNF_2$ had the highest mean (64.33) which was not significantly different from TZE

Table 1: Means, standard deviation and ranges of fourteen characters of the maize varieties

Variable	Mean	STD	MINI	MAX
Days to 50%tasselling	54.7	6.2	46	66
Days to 50%silking	58.53	7.09	50	77
Plant height(cm)	145.3	17.074	114	173
Ear height (cm)	56.97	8.27	42	79
Plant girth	6.6	0.563	6	8
Number of cobs	11.4	4.74	5	24
Cob length (cm)	15.13	2.29	12	19
Girth of cobs (cm)	14.7	0.837	14	17
Field weight (g)	1206.07	620.13	151	2160
Cob weight (g)	118.67	28.88	20	30
Grain weight (g)	103.73	10.808	88	127
Kernel row	23.83	2.653	20	30

Table 2: Means of vegetative and reproductive traits I selected varieties of maize

Varieties	Days to Tasselling	Days to Silking	Plant Girth (cm)	Kernel Row	500 Grain weight (g)	Cob girth (cm)	Cob Length (cm)	Cob Weight (g)	Ear Height (cm)	Plant Height (cm)	Fresh Weight (g)
TZE.COMP 5 WCT	50.33c	53.33c	7.37a	24.00a	95.33cde	14.67ab	14.80cd	105.40c	45.73c	148.87bc	939.67d
POOL18 SR/ARC94 DMR ESR	49.67c	52.33c	7.16ab	25.67a	109.33ab	14.26b	12.03e	95.06cd	61.00b	168.37a	1037.67cd
ARC91.SUWAN1 SRC1	51.33c	60.00abc	6.84abc	24.00a	104.67bc	14.40b	14.80cd	146.23ab	57.10b	135.94cd	167.33e
SUWAN1 SR-Y	50.00c	53.33c	6.99ab	24.33a	90.67e	15.06ab	13.80d	130.69b	58.70b	164.10ab	140.00bc
TZE COMP.3C$_2$DT	62.33ab	60.00abc	6.83abc	22.33a	92.33de	14.23b	18.36a	158.26a	55.533b	147.30c	208.33e
SUWAN1 SR QPM	52.00c	52.00c	6.73bc	22.00a	120.67a	14.17b	14.03d	78.23d	54.83b	145.50c	2042.00a
DMR ESR-Y	50.00c	55.00bc	6.05de	24.33a	120.33a	14.87ab	18.70a	108.84c	58.22b	136.12cd	1514.00b
DT-Y-SYN15	62.33ab	66.67ab	5.99de	26.67a	101.33bcde	16.30a	16.80b	163.47a	71.89a	120.97d	1629.67ab
IWDC$_3$SYNF$_2$	64.33a	71.00a	6.40cd	22.00a	100.00bcde	14.10b	12.36e	109.36c	62.40b	163.73ab	1736.00ab
ARC.94.TZE.COMP5Y	54.33bc	61.67abc	5.84e	23.00a	102.67bcd	14.93ab	15.33c	90.96cd	43.77c	122.18d	1386.00bc

Means in a column with the same letter (s) are not significantly different by Tukey's test ($p \leq 0.05$)

Table 3: Coefficient of variation, heritability and genetic advance of evaluated characters of the maize varieties

Characters	Genotypic coefficient of variation (GCV) (%)	Phenotypic coefficients of variation (PCV) (%)	Heritability (%)	Genetic advance	Expected genetic gain
Days to tasselling	10.33	11.67	78.35	10.30	18.83
Days to silking	10.45	12.55	69.29	10.45	17.92
Plant height (cm)	11.36	11.95	90.39	32.34	22.25
Ear height (cm)	13.78	14.69	87.97	15.17	26.64
Field weight (g)	51.17	52.7	94.28	1234.48	89.3
500grain weight(g)	9.86	10.55	87.31	19.69	18.98
kernel row	3.49	10.12	11.86	0.59	2.48
Cob weight	8.62	9.22	87.31	19.68	16.58
Plant Girth	7.73	8.30	86.67	0.98	14.82
Cob girth	3.79	5.68	5.46	0.76	5.19
Cob length	14.94	15.16	97.15	4.59	30.33

COMP.3C$_2$DT and DT-Y-SYN15. POOL18 SR/ARC94 DMR- ESR (49.67) with the least number of days to 50% tasselling was significantly different from other populations.

