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Genetic variability, Interrelationship and Path-coefficient Analysis for Grain Yield and other Yield Attributes among Maize (*Zea mays* L.) Genotypes

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Abstract

Assessment of genetic variability and association existing between different agronomic traits determine the progress of selection in crop improvement program. The objective of this study is to estimate genetic variability, correlation and path analysis for grain and yield components of traits of maize genotypes. Fifteen maize genotypes arranged in randomize complete block design with three replicates were evaluated at two different sites (Gezira and White Nile) during one season, 2017/2018. Then studied the growth performance such as days to 50% tasseling and silking, plant height and ear height, and reproductive stage such as ear characteristics (length, size and hundred kernel weight) and grain yield. Amount of genetic variability was detected among the studied genotypes due to significant differences observed among the most of studied traits with the grain yield. The overall mean for grain yield was 1568 kg/ha in the first location and 4959.2kg\ha in the second location. Genotypes for grain yield ranged from1300kg\ha genotype 2011DTMA-WSTR to2035.5kg\ha genotype Hudiba-2.in the second location, on the other hand, it ranged from 4161.5kg/ha for genotype TZEE-WPOP STRXZ 104 to 5989.6kg/ha for genotype; 2008DTMA-WSTR. Association studies indicate that the traits like days to 50% tasseling and silking, ear length and hundred kernels weight were showed a significant positive association with grain yield. Out of ten traits taken for path analysis, plant height recorded a maximum direct effect with grain yield followed by ear diameter, number of kernels per rows and hundred kernel weight and they strongly contributed for higher grain yield and could be relied upon for selection of genotypes to improve genetic yield potential of maize. Direct selection of plant height, ear diameter and number of kernel per rows might be rewarding for yield improvement since they revealed true relationship with grain yield. The variability in maize genotypes scored high values of yield and other related traits could be used in any maize breeding program in Sudan in the future.

Key words: Genetic variability, Correlation, path coefficient analysis and Maize (*Zea mays* L.).

I. INTRODUCTION

Maize (*Zea mays* L.) is considered as the third world most important cereal crop after wheat and rice [4], it is grown in various agro-Eco logical zones, the genus Zea belongs to the tribe Andropogneae, at sub family Panicoideae and family Poaceae. There are five species including the genus Zea. They have been examined largely and have a chromosome number (2n=20) [10]. Maize is versatile crop grown over a range of agro climatic zones, in fact the suitability of maize to diverse environments is unmatched by any other crop. It is grown from 580N to 400S, from below sea level to altitudes higher than 300 mm, and in areas with 250 mm to more than 500 mm of rainfall per year, its staple food for many people [15] The worldwide production of maize was more than 960 million MT in 2013. Cultivated area 2.2% from 177 million hector, USA is the largest production at 37%, China 22%, Brazil7%, and other countries 17% [12]. The maize grain can be prepared for food in many different ways (fried, grilled, in a salad or soup). Processing maize can also produce a wide range of products, such as corn flour and cornmeal. Maize is also used in livestock feed (Poultry, Pigs, Cattle) in the form of grains feed milling or fodder. In addition is also used a raw material in a range of industries (Agric-Food, Textile, Pharmaceutical). To create biodegradable plastics, bio fuel, and even alcohol [8] 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 [12].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 [14].

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 [11]. Therefore, objective of this study to identify the genetic variability on maize genotypes and the relationship associated with grain yield and path coefficient analysis under irrigation condition to asses yield potential of superior germplasm and compare grain yield of released varieties with the introduced germplasm.

