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Research Article

Genetic Variability among Maize Genotypes for Grain Yield and its Components Under Autumn Crop Season of Multan

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ABSTRACT

The present research was conducted at the research area of the MNS-University of agriculture Multan Pakistan during kharif 2018, to determine the genetic variability for yield related traits of twenty-five maize (*Zea mays* L.) hybrids collected from International Maize and Wheat Improvement center (CIMMYT). The study was carried out in a randomized complete block design (RCBD) with two replications. Significantly variability (P≤0.01) among the hybrids was found for all yield related traits. Mean values for plant height were ranged from 82.61 to 223.72 (cm), ear height from 23.6 to 98.5 (cm), ear length from 9.8 to 21.8 (cm), number of ears from 1.005 to 1.85, cob weight from 67.63 to 179.3 (g), kernels per cob from 198.1 to 574.2, kernel rows per cob from 10 to 15.54, kernels per row 18.520 to 38.950, 100 grains weight from 18.3 to 34.4 (g) and grain yield per plant from 44.32 to 149.40 (g). Highest estimate of genotypic (GCV) along with phenotypic (PCV) coefficient of variations was recorded for ear height 43.07% and 45.13 %, plant height 30.20% and 33.23%, grain yield per plant 31.75% and 33.54 %, cob weight 27.46% and 29.34% and kernels per cob 24.13% and 25.13%, respectively. Hybrid CZH132151 and CZH132150 performed better for yield related traits. All traits were significantly correlated with each other except number of ears per plant which was non-significantly correlated with most of the traits. The positive correlations suggest that the desired characters in these hybrids can be improved simultaneously in further maize breeding programs. Predicted on the results of current study, maize hybrid CZH132151 and CZH132150 could be suggested for commercial cultivation for the agro climatic condition of Multan.

Keywords: Zea mays, enotypic, phenotypic, variation, association

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1. INTRODUCTION

Maize is one of the most important crop in the world and ranked as 3rd major crop after rice and wheat in Pakistan (Wasaya *et al*., 2017). In the world it is grown in different climatic conditions. It is cultivated in temperate, tropical to sub-tropical climates as well as in irrigated and semi-irrigated conditions (Kumar *et al.*, 2014). In many countries maize is used as staple food and is known as "Queen of Cereals due to its feature to grow throughout the year and a cheap staple food compared to other small grains cereals such as rice and wheat (Khan *et al*., 2014 and Baloch *et al*., 2015). Its grain is also used to feed livestock and to manufacture industrial products such as oil, protein and starch (Mmboyi *et al*., 2010). Various food products are also prepared from its grains such as maize chips, cereal and maize bread. It is capable to produce large quantities of grains from per unit area and is cultivated twice a year i.e. summer and spring season therefore, it is a staple food for a massive population in hilly areas of Pakistan (Akbar *et al*., 2008). The area under corn occupies the 3rd position after rice and wheat, of which 98% is grown in Khyber Pakhtunkhwa and Punjab. During 2018-19, the cultivation of maize in Pakistan was under an area of 1.318million hectares and produced 6.309 million tons (Pakistan Economic Survey, 2018-19) US leads in the yield with 10.96 metric tons/ha followed by Canada (9.82 metric tons/ha), Turkey (9.65 metric tons/ha), Argentina (8.37 Metric tons/ha) and Egypt (8.00 metric tons/ha), while Pakistan produces 4.53 metric tons/ha (USDA, 2018). Pakistan is ranked 23rd in area under maize cultivation and 26th in maize production throughout the world. Due to non-availability of improved germplasm and resources with respect to other countries the maize production in Pakistan is very low. Selection of unsuitable cultivars is one of the prime constraints to enhance maize productivity in a given set of environment. Therefore, for potential production of maize the knowledge of genetic variation and environmental interaction is very important (Phuke *et al*., 2017). Genetic variability is an inherited variation between cultivars within a population necessary in a considerable amount to sustain and enable an effective maize breeding program (Charles *et al*., 2013). Assessment of genetic variability assists breeders to determine a strategy and adequate selection criteria for improving desired characters (Kuswantoro *et al*., 2018). Association existing among different traits decide the performance of selection in any crop breeding programs (Rajesh, 2013). Therefore, for improvement of breeding program by the use of suitable selection indices correlation analysis is effective tools (Mohammadi *et al.,* 2003). The present study was pursued viewing the above information to assess the performance of different maize hybrids under the climatic condition of Multan.

