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EVALUATION OF SOME PROMISING MAIZE CROSSES FOR THEIR GENETIC BEHAVIOR IN SOME IMPORTANT TRAITS

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ABSTRACT

The nature of gene action for yield and its components was studied in four populations of white maize (*Zea mays* L.). Six populations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of four promising crosses among five inbred lines for each cross were evaluated for silking date, plant height, ear height , number of kernels/row, number of rows/ear, ear length, ear diameter and grain yield/plant through two successive seasons. These crosses were Sd-7 x Sd-34, Sd-7 x L-7041, Gz-628 x L-8084 and L-7041 x L-8084. The results obtained revealed the presence of highly significant differences among crosses as well as populations within each cross with respect to all the studied traits. Furthermore, crosses and populations within crosses interacted significantly with years for all the studied traits. This finding detected that these crosses and their populations gave different performances in different years for the studied traits. In addition, the results showed that the non-additive genetic variance including dominance play the major role in the genetic expression of these traits. Also, the results indicated that most of the studied traits were significantly influenced by one or more types of epistatic gene effect, which included additive x additive (aa), dominance x dominance (dd) and additive x dominance (ad) gene effects as appeared in the four crosses for yield and other traits, indicating the role of non-allelic interaction in the genetic expression of studied traits. From the previous results, it could be concluded that the production of hybrids is the best breeding program for the improvement of maize with respect to the studied traits.

INTRODUCTION

Information about the relative importance of additive and non-additive gene action would help in selecting suitable breeding program. Selection program leads to maximum progress in improving a trait when the additive gene action is the main component. Heterosis effects in F_1 hybrids may exploited by choosing parental lines in which the non-additive (dominance and epistasis) effects are more important in the inheritance of the characters. Also, where both additive and non-additive gene action are important, it is advisable to adapt recurrent selection for handling such population. In this respect, Reddy and Agrawal (1992), Ochieng and Compton (1994), Abd El-Maksoud (1997), Amer *et al.* (1997), Galal *et al.* (2002) and Amer *et al.* (2003) reported that non-additive genetic variance plays the major role in the inheritance of most studied traits. While, Choukan (1999) and El-Shouny *et al.* (2003), reported that both additive and non-additive genetic variances involved in the inheritance of silking date, plant height, ear height, ear length, no. of kernels/row and grain yield per plant. On the other hand, Daune and Hallauer (1997) indicated that the epistatic gene effects (additive x additive, dominance x dominance and additive x dominance) gene effects contributed in the genetic expression of plant height, ear height, silking date, no. of kernels/row, ear length and ear diameter. Thus, this study was conducted to obtain further information related to the nature of gene action for yield and some other traits in maize.

MATERIALS AND METHODS

The genetic materials used in this investigation included five genetically divergent inbred lines namely Sids-7, Sids-34, Giza-628, inbred line-7041/6-6 and Inbred line-8084. These inbred lines were provided by Maize Research Section, Sakha Agric. Res. Station. During the season of 1998, these lines were sown and all possible combination excluded reciprocal were made by hand crossing among them to obtain ten F_1 hybrids. During the season of 1999, the parental lines and their F_1 hybrids were split sown at the Farm of Sakha Agricultural Research Station for preliminary evaluation. Four crosses were chosen according to their behavior in some vegetative and earliness traits. These chosen crosses were as follows:

Sd-7 x Sd-34, Sd7 x L-7041, Gz-628 x L-8084 and L-7041x L-8084.

During the summer season of 2000, seeds of these crosses and their parental lines were split sown. At the flowering time, each F_1 plants were back crossed to their respective parents to produce the first (BC_1) and the second (BC_2) backcrosses. In the same time, the crosses between these lines were done again in the same manner to produce more F_1 seeds. Also, the F_1 plants and their parental lines were self pollinated to produce F_2 generation seeds and increasing seeds from each line.

During 2001 and 2002 summer seasons, the obtained seeds of six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) for four crosses were evaluated using a split plot design with four replications. Each block/replicate consisted of four main plots which included the four crosses. Each main plot divided into six sub-plots, which included six generations of each cross. The sub-plot size was three rows for each parental line as well as each F_1 hybrids, four rows for each backcross and six rows for each F_2 generation. All rows were six m. long, 80 cm apart with spacing 25 cm between hills to obtain population density of 21.000 plants per feddan. All cultural practices were applied as recommended for maize cultivation. Data were recorded on guarded individual plants for following traits: silking date (days), plant height (cm), ear height (cm), no. of kernels/row, no. of rows/ear, ear length (cm), ear diameter (cm) and grain yield/plant (gram).

Analysis of variance according to split plot design for the studied traits was made to detect the significance of the observed difference among and within crosses (Singh and Narayanan, 2000). The scaling test which includes the three parameters (A, B and C) were determined according to the formulae outlined by (Mather and Jinks, 1982) for testing deviations of segregation from the additive and dominance model of gene effects. Then, the standard errors of A, B and C was worked out by taking the square root of corresponding variances and "t" values were calculated by dividing the effects of A, B and C by their respective standard error. The calculated "t" values of these three tests were compared against tabulated values of "t" at 5% and 1% levels of significance. The significance of any one of these scales is taken to indicate the presence of non-allelic interaction. Therefore, the six parameters model is used to estimate various types of gene effects. While, if the t - test is insignificant differed from zero, the additive-dominance gene effect is adequate to interpret the nature of gene action. Six parameter models are m, a, d, aa, ad and dd, these stand for mean effects, additive, dominance, additive x additive, additive x dominance and dominance x dominance gene effects, respectively. These genetic components, variance, standard error and calculated "t" values were estimated according to Gamble (1962). In the absence of non-allelic interaction, the additive-dominance model is adequate. Thus, m, a and d were estimated according to Jinks and Jones (1958). Significance of the genetic effects is tested in a similar manner as done in case of scaling test.