II. Materials and Methods

Plant materials and experimental sites

A total of fourteen maize genotypes and one a local check (Hudiba-2) were used in this study and were presented in Table 1. The genotypes were evaluated for grain yield and agronomic performance for two consecutive seasons at two locations in Gezira and White Nile research Stations Farms. The field experiment was arranged in a randomized complete block design with three replicates. The plot size was 2 rows of 5 m length and sowing was done on ridges of 80 cm at an intra-row spacing of 20 cm. The seeds were sown at three seeds per hill and thinned to one plant after two weeks from sowing. Urea was broadcasted at the rate of 86 kg N/ha in split dose; one was added at two weeks from sowing and the other before the flowering stage. The irrigation was done at 10-14 days and weeding was manually done. Other cultural practices were carried as recommended by the Agricultural Research Corporation.

Data collection

The agronomic parameters recorded were; days to flowering 50%, tasseling and silking, plant height, ear height, ear length, ear diameter and grain yield.

Statistical analysis

The statistical analysis was done by using SAS software for each location in each year and then combined [16]. The association and path analysis there were done according to Dewey and Lu [6] methodology for the partition the genotypic correlation coefficients into measures of direct and indirect effects.

III. Results and Discussion

Genetic variability

Among the studied genotypes most of the studied traits there were shown a significant difference, this was indicating that the were amount of genetic variability was detected tables 2,3 and 4. Days to 50% flowering silking and tasseling there were shown a significant difference in the second site and their combined therefor, the earliest genotypes were 2004 TZE-Y POPDT STRC4and 2008 DTMA-W STR, also the shortness genotypes were 2004 TZE-Y POPDT STRC4 and 2008 SYN EE-W TR. Only significant differences were detected in White Nile location for ear length, ear size and kernels weight, therefore, the best genotypes were 2008 TZEE-W STR, 2008 SYN EE-W TR and TZE-Y DTC4 STR respectively. The grain yield was shown a significant difference in a two sites and their combined the higher yielding genotypes were 2008 DTMA-W STR followed by SYN DTE STR-W and TZE COMP5-WC7F2 respectively, table 4.

Inter-correlation among the yield attributes

Day to 50% flowering (tasseling and silking) having a positively and significate associated with the ear length and hundred kernels weight, and negatively significant with the grain yield, number of kernels per row and plant height table 5 this results are in accordance with the findings of [5] observed the same results of plant height with the most of studied traits, therefore, the obtained results for plant height revealed that there were a significantly and positively correlated with ear length, ear diameter, number of rows per ear and number of kernels per row and grain yield. Ear characteristics such ear length and diameter the were indicated to have positively significantly correlated with the number of rows per ear, number of kernels per row, kernels weight and grain yield table 5, this results are in accordance with the [17]. In this study, number of rows per ear and number of kernels per rows had a positively and significantly correlated with the hundred kernel weight and grain yield also the hundred kernel weight was shown positively significant correlated with the grain yield table 5, this results were in agreement with findings of [13] reported that there was appositive correlation between hundred kernel weight and grain yield.

Path analysis

The estimates of correlation coefficients revealed only the relationship between yield and yield associated characters but did not show the direct and indirect effects of different traits on yield per se. This is because, the attributes that are in association do not exist by themselves, but are linked to other components. The path analysis suggested by Dewey and Lu (1959) specified the effective measure of direct and indirect cause of association and also depicts the relative importance of each factor involved in contributing to the final product i. e., yield. In order to find out the cause and effect relationship between grain yield and it is related characters, path analysis was taken up in the present investigation. Path analysis values based on fifteen genotypes involved in this study at genotypic level showing the existent of direct and indirect effect on grain yield are presented. Out of the ten traits taken for path analysis, plant height was had a maximum positive direct effects on grain yield (2.88), this results were in agreement with the Nemati *et al*., (2009) reported that a highly significant and positive direct effects for plant height with the grain yield, followed by ear dimeter (2.51), number of kernel per row (2.30), but days to 50% tasseling and silking obtained negative direct effects on grain yield table 5.

