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Genetic variation and correlation studies in maize testcrosses under the agro climatic condition of Nowshera

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Abstract

In order toassess the genetic variation in maize via S_1 testcross (121genotypes), a tri-replicated experiment was conducted at Cereal Crops Research Institute (CCRI) Pirsabak, Nowshera in randomized complete block (RCBD) design. The experiments were conducted in two seasons.Analysis of variance revealed that all the tested hybrids were significantly different for all the studied traits. The data for days to 50% tasseling, days to 50% silking, plant height, ear height, ear diameter, ear length, fresh ear weight, number of kernel row ear^{-1}, 100-grain weight and grain yield (metric tons hac^{-1}) ranged from 46 to 53 days, 47.66 to 54.66 days, 131.66to 198 cm, 95.33 to 58.33 cm, 3.75 to 4.79 cm, 12.72 to 17.19 cm, 2.19 to 5.78 kg, 10.53 to 15.60 rows ear-^{1}, 26.06 to 39.53g and 4.35 to 12.68 (metric tons hac^{-1}) respectively. Analysis of correlation revealed that yield was highly significant and positively associated with plant height, ear height, ear diameter, ear length, fresh ear weight, 100-grain weight, while non-significant and positive correlation was found with number of kernel rows ear^{-1}. The negative and non-significant association of grain yield was founded with days to 50% tasseling, days to 50% silking. The promising hybrid for number of kernels rows ear^{-1}was "TC49" while TC-26 and TC-49 showed minimum days to 50% tasseling and silking and could be released as early maturing hybrids.

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Introduction

Maize (*Zea mays*L.) is one of the imperative crops belonging to the family of Poacea. Maize is grown throughout the country, however Punjab and Khyber Pakhtunkhwa is the major zones of production in Pakistan.It is a multi-purpose crop and used for food and feed along with any other industrial products (Kuşaksız, 2010). Maize production has increased to 4,527 thousand tons in 2013-14, as compared to 4,220 thousand tons in 2012-13, showing an increase of 7.3 percent (MINFAL).

The main objectives of breeding program in maize are to produce varieties/hybrids with high yielding and desirable characters. Several breeding techniques have been established to increase grain yield of maize populations. In order to select the best and high yielding hybrid combinations, a considerable number of best performing inbred lines are crossed to each other (Unay*et al.* 2004). Thus, there is an amazing innovation stream for maize breeders to utilize in their experiments to significantly increase maize productivity in an environmentally sensitive way (Yan *et al.,* 2011). Several factors affect the total production of this crop, like favorable environmental conditions, cultivation of hybrids, proper use of inputs and the utilization of adopted objective techniques of yield estimation (Ali *et al.,* 2012). Maize being the highest yielding cereal crop in the world; has a significant importance for countries like Pakistan, where rapidly increasing population has already outstripped the available food supplies.

The pivotal targets ina maize breeding programare the production of high yielding, diseaseresistant varieties (Ali *et al.,* 2012).The correlation studies basically measure the relation between yield and different characteristics. It gives data that selection for one quality will result about progress for all positively associated characters. Correlation has been measured as a systematic interrelationship between variables (Rangaswamy, 2010). For plant breeders it is essential to examine correlation to see the interrelationship between characters in order to decide for suitable selection criteria for a successful breeding program (Alan *et al.* 2013). Correlation can serve as a marker of the plant character that has an impact on its yield performance. This correlation analysis was embraced to conclude the interrelation between maize grain yield and yield traits and use as choice criteria in the maize work (Yohanna, 2014). The objectives of the present study are to estimate genetic variability among the hybrids and find out the possible correlation among yield traits.

