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Research Article

Combining Ability Analysis in A 5x5 Diallel Cross of Maize Inbred Lines

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Abstract: A complete diallel cross between five maize inbred lines viz; Elp-326, Elp-433, Elp-612, Elp-326 and Elp-780 was used to determine the genetic behavior of grain yield, days to 50% tasseling, days to 50% silking, plant height, cob height and cob girth during growing seasons 2018 and 2019. Analysis of variances was carried out for all the parameters following (Steel, R.G.D., & Torrie, J.H. 1980) technique which revealed highly significant differences for all the traits studied. The analyses of GCA and SCA were carried out using (Griffing, B. 1956) technique, Method I, Model II. Both GCA and SCA mean squares were highly significant for all the traits indicating the involvement of additive as well as non additive gene interactions in the expression of these traits. SCA mean squares and variances were larger than those of GCA mean squares and variances which suggested that non additive genes had major role in the inheritance of grain yield and its related characters under study. Elp-433 was found the best general combiner for all the parameters. Elp-426, Elp-326 were good general combiners for grain yield only. Elp-326 x Elp-780 and Elp-426 x Elp-433 were best combinations for grain yield and most of its components. The crosses Elp-780 x Elp-433, Elp-780 x Elp-426, Elp-780 x Elp-433, Elp-326 x Elp-433, Elp-612 x Elp-426 and Elp-326 x Elp-612 having higher reciprocal effects pointed out that partial role of cytoplasmic inheritance cannot be ruled out in controlling the physiology of these traits.

Keywords: Inheritance, maize, GCA, SCA

INTRODUCTION

Maize is the third most important cereal crop after wheat and rice in Pakistan. Maize hybrids with high yield potential are a pre requisite to be developed for increased production. Identification of inbred lines to judge the nature of gene action involved in different quantitative characters is helpful for plant breeder to formulate hybrid breeding program.

In conventional breeding combining ability is regarded as the best tool to ascertain the genetic mechanism of both the traits and the genotypes under study. Once the inheritance pattern for yield and its attributes is established, one can easily manipulate it by adopting proper breeding programs to boost yields (Dabholkar, A.R. *et al.*, 1989; & Muraya, M. M. *et al.*, 2006).

Combining ability has two components; General combining ability (GCA) and Specific combining ability (SCA) (Sprague, G.F., & Tatum, L.A. 1942). Comprehensive knowledge of both GCA and SCA is very important in determining the inheritance pattern of desired traits/ inbred lines. GCA is a good indicator of additive gene action while SCA for non-additive type of gene interaction. Both GCA and SCA also give vent on dominance and epistatic interactions.

The knowledge of nature and magnitude of gene action is very important for the selection of promising genotypes and efficient breeding program. Through combining ability analysis both additive and non-additive gene effects have been reported by (Moll, R. H. *et al.*, 1962; Mason, L., & Zuber, S.M. 1976; Nienhius, J., & Singh, S.P. 1986; Saad, I. M. *et al.*, 2004; Sharma, S. *et al.*, 2004; Seyoum, A. *et al.*, 2016; & Rojas, B.A., & Sprague, G.F. 1952). On the other hand (Gamble, E.E. 1962; Darrah, L.L., & Hallauer, A.R. 1972; & Kambe, G.R. *et al.*, 2013) have reported that non-additive gene interactions have greater influence in controlling the inheritance of grain yield and related traits. Thus equipped with a comprehensive know how of inheritance pattern one can easily identify superior breeding material and select a successful breeding program.

Present study was therefore under taken to investigate the breeding behavior of five maize inbred lines for grain yield, days to tasseling, days to silking, plant height, cob height and cob girth.

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MATERIALS AND METHODS

The experimental material, comprising of five inbred lines viz; Elp-426, Elp-433, Elp-612, Elp-326 and Elp-780 was sown on 27-03-2018 at Maize Breeding Sub-station, Chharrapani – Murree (Pakistan). Inbred lines were crossed in all possible combinations. The F_1 hybrids were sown during the next season on 25-03-2019. Data were recorded for the characters under exploration.