Indirect effects

Indirect effects of days to tasseling on grain yield via ear length and kernel weight were positive but via days to silking, plant height, ear diameter, number of rows per ear and number of kernels per row were negative. Positive indirect effects of days to silking on grain yield was noticed only via kernel weight, but it was negative indirect effects through other all traits. positive indirect effects were noticed through plant height on grain yield via ear length, ear diameter, number of row per ear and number of kernels per row and negative indirect effects for hundred kernel weight. Other ear characteristics such as (ear length, ear diameter, number of rows per ear and number of kernels per rows) they were shown positive indirect effects on grain yield for all other traits. Four of six traits there were shown positive indirect effects for hundred kernel weight on grain yield via ear length and diameter, number of kernels per row and number of row per ear, but via days to tasseling, days to silking and plant height were negative indirect effects, table 6 respectively.

IV. Conclusion

The studied genotypes revealed amount of genetic variability among the most of the studied traits. The grain yield having a positively association with the most of the studied traits with except of days to 50% tasseling and silking as they were negatively. Plant height recorded a maximum correlated with grain yield followed by ear diameter, number of kernels per rows and hundred kernel weight. Direct selection of plant height, ear diameter and number of kernel per rows might be rewarding for yield improvement since they revealed true relationship with grain yield.

References

[1] Ahmed A M, Ali E S., Hamada AA. and Siraj,OM. (2008). Optimum sowing time for maize (Zea Mays) in northern Sudan Publishedby Sudan. J. Agric. Res: (2008),12,1-10.

[2] Abou-Deif,M.H.,2007.Estimation of gene effects on some agronomic characters in five hybrids and six population of maize(Zea maysL.).World.J.Agric.Sci.,3:86-90.

[3] Ali O A.,Yousif. MT and Bakheet G A (2010) A note on chemical constituents of some local maize (Zea mays L.). published by Sudan Journal of agricultural Research. ISSN:1561-770X.Wad Medani, Sudan.

[4] FAO 2006, FAOSTAT data. (www.File /FAOSTAT.htm).

[5] Bello, O.B,G .Olaoye, S.Y.Abdulmaliq ,M.S.A folabi and S.A.Ige,2010.Correlation and path coefficient analysis of yield agronomic character among open pollinated maize varieties and their F1 hybrids in a Diallel cross. Afr.J. Biotechnol.,9:2666-3639.

[6] Dewey ,J.R and Lu,1959.Acorrelation and path coefficient analysis of components of crested wheat seed production.J.Agron. 51:515-518.

[7] Khayatnezhad. M.R. Gholamin,S. Jamaati-e Somarin and R.Zabihi-eMahmoodabad,2010.Study of genetic diversity and path analysis for yield in corn genotypes under water and dry condition. World Applied Sci.J.,11:96-99.

[8] Mohammed AA., Ali ES, Hamada A.A.and Siraj, OM. (2008). Optimum sowing time for maize (Zea Mays) in northern Sudan –Published by Sudan. J. Agric. Res: (2008),12,1-10.

[9] Mohammed AA and Ali ES (2006). Response of maize to different Nitrogen fertilizer under under different moisture regimes. Annual Report, Maize Program Breeding. Ministry of science and technology, Sudan,

[10] Nafziger ED (2008). Growth and Production of maize: Mechanized Cultivation. Soils, Plant Growth and Production. Crop Sciences, University of Illions Goodwin, Urbana IL 61801, USA. Vol (1).

[11] Nass L.L and Paterniani L (2000). Pre-breeding: A link Between Genetic Resources and Mize Breeding. Embrapa Recourses Genetics Biotechnologies,SAIN Parquet Rural,CEP:70770-900-Brasília,DF.2 Depto. De Genética,SP/ESALQ, llnass@cenargen.embrapa.br Scientia Agricola, v.57, n.3, p.581- 587, jul./set. 2000.

[12] Ngosamnick, EL. (2012). Maize production and processing, www.isf- camiroun .org. © CTA and ISF 2012. ISSBN, (CTA): 978-92-908 511-2.