RESULTS AND DISCUSSION

The results of the analysis of variance and the mean squares of yield and other traits of crosses and their populations in 2001, 2002 and their combined data are presented in Table 1. The obtained results indicated the presence of highly significant differences among crosses for all the studied traits in the two years and their combined. Also, the results revealed that the populations within each cross exhibited highly significant differences for the studied four crosses. This significant variation suggested the existence of some sort of genetic variabilities between the used parental lines which might reflect their difference in the genetic background. Therefore, the comparisons between genotypic means are valid and the partition of this genotypic variance to its components could be made. On the other hand, the crosses and populations within crosses interacted significantly with years for all the studied traits. Also, populations within each cross interacted significantly with years in the cases of 2nd, 3rd and 4th crosses for silking date; 3rd and 4th crosses for plant height and ear height; four crosses for no. of kernels/row and ear length; 2nd, and 4th crosses for no. of rows/ear; 3rd cross for ear diameter and 1st, 3rd and 4th crosses for grain yield/plant. These results refered that these crosses and their populations behaved differently in different environmental conditions. Numerous authers reported that the genotypes and their partitions (lines and crosses) differed in their performance from one year or location to another, among them, Jay and Hallauer (1997) for grain yield; and Amer (2002) for silking date, plant height, ear height and grain yield; Galal *et al.* (2002) for silking date, plant height and ear height and Amer *et al.* (2003) and Mosa (2003) for grain yield, no. of kernels/row, no. of rows/ear and ear diameter.

Table 1: Analysis of variance and mean squares for all studied characters of crosses and their populations in 2001, 2002 and their combined data

S.O.V	d.f	Silking date			Plant height			Ear height			No. of kernels/row		
		2001	2002	Comb.	2001	2002	Comb.	2001	2002	Comb.	2001	2002	Comb.
Years (Y)	1			24.99**			13614**			49488.5**			473.1**
R/Y	6	8.76**	8.92**	8.84**	1476**	310.3**	893.1**	623.05**	343.86**	483.46**	13.01*	8.87	10.94**
Crosses (C)	3	3.18**	9.42**	7.98**	17330**	12371**	29242**	4693.26**	4953.94**	9524.61**	235.87**	373.01**	570.8**
C x Y	3			4.63**			460.1**			122.60			38.03**
R. W. Y (Ea)	18	0.38	1.34	0.86	47.7	41.08	44.39	16.41	27.29	21.85	2.49	2.76	2.63
Pop. W.C.	20	17.30**	32.02**	45.20**	6126**	7940**	13917**	2507.62**	3370.81**	2757.29**	141.49**	185.89**	312.4**
Pop. W. C1	5	22.96**	19.49**	41.07	4767**	5986**	10687**	2057.37**	2727.14**	4720.28**	128.03**	156.38**	274.6**
Pop. W. C2	5	20.33**	32.53**	49.76**	10278**	1189**	22107**	4160.23**	4402.57**	8545.54**	194.16**	272.04**	450.3**
Pop. W. C3	5	19.30**	39.82**	55.69**	3378**	5690**	8777**	1161.91**	2534.81**	3393.94**	148.29**	81.32**	221.1**
Pop. W. C4	5	6.90**	36.25**	34.28**	6083**	8193**	14097**	2650.98**	3818.74**	6389.40**	95.48**	233.84**	303.5**
Pop. W. C x Y	20			4.12**			149.4**			121.14**			14.96**
Pop. W. C1 x Y	5			1.39			66.3			64.22			9.80*
Pop. W. C2 x Y	5			2.81**			61.1			17.26			15.85**
Pop. W. C3 x Y	5			3.43**			291.2**			302.77**			8.47**
Pop. W. C4 x Y	5			8.86**			179.1*			100.32*			25.74**
R. W Pop x C. (Eb)	120	0.43	2.07	1.25	35.5	68.29	51.9	19.65	56.43	38.04	2.72	4.24	3.48
R. W. Pop. X C1	30	0.52	1.40	0.96	19.3	79.86	49.5	10.66	74.96	42.81	3.39	4.93	4.16
R. W. Pop. X C2	30	0.56	2.72	1.64	25.3	103.4	64.3	19.02	65.87	42.45	2.09	6.86	4.48
R. W. Pop. X C3	30	0.16	2.77	1.46	34.9	44.07	39.4	19.52	52.47	35.99	2.46	3.31	2.89
R. W. Pop. X C4	30	0.48	1.40	0.94	62.6	45.8	54.2	29.41	32.44	30.92	2.96	1.87	2.41

Table 1: Continued

S.O.V	d.f	No. of rows/ear			Ear length (cm)			Ear diameter (cm)			Grain yield/plant (gram)		
		2001	2002	Comb.	2001	2002	Comb.	2001	2002	Comb.	2001	2002	Comb.
Years (Y)	1			15.45**			296.39**			13 25**			115287**
R/Y	6	1.18*	0.70*	0.94**	7.34**	1 04	4.19**	0.21**	0 04**	0.12**	878.68*	207.14	442.91*
Crosses (C)	3	27.96**	30.19**	57.29**	16.23**	62.05**	70.07**	0 12**	0.05**	0.13**	2937.83**	3486.7**	759.97**
C x Y	3			0.87*			8.22**			0 04**			864.59**
R. W. Y (Ea)	18	0.27	0.10	0.19	0.33	0.34	0.34	0.01	0.002	0.01	106.50	116 48	111.49
Pop. W.C.	20	5.38**	5.16**	9.38**	13 33**	17.73**	28.77**	0.90**	0.76**	1.00**	815451**	4653.4**	12256**
Pop. W. C1	5	2.51**	2.68**	5.02**	9 04**	9.60**	16.08**	0.61**	0.51**	1.05**	8563.59**	4868.4**	2808.6**
Pop. W. C2	5	6.91**	5.01**	9.10**	18.87**	30.40**	46.48**	0.99**	1.02**	1.95**	9948.11**	5862 4**	5339.6**
Pop. W. C3	5	5.90**	6.40**	12 21**	15.73**	10.62**	24.81**	1.10**	0.57**	1.59**	8162 22**	3354 8**	0786 9**
Pop. W. C4	5	6.21**	8.55**	11.18**	9.69**	20 28**	27.70**	0.89**	0.97**	1.82**	5944.11**	4527.8**	0091.5**
Pop. W. C x Y	20			1.17**			2.29**			0.07**			551.18**
Pop. W. C1 x Y	5			0.18			2.56*			0.06			623.39*
Pop. W. C2 x Y	6			2.82**			2.80**			0 05			470.66
Pop. W. C3 x Y	5			0.10			1.54*			0 08**			730.22**
Pop. W. C4 x Y	5			1.58**			2.27**			0.04			380.45**
R. W. Pop x C. (Eb)	120	0 13	0.17	0.15	0.39	0.87	0 63	0.02	0.03	0.02	76.29	222.31	149 30
R. W. Pop. X C1	30	0 18	0 08	0 13	0.50	1.19	0.84	0.03	0.04	0.03	79.62	306.10	192.86
R. W. Pop. X C2	30	0.14	0.21	0.17	0.25	1.18	0.72	0.02	0 03	0.03	100.67	367.76	234.22
R. W. Pop. X C3	30	0 08	0.23	0.16	0.60	0.42	0 51	0.01	0.01	0.01	75.67	61 51	68.59
R. W. Pop. X C4	30	0.11	0.16	0.13	0.22	0.71	0.48	0.01	0.03	0.02	49.20	153.89	101.54

*,**significant at 0.05 and 0.01 levels of probability, respectively.

