CORRELATION AND PATH COEFFICIENTS STUDIES OF SOME MORPHOPHYSIOLOGICAL TRAITS IN MAIZE DOUBLE CROSSES

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Thirty double crosses alongwith two checks Hicorn-984 and Hicorn 11+ were studied for ears plant$^{-1,}$ plant height, ear height, days to 50 % tasseling, days to 50% silking and grain yield plant^{-1} through phenotypic coefficient of variability, genotypic coefficient of variability, broad sense heritability, genetic Advance, correlations and path coefficient analysis. Significant differences were found among the crosses for ears plant^{-1}, plant height, ear height and highly significant differences for days to 50 % tasseling, days to 50 % silking and grain yield. Grain yield plant^{-1} followed by days to 50% silking and days to 50 % tasseling were found high heritable traits for grain yield improvement. Plant height followed by ear height, days to 50 % tasseling and days to 50 % silking had strong genotypic and phenotypic association with each other and significantly positive genotypic correlation with grain yield too. Plant height followed by days to 50 % tasseling also exerted positive direct effect on grain yield.
Keywords: Maize double-crosses, genotypic coefficients of variability, broad sense heritability, genetic advance, correlations, path coefficients analyses, grain yield improvement.

INTRODUCTION

Maize is the third important cereal food crop in the world as well as in Pakistan after wheat and rice. It is a major food and calorie source for the people in the developing world, with a total direct consumption of 100 million tones as food, contributing 15 % of the protein, and 19 % of the calories delivered from food crops (Tabassum, 2002). In Pakistan, area under the crop was 1042 thousands hectares, annual production 3109.6 thousand tonnes and average grain yield was 2984 kg /ha for the year 2005-6. Among cereals it is highly profitable crop due to higher yield per unit area per unit time. Due to short duration crop two successful crops are sown in spring and autumn per annum for grain yield in Pakistan. Grain yield per unit area in Pakistan is 1.59 times less as compared to the world yield (Anon**.** 2005-6). It is therefore, imperative to adopt appropriate measures for yield maximization. The efforts are underway to develop better single, double and 3-way crosses with improved yield potential. High yielding composites and synthetics are also constituted for those farmers who are unable to purchase costly hybrid seed every year. Such consolidated breeding efforts need critical evaluation of existing genetic variability, heritability, genetic advance, interrelationship among grain yield and its components as studied by Venugopal *et al*. (2003).

MATERIALS AND METHODS

Thirty double-crosses comprising FDC-4016 to FDC-4045 with two checks Hicorn-984 and Hicorn 11+ were evaluated in Preliminary Yield Trial-1 in Kharif, 2005 at Maize Research Station, Faisalabad during 2005. All the crosses along with checks were sown in replicated randomized complete block design, keeping plot size 5 x 1.5 m^2, on ridges spacing 2.5 m and plant spacing 7 inches respectively. Data recorded for ears plant^{-1} , plant height, ear height, days to 50% tasseling, days to 50% silking and grain yield plant^{-1} were used for various statistical analysis according to Steel and Torrie (1984). Genotypic (GCV) and phenotypic (PCV) coefficients of variability, broad sense heritability ($h^2_{B.S}$), genetic advance as % of mean, genotypic (r_g) and phenotypic correlation (r_P) coefficients were analyzed according to Kwon and Torrie (1964) and path coefficient analysis were made as proposed by Dewy and Lu (1959).

RESULTS AND DISCUSSION

Mean performance of the double crosses alongwith variability parameters and coefficient of variation (CV) are presented in Table-1. CV were used to compare precision of experiments with different means that was less than 20% for all the traits which showed the reliability of the data. Genotypic mean squares found significant for ears plant^{-1} plant height and ear height and highly significant for days to 50 % tasseling, days to 50 % silking and grain yield plant^{-1}. Genotypic and phenotypic coefficients of variability, broad sense heritability and genetic advance as % of mean were calculated for all the traits (Table-2). A perusal of the data revealed low genotypic variability; heritability ($h^2_{B.S}$) and genetic advance as % of mean for ears plant^{-1}, plant height, days to 50 % tasseling and days to 50% silking However, grain yield plant^{-1} followed by ear height had comparatively better genotypic variability, better broad sense heritability alongwith better genetic

Table 1. Mean performance of the 30 maize double-crosses with two commercial checks.

