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Correlation And Path Analysis Of Grain Yield Components In Some Maize (Zea Mays L.) Genotypes

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Abstract: Present study was aimed to investigate the genotypic association among grain yield components and their direct and indirect effects on yield. Correlation studies revealed significant positive d phenotypic relationship of grain yield with plant and ear height, ear length and diameter and hundred kernel weight. Therefore ear length and diameter and hundred kernel weight had high positive direct effects on grain yield. Flowering day such as days tasseling had high negative direct effect on yield. These result depicted that ear length and diameter may be used as reliable criteria for improving grain yield. Heritability estimates described the genetic attributes of the traits under study. All the traits except ear height and grain yield had non additive type of gene action with high heritability. The exploitation of these traits would be effective in hybrid maize breeding. Ear height and grain yield showed both additive and non additive type of gene action with environmental influence due to high environmental variance. These traits can be utilized effectively through selection in varietal development.

Keywords: Zea mays L.; Correlation Analysis; Path Coefficient Analysis; Heritability Analysis; Grain Yield

Introduction

Maize (Zea mays L.) is an important food and feed crop of the world. Globally, it is grown on more than 120 million hectares and is called the “king of grain crops”. It ranks third in production close behind wheat and rice. Despite of staple food of many countries the average yield of maize around the world is less than to meet the food requirements of increasing world population. Maize grain has high nutritional value as it contains 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 1% ash [1]. 35% of maize production is used for human nutrient requirement and about 65% for animal feed [2]. In Sudan maize is the fourth cereal crop after Sorghum, Millet and wheat [1]. There has been an increasing interest in developing Maize cultivates. It is introduced in the diversification policy as a new food crop in the irrigated schemes. Local varieties are adapted to the unfavorable growing conditions. They constitute a good source of genes for breeding program [3]. Maize is of recent introduction and occupies 36960 hectares with 70000 tones production and yielded 1894 Kg/hectare. Maize cultivated under irrigation in central, eastern and northern States [4]. Maize is among substitute crops to replace the wheat in agricultural schemes especially in the Gezira scheme, it can occupy an important position in the economy of the country due to the possibility of blending it with wheat for making bread [5].Maize is a genetically highly studied plant species, consequently, the inheritance of several characteristics and its genome are well known and there are several alternatives for incorporating useful characteristics into adapted materials. The methodology depends on the heritability, gene action, number of genes involved, heterosis, and genotype x environment interactions [7].At present grain yield of maize in Sudan much lower than world average. It is mainly due to the poor genetic composition of the cultivars, non availability of good quality seed of varieties/hybrids with high yield potential and less acclimatization of exotic hybrids due to biotic and a biotic stresses. Therefore, the development of improved cultivars/hybrids of maize is the need of the day. Determination of correlation and path coefficients between yield and yield traits is important for the selection of favorable plant types for effective maize breeding programs. Correlation coefficients in general show associations among independent characteristics and the degree of linear relation between these characteristics. It is not sufficient to describe this relationship when the causal association among characteristics is needed [4]. Therefore, objective of this study to identify the genetic variability on maize genotypes under irrigation condition to asses yield potential of superior germplasm and Path analysis is used to determine the amount of direct and indirect effect of the causal components on the effect component. Keeping this in view, the present study was therefore, designed to genetic basis of grain yield components and to develop suitable selection criteria for future maize breeding program.

Materials and Methods

The assessment of yield performance, genetic architecture and association of different yield components of the studied genotypes were presented in table.1

Experiment site: These experiment was conducted in Gezira season 2015, Gezira Research Station Farm (GRSF) located in the central clay plain in the Sudan (14º 24′ N, 33º 29′ E and 408 meter), the soil was characterized by heavy cracking clay vertisol, very low permeability, PH (8.5), organic matter (0.4%), nitrogen (0.038%) and phosphorus (ESP, 4 ppm).

Experimental material and Design: The genetic material used in this study consisted of thirteen advance genetic maize with one local check presented in table. The experiment was carried out in Randomized Complete Block Design (RCBD), with three replicates, planting was done manually in plots consisted of 4 rows of 5 meters long which spaced 0.80 m between rows, 0.25 m between holes the harvested area was 16.0 m^2 .

Cultural Practices: Sowing date was done in cropping season, 2015, after land preparation was done as the following: deep plowed first using chisel, harrowed by disc harrow, leveling and ridging. Thinning was carried out two weeks after seedling emergence to one plant per hill. A dose of fertilizer application, 2N (100 kg/ha) was add in split dose after emergence of two week and before flowering. Hand weeding was done to kept the plot free of weeds. At physiological maturity, when the leaves and husks of the plant started to turn yellow and dry; the central rows was harvested in each plot then grain weight per plot after threshing.

