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Association of Heterotic Expression for Grain Yield and its Component Traits in Maize (*Zea mays* L.)

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Abstract: In the present study fifteen phenotypically diverse white maize inbred lines (both local and exotic) were crossed to three testers namely W3, W5 and W3×W5 in line x tester fashion to generate 45 test cross progenies, which were evaluated in two diverse locations of Kashmir valley namely High Altitude Research Station, Larnoo and Regional Research Station, Wadura, representing diverse climatic regions, using randomized complete block design with three replications at each location. The analysis of variance for line x tester design pooled over locations revealed significant environmental variance for all traits except harvest index, genotype x environment interaction was significant for all traits except 100-seed weight, indicating greater influence of environment on the expression of these traits. Grain yield recorded heterosis upto 78.83% (mean value of 41%) in the present study. The mean heterosis estimates among component traits were highest in case of ear diameter (25%) followed by ear height (23%), 100-seed weight (21%) whereas, it was lowest in case of harvest index (7%). Ear diameter, harvest index and 100-seed weight had the highest correlation with grain yield in terms of heterotic expression (0.588, 0.518 and 0.495, respectively).

Key words: Maize, heterosis, line x tester, correlation

INTRODUCTION

Heterosis is perhaps the greatest practical achievement of the science of plant breeding. Early plant breeders recognized the benefits of mating diverse individuals as increased luxuriance, superior expression of yield and yield contributing traits and wider adaptability (Gartner, 1849). East and Hays (1912) were first to advocate heterosis as an alternate crop improvement strategy. Although several economically important crops benefit from the manifestation of heterosis, maize has witnessed enormous exploitation of heterosis owing to its wide genetic variability and biological diversity. US corn yields collected over lat 130 years illustrate successful utilization of heterosis as an important component of breeding schemes aimed at enhancing grain yield. Since, 1960, great progress has been made in development and testing procedure of inbred lines for development of hybrids, which increased the yield advantage at a tremendous rate (Budak *et al*., 2002).

Heterosis is the property of quantitative traits, which are complex in inheritance. Grain yield is affected by a number of component traits and environment, which modifies the expression of such traits. In fact the greatest difficulty encountered in interpretation of heterosis arises out of the failure to recognize the importance of these component traits. Therefore, component analysis approaches have been used to quantify the effect of heterosis for component traits on grain yield (Sinha and Khanna, 1975; Ahmadzedah *et al*., 2004;Tollenaar *et al*., 2004;Lee *et al*.,2005). The objective of present study was to elucidate the effect of heterosis for various grain yield component traits on grain yield.

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MATERIALS AND METHODS

The material for present study was generated by crossing fifteen phenotypically diverse white maize inbred lines (both local and exotic) to three testers namely W3, W5 and W3×W5 in line x tester fashion, by controlled hand pollination at winter maize nursery, Amberpet, Hyderabad, India. The parental lines, testers and test crosses (63 entries in all) were evaluated in two diverse locations of Kashmir valley namely High Altitude Research Station, Larnoo and Regional Research Station, Wadura, representing diverse climatic regions, using randomized complete block design with three replications at each location. The parents are Fis were randomized separately. Each entry was represented by two rows of 2 m length with inter and intro-row spacing of 60 and 25 cm, respectively. Data was recorded on ten randomly selected competitive plants for eight quantitative traits including grain yield. The data was analysed as per the procedure of Singh and Chowdhary (1999) for analysis of variance and estimates of mid-parent heterosis using WINDOSTAT Software. Correlation coefficients were worked out following Aljibouri *et al*. (1958). However, in the present study, instead of mean performance values, heterotic effects were used as variables to quantify the effect of heterosis for component traits on grain yield, in order to identify the traits, which have significant heterotic effects.