Cross1 = Sd-7 x Sd-34   Cross 2 = G-628 x L-8084   Cross 4 = L-7041 x L-808

The six populations means and their standard error of the studied crosses for yield and other traits were calculated and the obtained results are shown in Table 2. The means showed that the inbred line Sd-7 was the highest parent for no. of kernels/row (27.76), while, this inbred was the lowest parent for no. of rows/ear (10.51). The parental line L-7041 was the earliest parent for silking date (69.46 days) and it was highest parent for no. of rows/ear (13.04). The inbred line Sd-34 was the highest parent for plant height (212.13 cm), ear height (110.58 cm), ear length (15.44 cm), ear diameter (3.98 cm) and grain yield/plant (87.02 gram), but the inbred line L-8084 appeared to be the shorter parent for plant height (138.32 cm) and ear height (76.31 cm). All F_1 hybrids appeared to be earlier than their earliest parent in the two years and combined. Also, all F_1 hybrids showed superiority over their highest parent for plant height, ear height, no. of kernels/row, no. of rows/ear, ear length, ear diameter and grain yield/plant in the two years and their combined data. Generally, the results showed that the 3rd cross was the earliest hybrid (64.78 days) while, the 4th cross was the latest hybrid (66.28 days). On the other hand, the 2nd, 2nd, 1st, 3rd, 1st, 3rd and (1st and 2nd) crosses were the highest crosses for plant height, ear height, no. of kernels/row, no. of rows/ear, ear length, ear diameter and grain yield/plant. The results also showed that the F_2 generations of the four crosses in the two years and their combined appeared to be later than their F_1 hybrids for silking date. Furthermore, the F_2 generation of the four crosses in the two years and combined were less than the corresponding values of F_1 hybrids for the remain traits. These results reflect the presence of heterotic effect and the non-additive genetic variance plays the major role in the inheritance of these traits with respect to these crosses. The obtained results revealed that the backcrosses means of most studied crosses strongly tended to be toward the respective recurrent parents in most of the studied traits, reflecting the role of additive and epistatic gene effects.

The results of scaling tests (A, B and C) for yield and other traits in each year in addition to their combined data are presented in Table 3. The values of scaling tests insignificantly differed from zero for the 1st cross for ear length in each year and their combined and 3rd cross for plant height in the growing season 2001. Thus, the additive-dominance model is adequate to interpret gene effects in these crosses. While, the six parameter model is valid to explain the nature of gene action for the other crosses with respect to these traits. Therefore, the gene effects using the populations means of the four crosses for yield and other traits in the two years as well as their combined are presented in Table 4. The results showed that the estimates of mean effects parameter (m), which reflects the contribution due to the overall mean (additive) plus the locus effects (dominance) found to be highly significant for all the studied traits in both years and their combined. In general, the crosses exhibited different magnitude and sign of gene action types with different years. Therefore, it could be more accurate, concentrating on the results obtained from the combined data over all both years. The results showed that the estimates of additive gene effects (a) values were negatively or positively significant for most of the studied crosses.

Table 2: Mean performances and standard errors of populations within each cross for yield and other traits in 2001,2002 and their combined data

