Journal Of Harmonized Research (JOHR)

Journal Of Harmonized Research in Applied Sciences
2(3), 2014, 198-203

ISSN 2321 – 7456

Original Research Article

ESTIMATIONS OF HERITABILITY AND CORRELATION COEFFICIENTS FOR GRAIN YIELD AND IT COMPONENTS IN MAIZE (*Zea mays* L.) UNDER DROUGHT CONDITIONS IN SAVANNA ZONES OF BORNO STATE, NIGERIA

D. Aminu, J. W. Wabekwa and A. S. Muhammad

Department of Crop Production, Faculty of Agriculture, University of Maiduguri,
P M B 1069 Maiduguri,Nigeria

Abstract

A study was carried out to estimates the percentage of heritability and correlation coefficients of desirable maize agronomic traits under drought tolerance condition. Nine parental-lines (five males and four females) were crossed to generate twenty hybrids using a line x tester mating design. Twenty-nine entries consisting of 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 *vis* Biu and Damboa during the cropping season in 2009. The sowing was carried out in mid and end of August (15^{th}-30^{th} August) in Sudan and Northern Guinea savannas respectively in order to subject the entries to moisture stress. Evaluations were done to investigate broad-sense heritability and correlation coefficients between the traits and total grain yield. The results for combined locations showed higher heritability estimates of 62.37%, 65.29%, 60.09% and 65.37 for days to 50% tasseling, days to 50% silking, dehusked cobs and grain yield respectively. However, moderates heritability estimates of 53.84%, 51.28%, 54.73%, 54.04% and 57.75% for number of stands per plot, anthesis silking interval, plant height, weight of cobs and 100 seed weight respectively were observed. Higher and relatively moderate broad-sense heritability of the traits revealed that variations were transmissible and potential for developing high yielding varieties through selection of desirable plants in succeeding generations exist. Correlation coefficients analysis revealed that days to 50% tasseling (r = 0.3677), number of cobs per plant (r = 0.5646), number of cobs per plot (r = 0.4992), weight of cobs (r = 0.3757g, r = 0.3616p and r = 0.7727e), dehusked cobs (r = 0.3746p and 0.7884e) and 100 seed weight (r = 0.3767) showed positive and significant genotypic (g), phenotypic (p) and environmental (e) correlation with grain yield except number of stands per plot and ear height which were negatively correlated with grain yield. The magnitude of genotypic correlations were higher than those in phenotypic and environmental correlation coefficients to grain yield, which means that selection for these traits will improve grain yield. The study also observed that correlations as well as heritability were suitable as models for yield improvement and selection for drought tolerant genotypes.

Key Words: Correlation, drought, heritability, maize, traits and savanna.

Introduction: Maize (*Zea mays* L.) is one of the most important food crops worldwide and grown between latitude 58^o N and 49^o S of the equator. Varying latitudes have an effect on

For Correspondence:
dattiaminuATyahoo.com
Received on: July 2014
Accepted after revision: August 2014

number of days to flowering and maturity. It is the most important cereal in the Sub-Saharan Africa and 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). The nature of association between grain yield and its components determine the appropriate traits to be used in indirect selection for improvement in grain yield (Rafiq *et al.*, 2010).

Yield of maize (*Zea mays* L.) is considered as a complex inherited character, therefore, direct selection for yield *per se* may not be the most efficient method for its improvement, but indirect selection for other yield related characters, which are closely associated with yield and high heritability estimates will be more effective. Several researches (Nawar *et al.*, 1991 and Mohamed, 1993) studied the genetic variance and heritability in maize. 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 programmes.

The correlation studies simply measure the associations between yield and other traits. It provides information that selection for one trait will result in progress for all positively correlated characters. Many investigators determined the associations among different characters in maize (Moursi *et al.*, 1975). 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 year as potential selection criteria in breeding programmers aiming at higher yield.

The objective of the present study was to estimate the heritability as well as correlation coefficients for some agronomic and yield traits for yield improvement and selections for drought tolerance in maize.