Data collection: Data were collected on the following traits during the crop growth, maturity and after harvest included Days to 50% Tasseling (DT) ,Plant Height (PH), Ear Height (EH), Ear length (EL),100 Kernel Weight (KW) and Grain Yield per Hectare (GY/ha)

Statistical analysis: Analysis of variance was used to check significance of differences among genotypes for all traits [10]. Genotypic and phenotypic components of variations were computed following Burton and Devane [6]. Broad sense heritability and genetic advance was computed using formula given by Falconer and Mackay [8]. 5% selection intensity (2.06) was used in estimation of genetic advance. Phenotypic and Genotypic correlation coefficients were estimated using formula given by Kown and Torrie [9]. Path analysis for estimating direct and indirect effects of traits in yield was performed using formula given by Dewey and Lu [10].

Results and Discussions

Analysis of variance which was presented in table 2, indicated significant differences (P<0.01) for most of the studied traits among genotypes that showed diverse variability among the yield traits of different maize genotypes. Correlation among the traits may be the consequence of the genetic association among the traits. From the breeder's view point, the type of association of grain yield and its component traits is of supreme importance. Higher genotypic correlations than their corresponding phenotypic correlations showed the higher genetic association among traits with the yield and the lower differences among both GCV and PCV for most of the traits attributed to lower modifying effect of environment on the association of characters [11]. Heritability and phenotypic and genotypic coefficient estimates (Table 3) described the genetic attributes of the traits. All the traits except ear height and grain yield had non additive type of gene action with high heritability and genetic coefficient of variation values. These results depicted that these traits can effectively be used in hybrid maize breeding as these possess high dominance. Both additive and non additive type of gene action was observed in ear height and grain yield due to medium scoring of heritability and low genotypic coefficient of variation. The high environmental variance for both traits also described the modifying effects of environment on both traits. The results related to correlation studies (Table 4) revealed that grain yield had significant relationship with plant and ear height, ear length, ear diameter and kernel weight with r values of 0.40, 0.41, 0.70, 0.62 and 0.50 respectively. These findings suggested that improvement of grain yield in maize is linked with the development of these traits that might have good impact on grain yield [12]. Other traits i.e. days to 50% tasseling and silking had no significant but negative correlation with the yield at phenotypic level with the r values of -0.20 and -0.22 respectively this finding in agree with [13] findings reported anon significant negatively correlated with grain yield at phenotypic level only. Path analysis depicted the strength of association of all independent variables under study on the grain yield (Table 5). This analysis also allows separating direct effect and their indirect effects through other attributes by partitioning Correlation which helps breeders to find out the characters that could be used as selection criteria in maize breeding program [14]. Path coefficient analysis (Table 5) revealed that ear length had maximum direct effect on yield followed by ear diameter and ear height. However overall positive effects on yield of days to 50% silking and plant height is diluted due to their negative indirect effects. These results showed that the selection of these characters would be less effective for improving grain yield. Direct negative effects on grain yield were attributed by days to 50% tasseling and hundred kernels weigh which indicated that improvement of these traits is essential before selecting them for high grain yield [15] Days to 50% tasseling was important trait on earliness of the maize crop the late flowering reflect on delay the maturity periods of the crop and decrease the grain fill stage. The result was shown that the days to tasseling had negative direct effect (-0.377) on yield due to negative indirect effect of days to 50% silking (-0.140), in addition to their non significant and negatively correlated with grain yield. Plant height is an important trait that effect grain yield. Taller plants needed more plant nutrients to complete more vegetative growth than reproductive phase that results in late maturation of cob. The results indicated that plant height had positive indirect effect (0.090) on yield because of its positive indirect effect through ear length, ear diameter and kernel weight [16, 17]. The direct effect of ear length was positive (0.592) but the magnitude of positive direct effects through almost all other yield contributing traits computed his positive association with grain yield. Kernel weight have a negative direct effect on grain yield attributed through negative indirect effect of all traits except of days to 50% tasseling, therefore, the late flowering was reflecting on decrease on grain filling period and finally on grain weight Grain yield in Maize is directly influenced by cob height or position, ear length and ear diameter. The selection of these traits would be effective in maize hybrid program. The non additive behavior of the traits like with high heritability also favors the selection for the development of maize hybrids. Ear length and diameter having both additive and non additive type of gene action with high environmental variance can be utilized through selection in varietal development.