Materials and methods

Study side and experimental design

The present studies were carried out at Cereal Crops Research Institute (CCRI), Pirsabak, Nowshera.S_1 lines from 5 different source populations (Sarhad White, Azam, Jalal, Iqbal and Pahari) were developed during kharif (July-October) 2012 at CCRI. In spring 2013 (Feb-June) 24 testcross hybrids from each of five populations were developed using a common male parent (FRHW-20-4) in perfect space isolation at CCRI. During kharif (July-October) 2013 the total of 120 testcross F_1 hybrids were evaluated for their performance at CCRI Pirsabak, Nowshera. The field was thoroughly prepared and laid out in randomized complete block design with three replications. Fertilizers were applied also in the quantity of 15kg each of DAP, Urea and SOP to each replication. Furandan insecticidal and nematicidal were also used, with 6 times of irrigation. The plot size comprised of 2 rows each. The rows were 5 meter long with row to row spacing of 75 cm and the plants were kept 25 cm apart. Recommended agronomic practices were carried out for successful crop production. Ten plants were randomly selected from each plot in each replication to record the data.

Observations recorded

Data was recorded on the following parameters after germinations,days to 50% tasseling(TSS), days to 50% silking(DS), plant height (PH), ear height (EH), ear diameter (ED), ear length (EL), fresh ear weight (FEW), number of kernel rows ear^{-1}(NOKRE), 100-grain weight(100GW), and grain yield (GY) (metric tons ha^{-1}).

Data analysis

Averages were calculated for recorded data in each replication. Data was analysed by using statistical software Statistix 8.1

Results and discussion

Analysis of variances showed highly significant variation for all the studied characters.The data on ten parameters for S_1testcross hybrids revealed significant variation for days to 50% tasseling, days to 50% silking, plant height, ear height, ear diameter, ear length, fresh ear weight, number of kernel rows ear^{-1},100 grain weight and grain yield (Table 1).

Table 1. ANOVA Mean squares of the 121 genotypes of Maize S_1 Testcross.

	DF	TSS	DS	PH	EH	ED	EL	FEW	NOKRE	100-GW	GY
Replication	2	27.3168	67.7052	5747.41	518.631	0.19967	1.59136	7.60823	1.62876	29.8654	29.0507
Varieties	120	5.8039**	6.6620**	613.79**	178.289**	0.12099**	2.75231**	1.52627**	3.16722**	22.4031**	6.7683**
Error	240	1.9029	1.9525	197.93	46.225	0.02634	0.58751	0.29659	0.55537	5.2161	1.1460
Total	362	1207.81	1403.44	132653	33526.0	21.2407	474.461	269.551	516.613	3999.96	1145.34

**=show highly significant, * = significant.

The data for days to 50% tasseling ranged from 46 to 53 days, for days to 50% silking from 47.66 to 54.66 days, for plant height from 131.66 cm to 198 cm, for ear height from 58.33 cm to 95.33 cm, for ear diameter from 3.75 to 4.79 cm, for ear length from 12.72 to 17.19 cm, for fresh ear weight from 2.19 to 5.78 kg, for number of kernel row ear^{-1} from 10.53 to 15.60, for 100-Grain weight from 26.06 g to 39.53 g and for Grain yield were 4.35 to 12.68 (metric tons hac^{-1}).High variability observed might be attributed to their genetic makeup and the differences in the geographical region. These results are in confirmation with the previous findings of Rahman*et al.* (2007), Saleem*et al.* (2007), Ahsan*et al.* (2008), Noor *etal.* (2010), Khayatnezhad*et al.* (2011), Lashkari*et al.* 2011), Ahmad *et al.* (2012),Mukhtar*et al.* (2012), Divan *et al.* (2013), Bello *et al.* (2014) and Chandrashekara*et al.* (2014).

Table 2. Mean performance of 121 test cross hybrids for days to 50% tasselling, days to 50% silking, plant height, ear height, ear diameter, ear length, fresh ear weight, number of kernel rows ear^{-1}, 100-grain weight, grain yield.