Materials and Methods

A nursery experiment was carried out for the initial formation of F_1 hybrids population at the Faculty of Agriculture, Teaching and Research Farm, University of Maiduguri (latitudes 11^o 14$^|$N and longitude 13^0 04$^|$E on an altitude of 354 m above sea level) to produce twenty F_1 hybrids. The hybrids produced together with their parents were evaluated in two locations (Biu and Damboa) during the rainy season of 2009. Biu is located in Northern Guinea Savanna and is characterized by a rainy season period of 130 – 160 days with range of average annual rainfall of 900 – 1400 mm (latitude 11^0 2$^|$N and longitude 13^0 2$^|$E), the soil type is clay or black cotton vertisols (FAO/UNESCO, 1998) soil. Damboa on the other hand, is located in Sudan Savanna (latitude 11^o.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 sowing were conducted in mid to August end (15th to 30th August) in Sudan and Northern Guinea savanna respectively in 2009 to subject the genotypes to moisture stress. The plot consisted of four rows of 5 m ridges. The plants stand 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, anthesis silking interval (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 combined locations are presented in Table 1. Locations played a major role in modifying the heritability estimates for different traits. The heritability estimates is important in choosing the suitable segregating generations for exhibiting the best expression of gene of different studied traits (Wannows *et al.,* 2010). Estimates of broad-sense heritability were high for most of the traits studied. High broad-sense heritability estimates for combined locations were found for days to 50% tasseling (62.37%), days to 50% silking (65.29%), dehusked cobs (60.09%) and grain yield (65.37%) and they are above the combined average. Most of the traits had high heritability estimates indicating to preponderance of additive gene action. These results are in line with earlier results reported by Olakojo and Olaoye (2011), Rafiq *et al*., 2010 and Wannows (2010). However, moderate broad-sense heritability estimates were obtained for number of stands per plot (53.84%), ASI (51.28%), plant height (54.73%), weight of cobs (54.04%) and 100 seed weight (57.75%), while low heritability estimates were recorded for ear height (48.43%), number of cobs per plant (40.91%) and number of cobs per plot (45.91%). Similar results were reported by El-Hosary and Abd-El-Sattar, (1998), Amer and Mosa (2004) and Yassien (1993). High estimates of broad-sense heritability for most of the traits revealed that variations were transmitted to the progeny and indicated potential for developing high yielding varieties through selection of desirable plants in succeeding generations. These results were in line with those of various researchers (Saleem *et al*., 2008 and Swati and Ramesh, 2004).

Analysis of genotype (g) phenotype (p) and environmental (e) correlation coefficients for twelve agronomic traits in maize at Biu and Damboa combined locations in 2009 are presented in Table 2. Genotypic correlation coefficients were higher than the phenotypic and environmental correlations. This result is in harmony with those obtained by Duvick *et al*. (2001) and Mohammadia *et al*. (2003). The correlation coefficients results revealed most of the traits had positive and direct effect on grain yield. Correlation coefficient revealed that, days to 50% tasseling (r = 0.3677), number of cobs per plant (r = 0.5646), number of cobs per plot (r = 0.4992), weight of cobs (r = 0.3757g, r = 0.3616p and r = 0.7727e), dehusked cobs (r = 0.3746p and 0.7884e) and 100 seed weight (r = 0.3767) showed significant and positive correlation with grain yield. This showed that selection for any of these traits would lead to indirect selection for grain yield. The result is in agreement with that of Devi, *et al*. (2001), Mohan *et al*. (2002) and Rafiq *et al*. (2010). Number of stands per plot, plant height and , ear height expressed negative phenotypic correlation coefficient with total grain yield per hectare suggesting that these traits were not closely associated and therefore, may not be jointly selected. Similar work was conducted and reported by Olakojo and Olaoye (2011) that phenotypic correlation of ear height and grain yield was however, negatively and significantly correlated and suggested that the two traits were closely associated.

Conclusion

High to moderate heritability estimates exhibited in this study indicated considerable potential for development of drought tolerance and high yielding varieties through selection of desirable plants in succeeding generation. The results showed that days to 50% tasseling, days to 50% silking, dehusked cobs and grain yield had high broad-sense heritability. These traits are important in selection programs aiming to maize yield improvement on drought tolerance and the breeder may consider these traits as the main selection criteria. The study also showed that genotypic, phenotypic and environment correlations were found suitable as models for yield improvement and selection for maize drought tolerant genotypes. Some traits such as days to 50% tasseling, number of cobs per plant, number of cobs per plot, weight of cobs and, dehusked cobs and 100 seed weight were positively correlated with grain yield under water stress (drought). These traits may be used as target traits to improve maize grain yield.