[13] Prakash.O., P,Shanthi.E.Satyanarayana and R,S.Kaumar,2006.Studies on interrelationship and path analysis for yield improvement in sweet corn genotypes. New Bot,33:91-98.
[14] Johnson H.W, ,Robinson, HF and Comstock R.H (1955).Estimation of genetic variability and environmental variability in soybean Agron. J., 47: 314-318.
[15] Saad M A (2009). MSc. Determent of the optimum dose rate of gamma irradiation for mutation induction in maize (Zea mays. L). Sudan Academy of sciences, Sudan.
[16] SAS Institute 1997. SAS/STAT user's guide Version 6, fourth ed. SAS Inst., Cary, NC
[17] Singh AD (2014). India Maize (SUMMIT), © 2014 KPMG India. Pvt National Commodity and Derivatives Limited, Ackruti Corporate Park 1st floor, Near G.E. Garden Kanjurmarg,Mumbai-78. Website: www.ncdex. Com.

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Table 1 The **fifteen maize genotypes were evaluated at two different sites (Gezira and White Nile) during the winter season, 2017/018**

Number	Genotype
1	TZE COMP5-WC7F2
2	2004 TZE-Y POPDT STRC4
3	2011 DTMA-W STR
4	TZE-Y DTC4 STR
5	2008 TZE COP-Y
6	2008 DTMA-W STR
7	SYN DTE STR-W
8	2011 DTE STR-Y SYN THETIC
9	2011 DE STR-W SYN THETIC
10	2008 SYN EE-W TR
11	2008 TZEE-W STR
12	TZEE-W POP STR C4
13	TZEE-W POP STRXZ 104
14	TZEE-W POP STRXZ 108
15	Hudiba-2

Table 2 The mean performance of fifteen maize genotypes were evaluated at Gezira site, during the season, 2017/018

Genotypes	Days to 50% Tasseling	Days to 50% Silking	Plant Height (cm)	Ear Length (cm)	Ear Diameter (cm)	Kernel Weight (g)	Grain Yield (kg/ha)
TZE COMP5-WC7F2	58a	61a	153.3a	14.4ab	3.2a	25.9a	1652.9ab
2004 TZE-Y POPDT STRC4	58a	61a	133.3ab	12.7ab	3.3a	23.7a	1390.2b
2011 DTMA-W STR	59a	61a	121.6ab	11.9b	2.7a	22.4a	1300.9b
TZE-Y DTC4 STR	58a	61a	145a	14.2ab	2.9a	26.4a	1615.2ab
2008 TZE COP-Y	57a	60a	156.6a	14.1ab	3.7a	27.3a	1549.6ab
2008 DTMA-W STR	59a	62a	148.3a	15.7a	3.6a	27.4a	1825.1ab
SYN DTE STR-W	59a	62a	133.3ab	12.1ab	3.1a	23.7a	1430.8b
2011 DTE STR-Y SYN THETIC	58a	61a	141.6a	15.1ab	3.9a	26.3a	1756.8ab
2011 DE STR-W SYN THETIC	58a	61a	140ab	13.6ab	2.9a	26.4a	1479.8b
2008 SYN EE-W TR	58a	61a	85b	11.4b	3.1a	24.2a	1482.1b
2008 TZEE-W STR	58a	61a	160a	14.4ab	3.6a	28a	1641.4ab
TZEE-W POP STR C4	57a	60a	143.3a	14.9ab	3.3a	26.3a	1308b
TZEE-W POP STRXZ 104	58a	61a	140ab	13.5ab	2.3a	25.9a	1692.2ab
TZEE-W POP STRXZ 108	58a	61a	131.6ab	12.1ab	3.0a	23.4a	1359.9b
Hudiba-2	59a	62a	170a	14.2ab	3.9a	28a	2035.5a
Mean	58.5	61.4	140.2	13.6	3.2	25.7	1568
CV%	1.77	1.50	20.7	13.9	18.8	12.3	17.7
F value	0.83	0.88	1.36	1.40	1.14	0.94	1.66

The mean with the same later was not significant different according to Duncan Multiple Range Test (DMART).
*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels, respective

