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COMBINING ABILITY FOR YIELD, PHENOLOGICAL AND EAR CHARACTERS IN WHITE SEEDED MAIZE

R. K. MATHUR*, CHUNILAL, S. K. BHATNAGAR AND V. SINGH

Department of Genetics and Plant Breeding, Rajasthan Agricultural University Campus, Udaipur 313 001

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ABSTRACT

Seventy eight single cross hybrids involving thirteen diverse inbred lines and three checks of maize (*Zea mays* L.) were evaluated in a simple lattice design (9 × 9 structure) with two replications in two environments viz, normal and stress. Combining ability analysis revealed significant GCA variance for days to silking, ear length, ear girth, number of rows/ear, number of kernels/row, shelling percent and grain yield/plant in both the environments and SCA variance for ear length and shelling percent in normal and grain yield/plant in stress environment. Preponderance of additive gene effects was observed in the expression of all the characters studied. Inbreds P1, P2, P3 and P4 identified as good general combiners for early silking in the present study can be used as the potential components for improving/developing heterotic pool/population aimed at earliness. Under high plant density and rainfed conditions the inbreds P5, P6, P8, P12 and P13 can be used to develop high yielding white-seeded maize hybrids. Hybrid P1 × P5 is suggested for further extensive testing at different locations under irrigated and rainfed conditions for critical evaluation of its yield potential.

Key words: Combining ability, white-seeded maize, grain yield.

Maize (Zea mays L.) is mainly grown under rainfed conditions during kharif season in Rajasthan. Its production and productivity in India viz, 10.2 million tonnes and 1694 Kg/ha, respectively [1], are very low. Cultivation of white seeded maize hybrids could not be popularized in Rajasthan because of their longer growth period. The development of high yielding single cross hybrids of maize depends on the *per se* performance of inbred lines and their combining ability for important ear characters. Keeping this in view the present investigation was undertaken.

MATERIALS AND METHODS

Thirteen inbred lines, derived from divergent heterotic pools/populations (Table 1) were intermated in nonreciprocal diallel cross faishon in *rabi*, 1990-91. The resultant

*Present address: National Research Centre for Groundnut, Post Box 5, Junagadh 362001

Table 1. Pedigrees of the parental maize inbreds lines

Pedigree	Inbred	Origin
P15 C14 MH-326-1-2	P1	CIMMYT, Mexico
X2Q 3661-1-1-1-1-2	P2	Udaipur, Rajasthan
X2W 3523-6-3-1-2-1	P3	Udaipur, Rajasthan
X2W 3122-3-4-1-1-1-3	P4	Udaipur, Rajasthan
X2W 3527-2-3-1-1-4	P5	Udaipur, Rajasthan
X2W 3232-1-1-1-1-3	P6	Udaipur, Rajasthan
X1W 17-3-3-1-1-2	P7	Udaipur, Rajasthan
X1W 1020-2-1-1-2	P8	Udaipur, Rajasthan
X1W 372-1-1-2-1-	P9	Udaipur, Rajasthan
Pop 49-54-2	P10	CIMMYT, Mexico
Pop 30-161-2	P11	CIMMYT, Mexico
P 31-C15-MH 436-2-1-5-#b-#b-#-#-#-#	P12	CIMMYT, Mexico
Pob 44-C4-HC-101-3-1-2-bx-#-#-b-#-b-#-#-#	P13	CIMMYT, Mexico

78 single crosses and three check varieties were evaluated in simple lattice design (9 × 9 structure) with two replications during *kharif,* 1991 in two environments namely, normal (irrigated, heavy soil with normal plant population of 66,666 plants/hectare) and stress (rainfed with one life saving irrigation, light soil with high plant population of 99,800 plants/hectare). In both the environments, row spacing was 60 cm and plot size one row of 5m length. Data were recorded on ten random plants for five quantitative traits (Table 2). Analysis of variance for simple lattice design was done [2]. The general combining ability (gca) and specific combining ability (sca) effects were estimated following Griffing's method-4, model-I [3].

