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Heritability and Correlation Coefficients Analysis of Maize (Zea Mays L.) Agronomic Traits for Drought Tolerance in Savanna Zones of Borno State, Nigeria

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Abstract - Twenty-nine entries consisting of the twenty F_1 hybrids plus nine parental lines were laid-out in a randomized complete block design (RCBD) with three replications and were evaluated in two locations namely: Biu and Damboa in the cropping season in 2008. The sowing were carried out in mid and end of August (15^{th}-30^{th} August) in Sudan and Northern Guinea savanna respectively in order to subject the entries to moisture stress. Evaluations were done to estimates the level of broad-sense heritability and correlations between the traits and total grain yields. The results showed high heritability estimates for days to 50% tasseling (56.61%), days to 50% silking (59.67%), anthesis silking interval (ASI) (64.23%), plant height (67.26%), ear height (56.83% and grain yield (55.57%), they are all above the average. However, moderate heritability estimates were recorded for number of stands per plot (49.36%), number of cobs per plant (50.69%), number of cobs per plot (45.54%) and 100 seed weight (45.89%). High and moderate broad-sense heritability of these traits revealed that an increment of production may be achieved upon improving either one or more of these traits. The analysis of the correlation coefficient revealed that number of stands per plot (r = 0.6045g and 0.4149e), ASI (r = 0.4580), plant height (r = 0.6236), number of cobs per plant (r = 0.4926), number of cobs per plot (r = 0.9405), weight of cobs (r = 0.8343) and dehusked cobs (r = 0.4193) exhibited positive and significant genotypic (g), phenotypic (p) and environmental (e) correlation with grain yield across locations.

Keywords: Correlation Coefficients, Drought, Heritability, Maize and Traits.

Introduction

Maize (*Zea mays* L.) has a wide adaptation, and is able to grow in regions ranging from semi arid with annual rainfall of 20 to 25 cm, to those where annual rainfall may exceed 400 cm (Mahmood, 2004). It is one of the most important food crops worldwide and grown between latitude 58° N and 49° S of the equator. Varying latitudes have an effect on number of days to flowering and maturity. This is as a result of higher temperatures at lower altitudes, which accelerate growth while the lower prevailing temperatures at high altitudes retard growth and extend time to mature (Seed Co., 1999). It is a tropical cereal and is currently the third most important cereal, after wheat and rice, cultivated on over 160 million hectares. Africa harvests 29 million hectares, with Nigeria, the largest producer harvesting 3% (FAO, 2009).

Heritability estimates have been extensively used by plant breeders in selection of promising genotypes, and in prediction of percentage heritability of desirable traits Morakinyo (1996). Lukhele (1981) also used heritability estimates to predict yield component in sorghum. From these reports, they all affirmed the suitability of these estimates in prediction and selection of promising crop genotypes during crop improvement. Several researches (El-Hefnawy and El-Zeir, 1991); Nawar,*et al*., 1991 and Mohamed, 1993) studied the genetic variance and heritability in maize, concerning narrow sense heritability, it was found to be high for ear height, ear diameter, 100 – kernel weight and grain yield (El-Agmy *et al*., 1992 and Mourad *et al*., 1992).

Knowledge of the nature of association between yield and its components and among various components is of great assets in any breeding programme. The extent and direction of association is measured by correlation coefficients. Correlation studies provide information that selection for one character will result in progress for all positively or negatively correlated characters. Many of the characters are correlated because of mutual association, positive or negative, with other characters. El-Shouny *et al.* (2005) and Tollenaar *et al.* (2004) identified different traits like ear length, ear diameter, kernels per row, ears per plant, 100 seed weight and rows per ear as potential selection criteria in breeding programs aiming at higher yield.

The present study was conducted to determine various parameters of genetic variability as well as genotypic, phenotypic and environmental correlation coefficients as models for yield improvement and selections for drought tolerance in maize.