Cross	Y	Silking date						Plant height (cm)						Ear height (cm)						No. of kernels/row					
		P_1	P_2	F_1	F_2	BC_1	BC_2	P_1	P_2	F_1	F_2	BC_1	BC_2	P_1	P_2	F_1	F_2	BC_1	BC_2	P_1	P_2	F_1	F_2	BC_1	BC_2
Cross#1 (7 x 34)	2001	73.08 ±0.20	69.83 ±0.25	65.65 ±0.20	68.93 ±0.18	69.05 ±0.17	68.7 ±0.2	203.9 ±2.14	238.9 ±2.06	296.5 ±1.83	275.9 ±1.49	272.8 ±1.42	283.0 ±1.35	117.2 ±1.61	124.0 ±1.61	175.7 ±1.47	153.5 ±1.21	159. ±1.41	159.1 ±1.31	29.90 ±0.72	26.58 ±0.65	41.86 ±0.72	34.45 ±0.49	38.20 ±0.62	36.53 ±0.59
	2002	72.1 ±0.30	71.35 ±0.30	65.87 ±0.23	68.46 ±0.18	68.72 ±0.20	69.0 ±0.2	141.9 ±2.38	182.0 ±1.67	250.3 ±1.99	224.0 ±1.21	220.4 ±1.35	224.1 ±1.51	81.91 ±1.66	93.98 ±1.73	151.5 ±1.83	132.9 ±1.11	130.4 ±1.17	125.0 ±1.39	24.73 ±0.72	26.61 ±0.69	41.03 ±0.75	35.93 ±0.47	36.71 ±0.61	34.88 ±0.60
	Com.	72.67 ±0.18	70.53 ±0.20	65.76 ±0.15	68.69 ±0.13	68.88 ±0.13	68.87 ±0.14	177.2 ±3.13	212.1 ±2.79	273.2 ±2.09	249.9 ±1.41	246.5 ±1.68	253.8 ±1.96	101.8 ±1.94	110.5 ±1.87	163.6 ±1.46	143.2 ±0.92	144.9 ±1.19	142.1 ±1.31	27.76 ±0.56	26.69 ±0.56	41.47 ±0.52	35.10 ±0.34	37.57 ±0.44	35.84 ±0.43
Cross #2 (7 x 7041)	2001	73.08 ±0.20	69.13 ±0.23	66.29 ±0.17	69.14 ±0.15	66.10 ±0.17	68.82 ±0.19	203.9 ±2.14	179.5 ±1.74	319.2 ±1.83	262.2 ±1.66	276.2 ±19.8	256.1 ±1.87	117.2 ±1.61	96.54 ±1.46	188.8 ±1.75	146.6 ±1.30	155.2 ±1.50	145.8 ±1.48	29.90 ±0.72	21.48 ±0.50	42.53 ±0.58	32.46 ±0.48	36.38 ±0.51	34.01 ±0.61
	2002	72.13 ±0.30	69.83 ±0.28	63.76 ±0.25	67.33 ±0.19	67.21 ±0.20	66.81 ±0.23	141.9 ±2.38	100.9 ±2.22	262.1 ±2.33	204.9 ±1.29	213.6 ±1.62	202.0 ±1.52	81.91 ±1.66	55.52 ±1.44	151.3 ±1.81	116.5 ±1.30	110.1 ±1.63	112.6 ±1.45	24.73 ±0.72	15.00 ±0.48	38.34 ±0.67	31.38 ±0.40	34.74 ±0.57	30.64 ±0.58
	Com.	72.67 ±0.18	69.46 ±0.18	65.02 ±0.18	68.24 ±0.13	67.65 ±0.13	67.81 ±0.16	177.2 ±3.13	151.0 ±3.24	290.7 ±2.52	233.6 ±1.53	244.9 ±2.07	229.5 ±1.84	101.8 ±1.94	79.77 ±2.02	170.1 ±1.84	132.6 ±1.12	137.1 ±1.46	129.2 ±1.35	27.76 ±0.56	19.28 ±0.46	40.56 ±0.46	31.98 ±0.34	34.31 ±0.43	33.07 ±0.42
Cross # 3 (628 x 8084)	2001	71.52 ±0.22	71.45 ±0.24	65.54 ±0.18	69.65 ±0.15	69.19 ±0.17	69.02 ±0.19	180.3 ±1.62	163.0 ±1.33	248.0 ±1.63	211.5 ±1.42	218.9 ±1.55	200.2 ±1.50	109.1 ±1.36	93.36 ±1.48	143.6 ±1.14	118.2 ±0.95	123.2 ±1.10	126.3 ±1.22	26.37 ±0.65	20.56 ±0.46	36.91 ±0.42	31.71 ±0.39	35.19 ±0.44	32.51 ±0.44
	2002	71.67 ±0.24	72.96 ±0.35	64.02 ±0.25	69.55 ±0.21	68.50 ±0.22	67.75 ±0.26	131.0 ±1.76	104.7 ±1.73	204.0 ±1.97	174.1 ±1.28	193.0 ±1.66	155.5 ±1.43	68.43 ±1.30	53.18 ±1.15	116.4 ±1.63	88.59 ±1.03	115.8 ±1.22	90.63 ±1.14	22.80 ±0.53	17.23 ±0.48	28.68 ±0.60	28.07 ±0.38	28.47 ±0.50	28.20 ±0.45
	Com.	71.59 ±0.16	72.05 ±0.21	64.78 ±0.16	69.60 ±0.13	68.84 ±0.14	68.84 ±0.17	164.6 ±2.56	138.3 ±2.73	226.0 ±2.02	192.8 ±1.21	206.0 ±1.33	180.9 ±1.68	93.20 ±1.93	76.31 ±1.89	130.0 ±1.39	103.4 ±0.92	119.5 ±0.84	108.5 ±1.25	24.87 ±0.45	19.39 ±0.37	33.04 ±0.47	30.12 ±0.28	32.37 ±0.38	29.88 ±0.36
(7041 x 8084)	2001	68.13 ±0.23	71.45 ±0.24	68.15 ±0.21	70.75 ±0.13	69.05 ±0.17	70.92 ±0.17	179.5 ±1.74	163.0 ±1.33	270.5 ±1.25	224.8 ±1.54	235.2 ±1.77	210.4 ±1.67	96.54 ±1.46	93.36 ±1.48	160.1 ±1.44	132.0 ±1.27	137.7 ±1.36	126.3 ±1.12	21.48 ±0.50	20.56 ±0.46	31.60 ±0.58	29.50 ±0.35	30.25 ±0.45	30.36 ±0.44
	2002	69.63 ±0.28	72.96 ±0.35	64.41 ±0.21	68.18 ±0.17	66.49 ±0.20	70.00 ±0.22	109.9 ±2.22	104.7 ±1.73	217.1 ±2.67	176.3 ±1.50	193.3 ±1.89	168.0 ±1.43	55.52 ±1.44	53.18 ±1.15	129.7 ±1.89	110.0 ±1.19	105.9 ±1.33	88.52 ±1.29	15.00 ±0.48	17.23 ±0.48	35.22 ±0.61	28.41 ±0.39	25.20 ±0.46	29.00 ±0.50
	Com.	69.46 ±0.18	72.05 ±0.21	66.28 ±0.20	69.46 ±0.12	67.77 ±0.15	70.46 ±0.14	151.0 ±3.24	138.3 ±2.73	243.8 ±2.41	200.6 ±1.45	214.3 ±1.69	192.2 ±1.66	79.77 ±2.02	76.31 ±1.89	144.9 ±1.61	121.0 ±0.97	121.8 ±1.26	107.5 ±1.31	19.28 ±0.46	19.39 ±0.37	33.36 ±0.44	29.02 ±0.28	28.13 ±0.35	29.79 ±0.34