Genotype	Tss	DS	PH(cm)	EH(cm)	ED(cm)	EL(cm)	FEW(kg)	NOKRE	100-GW	GY(metric tons hac^{-1})
TC-1	53.00	54.00	151.66	72.00	3.97	14.65	3.82	11.80	28.93	8.20
TC-2	52.66	54.66	146.66	62.33	3.89	14.59	2.79	12.40	27.86	5.44
TC-3	51.33	53.33	145.66	67.33	3.75	14.00	2.66	11.93	28.13	5.64
TC-4	52.00	54.33	170.00	83.00	4.29	15.35	5.10	13.00	34.86	9.93
TC-5	51.00	52.00	174.33	80.33	4.15	14.17	2.97	12.60	29.73	5.76
TC-6	51.33	52.00	131.66	61.66	3.90	14.46	3.45	12.80	29.26	6.74
TC-7	51.66	53.00	145.33	66.33	4.22	13.27	3.52	13.26	30.03	7.35
TC-8	51.66	52.66	140.33	62.66	4.24	14.25	3.18	12.66	32.13	6.29
TC-9	52.33	53.66	154.66	82.33	4.22	16.27	3.96	13.53	28.53	7.46
TC-10	50.00	52.00	165.33	76.66	3.92	13.68	3.20	12.70	29.00	6.52
TC-11	49.33	51.00	148.33	70.00	3.88	12.96	3.18	12.06	29.53	6.53
TC-12	49.00	50.66	165.33	77.66	4.02	15.84	4.49	11.33	34.06	8.43
TC-13	50.00	51.33	177.33	82.66	4.26	16.33	3.62	12.66	39.00	7.44
TC-14	49.66	52.33	167.33	81.66	4.30	15.73	4.26	12.40	32.73	9.11
TC-15	51.33	53.66	155.00	71.66	4.00	14.09	4.57	12.40	33.26	7.71
TC-16	52.66	54.00	170.00	82.00	3.92	14.23	3.72	11.93	31.60	6.59
TC-17	52.33	53.33	152.33	72.00	4.16	16.50	4.28	12.40	33.53	8.36
TC-18	53.00	53.66	140.00	64.33	4.30	15.29	3.48	12.80	32.66	6.54