Table 3 The mean performance of fifteen maize genotypes were evaluated at White Nile site during the season, 2017/018

Genotypes	Days to 50% Tasseling	Days to 50% Silking	Plant Height (cm)	Ear Length (cm)	Ear Diameter (cm)	Kernel Weight (g)	Grain Yield (kg/ha)
TZE COMP5-WC7F2	52abc	56abcd	218.3a	13.3c	3.8bcdef	22.3abc	5382.1abc
2004 TZE-Y POPDT STRC4	50de	53.6cd	200.7b	15.1abc	4.0abcd	23.1abc	4639.6abc
2011 DTMA-W STR	53ab	58ab	210.9ab	14.9abc	3.6fg	22.3abc	4961.5abc
TZE-Y DTC4 STR	51cd	53d	205.4ab	14.6abc	4.0ab	24.6ab	4466.7bc
2008 TZE COP-Y	51.6abcd	55abcd	199.6b	14.5abc	3.7cdefg	20.5c	4765.4abc
2008 DTMA-W STR	51cd	54.6bcd	211.6ab	15.3abc	3.7defg	23abc	5989.6a
SYN DTE STR-W	48f	54cd	209.7ab	15.1abc	3.7efg	22.1abc	5716.7ab
2011 DTE STR-Y SYN THETIC	52abc	55abcd	203.4ab	15.2abc	4.0abc	22.5abc	4833.4abc
2011 DE STR-W SYN THETIC	53ab	55.6abcd	206.2ab	13.5bc	3.8bcdef	22.3abc	4891.7abc
2008 SYN EE-W TR	51.3bcd	58.3a	210.4ab	16.7a	3.9abcde	23.3abc	5191.7abc
2008 TZEE-W STR	48f	55abcd	201.7b	15.7ab	4.1a	25a	4765.7abc
TZEE-W POP STR C4	53.3a	56.6abc	202.4b	15.abc	3.7efg	22.8abc	5336.5abc
TZEE-W POP STRXZ 104	52abc	57.6ab	209.7ab	15.3abc	3.7defg	21.6bc	4161.5c
TZEE-W POP STRXZ 108	52.3abc	58ab	20.63ab	14.8abc	3.5g	22.6abc	4461.5bc
Hudiba-2	52.3abc	55abcd	204.2ab	14.6abc	3.7efg	22.3abc	4829.2abc
Mean	51.4	55.7	206.7	14.9	3.81	22.7	4959.2
CV%	1.86	3.29	3.78	7.71	3.82	6.91	15.1
F value	7.7**	2.52*	1.26*	1.49	4.64**	1.45**	1.28**

The mean with the same later was not significant different according to Duncan Multiple Range Test (DMART).
*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels, respective

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Table 4 The mean performance of fifteen maize genotypes evaluated at two sites (Gezira and White Nile) combined during the season, 2017

