Bayero Journal of Pure and Applied Sciences, 6(2): 35 - 40
Received: March 2013
Accepted: September 2013
ISSN 2006 – 6996

HERITABILITY OF SOME QUANTITATIVE CHARACTERS IN FIVE VARIETIES OF MAIZE (*ZEA MAYS L.,*) UNDER THE INFLUENCE OF VARIOUS LEVELS OF NITROGEN

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ABSTRACT
A field experiment was conducted at the Kano University of Science and Technology Wudil teaching and research farm during the 2010 and 2011 rainy seasons. Five varieties of maize were studied to estimate components of genetic variance and heritability of some quantitative characters that might exist among them, under the influence of different levels of Nitrogen fertilizer. The experiment was laid out in a randomized complete block design, and replicated three times. The genotype × different levels of nitrogen fertilizer (G × N) influenced the expression of the ear height and yield component. Analysis of variance for plant height revealed highly significant differences among varieties with genotypic coefficient of variation (1.67%) which is smaller than the phenotypic coefficient of variation (1.72%). The estimate of broad-sense heritability was high (0.79), thus showing the presence of considerable amount of genetic variation in total phenotypic variation. While the analysis of variance for ear height showed highly significant differences among genotypic coefficient of variation (0.93%) which is smaller than the phenotypic coefficient of variation (1.05%). The estimate of broad-sense heritability was high (0.49) indicating the presence of considerable amount of genetic variation in total phenotypic variation. The results confirmed the findings of other researchers on high heritability for plant height. Analysis of variance for grain yield per plot showed greater Genotypic variance than the environmental variance with genotypic coefficient of variation (5.33%) which is smaller than the phenotypic Coefficient of variation (6.24%)and the estimate of broad sense heritability (0.78) was moderately high.
Keywords: Heritability, variation, ear height, genes.

INTRODUCTION

Maize (Zea mays L.) is one of the most important food crops worldwide. After wheat and rice, maize is one of the major cultivated cereals in Nigeria; it is used as human food, livestock feed and as raw material for industrial uses such as manufacture of vegetable oil, commercial starch and pulp for rough material paper (Azanza,1996), (Ife Journal of Agric, 1982).

Nigeria is one of the developing countries of the world; the majority of its populace depends on plant carbohydrate sources. Maize as a cereal crop contains a high percentage of carbohydrate. However, the amount of maize produced in Africa does not commensurate with the carbohydrate requirement. In line with this therefore, maize seed production needs to be expanded in order to meet the carbohydrate requirements. This study was undertaken with the aim of selecting variety (ies) with uniform ear height under optimum nutrient requirement for extensive mechanized maize production.

Many researchers have experimentally demonstrated that grain yield of maize is contingent upon genotype and growth conditions (Gozubenli *et. al*, 2001 and Ha, 2007). An extensive maize breeding programme was started at International Center for the Improvement of Maize and Wheat CIMMYT with head quarter at Mexico city, Mexico some years ago, aimed at producing superior hybrids with a short growing season(early maturing), high yield and tolerant to draught.

The aim of the study was to estimate genetic variances for some quantitative characters under the influence of different levels of nitrogen fertilizer and to estimate their heritability. The estimation of heritability of some genetic traits is necessary in order to provide successful selection for certain traits. Therefore, the discovery of genetic variability of different maize quantitative characters (yield component etc) can be significantly altered by selection. Hence an auspicious selection and breeding for these traits is facilitated by the abundant genetic variability found in it (Eltahir *et. al*., 2003; Kumari *et. al*., 2006; Pal *et. al*., 1986 and Sujiprihati, *et. al*., 2005)

MATERIALS AND METHODS

The four different varieties used in these studies were obtained from Institute of Agricultural Research ABU Zaria, Nigeria and they comprised: Sammaz 17, Sammaz 18, sammaz 20, and sammaz 28. These are extra early maturing, intermediate maturing and striga resistant varieties as well as a local variety HH that is commonly grown in the area which is used as a local check in the experiment. The experiment was conducted at the Kano University of Science and Technology Wudil teaching and research farm (Bagauda, the former ICRISAT research station and L.I.B.C Gaya) during the 2010 and 2011 rainy seasonswith four levels of N-fertilizers: 0kg/ha, 80kg/ha, 100kg/ha, and 120kg/ha).