RESULTS AND DISCUSSION

The analysis of variance for line x tester design pooled over locations revealed significant environmental variance for all traits except harvest index, genotype x environment interaction was significant for all traits except 100-seed weight, indicating greater influence of environment on the expression of these traits, as is expected of quantitative characters. The performance of lines, testers and hybrids was significantly different as evidenced by significant mean squares due to lines, testers, crosses and parents v/s crosses. Therefore, it can be inferred that the inbred lines possessed substantial variability for the traits studied and that all traits, had some degree of heterosis, as heterosis is the performance of crosses relative to that of parental lines (Table 1). Most of the traits also exhibited significant heterosis x environment interaction except for prolificacy index (data not shown), quite evidently due to the fact that when lines and crosses respond differently to the environments; heterosis will also vary significantly across environments (Tollenaar *et al*., 2004).

Grain yield recorded heterosis upto 78.83% (mean value of 41%) in the present study (Table 2). The mean heterosis estimates among component traits were highest in case of ear diameter (25%) followed by ear height (23%), 100-seed weight (21%) whereas, it was lowest in case of harvest index (7%). The inconsistency recorded in heterotic effects of indicated that there is greater discrepancy between them in parents and crosses and therefore, as opined by Tollenaar *et al*. (2004). Grain yield components and physiological processes underlying such components that limit grain yield are different for parental lines and hybrids.

Table 1: Analysis of variance for grain yield and its components traits in maize

Source of variance	df	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	100-seed weight (g)	Kernel rows/ear	Harvest index (%)	Grain yield/ plot (g)
Environments	1	64194.38**	2177.55**	251.66**	10.61**	535.80**	2.18**	6.243	62.28**
Progenies	62	1328.81**	920.83**	21.23**	0.80**	39.59**	3.77**	39.39**	1.70**
Lines	14	582.54**	273.08**	21.36**	0.45**	92.59**	0.99*	18.81*	0.92**
Testers	2	4044.38**	1775.00**	51.99**	2.01**	49.78*	1.40**	28.39**	2.63**
Crosses	44	418.60**	739.60**	17.53**	0.55**	125.79**	2.45**	29.86**	1.25**
Parents v/s crosses	1	4496.38**	1577.25**	402.79**	17.94**	1064.74**	110.14**	797.41**	43.10**
GxE interaction	62	650.24**	227.30**	4.34**	0.19	10.82	1.14*	16.27*	0.40**
Error	248	169.12	39.20	1.54	0.08	19.99	0.52	7.08	0.16

*, **: Significant at 5 and 1% level of significant, respectively

Table 2: Mean values of lines, crosses and estimates of better parent heterosis for eight quantitative traits in maize

Trait	Parental mean	Cross mean	Heterosis (%)	Range of heterosis (%)
Plant height (cm)	183.12	204.73	12	(-0.18)-(31.05)
Ear height (cm)	87.64	107.26	23	(-0.99)-(53.40)
Ear length (cm)	12.93	15.07	16	(-1.82)-(47.27)
Ear diameter	3.59	4.51	25	(-2.75)-(38.03)
100-seed weight (g)	24.47	29.62	21	(-0.62)-(37.33)
Kernel rows/ear	13.48	15.03	11	(-2.78)-(28.63)
Harvest index (%)	32.60	34.76	7	(1.12)-(19.43)
Grain yield/plot (g)	925.47	1560.36	41	(-18.59)-(78.83)

Table 3: Genotypic correlation between heterotic expression for grain yield and its components traits in maize

Trait	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	100-seed weight (g)	Kernel rows/ear	Harvest index (%)	Grain yield/ plot (g)
Plant height (cm)	1.00	0.813**	-0.164	0.259	0.315	0.271	0.337*	0.477**
Ear height (cm)		1.00	-0.006	0.207	0.269	0.229	0.312	0.425**
Ear length (cm)			1.00	-0.024	0.450**	-0.074	0.321*	0.058
Ear diameter (cm)				1.00	0.424**	0.452**	0.321*	0.588**
100-seed weight (g)					1.00	0.091	0.255	0.495**
Kernel rows/ear						1.00	0.364*	0.328*
Harvest index (%)							1.00	0.518**
Grain yield/plot								1.00