IWDC$_3$SYNF$_2$ had highest mean number of days to 50% silking (71.00) and was not significantly different from other populations except DT-Y-SYN15, ARC91 SUWAN1 SRC$_1$, TZE COMP.3C$_2$DT and ARC.94.TZE COMP5Y. SUWAN1 SR QPM (52.00) had the least number of days to silking. It was not significantly different from TZE.COMP3 WCT, POOL18 SR/ARC94DMR-ESR and SUWAN 1 SR-Y.

POOL18 SR/ARC94DMR-ESR (168.37) had the highest mean plant height but not significantly different from SUWAN1 SR QPM and IWDC$_3$SYNF$_2$. DT-Y-SYN15 (120.97) had the lowest mean of plant height and was significantly different from other populations.

There was no variation in the following characters such as: number of cob, leaf feeding damage, plant girth, cob girth and kernel row.

SUWAN1 SR QPM had the highest field weight (2042.00). It was significantly different from DT-Y-SYN15 and IWDC$_3$SYNF$_2$ while ARC91 SUWAN1 SRC1 (140.00) had the least field weight having no significant difference with TZE.COMP.3C$_2$DT.

SUWAN1 SR QPM (120.67) had the highest 500 grainweight and it is not significantly different from DMR ESR-Y while SUWAN-1SR-Y (90.67) had the least 500 grain weight.

DMR ESR-Y had the highest cob length (18.70) while POOL18 SR/ARC94 DMR ESR had the least cob length (12.03).

DT-Y-SYN15 (71.89) had the highest ear height with significant difference among the populations while ARC.94.TZE.COMP5Y (43.77) had the least ear height and was not significantly different from TZE.COMP 5 WCT.

Coefficient of Variation, Heritability and Genetic Advance of Evaluated Characters of the Maize Varieties Are Presented in Table 3: Generally, phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the characters studied. Days to 50% tasselling, days to 50% silking, ear height, 500 grain weight, cob weight, plant height, plant girth, cob girth, cob length and kernel row had low phenotypic coefficient of variation, number of cobs, leaf feeding damage had moderate phenotypic coefficient of variation while field weight had high phenotypic coefficient of variation.

Table 4: Correlation among evaluated characters of the varieties

	Days to 50% Silking	Plant height (cm)	Ear Height (cm)	Cob Number	Field Weight (g)	500 grain weight (g)	Kernel row
Days to 50% tasselling	0.761	-0.130	0.373**	0.207	0.072	-0.280	-0.026
Days to 50% silking		-0.479	0.321**	0.243	0.026	-0.248	-0.061
Plant height (cm)			0.115	-0.268	0.22	-0.136	-0.062
Ear height (cm)				0.115**	0.235	0.117	0.375**
Cob number					0.685**	0.296	0.261
Field weight (g)						0.422	0.004
500 Grain weight (g)							0.147

**and* - Statistically significant at 0.05 and 0.01 probability levels respectively. Those without asterisk are not significant.

Days to 50% tasselling, days to 50%silking, ear height, 500 grain weight, cob weight, plant height, plant girth, cob girth, cob length, leaf feeding damage and kernel row had low genotypic coefficient of variation, number of cobs had moderate phenotypic coefficient of variation, while field weight had the highest genotypic coefficient of variation.

Leaf feeding damage, cob girth and kernel row all had low heritability estimates while the other characters studied had high heritability estimate.