The experiment was laid in randomized complete block design, with twenty treatments and three replications. The treatment consisted of five (5) varieties of maize and four (4) levels of Nitrogen fertilizer (R_1 0, R_2 80, R_3 100, and R_4 120), making a total of 20 treatments.
The area of each plot consists of four rows of five meters (5m) long with 75cm between the rows and 3m wide resulting in $15m^2$ with total of 60 plots, with the plant densities averaging 40.000 plants/ha in the whole experiment.
The land was ploughed and harrowed which was followed by ridging. The ridges were later marked out for plots, discards and pathways. Ridges were remolded at 5 WAS to prevent stalk and root lodging. After rain was fully established, the seeds were sown the same day at the spacing (75cm x 25cm) inter and intra row respectively.
Nitrogen was applied at four (4) different rates of 0kgN, 80KgN, 100KgN, and 120KgN, using N.P.K 20:10:10 compound fertilizer first application was done at two WAS and second at six WAS.
Data for quantitative characters were collected from the net plot for the following parameters:

1. ***Plant height***
2. ear height
3. No of ears/plant
4. cob length
5. number of rows per cob
6. number of seed per cob
7. Weight of 100 seed

The collection of data started at the time of crop maturity, considering the three middle rows of each plot..
Plant height: This was measured from the soil surface to the lowest branch of tassel of ten randomly selected samples from the middle rows of each plot.
Ear height: Was measured from the soil surface to the first ear node of ten randomly sampled plants from the middle rows of each plot.
All the data were analysed using analysis of variance (ANOVA) procedure in the statistical software package GENSTAT. The comparisons of the treatment means were made using the Duncan's multiple range test (p<0.05).
Four plants were selected at random from each plot at harvest for measurement and observation. Phenotypic, genotypic and environmental variances were computed from the respective mean squares. Broad-sense heritability for each trait was calculated as the ratio of the genotypic variance to phenotypic variance. Treatments of means were compared using DMRT, Pearson's correlation were taken to determine the types of associations between some characters and grain yield of maize. The variance of the observed values of phenotypic variance (Vp), was partitioned into different components:
Vp = VG + VE .

Heritability (H %) was estimated as:

$$H_B^2 = \sigma_g^2 / \sigma_g^2 + \sigma_e^2 / r$$

Where: σ^2g= total genetic variance; σ^2e= environmental variance (Sprague, 1967):

RESULTS

Stand Count at harvest

Table 1 shows the influence of variety and nitrogen level on stand count at harvest of maize. The performance of the varieties was significantly ($P \leq 0.05$) different in relation to stand count at harvest, Sammaz 18 produced significantly ($P \leq 0$. the highest stand count. This was followed by Sammaz 17, sammaz 18 and HH which were at par, the least stand count was produced by sammaz 20. The influence of Nitrogen levels with regard to stand count at harvest was not statistically significant. The interaction between variety and Nitrogen level was also not significant.

Plant height

Table 2 shows the effect of variety and nitrogen level in relation to plant height at harvest. The performance of variety in relation to plant height was significant ($P \leq 0.05$).The tallest plant was produced by HH. This was followed by Sammaz 17. Sammaz 18 produced the next tallest plants after sammaz 17. The shortest plants were produced by Sammaz 20 and Sammaz 28 which were at par. The effect of Nitrogen level on plant height was statistically significant ($P \leq 0.05$), the tallest plant was produced by the application of 80kg/ha of nitrogen, this was followed by the application of 100kg/ha and 120kg/ha of nitrogen which were at par. The least plant height was produced by the controlled condition which was 0kg/ha of nitrogen. The interaction between variety and nitrogen level was not statistically significant.

Ear height

Table 3 shows the effect of variety and nitrogen level on ear height at the time of harvest. The performance of varieties in relation to ear height showed that the largest ear height was significantly ($P \leq 0.05$) obtained in sammaz 17 and HH which were at par, followed by sammaz 18 and sammaz 20 that were also at par, while the least ear height was recorded in sammaz 18. The effect of nitrogen levels on ear height was not statistically different. Also the interaction among variety and nitrogen levels was not significant.

Number of ears per plant

Table 4 shows the effect of variety and nitrogen level on number of cobs per plant at harvest. The effect of the varieties was significantly different ($P \leq 0.05$), Sammaz 18 and Sammaz 20 which were at par produced the highest number of cobs. This was followed by Sammaz 17 and Sammaz 28 which were at par. The least number of cobs per plant was produced by HH. The influence of nitrogen levels with regards to number of cobs per plant at harvest was not statistically significant. The interaction between variety and nitrogen level was not significant.

Weight of 100 seed

Table 5 shows the effect of variety and nitrogen rate in relation to weight of 100 seed. Sammaz 28 produced significantly ($P \leq 0.05$) heavier seeds.This was followed by Sammaz 20 and HH which are at par. Sammaz 17 and sammaz 18 which were at par produced the least weight of 100 seed. The effect of Nitrogen levels on weight of 100 seeds was statistically insignificant. The interaction between variety and nitrogen level was not significant.

Grains weight per plot

Table 6: shows the influence of variety and nitrogen level in relation to grains weight per plot. The varieties performed significant ($P \leq 0.05$) different in term of grains weight per plot. Sammaz 20 and Sammaz 28 which were at par performed better in terms of grain weight. This was followed by Sammaz 18, HH produced the next grain yield after sammaz 18. The least yield was obtained from sammaz 17.