2. MATERIALS AND METHODS

The study was performed at MNS University of Agriculture, Multan Pakistan in autumn season 2018. Multan is located in southern part of Punjab province in Pakistan at 30.15750 latitude and 71.52490 longitude and its elevation is 128.93m above sea level. Southern part of Punjab had arid type of climate in which summer is long and hot and winter is short and cold. During the crop growth season the temperature ranged from 29.9°C to 40.7°C. The highest temperature 40.7°C was recorded on 29th August. The total precipitation received during the crop growth season was 2 mm which was received during the first week of August 2018. The germplasms comprised of twenty-five maize hybrids (Table 2.1) collected from International Maize and Wheat Improvement Centre (CIMMYT) Mexico were grown in a completely randomized design with two replications. Each hybrid was represented by single row, four meters in length, having row to row spacing of 75cm. Spacing between plant to plant was 25cm. For initiation and establishment, the crop received 10 to 12 irrigations of four days' interval. Appropriate amounts of chemical fertilizer, urea (1N=40 kg/ha) were applied after three weeks from sowing. Weeding was carried out by hand hoeing. To raise the crop all recommended agronomic measures were practiced. Before planting seeds were treated by a protective fungicide (thiram). A systemic insecticide (furidan) was used twice, one of them at sowing for protection against stem borer, which had more effect. The crop was sprayed with Durispan against termites. In each replication 5 plants were tagged at random and data has been collected for the following traits, plant height (cm), ear height (cm), ear length (cm), ears per plant, cob weight (g), kernels per cob, kernel per row, kernel rows per cob, hundred grains weight (g) and grains yield per plant (g).

Table 2.1 Names of maize hybrids evaluated in the study

Sr.No	Hybrids	Sr.No	Hybrids	Sr.No	Hybrids	Sr.No	Hybrids	Sr.No	Hybrids
1	CZH1261	**6**	CZH142023	**11**	CZH132156	**16**	CZH15008	**21**	CZH15198
2	CZH132150	**7**	CZH142145	**12**	CZH15002	**17**	CZH15010	**22**	CZH15045
3	CZH132151	**8**	CZH142056	**13**	CZH15003	**18**	CZH15011	**23**	CZH15220
4	CZH132117	**9**	CZH132119	**14**	CZH15005	**19**	CZH15017	**24**	ZH169
5	CZH142023	**10**	CZH142151	**15**	CZH15006	**20**	CZH15187	**25**	E3ZH15445

2.11 Statistical Analysis

Analysis of variance was performed for the studied parameters following Steel *et al*. (1997). The variation coefficient was computed as proposed by Johnson *et al*. (1955). The coefficient of variation (phenotypic and genotypic) values were graded as low if they were lower 10 %, moderate, 10 to 20% and high above 20 % as suggested by (Deshmukh *et al*. 1986). To determine the association among traits correlation analysis was carried out following the Kwon and Torrie (1964).