Table 1: Estimates for broad-sense heritability (%) of hybrids for twelve agronomic traits in maize at Biu in 2009, Damboa in 2009 and Biu/Damboa 2009 combined locations

Traits	Biu 2009 Values	Damboa 2009 Values	Biu/Damboa 2009 combined Values
Number of stands per plot	54.31	53.37	53.84
Days to 50% tasseling	67.20	57.54	62.37
Days to 50% silking	68.04	62.54	65.29
Anthesis silking interval	56.00	46.56	51.28
Plant height	56.53	52.93	54.73
Ear height	51.19	45.67	48.43
Number of cobs per plant	45.61	36.21	40.91
Number of cobs per plot	45.65	46.17	45.91
Weight of cobs	57.26	50.82	54.04
Dehusked cobs	60.86	59.32	60.09
100 seed weight	58.45	57.05	57.75
Grain yield	68.23	62.51	65.37
Range	45.61 - 68.23	36.21 - 62.51	40.91 - 65.37
Mean	57.44	52.56	55.00

Table 2: Analysis of genotype (g) phenotype (p) and environmental (e) correlation coefficients for twelve agronomic traits in maize at Biu/Damboa in 2009 combined locations

		DTT	DTS	AS1	PHT	EHT	NCPL	NCPT	WC	DC	HSW	GRY
	G	0.2203	0.2003	0.0813	0.8511**	0.5842*	-0.1532	-0.8828**	-0.2533	-0.3050	-0.0540	-0.8392**
NSP	P	0.1135	0.1318	-0.0134	0.1607	0.1417	-0.0170	0.0977	0.0018	-0.0096	-0.0192	-0.0219
	E	0.0463	0.0864	-0.0307	0.1797	0.2124	-0.0203	0.2210	0.0281	0.0146	-0.0321	0.0142
	G		0.8603**	0.5550*	0.2905	0.7025**	-0.0630	0.9568**	0.5046*	0.3896*	-0.2217	0.3677*
DTT	P		0.5166*	0.1283	0.2609	0.3437	-0.1228	-0.1504	-0.1425	-0.1425	-0.1802	-0.1159
	E		0.9539**	0.2203	0.4144*	0.6200*	-0.2559	-0.3675*	-0.3814*	-0.3414	-0.3538*	-0.2853
	G			0.3484	0.3395	0.6756*	0.1083	0.2145	0.3644*	0.0942	0.1599	0.3273
DTS	P			0.1343	0.2763	0.3635*	-0.1259	-0.1437	-0.1316	-0.1296	-0.1739	-0.1124
	E			0.2509	0.4418*	0.6684*	-0.2849	-0.3668*	-0.3377	-0.2975	-0.3512*	-0.2738
	G				-0.6897*	0.5764*	0.1335	0.6590*	0.7483**	0.6093*	0.1807	0.0140
AS1	P				0.0299	0.0503	0.0250	-0.0242	0.0341	0.0427	-0.0356	0.0233
	E				0.0893	0.0620	-0.0547	-0.1189	0.0279	0.0489	-0.1966	0.0073
	G					0.8591**	0.2395	0.8687**	0.4921*	0.0882	-0.9803**	-0.1161
PHT	P					0.3106	-0.1078	-0.0452	-0.0905	-0.0930	-0.1720	-0.1077
	E					0.5746*	-0.2376	-0.1134	-0.2224	-0.2013	-0.2751	-0.1653
	G						-0.0709	-0.2899	0.3077	0.6742*	-0.4011*	-0.4301*
EHT	P						-0.1723	-0.1065	-0.1101	-0.1067	-0.1629	-0.1255
	E						-0.3569*	-0.1671	-0.2712	-0.2386	-0.2903	-0.2526
	G							0.3387	0.0050	0.2124	0.4476*	0.5646*
NCPL	P							0.1320	0.1540	0.1572	0.0884	0.1361
	E							0.2307	0.2378	0.2155	0.0388	0.1893
	G								0.7705**	0.8676**	-0.3272	0.4992*
NCPT	P								0.1993	0.1937	0.1196	0.1223
	E								0.2865	0.2567	0.3221	0.2207
	G									0.9187**	0.2504	0.3757*
WC	P									0.5077*	0.1489	0.3616*
	E									0.9725**	0.2866	0.7727**
	G										0.2602	-0.1101
DC	P										0.1617	0.3746*
	E										0.3105	0.7884**
	G											0.3767*
HSW	P											0.3616*
	E											0.2276

KEYS

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

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