Table 2: Continue

Cross	Y	No. of rows/ear P1	P2	F1	F2	BC1	BC2	Ear length (cm) P1	P2	F1	F2	BC1	BC2
Cross#1 (7 x 34)	2001	10.64 ±0.21	12.58 ±0.17	12.85 ±0.13	12.20 ±0.10	11.78 ±0.12	12.42 ±0.12	16.20 ±0.32	15.44 ±0.37	19.37 ±0.31	17.70 ±0.20	18.31 ±0.24	18.48 ±0.25
	2002	10.33 ±0.18	12.33 ±0.13	12.39 ±0.11	11.28 ±0.10	10.98 ±0.13	11.76 ±0.13	14.09 ±0.39	15.45 ±0.23	18.61 ±0.32	17.31 ±0.23	15.83 ±0.29	18.16 ±0.28
	Com.	10.51 ±0.15	12.47 ±0.11	12.53 ±0.09	11.79 ±0.07	11.45 ±0.09	12.14 ±0.09	15.33 ±0.26	15.44 ±0.23	19.01 ±0.22	17.63 ±0.15	17.27 ±0.20	17.50 ±0.20
Cross #2 (7 x 7041)	2001	10.64 ±0.21	13.84 ±0.19	13.69 ±0.18	13.39 ±0.11	12.21 ±0.10	14.03 ±0.12	16.20 ±0.32	12.87 ±0.22	19.15 ±0.22	16.43 ±0.19	16.59 ±0.24	17.85 ±0.21
	2002	10.33 ±0.18	11.88 ±0.25	13.15 ±0.14	12.57 ±0.11	13.32 ±0.14	11.71 ±0.14	14.09 ±0.39	8.80 ±0.24	16.92 ±0.29	14.68 ±0.20	15.71 ±0.28	13.88 ±0.24
	Com.	10.51 ±0.15	13.04 ±0.17	13.44 ±0.11	13.03 ±0.08	12.67 ±0.09	13.08 ±0.11	15.33 ±0.26	11.39 ±0.23	18.09 ±0.20	15.62 ±0.14	18.22 ±0.18	16.10 ±0.19
Cross # 3 (628 x 8084)	2001	12.40 ±0.18	12.61 ±0.19	15.67 ±0.13	14.31 ±0.10	14.27 ±0.12	14.17 ±0.13	12.58 ±0.36	15.81 ±0.33	18.31 ±0.20	16.50 ±0.16	16.72 ±0.21	17.40 ±0.21
	2002	12.20 ±0.18	12.33 ±0.21	15.47 ±0.16	14.07 ±0.11	13.86 ±0.14	14.36 ±0.16	10.71 ±0.23	11.31 ±0.30	14.64 ±0.23	13.64 ±0.18	13.59 ±0.23	14.25 ±0.21
	Com.	12.31 ±0.13	12.51 ±0.14	16.58 ±0.10	14.21 ±0.08	14.10 ±0.09	14.25 ±0.10	11.72 ±0.23	14.22 ±0.31	16.58 ±0.20	15.25 ±0.13	15.41 ±0.18	16.08 ±0.17
Cross #4 (7041 x 8084)	2001	13.64 ±0.19	12.81 ±0.19	18.11 0.18	14.89 ±0.11	14.38 ±0.14	15.41 ±0.14	12.67 ±0.22	15.81 ±0.33	17.35 ±0.23	15.75 ±0.18	15.90 ±0.19	18.19 ±0.20
	2002	11.88 ±0.25	12.33 ±0.21	14.53 ±0.15	14.49 ±0.13	14.86 ±0.16	14.15 ±0.18	8.89 ±0.24	11.31 ±0.30	15.17 ±0.25	14.10 ±0.20	13.29 ±0.23	13.44 ±0.23
	Com.	13.04 ±0.17	12.51 ±0.14	15.36 ±0.13	14.61 ±0.08	14.57 ±0.10	14.88 ±0.11	11.39 ±0.23	14.22 ±0.31	16.32 ±0.19	15.03 ±0.13	14.80 ±0.16	15.04 ±0.17

Cross	Y	Ear diameter (cm) P1	P2	F1	F2	BC1	BC2	Grain yield/plant (gram) P1	P2	F1	F2	BC1	BC2
Cross#1 (7 x 34)	2001	3.74 ±0.06	4.12 ±0.06	4.87 ±0.03	4.38 ±0.03	4.39 ±0.04	4.50 ±0.04	89.5 ±3.1	101 ±4.1	214 ±3.9	147 ±3.8	180 ±4.4	170 ±4.2
	2002	3.28 ±0.05	3.80 ±0.03	4.29 ±0.05	4.19 ±0.04	3.80 ±0.04	3.96 ±0.04	50.7 ±2.1	69.6 ±2.6	144 ±4.7	119 ±2.8	118 ±3.1	105 ±3.1
	Com.	3.55 ±0.04	3.98 ±0.03	4.60 ±0.03	4.30 ±0.02	4.21 ±0.02	4.20 ±0.03	73.2 ±2.8	87.0 ±2.9	181 ±3.8	135 ±2.5	143 ±3.1	143 ±3.3
Cross #2 (7 x 7041)	2001	3.74 ±0.06	3.92 ±0.05	5.01 ±0.03	4.53 ±0.03	4.59 ±0.04	4.72 ±0.04	89.6 ±3.1	74.7 ±2.0	212 ±5.1	141 ±3.3	153. ±4.2	157 ±4.1
	2002	3.28 ±0.05	3.17 ±0.04	4.38 ±0.04	4.16 ±0.04	4.00 ±0.04	4.17 ±0.04	50.7 ±2.1	46.2 ±1.8	146 ±6.0	101 ±3.1	111 ±3.8	90.6 ±3.3
	Com.	3.55 ±0.04	3.67 ±0.04	4.71 ±0.03	4.37 ±0.02	4.42 ±0.03	4.41 ±0.02	73.2 ±2.6	84.0 ±1.9	181. ±4.3	124 ±2.4	135 ±3.1	129 ±3.3
Cross # 3 (628 x 8084)	2001	3.80 ±0.07	3.92 ±0.05	5.15 ±0.03	4.61 ±0.03	4.65 ±0.03	4.81 ±0.03	92.2 ±3.8	73.7 ±1.8	192 ±3.0	146 ±2.6	168 ±3.0	145 ±2.8
	2002	3.59 ±0.04	3.51 ±0.04	4.55 ±0.04	4.03 ±0.03	4.08 ±0.04	4.03 ±0.03	48.3 ±1.5	40.8 ±1.6	121 ±3.8	85.0 ±2.5	82.2 ±2.5	79.7 ±2.9
	Com.	3.71 ±0.04	3.78 ±0.03	4.87 ±0.03	4.36 ±0.02	4.41 0.030	4.48 ±0.03	71.3 ±2.8	61.8 ±1.9	158. ±3.5	120 ±2.2	132 ±3.1	117 ±2.7
Cross #4 (7041 x 8084)	2001	3.02 ±0.05	3.92 ±0.05	5.08 ±0.04	4.52 ±0.03	4.47 ±0.04	4.05 ±0.04	74.7 ±2.0	73.7 ±1.8	167 ±2.8	129 ±2.4	148 ±2.5	129 ±2.5
	2002	3.17 ±0.04	3.51 ±0.04	4.55 ±0.03	4.06 ±0.04	3.80 ±0.04	3.18 ±0.04	45.2 ±1.8	40.8 ±1.6	130 ±3.9	88.0 ±2.6	94.3 ±2.9	84.4 ±2.6
	Com.	3.07 ±0.04	3.78 ±0.03	4.83 ±0.03	4.32 ±0.02	4.19 ±0.03	4.57 ±0.03	64.0 ±1.9	61.8 ±1.9	150 ±2.7	111 ±1.9	125 ±2.4	102 ±2.6

*,**significant at 0.05 and 0.01 levels of probability, respectively.