3. RESULTS

Significant variation was recorded among all the maizes hybrids studied for all recorded traits shown in Table 3.1. Plant height ranged from 82.61 to 223.72 (cm), ears height from 23.6 to 98.5 (cm), ear length from 9.8 to 21.8 (cm), number of ears from 1.005 to 1.85, cob weight from 67.63 to 179.3 (g), kernels per cob from 198.1 to 574.2, kernel rows per cob from 10 to 15.54, kernels per row 18.520 to 38.950, 100 grains weight from 18.3 to 34.4 (g) and grains yield per plant from 44.32 to 149.40 (g) shown in Table 3.2. For most of the studied traits Hybrid CZH132150 and CZH132151 exhibited maximum performance while hybrid CZH15005 for number of ears, CZH15198 for ear length and CZH15008 for kernel rows per cob showed maximum performance. While hybrids CZH15017, CZH15002 and CZH15003 showed poor performance for most of the traits as shown in Table 3.2. The estimate of variances and coefficient of variation for the investigated traits were shown in Table 3. 1. Genotypic variability was high for kernels per cob 9309.3, plant height 1873.81, cob weight 1027.02 and ear height 572.63. Moderate estimates of genotypic variability recorded for kernels per row 21.94 and 100 grains weight 14.67. Whereas low genetic variability was recorded for ear length 7.04, kernels row per cob 1.44 and number of ear 0. 059 shown in table 1. Highest estimate of genotypic (GCV) along with phenotypic (PCV) coefficient of variations was recorded for ear height 43.07 and 45.13 %, plant height 30.20 and 33.23%, grain yield per plant 31.75 and 33.54%, cob weight 27.46 and 29.34% and kernels per cob 24.13 and 25.13% respectively. Moderate to high PCV and GCV recorded for ear length 17.23 and 22.64%, number of ears 17.70 and 22.54 % and moderated values were recorded for kernels per row 15.60 and 19.45% and hundred grains weight 15.16 and 19.61% while moderated to low values were recorded for kernel rows per cob 8.879 and 13.41%.

For the improvement of crop correlation is an efficient breeding program which help in the selection of important traits which could be utilized to enhance the grain yield. Yield-contributed traits were calculated for the selection of important characteristics under all the hybrids correlation coefficient were estimated as shown in Table (3.3). All the studied traits were significantly correlated with each other except number of ear which was non-significantly correlated with all of the other traits except kernels per cob, ears height, plants height, and kernels per row at phenotypic level while in genotypic level number of ears was significantly associated with all of the traits except cob weight, 100 grains weight and kernel rows per cob which was non-significant.

Table 3. 1. Analysis of variance for various traits in maize

SOV	DF	PH	Eh	EL	NE	CW	KPC	GRC	GPR	HGW	GYPP
MS (R)	1	2745.81	1259.57	0.0885	0.0006	70.19	496.1	1.72608	0.3395	0.4608	4.77
MS (V)	24	4142.5**	1201.4 **	19.2**	0.15**	2199.7**	19403.7**	4.7397*	56.06**	39.2**	1958.6**
MS (E)	24	394.92	56.18	5.1134	0.0368	145.73	785.1	1.85	12.17	9.8823	107.09
GCV		30.20	43.07	17.23	17.70	27.46	24.13	8.879	15.60	15.16	31.75
PCV		33.23	45.13	22.64	22.54	29.34	25.13	13.41	19.45	19.61	33.54
GV		1873.81	572.63	7.04	0.059	1027.02	9309.3	1.44	21.94	14.67	925.76
PV		2268.74	628.81	12.15	0.09	1172.75	10094.4	3.29	34.12	24.56	1032.85

PH = Plants height (cm), **EH** = Ears height (cm), **EL**= Ears length (cm), **NE** = No. of ears per plant, **CW**= Cob weight (g), **KPC**= Kernels cob^{-1}, **GRC**= Grain rows cob^{1}, **GPR**= kernels row^{1}, **HGW**=Hundred grains weight(g), **GYPP**=Grains yield plant^{-1} (g), **SOV=** Source of variations**,** **MSR =** Replication mean sum of square**,** **DF=** degree of freedom **MSV=**Variety mean sum of square, **MSE** = Error mean sum of square **PV**= Phenotypic variance **GV**=genotypic variance, **PCV**=Phenotypic coefficient variance **GCV**=Genotypic coefficient variance. ***** = Significance at (P≤0.05) significance level, ** = Significance at (P≤0.01) significance level.