Analysis of variances was carried out for all the parameters following (Steel, R.G.D., & Torrie, J.H. 1980) technique. Highly significant differences were noticed for all the characteristics (Table I). The analyses of GCA and SCA were carried out using (Griffing, B. 1956) technique, Method I, Model II.

RESULTS AND DISCUSSION

General and Specific combining ability as well as reciprocal effects were highly significant for all characters under study. Maize inbred line Elp-433 was the best general combiner for grain yield and its components studied (Table III). Inbred line Elp-426 and Elp-326 were good general combiners for grain yield only. These genotypes had negative GCA effects for days to 50% tasseling, days to 50% silking and plant height. Inbred line Elp-326 and Elp-780 had negative GCA effects for cob height.

The crosses Elp-326 x Elp-780 and Elp-726 x Elp-433 proved the best combinations as these had highest SCA effects for grain yield and most of its attributes (Table IV). Other crosses showing promise were Elp-426 x Elp-780, Elp-433 x Elp-326, Elp-426 x Elp-612, Elp-612 x Elp-326 and Elp-433x Elp-612. These cross combinations had at least one good general combiner for grain yield. The crosses Elp-726 x Elp-433 and Elp-612 x Elp-326 showed negative SCA effects for days to 50% tasseling and days to 50% silking. One of the parents in these crosses also had negative GCA effects. These crosses proved to be the best combinations for grain yield and earliness.

The crosses Elp-780 x Elp-433, Elp-326 x Elp-426, Elp-326 x Elp-433, Elp-612 x Elp-426 and Elp-326 x Elp-612 having higher reciprocal effects (Table V), significantly differed from rest of the reciprocals regarding grain yield and most of its related traits studied.

Table I. Mean Squares for grain yield, days to tasseling, days to silking, plant height, cob height and cob girth in 5x5 diallel cross in maize

SOV	Df	Grain Yield	Days to 50 % Tasseling	Days to 50 % Silking	Plant Height	Cob Height	Cob Girth
Replications	1	10981	0.08	0.75	6.02	10.08	0.01
Treatments	24	3589331**	21.53**	23.76**	1954.19**	677.01**	6.26**
Error	24	50361	2.77	3.84	30.14	14.12	0.04

*and ** = Significant at 0.05 and 0.01 percent probability level, respectively.

Table II. Combining Ability Mean Squares for grain yield, days to 50 % tasseling, days to 50 % silking, plant height, cob height and cob girth in 5x5 diallel cross in maize

SOV	df	Grain Yield	Days to 50 % Tasseling	Days to 50 % Silking	Plant Height	Cob Height	Cob Girth
GCA	4	4326211**	4.01**	5.67**	1565.22**	615.23**	2.45**
SCA	10	3887861**	14.11**	22.44**	2200.88**	760.90**	7.18**
Reciprocals	10	298504**	36.08**	32.33**	1866.70**	670.50**	6.91**
Error	24	50659.67	2.77	3.86	29.88	14.33	8.04

*and ** = Significant at 0.05 and 0.01 percent probability level, respectively.

Table III. GCA effects for grain yield, days to 50 % tasseling, days to 50 % silking, plant height, cob height and cob girth in 5x5 diallel cross in maize

Inbred Lines	Grain Yield	Days to 50 % Tasseling	Days to 50 % Silking	Plant Height	Cob Height	Cob Girth
Elp-426	341.45	-0.41	-0.78	-0.18	1.50	-0.51
Elp-433	495.65	0.64	0.67	10.87	7.85	0.27
Elp-612	-220.90	0.29	0.17	6.67	0.75	-0.06
Elp-326	55.45	-0.31	-0.18	-4.38	-3.00	0.38
Elp-780	-67.65	-0.21	0.12	-11.98	-7.00	-0.08
SE	45.01	0.33	0.39	1.09	0.76	0.04

Table IV. SCA effects for grain yield, days to tasseling, days to silking, plant height, cob height and cob girth in 5x5 diallel cross in maize.

