Indian J. Genet., **52** (2): 126–131 (1992)

EVALUATION OF MAIZE INBRED LINES DERIVED FROM TWO HETEROTIC POPULATIONS

P. B. JHA* AND A. S. KHEHRA

Department of Plant Breeding, Punjab Agricultural University, Ludhiana 141 004

(Received: 24 August 1985; accepted: September 17, 1991)

ABSTRACT

Factorial mating analysis of eighty crosses of maize (*Zea mays* L.), produced by crossing five females with sixteen pollen parents, was conducted over two locations for combining ability. Mean squares due to environments (E), females (F), males (M), F x M, F x E, M x E, and F x M x E were significant for grain yield and most of the quantitative traits studied. Specific combining ability (sca) and sca x E components were of higher magnitude than general combining ability (gca) and gca x E components for grain yield, indicating greater contribution of nonadditive gene action and its pronounced interaction with the environments. Sixteen crosses significantly outyielded the best hybrid check. Some of the high yielding hybrids were short, with high harvest index and at par with the best check for silking and maturity. These studies provided possibility to obtain better hybrids which may be used in breeding programme.

Key words: *Zea mays* L., maize, combining ability, harvest index.

One of the consistent conclusions that has emerged from the well documented maize breeding programmes, is the importance of genetic diversity among the source populations from which inbred lines are derived. Earlier studies [1–3] emphasized the need for using germplasms from diverse origin. The present investigation was undertaken to study combining ability for grain yield and other quantitative traits of inbred lines derived from diverse populations.

MATERIALS AND METHODS

Makki Safed Disease Resistant (MS1DR) is an improved local variety from Punjab and gives high heterosis with Tuxpeno PBL. Tuxpeno PBL (Tu x PBL) is an adapted version of Tuxpeno Planta Baja C7, an introduction from CIMMYT, Mexico. Sixteen S3 lines of Tu x

*Present Address: Dept. of Plant Breeding, Rajendra Agricultural University, Pusa 848125.

PBL, designated as L1 to L16, emerged from the first cycle of reciprocal recurrent selection, were crossed on to five testers following factorial mating to produce eighty crosses. The pedigrees of five testers were PKMS1-49-2-2 (T1), MS1DR-120-2-1-1 (T2), MS1DR-60-4-2-1-1 (T3), MS1DR (T4) and Eto PL-13-1-#-#-1-# (T5), respectively. Eighty crosses and five hybrids as check were grown during Kharif, 1981 at two locations, namely, Ludhiana and Gurdaspur Farms of the Punjab Agricultural University, Ludhiana, in randomized block design with three replications. Each entry in a replication was provided two-row plot of 5 m length. Inter row and inter plant distances were kept at 75 cm and 22.5 cm, respectively. Observations were recorded on ten random competitive plants for ten quantitative traits. For grain yield, days to silk and days to brown husk, data were collected on plot basis. The pooled analysis of variance over environments for combining ability was performed as described by Dhillon and Pollmer [4].

RESULTS AND DISCUSSION

Pooled analysis of variance showed highly significant differences due to environments, genotypes and genotype x environment interactions for all the characters studied. The mean squares due to females, males and females x males were found to be significant for all the characters except due to females for ear girth and shelling percentage. Females x environments and males x environments were also significant for all the characters except the interaction for 1000-kernel weight. The females x males x environments mean squares were significant for grain yield, ear length, ear girth, 1000-kernel weight, kernel rows per ear, number of leaves per plant, ear leaf area, plant height and ear height.

For grain yield, variances due to sca and sca x environment were higher than gca and gca x environment (Table 1). This indicated that nonadditive genetic variance and its interaction with the environment were more important for grain yield. Most of the parental lines in the study had been selected on the basis of their top cross performance. Previous studies have shown that nonadditive gene action was more important than additive gene action in relatively selected material [5–7]. Several workers have reported greater importance of sca variance than gca for grain yield in maize [8–11]. In this study sca variance was maximum for ear girth, kernel rows per ear, shelling percentage and ear leaf area. For ear length, plant height, ear height, days to silk and days to brown husk, the estimate of gca variance was higher. However, gca and sca were recorded to be equally important for harvest index. The sca x environments was higher than other components in case of 1000-kernel weight and number of leaves per plant.