No.	Double cross	Ears $plant^{-1}$	Plant height (cm)	Ear height (cm)	Days to 50% tasseling	Days to 50% Silking	Grain yield $plant^{-1}$
1	**FDC 4016**	1.0	210	112.5	53.5	56.5	**143.36**
2	FDC 4017	1.0	204	113.5	54	**57**	124.64
3	FDC 4018	1.1	**219**	112	53.5	56.5	125.37
4	FDC 4019	1.0	201	104.5	53.5	56.5	113.32
5	FDC 4020	1.0	201.5	116.5	53.5	56.5	110.60
6	FDC 4021	1.0	203	101	52.5	55	129.00
7	FDC 4022	1.0	198.5	97.5	52.5	55.5	110.09
8	FDC 4023	1.0	197	98	53	56	99.05
9	FDC 4024	1.0	185.5	87.5	52.5	55.5	116.55
10	FDC 4025	1.0	203.5	112.5	53.5	56	128.86
11	FDC 4026	1.0	159.5	95.5	52	55.5	110.09
12	FDC 4027	1.0	212	102.5	53	55.5	110.33
13	FDC 4028	1.3	213.5	104.5	**54.5**	56.5	101.58
14	FDC 4029	1.0	213.5	**113.5**	54	**57**	130.73
15	FDC 4030	1.0	190.5	96.5	53	55.5	93.09
16	**FDC 4031**	1.0	195	109	53.5	**57**	130.85
17	FDC 4032	1.0	189	94.5	51	54	107.18
18	FDC 4033	1.0	207	110	53	56	89.32
19	FDC 4034	1.0	185.5	92	51.5	55	123.95
20	**FDC 4035**	1.0	194.5	103.5	51.5	55	132.20
21	FDC 4036	1.0	182.5	86.5	50	54	104.83
22	FDC 4037	1.0	200.5	98.5	53	56	121.10
23	FDC4038	1.0	190	98.5	50	53	110.52
24	FDC 4039	1.0	194.5	91	48.5	52	122.09
25	FDC 4040	1.0	197.5	92.5	51.5	53.5	119.26
26	FDC 4041	1.0	183.5	86	47.5	52.5	114.46
27	FDC4042	1.0	193	95	52	54.5	115.17
28	FDC 4043	1.0	199.5	100.5	52.5	55.5	116.95
29	FDC 4044	1.1	194.5	91	51.5	55	122.29
30	FDC 4045	1.0	185.5	90	50.5	54	110.65
31	Hicorn984	1.0	217	109	55	56	**156.68**
32	Hicorn 11+	1.0	**219**	113.5	52.5	54.5	127.43
S.E		0.0052	7.828	6.028	1.191	0.712	5.517
Grand Mean value		0.999	199.69	100.91	52.13	55.31	122.06
Genotypic mean square		0.002*	225.77*	167.14*	7.613**	2.96**	495.72**
Error mean square		0.001	122.55	72.68	2.837	1.014	60.883
LSD (5%)		.0601	22. 58	17. 39	3.435	2.054	15. 91
CV % = (√ Viance/ mean) x 100		2.95	5.54	8.45	3.23	1.82	11.54

Bold entries show desirability of the breeder for yield improvement

advance which considered the good estimates for effective selection of a trait. Better value of heritability with better genetic advance for grain yield $plant^{-1}$ and ear height depicted that visual selection based on these traits among the crosses would improve these traits. viz; Hi-corn 984 which stood first by giving grain yield of 156.68 g $plant^{-1}$ with ear height 109 cm., FDC-4016 stood 2nd by giving yield 143.36 g with ear height of 112.5 cm followed by FDC-4035 yielded 132.20 g with ear height of 103.5 cm and FDC-4031 yielded 130.85 g with ear height of 109 cm respectively should preferably be selected as compared the check “Hicorn 11+” which yielded 127.43 g with ear height of 113.5 cm (Table 1). Ears $plant^{-1}$ had non-significant genotypic

Table 2. Estimates of GCV, PCV, heritability, Genetic advance as % of mean in 32 double crosses

Traits	G.V	GCV	P.V	PCV	$h^2_{B.S\%}$	G.A as % of mean
Ears plant^{-1}	0.00	1.902	0.001	3.511	29.4	2.00
Plant height	51.609	3.598	174.157	6.609	29.6	4.02
Ear height	47.234	6.811	119.909	**10.852**	39.4	**8.81**
Days to 50%	2.388	2.965	5.225	4.385	45.7	4.12
Days to 50%silking	0.973	1.783	1.987	2.548	**49.00**	2.57
Grain yield plant^{-1}	217.419	**12.08**	278.302	**13.667**	**78.10**	**21.98**