Table 3. 2. Mean performance of maize hybrids for studied traits

G	PH	EH	EL	NE	CW	KPC	KRC	KPR	HGW	GYPP
CZH132150	223.72 A	98.5 A	18.9 ABCD	1.8AB	162.6ABC	574.2A	15.250AB	37.900 AB	31.04ABC	144.03 A
CZH132151	208.65 AB	91.2 AB	18.9ABCD	1.73ABCD	179.3A	570AB	14.820AB	38.875A	34.04A	149.40 A
CZH15220	201.9ABC	84.7 AB	19.5ABC	1.09HIJ	159.4ABC	510CD	13.633ABCD	38.330AB	31.9AB	138.54 AB
CZH142151	196.7ABC	85.9 AB	11.3 GH	1.26EFGHIJ	152.5BCD	472.2CDE	13.620ABCD	34.800ABCD	32.1AB	130.06 ABC
CZH1261	194.8ABC	87.2 AB	20AB	1.35DEFGHIJ	173.2AB	513.7BC	13.255ABCD	38.950 A	30.4ABCD	134.91 AB
CZH142145	189.8ABC	80.1 BC	18 ABCDE	1.175FGHIJ	139.7CDE	460.6CDEFG	15.080AB	31.300 BCDE	29.6ABCDE	117.79 BCE

CZH15011	188.5ABCD	78.5BC	17.7ABCDE	1.79ABC	133.3DE	455DEFGH	14.520ABC	32.250ABCE	26.9BCDEFGH	113.53CDE
CZH15187	187.3ABCD	76.7BC	16.9BCDEF	1.61ABCDE	149.8BCD	472.1CDEF	14.215ABC	35.365ABC	24.8CDEFGHIJ	137.71AB
CZH142056	177.2BCDE	77.5BC	16.6BCDEF	1.45ABCDEFGH	143.1CDE	473.8CDE	13.920ABC	34.515ABCD	28ABCDEF	120.69BCD
ZH169	165.1CDEF	65.2CD	16.5BCDEF	1.77ABC	101.1GHIJ	419.3EFGHIJ	13.965ABC	29.831CDEG	27BCDEFG	85.88FGHI
CZH15045	148.1DEFG	55.6DE	15.5BCDEFG	1.10GHIJ	105.3GH	240.9PQ	10.916DE	22.725GH	19.5JK	106.54DEF
CZH15005	138.9EFGH	40.5EFG	14.7DEFG	1.85A	98.1GHIJK	400.1HIJKL	14.390ABC	28.585CDEG	25.8BCDEFGHIJ	84.39GHI
CZH132156	135.5FGHI	36.1FGH	14.5DEFG	1.5ABCDEFG	119.8FGH	432.9EFGHI	14.950AB	29.486CDEG	25.7BCDEFGHIJ	97.46EFG
CZH15010	125.3FGHIJ	31.1FGH	15.2CDEFG	1.04IJ	103.6GHI	403.6GHIJKL	13.937ABC	30.525CDEF	26.3BCDEFGHI	81.79GHI
CZH15006	117.3GHIJK	43.3EF	15CDEFG	1.52ABCDEF	85.01HIJKL	327.1MN	11.995CDE	27.950DEFG	23.8EFGHIJK	66.40IJK
CZH142023	115.5GHIJK	41.1EFG	12.7FGH	1.045IJ	96.1GHIJK	378.4IJKLM	13.900ABC	27.715DEFG	24.5DEFGHIJK	72.04HIJK
CZH15008	111.6GHIJK	29.3FGH	13.9EFGH	1.17FGHIJ	99.3GHIJK	359.6KLMN	15.545A	23.900FGH	21.03GHIJK	82.07GHI
CZH132117	106.1HIJK	41.9EFG	14.8CDEFG	1.12GHIJ	130.2DEF	360.7KLMN	14.235ABC	26.735EFG	18.3K	80.46GHIJ
E3ZH15445	100.5HIJK	60.1DE	12.3FGH	1.6ABCDE	88HIJKL	367.1JKLMN	13.5ABCD	27.916DEFG	20.3IJK	70.99HIJK
CZH132119	98.23HIJK	30.4FGH	12.7FGH	1.05IJ	90.8HIJKL	350.1LMN	13.485ABCD	27.955DEFG	21.5FGHIJK	71.72HIJK
CZH142020	96.43IJK	26.7GH	12.5FGH	1.005J	106.3FGH	414.3FGHIJK	14.980AB	27.885DEFG	23.4EFGHIJK	91.27FGH
CZH15002	93.98JK	34.6FGH	12.9FGH	1.43BCDEFGHI	75.29KL	257.6P	10.444E	25.365EFGH	21.6FGHIJK	56.14KL
CZH15003	91.64JK	39.6FG	11.09GH	1.41CDEFGHI	67.63L	198.1Q	11.037DE	18.520H	20.5HIJK	44.32 L
CZH15198	87.16JK	28.3FGH	21.8A	1.25EFGHIJ	79.7IJKL	318NO	12.605BCDE	25.900EFG	20.8GHIJK	59.25JKL
CZH15017	82.61K	23.6H	9.8 H	1.18FGHIJ	77.3JKL	263OP	10.000E	27.36EFG	21.8FGHIJK	57.98KL