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***Table 1** The studied genotypes in Gezira Research Station Farm season, 2015.*

Number	Genotype name	Origen
1	2014E 37	ARC-Sudan
2	2014E 63	ARC-Sudan
3	2014E 74	ARC-Sudan
4	2014E 79	ARC-Sudan
5	2014E 80	ARC-Sudan
6	2014E 92	ARC-Sudan
7	2014E 95	ARC-Sudan
8	2014E 98	ARC-Sudan
9	2014E 104	ARC-Sudan
10	PDU	ARC- Sudan
11	LONGS	ARC- Sudan
12	BOMU	ARC- Sudan
13	GBAYA Red	ARC- Sudan

Table 2 *The mean squares for grain yield related traits of different maize genotypes.*

Source of variation	Days to 50% Tasseling	Plant Height	Ear Height	Ear Length	Kernel Weight	Grain Yield
Treatment SS	75.589	347.064	949.43	62.265	516.99	1513573.4
Replication SS	62.205	6.333	121.43	5.826	49.132	375823.4
Error SS	193.79	3708.0	1748.56	51.90	149.75	3466918.5
Total SS	331.58	7885.43	2819.43	119.99	715.87	5356315.4
General Mean	70	122.2	50	14.4	22.6	740.3
Treatment MS	6.299	347.064*	79.119*	5.188*	43.082**	126131.1**
Replication MS	31.102	6.333	60.717	2.913	24.566	187911.7
CV%	4	10.1	16.9	10.1	11	51
F value	0.78	2.3*	1.1*	2.4*	6.9**	0.9*

*, **, *** *Significant at 0.05, 0.01 and 0.001 probability levels, respective*

Table 3 *The Phenotypic, Genotypic Coefficient of Variation (PCV, GCV) and The Broad sense heritability (h^2B) of maize genotypes evaluated in Gezira Research Station Farm season, 2015.*

Genetic components	Days to 50% tasseling	Plant height	Ear height	Ear length	Ear diameter	Hundred Kernel weight	Grain yield
(P CV)	3.85	12.09	17.2	12.75	2.59	18.95	49.1
(GCV)	1.08	6.55	2.38	7.69	9.74	15.44	10.55
(h^2B)	7.9	29.4	2.78	36.4	7.06	66.3	4.61

PCV= Phenotypic Coefficient of Variation, GCV= Genotypic Coefficient of Variation and h^2B= Broad sense heritability

Table 4 *Estimation of interrelationship for yield related traits in maize genotypes evaluated in Gezira Research Station Farm season, 2015*

	DT	DS	PH	EH	EL	ED	KW	GY
DT	1	0.373*	-0.232	-0.054	-0.074	-0.098	-0.880	-0.207
DS	0.373*	1	0.116	0.005	-0.108	-0.209	0.052	-0.223
PH	-0.239	0.116	1	0.369*	0.260	0.385*	0.368*	0.404*
EH	-0.054	0.005	0.369*	1	0.368*	0.194*	0.334*	0.411**
EL	-0.074	-0.108	0.260	0.368*	1	0.553**	0.736**	0.705**
ED	-0.098	-0.209	0.385*	0.338*	0.553**	1	0.585**	0.662**
KW	-0.088	0.052	0.368*	0.334*	0.736**	0.585**	1	0.504**
GY	-0.029	-0.207	-0.223*	0.411**	0.736**	0.662**	0.502**	1

DT= days to 50% tasseling, DS= days to 50% silking, PH= plant height, EH= ear height, EL= ear length, ED= ear diameter, KW= kernel weight and GY=grain yield.

*, **, *** *Significant at 0.05, 0.01 and 0.001 probability levels, respective*

Table5 *the path coefficient analysis of thirteen maize genotypes evaluated in Gezira Research Station Farm season, 2016.*

	DT	DS	PH	EH	EL	ED	KW	GY
DT	**-0.37751**	0.02838	-0.00761	-0.00946	-0.04411	-0.03993	0.243238	-0.207
DS	-0.14088	**0.076052**	0.003711	0.001033	-0.06448	-0.08449	-0.01462	-0.223
PH	0.090576	0.008897	**0.031727**	0.064546	0.154467	0.155718	-0.10179	0.404*
EH	0.020442	0.000449	0.011721	**0.174718**	0.218338	0.078465	-0.09239	0.411**
EL	0.028113	-0.00828	0.008274	0.064408	**0.59228**	0.223584	-0.20338	0.705**
ED	0.037317	-0.01591	0.012231	0.059147	0.327833	**0.403938**	-0.1618	0.662**
KW	0.033255	0.004026	0.011696	0.058463	0.436244	0.236691	**-0.27612**	0.504**

Direct effects is diagonal and Indirect effects is off diagonals