Genotypes	Days to 50% Tasseling	Days to 50% Silking	Plant Height (cm)	Ear Length (cm)	Ear Diameter (cm)	Kernel Weight (g)	Grain Yield (kg/ha)
TZE COMP5-WC7F2	55ab	58.8abcd	185.8a	13.9a	3.6ab	24.1a	3517.5ab
2004 TZE-Y POPDT STRC4	54bc	57.6cd	167ab	14a	3.6ab	23.4a	3014.9b
2011 DTMA-W STR	56a	59.5abc	166.3ab	13.4a	3.4ab	22.4a	3131.2ab
TZE-Y DTC4 STR	54abc	57.1d	175.2ab	14.3a	3.4ab	25.5	3040.9b
2008 TZE COP-Y	55bc	57.8bcd	178.1a	14.4a	3.8a	23.9a	3154.5ab
2008 DTMA-W STR	55ab	58.5abcd	179.9a	15.5a	3.8ab	25.2a	3907.3a
SYN DTE STR-W	63c	58.1abcd	171.5ab	13.7a	3.5ab	22.8a	3573.8ab
2011 DTE STR-Y SYN THETIC	55ab	58.3abcd	172.5ab	15.2a	3.9a	24.3a	3295.1ab
2011 DE STR-W SYN THETIC	56ab	58.5abcd	173.1ab	13.6a	3.4ab	24.4	3185.7ab
2008 SYN EE-W TR	54abc	59.8a	147.7b	13.8a	3.8ab	23.8a	3336.9ab
2008 TZEE-W STR	53c	58.3abcd	180.8a	15.2a	3.8ab	26.5a	3203.5ab
TZEE-W POP STR C4	56ab	58.6abcd	172.8ab	14.9a	3.6ab	24.5a	3322.3ab
TZEE-W POP STRXZ 104	55ab	59.5abc	174.4ab	14.4a	3.4ab	23.8a	2927.9b
TZEE-W POP STRXZ 108	55ab	59.6ab	169ab	13.4a	3.1b	23a	2910.7b
Hudiba-2	56ab	58.5abcd	187.1a	14.4a	3.9a	25.6a	3432.4ab
Mean	54.9	58.6	173.4	14.3	3.6	24.2	3263.6
CV%	1.81	2.46	12.6	11.7	13.3	13.9	17.8
F value	2.97**	1.69*	1.10	0.97	1.51	0.66	1.27

The mean with the same later was not significant different according to Duncan Multiple Range Test (DMART).

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

Table 5 Simple linear Correlation Coefficient of grain yield with other traits evaluated on fifteen maize genotypes under Field condition at Gezira and White Nile locations during the season 2017 combined.

	DT	DS	PH	EL	ED	NRE	NKR	KW	GY
DT	1	0.9107**	-0.762**	0.320**	-0.497**	-0.063	-0.473**	0.374**	-0.897**
DS		1	-0.679**	-0.207*	-0.488**	-0.078	-0.412**	0.372**	-0.841**
PH			1	0.539**	0.657**	0.371**	0.644**	-0.031**	0.782**
EL				1	0.636**	0.524**	0.547**	0.469**	0.336**
ED					1	0.588**	0.540**	0.293**	0.535**
NRE						1	0.535**	0.551**	0.073
NKR							1	0.171	0.459**
KW								1	0.335**
GY									1

DT=Days to 50% Tasseling, PH= Plant Height, EL=Ear Length, ED= Ear Diameter, NRE= Number of Row per Ear, NKR= Number of Kernels per Row and KW= Kernel Weight.

Table 6 **Path coefficient analysis of fifteen maize genotypes traits evaluated in two locations Gezira & White Nile combined season,2017**

	DT	DS	PH	EL	ED	NRE	NKR	KW
DT	**-2.51602**	-2.36039	-2.200	0.458767	-1.24939	-0.0896	-1.09288	0.035374
DS	-2.29151	**-2.59164**	-1.95857	-0.29705	-1.22796	-0.1105	-0.95024	0.03518
PH	1.918967	1.759725	**2.884486**	0.772562	1.652776	0.523967	1.485042	-0.00297
EL	-0.80535	0.537144	1.554825	**1.433244**	1.598494	0.740069	1.261765	0.044299
ED	1.251442	1.26695	1.897934	0.912074	**2.511895**	0.829998	1.247239	0.027686
NRE	0.159918	0.203133	1.072077	0.752396	1.478878	**1.409763**	1.234072	0.052074
NKR	1.192492	1.068015	1.857696	0.784271	1.358684	0.754491	**2.305858**	0.016119
KW	-0.94326	-0.96627	-0.09066	0.672894	0.73704	0.778034	0.39391	**0.094356**

Direct effects= the diagonal
Indirect effect= off diagonal

DT=Days to 50% Tasseling, PH= Plant Height, EL=Ear Length, ED= Ear Diameter, NRE= Number of Row per Ear , NKR= Number of Kernels per Row and KW= Kernel Weight.