Table. 3. 3. Above diagonal (Genotypic) and below diagonal (Phenotypic) correlation coefficients of different traits among the maize hybrids.

Traits	PH	EH	EL	NE	CW	KPC	GRC	GPR	HGW	GYPP
PH		**0.97****	**0.96****	**0.48****	**0.89****	**0.78****	**0.53****	**0.87****	**0.86****	**0.93****
EH	**0.90****		**0.81****	**0.48****	**0.84****	**0.69****	**0.41****	**0.77****	**0.79****	**0.84****
EL	**0.66****	**0.58****		**0.61****	**0.78****	**0.70****	**0.84****	**0.61****	**0.92****	**0.74****
NE	**0.39****	**0.35***	**0.24**^{ns}		**0.22ns**	**0.41****	**0.21ns**	**0.46****	**0.28ns**	**0.33***

CW	**0.82****	**0.77****	**0.56****	**0.21^{ns}**		**0.94****	**0.88****	**0.97****	**0.94****	**0.99****
KPC	**0.73****	**0.65****	**0.49****	**0.30***	**0.85****		**0.99****	**0.99****	**0.95****	**0.89****
GRC	**0.41****	**0.31***	**0.36***	**0.12^{ns}**	**0.56****	**0.75****		**0.99****	**0.83****	**0.78****
GPR	**0.71****	**0.66****	**0.44****	**0.31***	**0.82****	**0.91****	**0.45****		**0.99****	**0.93****
HGW	**0.66****	**0.61****	**0.39****	**0.22^{ns}**	**0.67****	**0.80****	**0.54****	**0.76****		**0.98****
GYPP	**0.84****	**0.77****	**0.55****	**0.25^{ns}**	**0.96****	**0.83****	**0.52****	**0.81****	**0.68****	

PH = Plants height (cm)**, EH =** Ears height (cm)**, EL=** Ears length (cm)**, NE =** No. of ear per plant**, CW=** Cob weight (g), **KPC=** Kernels cob^{-1}, **GRC=** Grain rows cob^{1}, **GPR=** kernels row^{1}**, HGW=**Hundred grains weight(g), **GYPP=**Grains yield plant^{-1} (g),
***** = Significance at (P≤0.05) significance level, ****** = Significance at (P≤0.01) significance level., **ns** =Non-significant