Table 3: Scaling tests (A,B and C) and their standard errors for earliness and morphological traits in 2001,2002 and their combined data

C	Y	Silking date			Plant height (cm)			Ear height (cm)			No. of kernels/row		
		A± S.E.	B± S.E.	C± S.E.	A± S.E.	B± S.E.	C± S.E.	A± S.E.	B± S.E.	C± S.E.	A± S.E.	B± S.E.	C± S.E.
Cross#1 (7 x 34)	2001	-0.64 ± 0.45	1.92 ± 0.47**	1.49 ± 0.90	67.01 ±4.11**	12.48 ±3.87**	70.91 ±7.41**	25.85 ±3.56**	18.59 ±3.56**	21.39 ±6.18**	1.31 ±1.54	7.98 ±1.66**	-2.40 ±2.66
	2002	-0.56 ±0.55	0.87 ±0.59	-1.69 ±0.94*	56.05 ±4.33**	8.49 ±3.75*	71.45 ±6.89**	27.52 ±3.41**	4.51 ±3.75	52.96 ±6.25**	4.00 ±1.59*	5.78 ±1.59**	10.33 ±2.60**
	Comb.	-0.67 ±0.35	1.45 ±0.38**	0.04 ±0.65	57.24 ±5.34**	7.64 ±4.84	64.05 ±8.18**	24.47 ±3.39**	9.98 ±3.53**	33.40 ±5.41**	2.45 ±1.14*	7.09 ±1.17**	3.11 ±1.89
Cross #2 (7 x 7041)	2001	-3.17 ± 0.43**	2.22 ± 0.48**	1.76 ± 0.77*	29.35 ±4.82**	13.61 ±4.51**	26.91 ±7.75**	4.32 ±3.83	6.33 ±2.73*	2.96 ±6.62	0.34 ±1.37	4.00 ±1.43**	-6.61 ±2.40**
	2002	-1.47 ±0.56*	0.03 ±0.60	-0.14 ±1.00	23.23 ±4.64**	33.73 ±4.42**	43.73 ±7.68**	4.94 ±4.09	18.41 ±3.72**	25.86 ±6.71**	-1.80 ±1.52	16.14 ±1.41**	9.10 ±2.49**
	Comb.	-2.39 ±0.36**	1.15 ±0.41**	0.77 ±0.67	21.99 ±5.77**	17.32 ±5.51**	24.66 ±9.12**	2.42 ±3.95	8.63 ±3.84*	8.46 ±8.44	-0.37 ±1.11	8.78 ±1.07**	-0.23 ±1.81
Cross # 3 (628 x 8084)	2001	1.32 ± 0.46**	2.85 ± 0.48**	4.55 ± 0.77**	3.62 ±3.85	1.48 ±3.66	0.70 ±6.87	-6.36 ±2.82*	15.76 ±3.08**	-16.96 ±4.86**	7.10 ±1.16**	7.55 ±1.07**	8.10 ±1.82**
	2002	1.31 ±0.55**	-1.47 ±0.58*	5.54 ±1.07**	50.96 ±4.27**	2.34 ±3.87	52.85 ±6.90**	46.84 ±3.20**	11.61 ±3.03**	-0.19 ±5.54	5.46 ±1.29**	6.48 ±1.19**	14.86' ±2.07**
	Comb.	1.32 ±0.38**	0.84 ±0.43	6.20 ±0.67**	21.30 ±4.21**	-2.52 ±4.78	16.36 ±7.34*	16.83 ±2.91**	10.64 ±3.49**	-16.03 ±5.37**	6.84 ±1.00**	7.30 ±0.94**	10.13 ±1.59**
Cross #4 (7041 x 8084)	2001	0.81 ± 0.46	2.24 ± 0.47**	6.10 ± 0.75**	20.53 ±4.13**	-0.71 ±3.80	15.74 ±7.01*	18.77 ±3.41**	-0.39 ±3.05	17.87 ±6.18**	7.32 ±1.17**	8.47 ±1.15**	12.57 ±1.83**
	2002	-1.26 ±0.63**	2.64 ±0.60**	1.10 ±0.93	59.61 ±5.13**	14.31 ±4.28**	56.88 ±8.51**	26.72 ±3.57**	-5.90 ±3.39	72.10 ±8.33**	0.19 ±1.20	5.55 ±1.27**	10.98 ±2.08**
	Comb.	-0.20 ±0.40	2.58 ±0.41**	3.77 ±0.89**	33.72 ±5.27**	2.38 ±4.95	25.43 ±8.65**	19.00 ±3.61**	-6.19 ±3.66	38.20 ±5.79**	3.63 ±0.85**	6.84 ±0.88**	10.71 ±1.48**