The influence of Nitrogen levels on varieties was significant ($P<0.05$). The application 100kg N/ha and 120kg N/ha produced the highest grain weight per plot after 80kg N/ha. The least yield was obtained by the application of 0kg N/ha. The interaction between varieties and Nitrogen levels was not statistically significant.

Table 1: Stand count at harvest as affected by variety and Nitrogen levels 2010Bagauda

Varieties	**Means**
Sammaz 17	35.50ab
Sammaz 18	37.66a
Sammaz 20	34.00b
Sammaz 28	34.47ab
HH	34.33ab
SE ±	1.183 N.S
Nitrogen Rate	Mean
0kg	36.13
50kg	35.47
100kg	35.67
120kg	34.47N.S
SE ±	1.058 N.S
Interaction	Varieties x treatment = N.S

Means followed by the same letter(s) within the same column and treatment are not significantly different using DMRT, Where NS = Not significant

Table 2(a): Plant height at harvest as affected by variety and Nitrogen levels 2010

Varieties	**Means**
Sammaz 17	232.80ab
Sammaz 18	215.44bc
Sammaz 20	204.53c
Sammaz 28	204.35c
HH	249.03a
SE ±	8.877
Nitrogen Rate	Mean
0kg	208.40b
50kg	234.28a
100kg	217.38ab
120kg	224.85ab
SE ±	7.939 N.S
Interaction	Varieties x treatment N.S

Means followed by the same letter(s) within the same column and treatment are not significantly different using DMRT, Where NS = Not significant

Table 2(b): Plant height at harvest as affected by variety and Nitrogen levels 2011

Variety/ Nitrogen	**Sammaz 17**	**Sammaz 18**	**Sammaz 20**	**Sammaz 28**	**HH**
0	91.60c	89.50c	84.1c	83.4c	86.8c
50	109.4b	98.4bc	96.8bc	93.3bc	107.5b
100	125.1a	118.1a	112.5b	105.0b	129.6a
120	119.0a	120.1a	113.1b	129.1a	109.8b

SED=8.5 N.S

Means followed by the same letter(s) within the same column and treatment are not significantly different using DMRT, Where, N.S = Not significant

Table 3(a): Ear height of maize plant as affected by variety and Nitrogen2010

Varieties	**Means**
Sammaz 17	90.413a
Sammaz 18	84.09ab
Sammaz 20	74.84b
Sammaz 28	73.79b
HH	99.00a
SE ±	6.606*
Nitrogen Rate	Mean
0kg	77.69
50kg	92.52
100kg	85.96
120kg	84.53
SE ±	5.909 N.S
Interaction	Varieties x treatment N.S

Means followed by the same letter(s) within the same column and treatment are not significantly different using DMRT, Where * = Significant at 1% level of probability, NS = Not significant

Table 3(b): Ear height of maize plant as affected by variety and Nitrogen 2011

Variety/ Nitrogen	Sammaz 17	Sammaz 18	Sammaz 20	Sammaz 28	HH
0	14.20c	13.40c	13.03c	12.20c	13.63c
50	22.32b	21.07c	18.40bc	15.82c	19.80bc
100	30.20a	27.30b	19.93bc	19.30bc	32.17a
120	28.80a	26.40ab	26.62a	35.25a	24.43b

SED=10.3 Significant

Means followed by the same letter(s) within the same column and treatment are not significantly different using DMRT, Where, N.S = Not significant

Table 4: Number of ears per plant as affected by variety and Nitrogen levels 2010

Varieties	**Means**
Sammaz 17	1.25ab
Sammaz 18	1.38a
Sammaz 20	1.33a
Sammaz 28	1.29ab
HH	1.07b
SE ±	0.080N.S
Nitrogen Rate	Mean
0kg	1.23
50kg	1.23
100kg	1.22
120kg	1.38
SE ±	0.072 N.S
Interaction	Varieties x treatment N.S

Means followed by the same letter(s) within the same column and treatment are not significantly different using DMRT, Where NS = Not significant

Table 5: Weight of 100 seeds as affected by variety and Nitrogen levels 2010

Varieties	**Means**
Sammaz 17	16.66b
Sammaz 18	18.28b
Sammaz 20	19.59ab
Sammaz 28	21.43a
HH	18.88ab
SE ±	1.064*
Nitrogen Rate	Mean
0kg	19.40
50kg	19.67
100kg	18.49
120kg	18.32
SE ±	0.95N.S
Interaction	Varieties x treatment N.S

Means followed by the same letter(s) within the same column and treatment are not significantly different using DMRT, Where * = Significant at 1% level of probability, NS = Not significant