TC-19	49.66	51.00	176.33	87.33	4.21	14.77	4.14	12.43	33.66	8.49
TC-20	50.00	51.33	143.66	73.66	3.86	13.83	3.42	12.00	32.53	7.21
TC-21	48.66	49.66	165.00	70.33	4.13	13.88	3.52	11.93	28.93	7.38
TC-22	48.66	50.33	178.66	87.33	4.41	14.37	3.95	14.80	34.53	8.57
TC-23	49.00	50.66	175.00	72.33	4.22	14.59	4.09	13.26	33.80	8.45
TC-24	48.00	49.66	193.66	95.33	4.42	14.75	4.44	12.93	33.26	9.34
TC-25	47.66	49.00	172.66	80.66	4.20	14.47	3.46	14.60	27.93	7.37
TC-26	46.00	47.66	173.00	70.66	4.44	12.89	4.43	12.93	29.26	8.74
TC-27	48.00	49.66	182.66	85.00	4.45	15.10	4.50	14.86	34.80	9.43
TC-28	48.66	50.00	166.33	74.00	3.90	17.19	3.20	10.73	33.53	6.70
TC-29	50.66	51.66	160.00	81.00	4.53	13.47	4.66	15.20	30.33	8.54
TC-30	49.33	51.33	184.33	84.33	4.29	15.64	4.50	11.66	28.66	9.46
TC-31	49.33	51.00	154.33	71.66	4.17	12.76	2.97	12.53	27.66	6.47
TC-32	47.33	48.33	167.66	85.33	4.08	15.69	3.79	11.46	31.00	7.77
TC-33	49.66	51.33	184.66	92.00	4.27	14.36	4.43	13.53	34.20	9.36
TC-34	50.00	51.33	181.66	75.66	4.26	14.64	3.07	13.66	27.13	6.85
TC-35	49.33	50.33	169.00	80.00	3.84	12.80	2.53	12.20	30.40	5.19
TC-36	49.66	51.00	170.00	83.00	4.14	15.71	3.82	11.80	28.86	8.15
TC-37	50.33	51.66	171.00	77.00	4.37	15.00	3.34	14.60	28.80	7.01
TC-38	49.66	50.66	174.00	80.00	4.38	15.74	4.75	13.66	33.86	10.28
TC-39	50.66	52.33	153.66	77.00	4.21	14.66	3.32	12.33	28.46	7.47
TC-40	50.33	52.00	149.00	73.66	4.51	14.48	3.84	13.26	31.93	7.46
TC-41	49.33	51.00	154.66	74.66	4.00	14.07	3.45	13.40	32.00	7.03
TC-42	51.66	53.00	165.33	81.33	4.55	14.86	3.96	14.73	31.06	8.01
TC-43	47.66	48.66	158.00	69.66	4.10	15.01	3.60	12.93	31.13	7.48
TC-44	47.66	49.00	183.00	86.00	4.12	14.73	3.55	13.53	28.60	7.54
TC-45	49.66	51.33	180.00	85.00	4.16	15.54	3.86	13.33	29.33	7.92
Continued---										
TC-46	48.00	49.66	165.00	75.33	4.32	15.27	4.50	13.26	32.33	8.98
TC-47	50.66	51.66	184.33	84.00	4.42	15.26	4.10	13.06	33.46	8.37
TC-48	48.66	50.00	157.66	72.33	4.15	15.05	3.79	13.26	27.66	7.84
TC-49	47.00	47.66	197.00	91.66	4.54	16.07	5.78	15.60	34.26	12.68
TC-50	51.33	53.66	170.33	84.00	4.15	14.75	4.18	12.66	33.06	9.43
TC-51	51.66	53.00	167.66	80.00	4.37	15.98	5.44	13.53	33.40	10.79
TC-52	50.00	52.66	147.66	67.33	4.36	14.81	4.79	12.60	31.13	9.19
TC-53	51.00	52.33	185.00	80.33	4.62	15.20	5.07	13.80	31.33	10.73
TC-54	48.66	49.33	177.33	85.66	4.79	13.92	2.79	15.40	33.13	6.29
TC-55	48.66	49.33	175.00	73.66	4.20	15.15	2.68	14.26	30.26	6.10
TC-56	49.00	50.33	183.33	73.66	4.25	15.41	3.84	13.33	32.60	7.96
TC-57	47.66	49.00	177.00	85.33	4.70	13.26	4.69	14.73	30.86	9.36
TC-58	49.33	50.33	183.00	85.66	4.4	15.65	4.92	12.60	31.13	10.19
TC-59	48.33	49.33	166.33	68.00	4.33	15.30	3.92	13.53	34.26	7.53
TC-60	49.00	51.00	181.66	79.66	4.13	16.00	4.68	11.80	36.13	8.94
TC-61	49.66	50.66	166.33	82.00	4.16	16.30	5.41	12.53	32.33	10.18
TC-62	50.33	52.00	137.00	58.33	4.25	13.89	3.51	12.53	35.33	6.38
TC-63	50.66	52.33	177.66	84.33	4.32	16.45	4.22	12.66	33.26	8.28
TC-64	51.00	51.33	196.33	93.00	4.40	14.43	4.76	12.46	34.46	9.92
TC-65	49.33	51.00	198.00	93.33	4.27	14.74	4.82	13.06	30.26	9.46
TC-66	50.66	52.66	191.33	88.66	4.5	15.47	4.00	14.06	34.33	8.39
TC-67	49.66	51.33	180.33	75.66	4.48	16.45	5.06	13.20	35.66	10.31
TC-68	47.66	49.00	164.66	87.33	4.35	15.36	3.85	12.93	32.33	7.94
TC-69	50.00	51.33	180.66	91.00	4.57	16.34	5.16	13.53	31.53	8.96
TC-70	46.33	48.33	190.00	77.33	4.06	15.70	3.56	12.86	29.06	7.70
TC-71	49.33	50.66	182.33	84.00	4.35	14.60	4.09	14.80	31.13	8.27
TC-72	51.00	52.33	159.66	74.00	4.12	15.61	4.92	13.66	30.73	9.98
TC-73	50.00	51.33	146.66	72.33	4.36	14.92	3.71	13.46	31.46	7.92
TC-74	50.00	52.00	157.33	71.33	4.29	14.71	3.15	13.60	27.13	6.15
TC-75	48.66	49.66	166.66	82.33	4.23	14.73	4.23	12.80	32.06	8.21
TC-76	48.00	49.33	187.33	87.00	4.55	15.32	5.21	12.60	32.66	8.65
TC-77	50.00	52.00	177.00	88.00	4.52	15.24	3.84	13.80	35.00	7.93
TC-78	48.66	49.00	164.66	70.00	4.31	16.28	2.33	14.93	31.80	4.75