Table3: Continued

C	Y	No. of rows/ear			Ear length (cm)			Ear diameter (cm)			Grain yield/plant (gram)		
		A± S.E.	B± S.E.	C± S.E.	A± S.E.	B± S.E.	C± S.E.	A± S.E.	B± S.E.	C± S.E.	A± S.E.	B± S.E.	C± S.E.
Cross#1 (7 x 34)	2001	0.27 ±0.35	-0.48 ±0.23*	0.27 ±0.53	1.04 ±0.65	2.11 ±3.97	0.44 ±4.06	0.18 ±0.06*	-0.004 ±0.10	-0.08 ±0.17	17.82 ±10.16	25.11 ±10.28*	-28.71 ±17.90
	2002	-0.75 ±0.34*	-1.20 ±0.30**	-2.33 ±0.50**	-1.03 ±0.76	-1.74 ±0.89	2.40 ±1.28	0.34 ±0.10**	-0.49 ±0.09**	1.09 ±0.18**	42.94 ±7.96**	-2.54 ±8.04	70.17 ±14.61**
	Comb.	-0.15 ±0.25	-0.72 ±0.23**	-0.88 ±0.38*	0.21 ±0.52	0.54 ±0.51	1.32 ±0.82	0.27 ±0.08**	-0.17 ±0.08*	0.48 ±0.13**	31.97 ±7.79**	17.93 ±8.23*	18.77 ±13.38
Cross #2 (7 x 7041)	2001	3.73 ±0.35**	-2.92 ±0.31**	1.89 ±0.60**	-2.18 ±0.61**	3.88 ±3.58	-1.43 ±3.67	0.68 ±0.09**	0.25 ±0.09**	0.48 ±0.16**	4.97 ±10.41	27.30 ±9.95**	-21.40 ±17.29
	2002	-0.05 ±0.37	1.63 ±0.40**	1.79 ±0.60**	0.42 ±0.71	1.96 ±0.61**	1.49 ±1.08	0.35 ±0.10**	0.79 ±0.08**	1.42 ±0.17**	26.17 ±9.45**	-10.68 ±8.63	18.20 ±16.33
	Comb.	2.17 ±0.29**	-1.13 ±0.27**	1.70 ±0.44**	-0.98 ±0.48*	2.89 ±0.48**	-0.41 ±0.77	0.57 ±0.08**	0.45 ±0.08**	0.84 ±0.13**	17.24 ±8.11*	13.05 ±8.21	-2.80 ±13.56
Cross # 3 (628 x 8084)	2001	0.47 ±0.33	0.07 ±0.34	0.90 ±0.25*	2.67 ±0.58**	0.70 ±4.00	1.01 ±4.06	0.34 ±0.10**	0.54 ±0.08**	0.44 ±0.14**	51.89 ±7.87**	24.08 ±8.67**	36.18 ±13.06**
	2002	0.06 ±0.37	0.93 ±0.39*	0.79 ±0.62	1.83 ±0.56**	2.54 ±0.57**	3.27 ±0.92**	0.03 ±0.09	-0.17 ±0.08*	-0.08 ±0.15	-15.03 ±8.54*	-2.58 ±7.25	12.29 ±12.91
	Comb.	0.31 ±0.25	0.42 ±0.28	0.84 ±0.42*	2.61 ±0.47**	1.34 ±0.51**	1.88 ±0.77**	0.25 ±0.06**	0.32 ±0.08**	0.22 ±0.12	34.18 ±7.80**	14.66 ±6.83*	29.17 ±12.03*
Cross #4 (7041 x 8084)	2001	-1.03 ±0.38**	2.10 ±0.38**	0.30 ±0.62	1.78 ±0.49**	-0.78 ±4.00	-0.17 ±4.05	0.70 ±0.09**	-0.06 ±0.09	0.08 ±0.16	54.11 ±6.18**	18.37 ±8.11**	34.63 ±11.61**
	2002	3.34 ±0.43**	1.45 ±0.41**	4.73 ±0.68**	2.52 ±0.67**	0.40 ±0.60	5.89 ±1.01**	0.65 ±0.09**	-0.46 ±0.09**	0.45 ±0.16**	13.13 ±7.28	-42.17 ±6.85**	5.51 ±13.31
	Comb.	0.74 ±0.30*	1.89 ±0.29**	2.14 ±0.48**	1.90 ±0.44**	-0.47 ±0.50	1.86 ±0.74*	0.65 ±0.06**	-0.23 ±0.08**	0.17 ±0.13	37.16 ±5.92**	-6.97 ±8.20	19.87 ±10.06

*,**significant at 0.05 and 0.01 levels of probability, respectively.

Table4: The type of gene action and their standard error for earliness and morphological traits in 2001,2002 and their combined data

	Y	Silking date m	a	d	aa	ad	dd	Plant height (cm) m	a	d	aa	ad	dd
Cross#1 (7 x 34)	2001	68.93 ±0.18**	0.35 ±0.24	-6.01 ±0.92**	-0.21 ±0.88	-1.28 ±0.29**	-1.08 ±1.33	275.96 ±1.48**	11.01 ±2.10**	84.52 ±7.61**	8.88 ±7.28	27.28 ±2.57**	-88.03 ±11.20**
	2002	68.48 ±0.18**	-0.33 ±0.30	-4.17 ±0.98**	1.70 ±0.93	-0.72 ±0.36*	-2.01 ±1.53	224.07 ±1.21**	3.73 ±2.03	81.38 ±8.76**	-6.92 ±6.30	23.78 ±2.49**	-57.81 ±10.64**
	Comb.	68.69 ±0.13**	0.01 ±0.19	-5.10 ±0.67**	0.75 ±0.64	-1.06 ±0.24**	-1.53 ±1.02	249.99 ±1.41**	7.37 ±2.53**	78.38 ±8.15**	0.82 ±7.59	24.80 ±3.28**	-65.69 ±13.02**
Cross#2 (7 x 7041)	2001	69.14 ±0.15**	-0.72 ±0.25**	-7.54 ±0.83**	-2.72 ±0.79**	-2.70 ±0.28**	3.67 ±1.28**	282.22 ±1.56**	20.11 ±2.70**	143.63 ±8.57**	16.05 ±8.02*	7.87 ±3.30**	-69.00 ±13.30**
	2002	67.33 ±0.19**	0.40 ±0.30	-8.52 ±1.02**	-1.30 ±0.97	-0.76 ±0.37*	2.74 ±1.57	204.99 ±1.29**	10.77 ±2.22**	149.61 ±7.37**	13.23 ±6.08*	-6.25 ±2.15*	-70.19 ±11.73**
	Comb.	68.24 ±0.13**	-0.16 ±0.21	-8.05 ±0.69**	-2.01 ±0.65**	-1.77 ±0.24**	3.24 ±1.06**	233.60 ±1.53**	15.44 ±2.77**	141.17 ±8.82**	14.64 ±8.25	2.34 ±3.57	-63.96 ±14.35**
Cross#3 (628 x 8084)	2001	69.65 ±0.15**	-0.73 ±0.25**	-6.33 ±0.82**	-0.38 ±0.78	-0.78 ±0.30**	-3.79 ±1.27**	170.325 ±7.20**	11.61 ±1.04**	87.15 ±17.55**	—	—	—
	2002	69.65 ±0.21**	0.74 ±0.34*	-13.99 ±1.1**	-5.70 ±1.09**	1.39 ±0.40**	5.88 ±1.74**	174.16 ±1.28**	37.80 ±2.20**	86.60 ±7.13**	0.45 ±6.74	24.31 ±2.52**	-33.78 ±11.19**
	Comb.	69.60 ±0.13**	0.01 ±0.22	-10.09 ±0.71**	-3.04 ±0.68**	0.24 ±0.26	0.89 ±1.11	192.86 ±1.21**	26.10 ±2.14**	76.84 ±7.03**	2.42 ±6.47	11.91 ±2.85**	-27.20 ±11.28*
Cross#4 (7041 x 8084)	2001	70.76 ±0.13**	-1.87 ±0.23**	-5.19 ±0.75**	-3.05 ±0.70**	-0.71 ±0.29*	0.01 ±1.21	224.84 ±1.54**	18.83 ±2.72**	103.29 ±8.02**	4.08 ±7.84	10.62 ±2.66**	-23.91 ±11.97*
	2002	68.18 ±0.17**	-3.51 ±0.30**	-6.71 ±0.97**	0.28 ±0.92	-1.98 ±0.37**	-1.68 ±1.51	176.38 ±1.50**	25.27 ±2.37**	127.06 ±8.23**	17.26 ±7.65*	22.65 ±2.75**	-81.19 ±12.74**
	Comb.	69.48 ±0.12**	-2.69 ±0.20**	-3.98 ±0.68**	-1.39 ±0.63*	-1.39 ±0.25**	-1.00 ±1.06	200.61 ±1.45**	22.06 ±2.38**	109.79 ±8.16**	10.67 ±7.50	16.87 ±3.15**	-48.78 ±12.87**