Materials and Methods

A nursery experiment was conducted in 2007 at Faculty of Agriculture Teaching and Research Farm, University of Maiduguri, Nigeria, for the production of F_1 hybrids. Field evaluations were carried out during the rainy seasons of 2008 in Biu and Damboa. Biu is located in Northern Guinea Savanna (latitude 11°.10.5'N and longitude 12^0 46.3|E on an altitude of 291m above sea level). It has an average annual rainfall of 500 – 1000 mm distributed within the rainy season period of 100 – 120 days. On the other hand, Damboa is located in Sudan Savanna (latitude 11°.10.5'N and longitude 12^0 46.3|E on an altitude of 291m above sea level). It has an average annual rainfall of 500 – 1000 mm distributed within the rainy season period of 100 – 120 days. The materials were generated by crossing five open- pollinated varieties (drought tolerant) obtained from IITA Ibadan to four local varieties (susceptible to drought) in a line x tester mating design. The parental lines and hybrids evaluated were laid-out in a randomized complete block design (RCBD) with three replications in each location. The sowing were carried out in mid and end of August (15^{th}-30^{th} August) in Sudan and Northern Guinea savanna in each location respectively. Each plot consisted of four rows of 5 m ridges. The plant stands were spaced 75 cm between rows and 40 cm within rows. All cultural practices recommended for maize production were followed to ensure a good crop growth and development. Data were recorded on five randomly selected plant samples from each replication for twelve quantitative traits visa vis: number of stands per plot, days to 50% tasseling, days to 50% silking, ASI, plant height (cm), ear height (cm), number of cobs per plant, number of cobs per plot, weight of cobs (g), dehusked cobs (g), 100-seed weight (g) and grain yield (kg/ha). All statistical analysis was carried as described by Singh and Chaudhry (1985).

Results and Discussion

The results from the heritability estimates for individual and combined locations are presented in Table 1. Locations played its role in modifying the heritability estimates for different traits. Low, medium and high broad sense heritability estimates were found in different plant traits under study (Table 1). Results showed that high broad sense heritability estimates were detected for days to 50% tasseling (56.61%), days to 50% silking (59.67%), ASI (64.23%), plant height (67.26%), ear height (56.83%) and grain yield (55.57%) they were all above the average. This emphasizing that the additive genetic variation was the major component of genetic variation in the inheritance of these traits and the effectiveness of selection in the early segregating generations of the studied hybrids for improving these traits. Hence provides better opportunities for selecting plant material regarding these traits. Similar result was reported by Wannows *et al*. (2010). However, moderate broad sense heritability estimates were recorded for number of stands per plot (49.36%), number of cobs per plant (50.69%), number of cobs per plot (45.54%) and 100 seed weight (45.89%). Careful selection for these traits may also lead towards improvement in these trait, most of these results are in harmony with those obtained by El-Rouby *et al*., 1973; and Abd El-Sattar, 2003. The results indicated that number of stands per plot, number of cobs per plant, number of cobs per plot, weight of cobs, dehusked cobs and 100 seed weight had below average heritability values. The present results emphasized the portion of additive genetic variance for many of studied traits and suggest the importance of choosing suitable segregating generations for exhibiting the best expression of genes of different characters in the studied hybrids or improving such traits. These results are in line with earlier results reported by Olakojo and Olaoye (2011) and Wannows *et al.* (2010).

In selecting high yielding, genotypic (g) correlation studies supply reliable information on the nature, extend and direction of selection. In this study, genotypic correlations were higher in almost all cases than the phenotypic (p) and environmental (e) correlations explaining why genotypic showed more significant difference between the pairs of traits than phenotypic correlation (Table 2). This result is in harmony with those obtained by Duvick *et al*. (2001) and Mohammadia *et al*. (2003). The data showed that significant and positive correlation coefficients were found between grain yield and each of number of stands per plot (r = 0.6045g and 0.4149e), ASI (r = 0.4580), plant height (r = 0.6236), number of cobs per plant (r = 0.4926), number of cobs per plot (r = 0.9405), weight of cobs (r = 0.8343) and dehusked cobs (r = 0.4193). This result showed that selection for these traits may be accompanied by increase in grain yield of maize. Also, days to 50% silking and 100-weight were negatively correlated with grain yield. The magnitude of genotypic correlations were higher than those of phenotypic and environmental correlation coefficients to grain yield across locations, which mean that any improvement of these traits will induce increase in grain yield. The result is in agreement with that of Aydin *et al.* (2007), Wannows *et al.* (2010), Rafiq *et al*. (2010) and Sadek *et al.* (2006).

Conclusion

The results showed that days to 50% tasseling, days to 50% silking, ASI, plant height and grain yield had high broad-sense heritability. High to moderate heritability indicated considerable potential for development of drought tolerance and high yielding varieties through selection of desirable plants in succeeding generation. Some traits such as number of stands per plot, ASI, plant height, number of cobs per plant, number of cobs per plot, weight of cobs and dehusked cobs were positively correlated with grain yield under water stress (drought). Traits that had high heritability and positive correlation with grain yield may be considered as important traits in selection programme aiming to maize yield improvement and the breeder may consider these traits as main selection criteria.