*, ** significant at 5 and 1% level of significance, respectively

In order to further validate the results, we correlated heterosis for grain yield with heterosis for component traits (Table 3), instead of mean performances. Perusal of the correlation table revealed that the variables such as ear diameter, harvest index and 100-seed weight had the highest correlation with grain yield in terms of heterotic expression (0.588, 0.518 and 0.495, respectively), followed by plant height, ear height and kernel rows/ear. Interestingly harvest index and plant height did not exhibit larger mean heterosis. Among the component traits highest correlation for heterotic expression was observed between plant height and ear height (0.813), followed by kernel rows/ear and ear diameter (0.452). Neto and Miranda (2001) also observed similar results in maize.

The correlation coefficients indicate the set of variables to be used as effective selection indices, for improvement of response variable (grain yield). In the present study, the traits such as ear diameter, harvest index, 100-seed weight for which correlation with grain yield was significantly high, in terms of heterotic effects. Vasik *et al*. (2001) also used different sets of selection indices with different component traits and found the index that included ear diameter, kernel rows/ear, ear height and ears/plant as the most efficient one and gave yield advantage of 179.6 kg/selection cycle as against the system, using only grain yield. Echarte and Tollenaar (2006) also reported kernel number as an effective selection criterion and showed that differences among parent and hybrids for this trait greatly affects heterotic expression for grain yield. However, this and other studies (Ahmedzedah *et al*., 2004; Lee *et al*., 2005) emphasized that most of the yield components even though efficient selection indices are static attributes while as heterosis is a dynamic process and therefore, it is better to analyze the heterotic expression in terms of physiological processes underlying such yield components such as dry matter accumulation, leaf area index and stay green which can help to dissect heterosis for grain yield into more specific components which could unravel the physiological basis of grain yield heterosis.

REFERENCES

Ahmedzedah, A., E. Lee and M. Tollenaar, 2004. Heterosis for leaf CO_2 exchange rate during grain filling in maize. Crop Sci., 44: 2095-2100.

Al-jibouri, H.A., A.R. Miller and H.F. Robinson, 1958. Genotypic and environmental variances and covariances in upland cotton crosses of interspecific origin. Agron. J., 50: 633-637.

Budak, H., L. Cesurer, Y. Bolek, T. Dokuyuku and A. Akkaya, 2002. Understanding of heterosis. J. Sci. Eng., 5: 68-75.

East, E.M. and H.K. Hays, 1912. Heterozygotes in evolution and in plant breeding. USDA Plant Ind. Bull., pp: 243-258.

Echarte, L. and M. Tollenaar, 2006. Kernel set in maize hybrid and their inbred lines exposed to stress. Crop Sci., 46: 870-878.

Gartner, C.F., 1849. Versuche Und Beobachtungen Uber Die. Bastarderzeungung in Pflanzenreich Stut Gard. C.F. Hybrid Cultivar Development. Banga, S.S. and S.K. Banga (Eds.), Narosa Publishers, pp: 799.

Lee, E., A. Ahmedzedah and M. Tollenaar, 2005. Quantitative genetic analysis of physiological processes underlying maize grain yield. Crop Sci., 45: 981-987.

Neto, A.L. and J.B. Miranda, 2001. Genetic correlation between traits in ESALQ-PBI maize population divergently selected for tassel size and ear height. Scientia Agricola, 58: 113-119.

Singh, R.K. and B.D. Choudary, 1999. Biometrical Techniques in Quantitative Genetic Analysis. Kalyani Publishers, Ludhiana.

Sinha, S. and R. Khanna, 1975. Physiological, genetic and biochemical basis of heterosis. Adv. Agron., 27: 123-174.

Tollenaar, M., A. Ahmedzedah and E. Lee, 2004. Physiological basis of heterosis for grain yield. Crop Sci., 44: 2086-2094.

Vasik, N., M. Ivanovic, D. Jockovic, M. Stojakovk and J. Bocanski, 2001. Genetic relationship between grain yield and yield components in a synthetic maize population and their implication in selection. Acta Agron. Hung., 49: 337-342.