Table 6: Grain weight per plot as affected by variety and Nitrogen level 2010

Varieties	**Means**
Sammaz 17	1.62c
Sammaz 18	2.28ab
Sammaz 20	2.46a
Sammaz 28	2.65a
HH	1.68bc
SE ±	0.214**
Nitrogen Rate	Mean
0kg	1.83b
50kg	2.50b
100kg	2.07ab
120kg	2.15ab
SE ±	0.192N.S
Interaction	Varieties x treatment N.S

Means followed by the same letter(s) within the same column and treatment are not significantly different using DMRT, Where ** = Significant at 5% level of probability, NS = Not significant

Table 7.Phenotypic variation, genotypic variation, heritability, phenotypic coefficient of variation and genotypic coefficient of variation

Characters	**Phenotypic Variation**	**Genotypic Variation**	**Environmental Variance(BS)**	**Heritability**	**Ph. coef.,% Variation**	**Ge. coef.,% Variation**
plant height	0.92	0.69	0.21	0.79	1.72	1.77
Ear height	0.35	0.42	0.15	0.43	0.93	1.05
No. of ears/plant	0.000056	0.000003	0.000062	0.07	0.18	0.69
100 grain weight	2.67	2.35	0. 69	0.81	7.89	8.53
Grain yield	71.25	47.52	36.13	0.78	6.23	5.33

BS Broad sense
Ph.coef.,% Phenotypic coefficient of variation, %
Ge.coef.,% Genotypic coefficient of variation, %

DISCUSSION

Analysis of variance for plant height, ear height, number of ears per plant, weight of 100 grain and grain yield showed highly significant differences among varieties

Table 3 shows the interaction between nitrogen levels and ear height of the different maize varieties. The highest means were obtained at the fertilizer rates of 50kg/ha and 100kg/ha, and the least values were recorded for 0kg/ha. Khalifa et al. (1984) and Gozubenli et al. (2001) also recorded similar findings.

The genotypic variance, environmental variance, genotypic coefficient of variation, phenotypic coefficient of variation and Broad-sense heritability were high indicating sufficient genetic variability in total phenotypic variation and suggest the possibility of selection for these traits (Nagoli,1983)

Analysis of variance for plant height revealed highly significant differences among varieties. The genotypic variance was smaller than the phenotypic variance and both these variances were greater than the environmental variance genotypic coefficient of variation (1.67%) was smaller than the phenotypic coefficient of variation (1.72%). The estimate of broad-sense heritability was high (0.79) thus showing the presence of considerable amount of genetic variation in total phenotypic variation.

Analysis of variance for ear height showed highly significant differences among varieties. The genotypic variance was smaller than the phenotypic variance and both these variances were greater than the environmental variance genotypic coefficient of variation (0.93%) was smaller than the phenotypic coefficient of variation (1.05%). The estimate of broad-sense heritability was high (0.49) indicating the presence of considerable amount of genetic variation in total phenotypic variation. The results confirmed the findings of other researchers on high heritability for plant height (El-Nagouli*et al.,* 1983 and Pal *et al.,* 1986)).

Number of ears per plant showed non-significant differences among varieties of maize. Genotypic variance was smaller than the environmental variance as well as from the phenotypic variance. Genotypic coefficient of variation was low (0.19%) than the phenotypic Coefficient of variation (0.68%). Broad-sense heritability was very low (0.07) , this is indication that selection for this trait will not be effective.

Analysis of variance for 100-grain weight (Table 7) showed highly significant differences among the all the varieties. Genotypic variance was greater than the environmental variance (Table 8). Genotypic coefficient of variation was smaller (7.89%) than the phenotypic coefficient of variation (8.59%). The estimate of broad sense heritability (0.81) was observed to be moderate. This agreed with the findings of Rea, R. A.et., al (2007)

Analysis of variance for grain yield per plot revealed highly significant differences among the varieties. Genotypic variance was greater than the environmental variance. Genotypic coefficient of variation (5.33%) was smaller than the phenotypic Coefficient of variation (6.24%). The estimate of broad sense heritability (0.78) was moderately high.

CONCLUSION

Field experiments on heritability of some quantitative characters in five different varieties of maize, under the influence of various rate of nitrogen were conducted at the Research farm of Kano University of Science and Technology Wudil, during 2010 and 2011rainy seasons. The experiment was aimed at establishing the variability of some quantitative characters which could be used to estimate the heritability of ear height for mechanized harvesting breeding programme in maize. Highly significant differences were observed among all the 5 varieties for all the traits except for number of ears per plant where it was non-significant. Therefore, the discovery of genetic variability of different maize quantitative characters can be significantly altered by selection. Hence an auspicious selection and breeding for these traits is facilitated by the abundant genetic variability found in it.

Acknowledgement

Our special gratitude goes to the Maize Breeding Unit, Department of Plant Science, Ahmadu Bello University Zaria for providing us with improved seeds used in this research.

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