Crosses	Grain Yield	Days to 50 % Tasseling	Days to 50 % Silking	Plant Height	Cob Height	Cob Girth
Elp 426 x Elp433	1053.65	-3.44	-4.77	13.78	6.10	0.46
Elp 426 x Elp612	494.20	-0.34	4.78	-2.57	-5.80	-0.03
Elp 426 x Elp326	-377.40	0.76	-0.17	-11.77	0.05	-1.37
Elp 426 x Elp780	854.95	0.16	0.78	-11.67	-14.05	-0.28
Elp 433 x Elp 612	31.00	-0.39	0.03	-28.37	-17.65	-2.33
Elp 433 x Elp 326	808.90	0.21	-0.37	0.68	-8.55	-0.68
Elp 433 x Elp 780	-599.25	-0.14	0.33	4.28	0.60	1.53
Elp 612 x Elp 326	313.45	-1.19	-0.37	9.88	5.05	1.34
Elp 612 x Elp780	-365.95	-0.04	0.08	40.48	16.70	1.10
Elp 326 x Elp780	1068.45	2.06	1.43	21.53	18.05	0.18

Table V. Reciprocal effects for grain yield, days to 50 % tasseling, days to 50 % silking, plant height, cob height and cob girth in 5x5 diallel cross in maize

Crosses	Grain Yield	Days to 50 % Tasseling	Days to 50 % Silking	Plant Height	Cob Height	Cob Girth
Elp 433 x Elp 426	-42.25	0.25	1.00	-4.50	-8.25	1.07
Elp 612 x Elp426	204.75	-3.50	-4.25	25.00	4.76	-0.17
Elp 612 x Elp433	-308.25	3.00	2.75	-33.25	-22.75	0.67
Elp 326 x Elp426	1141.00	-4.50	-3.25	-39.75	-17.25	-1.80
Elp 326 x Elp 433	835.50	3.00	3.00	4.25	13.50	-0.07
Elp 326 x Elp 612	170.00	3.25	1.50	3.75	7.00	-0.10
Elp 780 x Elp 426	1156.25	-0.50	-1.00	20.25	-6.75	1.71
Elp 6780 x Elp 433	1647.25	2.75	1.50	-5.75	4.25	1.30
Elp 780 x Elp612	-692.50	-3.50	-5.25	-15.75	-1.25	2.81
Elp 780 x Elp326	-893.75	3.00	1.25	24.75	18.75	0.11

Table VI. Variance Components for grain yield, days to 50 % tasseling, days to 50 % silking, plant height, cob height and cob girth in 5x5 diallel cross in maize

Variance Components	Grain Yield	Days to 50 % Tasseling	Days to 50 % Silking	Plant Height	Cob Height	Cob Girth
Vg	-3645.89	-1.07	-1.54	-20.26	-6.71	-0.10
Vs	917285.94	-8.98	-11.63	611.47	159.22	1.95
Vr	548180.72	-2.05	-7.29	346.09	98.89	1.57
Ve	402890.33	22.14	30.75	241.17	112.97	0.32

CONCLUDING REMARKS

Both GCA and SCA mean squares were highly significant indicating the involvement of both additive and non-additive type of gene interactions in the inheritance of these characters. Similar findings have been reported by (Moll, R. H. *et al.,* 1962; Mason, L., & Zuber, S.M. 1976; Nienhius, J., & Singh, S.P. 1986; Saad, I. M. *et al.,* 2004; Sharma, S. *et al.,* 2004; Muraya, M. M. *et al.,* 2006; & Seyoum, A. *et al.,* 2016). However, higher values of SCA mean squares pointed out that non-additive genes had larger proportion in controlling these characters. Furthermore, comparatively higher SCA variances clearly indicated that non-additive genes were more important than additive ones for most of these traits. Present findings are in agreement with (Rojas, B.A., & Sprague, G.F. 1952; Gamble, E.E. 1962; Darrah, L.L., & Hallauer, A.R. 1972; & Kambe, G.R. *et al.,* 2013). However, higher reciprocal effects of some crosses suggested that partial role of cytoplasmic inheritance cannot be ruled out in controlling the physiology of parameters studied.

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