TC-79	49.33	51.00	144.66	68.66	4.53	13.84	3.78	15.00	30.86	7.36
TC-80	48.66	50.66	188.66	79.66	4.37	16.21	5.62	13.06	26.06	11.71
TC-81	48.66	50.00	162.00	69.66	4.10	13.64	3.52	12.66	30.86	7.10
TC-82	48.33	49.00	189.66	87.00	4.24	16.84	4.82	14.80	32.33	9.67
TC-83	48.66	49.66	170.00	75.00	4.14	14.54	4.09	14.80	28.40	8.31
TC-84	52.00	52.00	152.66	74.33	4.42	13.77	3.31	13.46	30.13	7.16
TC-85	50.33	51.66	154.33	68.33	4.29	14.38	3.68	15.46	28.40	7.80
TC-86	50.66	51.00	177.33	90.00	4.38	15.58	4.18	13.46	30.73	8.46
TC-87	49.33	50.00	175.66	78.66	4.35	14.47	3.26	14.86	30.00	6.94
TC-88	49.66	50.66	166.00	89.66	4.02	15.32	3.79	13.93	32.20	7.69
TC-89	50.33	50.66	161.66	75.66	4.05	13.40	3.51	13.26	29.33	6.20
TC-90	49.33	50.66	165.00	75.00	4.37	14.68	4.07	13.93	35.73	9.37
TC-91	51.33	53.00	157.33	78.33	4.33	15.58	3.71	15.26	30.33	7.31
TC-92	50.00	51.33	162.33	73.00	4.14	14.82	4.04	14.60	31.86	8.19
TC-93	49.00	50.00	190.33	90.00	4.23	15.18	3.52	14.66	31.06	7.41
TC-94	50.66	51.00	156.66	77.00	4.06	14.42	3.21	12.46	28.20	4.92
TC-95	51.00	52.33	136.00	64.33	4.29	15.43	3.20	12.06	29.26	6.29
TC-96	50.66	51.66	141.00	67.00	4.07	13.97	3.20	12.93	28.93	7.00
TC-97	50.33	51.00	166.66	73.00	3.95	16.00	4.23	12.33	30.86	8.45
TC-98	48.33	48.66	172.00	85.66	4.27	15.10	4.23	12.53	33.26	8.75
Continued---										
TC-99	52.00	53.00	156.66	70.00	4.52	15.09	3.98	13.66	33.66	7.69
TC-100	49.33	50.00	159.33	74.00	4.173	16.43	4.25	12.53	33.66	9.03
TC-101	50.00	51.33	147.33	72.66	4.413	15.16	2.36	14.60	35.40	4.35
TC-102	49.66	50.33	159.00	68.00	4.07	13.22	2.89	13.80	30.06	6.10
TC-103	49.66	51.00	180.00	79.33	4.13	15.16	3.95	13.80	36.53	8.27
TC-104	49.00	50.00	183.66	74.33	4.47	15.77	3.86	13.86	39.53	8.26
TC-105	50.33	50.33	152.00	66.66	4.12	15.50	3.48	10.53	35.26	7.28
TC-106	51.33	52.33	164.00	77.66	4.45	16.84	3.79	13.73	37.40	7.66
TC-107	51.33	52.33	159.33	74.66	4.01	14.28	2.83	12.46	31.80	5.36
TC-108	51.66	52.00	172.00	73.66	4.19	16.28	3.61	12.93	28.73	6.93
TC-109	47.00	48.33	177.66	73.66	4.22	13.94	3.40	13.93	28.73	7.25
TC-110	48.33	49.66	163.00	72.66	4.14	14.95	3.30	15.06	29.20	6.64
TC-111	49.00	49.33	144.66	63.66	4.13	14.33	2.193	12.66	28.46	4.54
TC-112	49.33	50.33	174.00	83.00	4.09	14.31	3.49	14.60	26.60	6.85
TC-113	49.00	49.66	184.33	86.66	4.23	15.64	3.86	13.46	30.13	8.23
TC-114	49.33	50.66	155.00	74.66	4.25	14.41	3.64	12.73	35.80	7.58
TC-115	49.00	49.66	194.00	89.66	4.12	14.85	3.96	12.53	35.93	8.31
TC-116	50.33	51.00	141.66	67	3.86	13.35	2.86	12.53	33.49	5.10
TC-117	50.66	51.66	151.33	64.66	4.12	16.33	3.34	12.33	33.40	6.48
TC-118	50.66	51.33	162.66	81.33	4.19	13.99	3.75	12.73	32.73	7.69
TC-119	49.66	50.00	164.33	68.00	4.06	12.72	3.63	13.26	27.86	7.74
TC-120	49.00	50.33	157.00	72.33	3.94	15.13	3.55	13.06	26.60	7.44
p30k08	50.33	50.66	188.00	86.00	4.68	16.95	5.67	13.53	38.46	9.95
LSD $_{0.05}$ genotype	2.2187	2.1260	4.3395	3.7045	0.1196	0.9935	0.7337	1.1293	3.5244	1.5166
CV%	2.77	2.59	1.62	2.97	1.75	4.14	11.77	5.30	6.93	12.03