association with all the traits except plant height (0.3894) that was minimized to non-significant phenotypic expression (0.0084) and had negative direct effect on grain yield. However, Plant height had strong genotypic association with ear height, days to 50 % tasseling, days to 50 % silking and significant positive correlation with grain yield plant^{-1} too. Similarly ear height had strong positive genotypic correlation with days to 50 % tasseling, days to 50 % silking and grain yield plant^{-1}; days to 50 % tasseling with days to 50 % silking and grain yield plant^{-1} and days to 50 % silking with grain yield but all turned non significant for its phenotypic correlation with grain yield due to negative environmental effect (Table 3). That is why direct selection on grain yield basis would not be fruitful in spite of the presence of higher variability, broad sense heritability and higher genetic advance as % of mean. However, plant height, ear height, days to 50 % tasseling and days to 50 % silking had strong genotypic and phenotypic association with each other and significantly positive genotypic correlation with grain yield. That is why selection on the basis of higher values of these traits would be fruitful indirectly for grain yield improvement. Rather *et al*. (1999) observed strong genotypic environmental interactions. Days to 50% silking was positively correlated with ear height and grain yield. Plant height had no association with grain yield in their findings. Results given by Rather *et al*. (1999) are partially in accordance with these findings. It might be due to different breeding material and its genetic behavior in different environments.

Table-4 revealed direct and indirect contribution of the traits in the development of grain yield. Ahmed *et al*. (2001), Devi *et al*. (2001), Mohan *et al*. (2002) and Yanugopal *et al*. (2003) studied path coefficient analysis for grain yield and yield components. Ahmed *et al*. (2001) found simple correlation coefficients between grain yield plant^{-1} and yield components. Ears plant^{-1} had non-significant association with grain yield plant^{-1} and it exerted negative direct and indirect effects through ear height on grain yield too. Plant height had significant positive association with ear height as well as significantly positive genotypic correlation with grain yield plant^{-1} as concluded by Ahmed *et al*. (2001) and it also exerted positive direct effect on grain yield plant^{-1} but indirect negative effect through ear height and days to 50 % silking reduced this association. The results are partially in agreement with Alvi *at el*. (2003) and

Table 3. Genotypic and Phenotypic correlation coefficients of 32 maize double crosses, 2005

Trait		Ears Plant^{-1}	Plant height (cm)	Ear Height (cm)	Days to 50% tasseling	Days to 50% Silking	Grain yield Plant^{-1}
Ears Plant^{-1}	r_g	**1**	**0.3894***	0.0099	0.0673	-0.0554	0.2252
	r_p		0.0084	-0.0279	-0.0164	0.0696	0.1522
Plant height	r_g		1	**0.9283****	**1.0024****	**0.7613****	**0.5312****
	r_p			**0.7174****	**0.4572****	**0.4171***	0.2991
Ear height	r_g			1	**1.1461****	**0.9388****	**0.444***
	r_p				**0.5244****	**0.6021****	0.2614
Days to 50% tasseling	r_g				**1**	**1.0668****	**0.2717***
	r_p					**0.7769****	0.2190
Days to 50% silking	r_g					1	**0.1508***
	r_p						0.1225

**=Highly significant *= significant and bold entries show interest of the breeder for yield improvement

Table 4. Path Coefficient Analyses of 32 Maize Double Crosses, 2005

Traits	Ears plant^{-1}	Plant height	Ear height	Days to 50% tasseling	Days to 50% silking	Grain yield plant^{-1}
Ears plant^{-1}	(-0.5185)	0.06805	-0.0074	0.0233	0.0474	0.2252
Plant height	-0.2019	**(1.7474)**	-0.6984	0.3468	-0.6628	**0. 5312****
Ear height	-0.0051	**1.6222**	(0.7523)	0.3965	-0.8174	**0.444***
Days to 50% tasseling	-0.0349	**1.7516**	-0.8622	(0.3460)	-0.9288	**0.2717***
Days to 50% silking	0.0282	**1.3303**	-0.7063	0.3691	(-0.8706)	**0.1508***

**=Highly significant *= significant and bold entries show desirability of the breeder for yield improvement

Devi *et al*. (2001). Ear height, days to 50% tasseling and days to 50% silking had significantly positive genotypic correlation with grain yield plant^{-1}. However, ear height and days to 50 % silking had negative direct effect on grain yield plant^{-1}. A trait which had higher coefficient of genotypic variability, higher broad sense heritability, higher genetic advance as % of mean , higher degree of positive correlation coefficient and higher direct effect on grain yield would be very effective and excellent tool for improving grain yield plant^{-1}.

CONCLUSION

Selection of taller plants with more ear height, which take more days to 50 % tasseling, would indirectly improve grain yield plant^{-1} in the breeding material studied.

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