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among the genotypes for all the characters studied (Table 2). Genotypic means for number of rows/ear and days to 50% silking in normal and grain yield/plant in stress environment were adjusted as per the standard technique of simple lattice design. Further, combining ability analysis for these traits was done with the adjusted means. Partitioning of genotypic SS into hybrids, checks and hybrids vs checks revealed significant differences among the hybrids for all the characters studied. Partitioning of SS due to hybrids into GCA (general combining ability) and SCA (specific combining ability) components revealed significant GCA for all the characters studied in both the environments, indicating the role of additive gene action in the manifestation of these characters. Non-additive gene action was also responsible for the genetic control of ear length and shelling per cent in the normal and grain yield/plant in the stress environment. Further, the GCA/SCA ratio indicated predominance of additive gene action in the expression of these traits. Improvement in these characters is possible by simple breeding procedures involving selection based on progeny performance. These findings are in conformity with earlier reports [4-7].

Table 2. Analysis of variance showing ms values for grain yield, phenological & component characters in maize

Character	Environment	Hybrids (77)	GCA (12)	SCA (65)	Interblock error (64)	Error (RBD) (80)
Days to 50%	normal	19.3**	64.7**	11.0	7.4	8.0
silking	stress	13.7**	55.8**	5.9	4.4	4.2
Number of	normal	2.0*	3.6**	1.7	1.2	1.3
rows/ear	stress	1.2*	2.2**	1.1	0.8	0.8
Number of	normal	21.4*	28.6*	20.1	14.8	13.9
krnels/row	stress	8.6*	18.5**	6.8	6.0	5.9
Ear length	normal	2.7**	4.6**	2.3*	1.6	1.5
	stress	1.4*	2.3**	1.3	0.9	0.9
Ear girth	normal	1.0**	1.9**	0.8	0.6	0.6
	stress	0.8**	1.9**	0.6	0.5	0.5
Shelling	normal	38.4*	63.6**	33.7*	23.7	22.7
percent	stress	72.6**	99.0**	67.7**	39.7	35.0
Grain	normal	368.9*	614.3**	322.1	243.9	228.3
yield/plant	stress	163.3**	309.7**	136.3**	77.6	82.0

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

Figures in parentheses indicate the corresponding degrees of freedom

No single inbred possessing high gca effects for all the characters studied was identified (Table 3). Inbreds P1, P2, P3 and P4 were identified as good general combiners for earliness; P12 and P13 for number of kernels/row; and P8 for number of rows/ear in both the environments. Inbreds identified as good general combiners in normal environment were P3 for ear length and ear girth; P11 for number of kernels/row and ear girth; and P2 for grain yield/plant. In the stress environment, P5, P6, P8 P12 and P13 for grain yield/plant; P9 for ear girth and shelling percent;

Table 3. **The estimates of gca effects in inbreds for grain yield and its components in normal and stress environments in maize**

Inbred parents	Days to 50% silking		Number of rows/ear		Number of kernels/row		Ear length		Ear girth		Shelling %		Grain yield/plant	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S
P1	−1.5**	−2.2**	−0.3	−0.2	−2.2**	−1.0*	−0.0	−0.6*	−0.2	−0.5**	−1.2	−1.6	−11.0**	−5.9**
P2	−2.3**	−1.8**	−0.5*	−0.2	0.2	−1.6*	0.2	−0.5*	−0.6**	−0.5**	−0.5**	−0.7	−2.1	6.1*
P3	−2.2**	−1.9**	0.2	−0.4*	−0.1	−1.3**	0.1	−0.1	−0.0	−0.5**	1.7	−5.5**	2.1	−3.6*
P4	−1.7**	−1.7**	−0.1	0.1	0.4	−0.1	0.4	0.5*	0.2	0.3*	0.5	0.2	3.4	−0.6
P5	0.7	0.6	−0.2	−0.7**	−0.8	−0.2	−0.1	0.1	−0.2	−0.1	−0.6	1.2	1.9	3.5*
P6	0.0	−0.5	−0.7**	−0.2	−0.7	0.2	0.4	−0.1	−0.1	0.1	−1.2	1.1	−8.4**	3.7*
P7	−0.4	−0.1	−0.3	0.1	−0.3	1.0*	0.0	−0.2	−0.1	−0.0	4.5**	1.4	0.7	−0.2
P8	0.4	1.3**	0.5*	0.6*	−1.0	0.1	−0.8**	0.2	−0.2	0.4**	0.7	0.3	−1.3	4.4*
P9	0.3	2.3**	0.8**	0.2	0.3	0.3	0.4	0.3	−0.0	0.3*	−1.2	2.9*	4.0	1.8
P10	3.2**	2.5**	0.3	0.3	−0.8	−0.0	−0.9**	−0.3	0.1	0.0	−2.0*	0.5	−4.3	−1.9
P11	0.4	0.4	0.0	−0.1	1.6*	−0.1	−0.2	0.2	0.5**	0.2	−0.0	0.4	3.2	−1.8
P12	1.4*	1.4**	0.0	0.2	1.8*	1.3**	−0.1	0.4*	0.3*	0.0	−1.3	1.8	−2.0	3.5*
P13	−0.4	−0.3	0.2	0.1	1.5*	1.3*	0.5*	0.2	0.4*	0.2	0.8	−0.6	5.7	3.5*
S.E. (gi) ±	0.6	0.4	0.2	0.2	0.8	0.5	0.3	0.2	0.2	0.2	1.0	1.5	3.1	1.8