Correlation Between Attributes Studied with Yields of the Varieties: Correlation coefficients among the characters are presented in Table 4. Days to 50% tasselling had positive and highly significant correlation with days to 50% silking (0.761) and negative correlation with 500grain weight (-0.280). Days to 50% silking had positive and high significant correlation with field weight (0.026) and 500grain weight (-0.248). Plant height had positive and high correlation with ear height and field weight (0.115, 0.22). Ear height was positive and had high correlation with field weight (0.235) and was correlated with number of cobs (0.115). Field weight was positive and had high correlation with 500 grain weight (0.422).

DISCUSSION

The result from this experiment revealed the significant ($p<0.01$) variation among the varieties in reproductive and field weight traits investigated in this study. This variation may be attributed to different genetic makeup of the genotypes [15]. The possible reason for the observed differences could be variation in their genetic akeup.

Moreover, different researchers have reported significant amount of variability in different maize populations including top-crosses and open pollinated varieties [16]. This result is in line with that of Grzesiak [17], who also observed considerable genotypic variability among various maize genotypes. Similarly, Sokolove and Guzhva [18] reported pronounced variation for different morphological traits among some maize population. Different lines have also been evaluated for morphological and agronomic traits, showing significant amount of variation among these [19]. Shah *et al.*[20] have reported significant amount of variability for different morphological traits. Mitchell-Olds and Waller [21] have also reported increased performance of heterogeneous populations over those resulted from self-pollination. Such genotypes help farmers compensate their inputs, as compared to hybrid cultivars, which asks for a strict crop production package.

Days to 50% tasselling, days to 50%silking and kernel row had low phenotypic coefficient of variation, plant height, ear height and 500grain weight had moderate phenotypic coefficient of variation while number of cobs and field weight had high phenotypic coefficient variation. Days to 50% tasselling, days to 50%silking, plant height, 500grain weight, kernel row had low genotypic coefficient of variation. Ear height and number of cobs had moderate phenotypic coefficient variation, while field weight had the highest genotypic coefficient variation. Days to tasselling and days to silking, ear height, field weight and kernel row all had moderate heritability estimates while the others had low heritability estimate. Heritability is the percentage of phenotypic variance that is attributed to genetic variance. High heritability indicates that the environmental influence is minimal on characters. Any of the characters with high heritability can, therefore, be used for selection. Rafiq *et al*. [22] have also reported high heritability for different yield controlling traits in maize. The comparatively lower heritability for grain yield of the maize, in this study, may be due to the fact that yield is a low heritable character which is controlled by many genes. The progress in selection for this character in maize is generally low [23]. Najeeb *et al*. [24] found that high heritability may not always associate with large genetic advance. Since high heritability does not always indicate a high genetic gain, heritability is recommended to be considered in association with genetic advance to predict the effect of selecting superior crops varieties.

In this study, there were strong and positive correlations between plant height and field weight. This finding was in agreement with what have been reported by Sigha and Prodhan [25] that grain yield is positively associated with plant height. Burak and Magoja [26] found maximum correlation between plant height and grain yield. Therefore, a breeder interested in improvement of maize could either select tall plants because they are high yielding. According to Burak and Magoja [26], plant and ear heights are strongly associated with grain yield. Grain yield also have positive correlations with ear height, ear length and ear diameter Burak and Magoja [26]; Singha and Prodhan [25], but not with kernel weight [27].

CONCLUSION

The result shows that variation existed among the varieties for field weight and reproductive traits studied. Ear height had positive and significant correlation with field weight and number of cobs. Varieties that had high earliness trait are not high yielding; tall varieties with moderate earliness had high field weight and had the highest yield (SUWAN1 SR QPM) while POOL18 SR1 ARC94 DMR ESR are the earliest in maturity. Therefore any of SWUWAN 1 SR QPM and POOL 18 SR1 ARC94 DMR ESR can be crossed to develop hybrid with combined traits (high yielding and early maturity).

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