4. DISCUSSION

The analysis of variance suggested significant variability for all traits. This highly significant differences indicate the existence of variability and genotypical variations implying the significance of their genotypic interest in determining the desire genetic makeup for a specific disorder, and hence providing a wider choice for selection (Rahman *et al*., 2017). (Kumar *et al*., 2015; Shrestha, 2016; Kandel *et al*., 2017 and Kandel *et al*., 2018) also found differences significantly in maize hybrids for the studied traits. Range of variability reported in literature were: from 116.13 to 234.53 cm for plant height (Ali, 2014; Khan *et al*., 2017 and Ramzan, 2018), from 33.65 to 102.43 cm for ear height (Izzam *et al*., 2017; Khan *et al*. 2017 and Ramzan, 2018), from 13.1 to 20.73 cm for ear length (Kariuki *et al*. 2017; Izzam *et al*., 2017 and Khan *et al*., 2017). from 1.00 to 2.60 for ears per plant Khan *et al*., 2017 and Ramzan, 2018) from 46.2 to 145.9 (g) for cob weight Ghimire *et al*., 2015; Rahman *et al*., 2017 and Hassan *et al*., 2018) from 218.4 to 576.4 for kernels per ear (Khan *et al*. 2018 and Ramzan, 2018), from 12.00 to 16.00 for kernel rows per cob Izzam *et al*., 2017 and Ramzan, 2018), from 15.20 to 39.80 for kernels per row (Ullah *et al*.,2016 and Kariuki *et al*., 2017), from 18.35 to 40.78 (g) for 100 grains weight (Turi *et al*., 2007; Izzam *et al*., 2017 and Ramzan, 2018). From 41.19 (g) to 170.55 (g) for grain yield per plant (Kariuki *et al*. 2017 and Ramzan, 2018). In present study the ranges of the observed traits kernels per cob, plant height, number of ears, ear height, kernels rows per cob,100 grains weight and grains yield per plant were quite low from the ranges recorded in the literature, these characters can therefore be relied upon and simple selection could be carried out for additional improvement. Highest estimate of variation suggesting a sufficient inherent genetic variation upon which selection will be successful. Similar result was also recorded in literature for ear length (Barman *et al*., 2018; Beulah *et al*., 2018; Hosamani *et al*., 2018 and Vishwanath *et al*., 2018), and for ears per plant by Khan *et al*., (2018). Higher to moderated values of (GCV) and (PCV) shows that selection upon the variability in these character can be effective. Significant genetic differences in high altitude maize inbreds coupled with moderated to higher coefficient of variance for yield attributing characters has revealed that these character are amenable to genetic enhancements. Similar result was also recorded in literature for kernels per row (Nigussie and Saleh, 2007; Kashiani *et al*., 2008; Reddy, *et al*. 2012; Barman *et al*., 2018; Beulah *et al*., 2018; Dar *et al*., 2018; Hassan *et al*., 2018 and Supraja *et al*., 2019 and for 100 grain weight (Mahmood *et al*., 2004; Abirami *et* *al*., 2005; Bello *et al*., 2012; Rajesh *et al*., 2013; Golam *et al*., 2014; Sandeep *et al*., 2015; Muchie and Fenntie, 2016; Ferdoush *et al*., 2017 and Hosamani *et al*. 2018). Moderated to lower variability of these characters indicated the need for improvement of base population. The low variation coefficient indicates a narrow genetic cause and therefore variability in these character must be produced either through mutation breeding or hybridization and introduction of divergent genotypes to regain transgressive segregants. It may also be facilitated by adopting different phenotypic selections such as stabilized, destructive and directional selections. Similar result was also recorded in literature for kernel rows per cob by (Rahman *et al*., 2017; Vishwanath *et al*., 2018 and Hassan *et al*., 2018). Grains yield displayed significantly strong associations with almost all the characters studied. By selecting for these characters that reveal positive and strong relation with grain yield, there is possibility of increasing maize grain yield therefor in the process of selection, much attention should be given to these traits which are helpful to improve yield on the basis of indirect selection. In literature similar results were recorded by (Choudhary and Chaudary, 2002; Chinnadurai and Nagarajan, 2011; Charles *et al*., 2013; Kumar *et al*., 2014; Nzuve *et al*., 2014; Kinfe and Tsehaye, 2015; Ajmal *et al*., 2016; Rahman *et al*., 2016; Kharel *et al*., 2017; Rahman *et al*., 2017; Shukla, 2017; Beulah *et al*., 2018 and Bartaula *et al*., 2019).

5. Conclusion

Further varietal development is unlikely without getting genetic diversity. The results indicated that the maize hybrids studied for selective desired characters have a broad potential for successful use in maize breeding programmes there were variations in the twenty-five maize hybrids studied. Considering, all the character's hybrid CZH132151 and CZH132150 performed better among the studied hybrids. High estimates of GCV and PCV were recorded for ear height, plant height, grains yield per plant, cob weight and kernels per cob which provides substantial variation and offers scope for genetic improvement by selection. And offers greater possibilities in the maize breeding program for the selection of plant material for these traits. Grain yield had positive association with ear height, cob weight, plant height, ear length, kernel rows per cob, kernels per row,100 grains weight and kernels per cob. Therefore, to achieve high productivity special attention should be given to these traits in selection.

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