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

Table 4. The estimates of desirable sca effects in hybrids for major yield traits in the normal and stress environments in maize

Characters	Normal	Stress
Days to 50% silking	P1 × P11 (–4.10)	P1 × P10 (–3.62)
	P3 × P5 (–3.57)	P1 × P11 (–2.61)
	P9 × P10 (–3.43)	P2 × P6 (–2.61)
		P9 × P10 (–3.12)
Number of rows/ear	P4 × P9 (1.80)	P3 × P6(1.80)
	P11 × P12 (1.69)	P4 × P9 (1.60)
	P5 × P6 (1.55)	P8 × P13 (1.60)
	P2 × P3 (1.40)	P10 × P 13 (1.20)
Number of kernels/row	P1 × P11 (6.05)	P2 × P5 (4.19)
	P4 × P9 (5.86)	P2 × P4 (3.06)
	P3 × P7 (5.32)	
	P11 × P13 (5.23)	
	P3 × P12 (4.70)	
Ear length	P2 × P 3 (2.29)	P2 × P3 (2.30)
	P1 × P5 (1.82)	P7 × P13 (1.24)
	P5 × P7 (1.78)	P2 × P4 (1.23)
	P4 × P6 (1.55)	P4 × P9 (1.23)
	P7 × P10 (1.55)	
Ear girth	P4 × P6 (1.42)	P5 × P11 (1.55)
	P2 × P3 (1.20)	P8 × P13 (1.02)
	P10 × P11 (1.02)	P3 × P5 (0.94)
	P11 × P12 (0.94)	
Shelling/per cent	P4 × P9 (8.38)	P2 × P4 (0.93)
	P1 × P2 (7.54)	P3 × P4 (8.63)
	P8 × P10 (6.03)	P6 × P11 (8.26)
Grain yield/plant	P6 × P8 (25.12)	P1 × P5 (23.46)
	P1 × P5 (21.76)	P9 × P12 (18.02)
		P3 × P12 (15.92)
		P5 × P11 (15.32)
		P7 × P10 (11.30)

and P13 for number of kernels/row were found to be good general combiners. Interestingly, P2 a good general combiner for grain yield in the normal environment, showed poor general combining ability for this character in the stress, however, P6 showed reverse trend. Thus, gca effects of inbred lines are greatly influenced by the environment and their inclusion in any breeding programme should be based on the their performance in that particular environment.

Like gca effects, no single hybrid was found with considerable sca effects for all the characters studied (Table 4). The hybrids showing consistent positive and significant sca effects over environments were $P_1 \times P_5$ for grain yield/plant, P2 $\times$ P_3 for ear length and $P_4 \times P_9$ for number of rows/ear. Significant and negative sca effects were observed in hybrids $P_1 \times P_{11}$ and $P_9 \times P_{10}$ for days to silking. In general, it was observed that the estimates of sca effects varied with environments for all the characters. Such discrepancies may be due to the polygenic inheritance pattern of these characters subjected to the environmental fluctuations. Hence, it is suggested that actual realization of the heterotic potential of the crosses should be done in a particular environment. It was observed from the present study that one of the parent in almost all the hybrids was either intermediate or good general combiner.

In nut shell, inbreds namely P_1, P_2, P_3 and P_4 identified as good general combiners for early silking in the present study can be used as the potential components for improving/developing heterotic pool/population aimed at earliness. The inbreds namely P_5, P_6, P_8, P_{12} and P_{13} can be used to develop high yielding white seeded maize hybrids for rainfed conditions. Hybrid $P_1 \times P_5$ is suggested for extensive testing at different locations under irrigated and rainfed conditions for critical evaluation of its yield potential. Hybrids $P_3 \times P_{12}$, $P_5 \times P_{11}$, $P_7 \times P_{10}$ and $P_9 \times P_{12}$ are also suggested for testing under high plant density and rainfed conditions.

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