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Table 1: Estimations of broad sense heritability (%) of hybrids for twelve agronomic traits in maize at Biu in 2008, Damboa in 2008, and Biu/Damboa 2008 combined locations

Trait	**Broad Sense Heritability**		
	Biu 2008 Values	Damboa 2008 Values	Biu /Damboa 2008 combined Values
Number of stands per plot	36.35	62.37	49.36
Days to 50% tasseling	43.82	69.41	56.61
Days to 50% silking	45.51	74.07	59.67
Anthesis silking interval	78.92	49.54	64.23
Plant height	84.04	50.48	67.26
Ear height	48.89	64.77	56.83
Number of cobs per plant	56.21	45.71	50.69
Number of cobs per plot	46.19	44.89	45.54
Weight of cobs	49.29	26.83	38.06
Dehusked cobs	66.01	22.45	44.23
100 seed weight	52.08	39.7	45.89
Grain yield	65.66	45.48	55.57
Range	36.35 – 78.92	22.45 – 69.41	38.06 – 67.26
Mean	56.08	49.64	52.82

Table 2: Analysis of genotype (g) phenotype (p) and environmental (e) correlations for twelve agronomic traits in maize at Biu/Damboa 2008 combined locations

		DTT	DTS	AS1	PHT	EHT	NCPL	NCPT	WC	DC	HSW	GRY
NSP	G	0.1691	0.9543**	-0.1449	0.7298**	0.5264*	-0.2062	-0.4702*	0.5644*	0.3163	-0.0174	0.6048*
	P	0.5431*	0.0498	0.0026	0.1008	0.0055	0.0229	0.2405	0.0744	0.0862	-0.0436	0.0680
	E	-0.0292	0.0400	0.1372	0.0323	0.0759	0.0912	0.5391*	0.1343	0.1641	0.0184	0.4149*
DTT	G		0.4485*	-0.1314	0.7733**	0.6711*	0.2556	0.8403**	0.2736	0.1583	-0.0477	0.0319
	P		0.4717*	-0.2221	0.2539	0.3543*	-0.1370	0.0039	-0.1007	-0.1323	-0.1939	-0.1396
	E		0.9483**	-0.4598*	0.4039*	0.6591*	-0.3163	-0.0585	-0.2347	-0.2969	-0.4100*	-0.3000
DTS	G			-0.1598	0.8461**	0.7827**	0.1683	0.6051*	0.3010	0.1412	-0.1123	-0.0524
	P			-0.1536	-0.2593	0.3599*	-0.1299	0.1563	-0.1071	-0.1342	-0.1847	-0.1367
	E			-0.3063	0.3898*	0.6484*	-0.2963	-0.0596	-0.2544	-0.3028	-0.3824*	-0.2864
AS1	G				0.2673	-0.2569	0.4350*	0.7961**	0.0551	0.7172**	0.0525	0.4580*
	P				-0.1028	-0.1827	0.1025	0.1157	0.1700	0.1880	0.1643	0.2091
	E				-0.2750	-0.3545*	0.1747	0.2014	0.2762	0.3274	0.3442	0.3944*
PHT	G					0.9171**	0.7797**	0.3595*	0.2918	0.9344**	0.2862	0.6236*
	P					0.3120	0.0391	0.1086	-0.0550	-0.0640	-0.0904	-0.0406
	E					0.3665*	-0.0038	0.1168	-0.2331	-0.2429	-0.2430	-0.1632
EHT	G						0.9174**	0.6475	0.3864*	0.3312*	0.1469	0.5061*
	P						-0.1301	-0.0344	-0.1320	-0.1573	-0.2394	-0.1694
	E						-0.3537	-0.1248	-0.3027	-0.3595*	-0.5285*	-0.3854*
NCPL	G							-0.2837	0.3994*	0.1699	-0.1154	0.4926*
	P							-0.0062	0.1069	0.1232	0.1378	0.1276
	E							0.0304	0.2005	0.2436	0.2975	0.2751
NCPT	G								0.8178**	0.9407**	0.1962	0.9405**
	P								0.0407	0.0495	0.0088	0.0768
	E								0.0317	0.0482	0.0601	0.1003
WC	G									-0.4697*	-0.6062*	0.8343**
	P									0.4466*	0.1825	0.4139*
	E									0.9822**	0.4197*	0.8907**
DC	G										-0.4700*	-0.4193*
	P										0.2000	0.4284*
	E										0.4576*	0.9101**
HSW	G											-0.4029*
	P											0.1915
	E											0.4374*

KEYS

NSP =Number of stands per plot ASI=Anthesis silking interval NCPL = Number of cobs per plant DC = Dehusked cobs
DTT =Days to 50% tasseling PHT = Plant height NCPT = Number of cobs per plot HSW= 100seed weight
DTS =Days to 50% silking EHT = Ear height WC = Weight of cobs GRY = Grain yield
* = Significant ** = Highly significant

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