LSD= least significant difference, CV%= coefficient of variation.

Correlation analysis

In the present study grain yield revealed highly significant and positive association with plant height, ear height, ear diameter, ear length, fresh ear weight and 100-grain weight, while non-significant and positive association with number of kernel rows ear^{-1} and shelling percentage.The non-significant negative correlation of grain yield was observed with days to 50% tasseling andsilking.

The present results are in agreement with the results obtained by Malik *et al.* (2005) who investigated 36 maize hybrids along with their parental lines and achieved a similar outcome of grain yield with day to 50% silking and days to 50% tasseling was negatively non-significant correlation.Bocanski *etal.*

(2009) conducted an experiment on 8 inbred lines and their hybrids and concluded corroborating results

of highlysignificant positive correlation of grain yield with plant height and ear height. Kumar *etal.* (2014) reported highly significant positive association of grain yield with ear diameter. Wannows*et al.* (2010) conducted an experiment on 15 maize hybrid and notified similar results of highly significant and positive association among grain yield with ear length. Eleweanya*etal.* (2005) also studied 19 open pollinated maize genotypes and concluded similar results of highly significant and positive correlation of grain yield with fresh ear weight.Nemati*etal.* (2009) conducted his experiments on SC-404 maize hybrid and observed similar outcomes of positive but non-significant relationship grain yield with number of kernels rows ear^{-1}. Kumar *etal.* (2011) conducted an experiment on elite inbreeds and their F_1 hybrids and concluded corroborating outcome of highly significant and positive relationship of grain yield with 100 grain weight.

Table 3. Correlation coefficient between traits for 121 test cross hybrids.

	DT	DS	PH	EH	ED	EL	FEW	NOKRE	100-GW
DS	0.93**								
DPS	0.89**	0.94**							
ASI	-0.08	-0.13							
LA	-0.28*	-0.30**							
PH	-0.4**	-0.40**							
EH	-0.25*	-0.22*	0.80**						
ED	-0.12	-0.11	0.38**	0.37**					
EL	0.02	0.02	0.32**	0.28*	0.22*				
FEW	-0.09	-0.02	0.49**	0.50**	0.45**	0.42**			
NOKRE	-0.18*	-0.20	0.23*	0.20*	0.52**	-0.05	0.06		
100-GW	0.03	0.02	0.21*	0.22*	0.33**	0.37**	0.32**	-0.04	
GY	-0.18	-0.10	0.56**	0.52**	0.45**	0.40**	0.94**	0.11	0.30**

Conclusion

The tested hybrids revealed highly significant variations for all the studied characters which confirm the presence of genetic variations and can be used for further breeding and improvement program. Among the tested test-cross hybrids, TC-49, TC-80, TC-67, and TC 51 out yielded all hybrids, including check; therefore it may be recommended for general cultivation as newly developed hybrids. Among 121 testcross hybrids TC-26, TC-70 and TC-49 were early maturing hybrids, therefore, these populations can be used in future breeding programs for development of early maturing hybrids.

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