The gca effects for grain yield ranged from –0.174 to 0.058 among females and from –0.465 to 0.490 among male parents. Among female parents T1, T3 and T4 were good general combiners for grain yield. T5 showed significant negative gca effect and, therefore, was a poor combiner. The parent T2 was an average combiner. Among male parents, line L 16 was the best general combiner for grain yield and it was significantly superior to other good

Table 1. Estimates of variances due to general combining ability (σ^2g), specific combining ability (σ^2s), and their interactions with environments in maize

Character	Variance components			
	σ^2g	σ^2s	σ^2gl	σ^2sl
Grain yield (kg/plot)	0.03	0.06	0.02	0.06
Ear length (cm)	0.71	0.45	0.16	0.28
Ear girth (cm)	0.03	0.19	0.03	0.12
1000-kernel weight (g)	41.10	165.30	20.40	276.30
Kernel rows/ear	0.09	0.20	0.04	0.15
Shelling %	0.14	1.03	0.55	NS
Harvest index	0.80	0.80	0.50	NS
No. of leaves/plant	0.04	0.06	0.08	0.09
Ear leaf area (cm^2)	185.50	789.60	58.80	720.70
Plant height (cm)	79.05	50.31	5.84	23.71
Ear height (cm)	28.09	19.16	2.88	10.52
Days to silk	1.33	1.21	0.17	NS
Days to brown husk	0.66	0.38	0.42	NS

NS—nonsignificant mean squares.

combiners, namely, L2, L3, L10, L11 and L12. The lines L1, L5, L6 and L7 were average combiners whereas, L4, L8, L9, L13, L14 and L15 were poor combiners. The gca effect for yield components indicated that the lines superior for grain yield were also superior for one or more components.

Desired plant type may be having short plant height, low ear placement, early maturity and high harvest index. Among female parents showing good gca for grain yield, T3 was found to be superior combiner for plant type as it had good gca estimates for lower ear placement, high harvest index and early maturity. Among the males, L3 and L11 showed comparatively better gca for short plant height. The line L16 was poor combiner for low plant and ear height but was good combiner for harvest index. L10 was also good combiner for harvest index and average for ear height. Lines of the same population which were superior for most of the traits but were deficient in one or few traits may be crossed together, and second cycle inbred may be developed to combine desirable traits into one inbred.

Sixteen hybrids significantly outyielded the best check Sangam (Table 2). The best cross, T1 x L16 showed 28 per cent superiority over Sangam and 44% over Ganga 2. This single cross was superior to Sangam for yield components and had better shelling percentage and harvest index in spite of being late and more leafy. It had positively significant sca effect for grain yield, ear length, ear girth, 1000-kernel weight, number of leaves per plant, ear leaf area, plant and ear height. Two single crosses, namely, T2 x L16 and T3 x L11, besides having

Table 2. Mean performance ($\bar{X}$) and specific combining ability (sca) effect of five top performing crosses and checks of maize

Character	Crosses										Checks			
	T1 x L16		T2 x L 16		T3 x L11		T3 x L 16		T4 x L12		San-gam	Ganga 2	CD at 5% for	
	$\bar{X}$	sca	$\bar{X}$	sca	$\bar{X}$	sca	$\bar{X}$	sca	$\bar{X}$	sca	$\bar{X}$	$\bar{X}$	$\bar{X}$	sca
Grain yield (kg/ha)	7489	533.33**	7227	333.3*	7193	66.7	7149	244.4	7038	333.3*	5851	5182	497	422.2
Ear length (cm)	16.6	1.15**	16.1	–0.18	17.5	0.47**	18.8	1.42**	16.0	0.53*	15.2	14.9	0.7	0.60
Ear girth (cm)	14.7	0.64**	14.3	0.23	14.1	0.27	13.8	–0.12	13.4	–0.03	13.2	12.5	0.5	0.47
1000-kernel weight (g)	274.5	25.18**	258.0	12.77	284.7	13.82	254.3	4.12	230.8	–6.95	241.3	226.5	21.6	23.66
Kernel rows/ear	12.6	0.18	12.0	–0.50*	11.4	0.52*	12.0	0.09	13.2	0.20	12.6	12.5	0.7	0.59
Shelling %	82.3	1.18	80.3	–0.17	81.7	–0.81	80.2	–1.17	82.5	0.46	81.2	83.2	2.6	2.26
Harvest index	44.7	2.30**	43.0	–0.11	44.0	0.10	40.7	–2.60	41.0	–1.0	42.0	39.5	2.5	2.2
No. of leaves/plant	14.5	0.76**	13.1	–0.34*	13.0	0.19	13.7	0.05	13.8	–0.08	13.8	13.3	0.5	0.45
Ear leaf area (cm^2)	537.5	47.75**	487.5	–2.81	447.2	24.11*	475.5	–8.79	564.5	32.19**	482.5	494.8	29.9	26.30
Plant height (cm)	213.4	12.80**	187.2	–6.20*	194.9	3.55	212.7	4.02	205.9	2.65	199.8	185.2	8.5	7.41
Ear height (cm)	114.1	11.19**	86.6	–9.50**	95.9	4.05*	105.4	4.88*	109.6	1.75	106.5	99.4	6.1	5.25
Days to silk	54.7	0.02	54.3	–0.80*	55.5	–1.17**	55.7	0.83*	56.3	0.19	55.7	54.8	1.4	1.08
Days to brown husk	86.7	–0.44	86.2	–0.84	86.8	0.02	88.0	1.38*	85.5	–0.59	86.3	86.5	1.7	1.40

*,**Significant at 5% and 1% levels, respectively.

significant superiority in grain yield over Sangam, were also better for most of the yield components. These two single crosses were shorter in plant height and ear length and, therefore, combined most of the desirable traits. Other two cross combinations, namely T3 x L16 and T4 x L12 also had yield superiority over Sangam and were similar to it in other traits like plant height and ear length and harvest index. These hybrids involved parents having good gca effect except T2 which was average combiner. The results revealed that crosses involving good gca lines had good sca effect. Parental lines of these crosses were derived from heterotic populations which were distinctly diverse from each other. The effects of genetic diversity of parental inbred lines on hybrid performance have been shown by several workers [1, 2]. Lower harvest index in tropical and sub-tropical germplasm including that from India is to be an important cause of low yield [12–14]. However, there is sufficient variability in tropical and subtropical materials as evident in present study. The harvest index of many hybrids was more than that of Sangam and Ganga 2. The performance of crosses under study and presence of variability for this trait indicated possibility of improving the grain yield and harvest index simultaneously.

Present study showed possibility of identifying new hybrids with superiority for yield as well as plant type over presently available commercial hybrids. Experimental data can be used to predict the performance of double-cross or double-top-cross hybrids so as to identify superior combinations [15].

REFERENCES

1. N. L. Dhawan and J. Singh. 1961. Flint x dent maize hybrids give increased yield. Curr. Sci., **30** : 233–234.

2. B. S. Ahloowalia and N. L. Dhawan. 1963. Effect of genetic diversity on combining ability of inbred lines of maize. Indian J. Genet., **23** : 158–162.

3. B. S. Dhillon and J. Singh. 1975. Study of combining ability and heterosis in intervarietal diallel of maize. Theor. Appl. Genet., **47** : 117–122.

4. B. S. Dhillon and W. G. Pollmer. 1978. Combining ability analysis of an experiment conducted in two contrasting environments. EDV in Medizin and Biologie, **9** : 109–111.

5. G. F. Sprague and L. A. Tatum. 1942. General vs specific combining ability in single crosses of corn. J. Am. Soc. Agron., **34** : 923–932.

6. B. Griffing and E. W. Lindstorm. 1954. A study of the combining abilities of corn inbreds having varying populations of corn belt and non-corn belt germplasm. Agron. J., **46** : 545–552.

7. L. L. Darrah and A. R. Hallauer. 1972. Genetic effects estimated from generation mean in four diallel sets of maize inbreds. Crop Sci., **12** : 615–621.

8. B. A. Rojas and G. F. Sprague. 1952. A comparison of variance component in corn yield trials. III. General and specific combining ability and their interaction with locations and years. Agron. J., **44**: 462–466.

9. D. F. Matzinger, G. F. Sprague and C. C. Cockerham. 1959. Diallel crosses of maize in experiments repeated over locations and years. Agron. J., **51** : 346–350.

10. L. A. Hanson, J. R. Bagget and K. E. Rowe. 1977. Quantitative genetic analysis of ten characters in sweet corn. J. Am. Soc. Hort., **102**: 158–162.

11. A. Ramamurthy, N. B. Kajjari and J. V. Goud. 1981. Diallel analysis of yield and maturity components in maize. Indian J. Genet., **41**: 30–31.

12. P. R. Goldsworthy and M. Colegrove. 1974. Growth and yield of highland maize in Mexico. J. Agric. Sci. Camb., **83** : 213–221.

13. H. K. Jain, B. K. Mukherjee, R. D. Singh and K. N. Agrawal. 1976. The present status and future possibilities of breeding for yield in maize. Z. Pflanzenzuchtg., **76**: 90–101.

14. B. K. Mukherjee, R. D. Singh and V. P. Ahuja. 1980. Role of Yugoslav germplasm in the improvement of relative partitioning of dry matter production in tropical maize cultivars. Z. Pflanzenzuchtg, **84** : 49–56.

15. P. B. Jha and A. S. Khehra. 1988. Multi-environment testing for the prediction of hybrid performance in maize. Indian J. Genet., **48**: 121–124.