	Y	Ear height (cm) m	a	d	aa	ad	dd	No. of kernels/row m	a	d	aa	ad	dd
Cross#1 (7 x 34)	2001	153.64 ±1.20**	0.25 ±1.92	78.09 ±8.47**	23.06 ±6.18**	3.63 ±2.29**	-67.48 ±9.87**	34.45 ±0.49**	-1.67 ±0.85*	26.28 ±2.75**	11.66 ±2.60**	-3.33 ±1.02**	-26.92 ±4.34**
	2002	132.88 ±1.11**	5.47 ±1.82**	42.88 ±6.15**	-20.93 ±5.75**	11.51 ±2.18**	-11.10 ±9.59	35.33 ±0.47**	-1.83 ±0.88*	14.81 ±2.69**	-0.55 ±2.54	-0.89 ±0.99	-8.22 ±4.30*
	Comb.	143.28 ±0.82**	2.86 ±1.77	68.48 ±5.47**	1.06 ±5.10	7.24 ±2.22**	-35.82 ±8.90**	36.10 ±0.34**	-1.74 ±0.61**	20.72 ±1.98**	6.43 ±1.85**	-2.32 ±0.73**	-16.96 ±3.10**
Cross#2 (7 x 7041)	2001	148.64 ±1.29**	8.37 ±2.10**	65.65 ±6.99**	7.69 ±6.08	-1.00 ±2.37	-18.3 ±10.7	32.46 ±0.48**	2.38 ±0.79**	27.60 ±2.59**	10.90 ±2.49**	-1.83 ±0.90*	-18.30 ±3.93**
	2002	116.50 ±1.30**	8.46 ±2.19**	80.12 ±7.12**	-2.51 ±8.79	-4.74 ±2.45**	-20.84 ±11.02	31.38 ±0.48**	-4.11 ±0.82**	23.72 ±2.65**	5.24 ±2.53*	-3.97 ±0.92**	-18.60 ±4.11**
	Comb.	132.67 ±1.12**	7.92 ±1.99**	61.51 ±6.42**	2.59 ±5.99	-3.10 ±2.43	-13.64 ±10.23	31.88 ±0.34**	-0.34 ±0.60	25.88 ±1.91**	8.64 ±1.83**	-4.80 ±0.70**	-17.05 ±2.99**
Cross#3 (628 x 8084)	2001	118.22 ±0.94**	-3.17 ±1.64	64.78 ±5.23**	26.35 ±5.00**	-11.06 ±1.92**	-35.75 ±8.18**	31.71 ±0.35**	2.66 ±0.82**	21.96 ±2.06**	8.54 ±1.98**	-0.23 ±0.73	-23.19 ±3.14**
	2002	88.59 ±1.03**	25.24 ±1.67**	114.32 ±6.62**	58.64 ±5.31**	17.62 ±1.88**	-117.06 ±8.67**	28.07 ±0.38**	2.27 ±0.68**	5.73 ±2.16**	-2.93 ±2.04	-0.81 ±0.76	-9.02 ±3.41**
	Comb.	103.41 ±0.92**	11.04 ±1.51**	87.82 ±5.14**	42.60 ±4.75**	2.59 ±2.05	-68.96 ±8.08**	30.12 ±0.26**	2.51 ±0.52**	14.92 ±1.64**	4.01 ±1.55**	-0.23 ±0.60	-16.16 ±2.83**
Cross#4 (7041 x 8084)	2001	132.0 ±1.26**	11.17 ±1.76**	65.71 ±6.42**	0.50 ±6.17	9.58 ±2.04**	-18.8 ±9.3*	29.60 ±0.34**	-0.11 ±0.63	13.90 ±1.99**	3.23 ±1.87*	-0.67 ±0.71	-18.0 ±3.1**
	2002	110.08 ±1.19**	17.48 ±1.85**	24.13 ±6.37**	-51.28 ±6.02**	16.31 ±2.07**	30.48 ±8.75**	28.41 ±0.39**	-3.60 ±0.69**	11.88 ±2.17**	-6.22 ±2.06*	-2.68 ±0.7**	-0.82 ±3.43
	Comb.	121.0 ±0.97**	14.33 ±1.82**	41.52 ±5.74**	-26.39 ±5.33**	12.59 ±2.31**	12.58 ±8.30	29.02 ±0.28**	-1.86 ±0.49**	13.79 ±1.61**	-0.23 ±1.47	-1.61 ±0.5**	-10.2 ±2.4**

*, ** significant at 0.05 and 0.01 levels of probability, respectively

Table 4: Continued

	Y	No. of rows/ear m	a	d	aa	ad	dd	Ear length (cm) m	a	d	aa	ad	dd
Cross#1 (7 x 34)	2001	12.20 ±0.09**	-0.83 ±0.17**	0.64 ±0.55	-0.40 ±0.51	0.34 ±0.22	0.53 ±0.87	13.09 ±2.23**	0.38 ±1.97	12.18 ±6.47	—	—	—
	2002	11.28 ±0.10**	-0.77 ±0.18**	1.45 ±0.56**	0.38 ±0.54	0.23 ±0.21	1.57 ±0.89	20.00 ±1.24**	-0.68 ±0.22**	-9.38 ±3.12**	—	—	—
	Comb.	11.79 ±0.07**	-0.69 ±0.13**	1.04 ±0.41*	-0.01 ±0.39	0.29 ±0.16	0.87 ±0.64	15.98 ±0.84**	0.08 ±0.17	3.23 ±2.13	—	—	—
Cross #2 (7 x 7041)	2001	13.39 ±0.10**	1.83 ±0.15**	0.47 ±0.57	-1.08 ±0.53*	3.33 ±0.21**	0.27 ±0.87	18.43 ±0.18**	-1.26 ±0.31**	7.84 ±2.04**	3.13 ±0.97**	-3.03 ±1.81	-4.83 ±3.88
	2002	12.57 ±0.11**	-1.61 ±0.20**	1.84 ±0.62**	-0.21 ±0.58	-0.84 ±0.25**	-1.36 ±1.08	14.58 ±0.20**	1.83 ±0.35**	8.32 ±1.12**	0.88 ±1.06	-0.77 ±0.42	-3.28 ±1.78
	Comb.	13.03 ±0.08**	0.39 ±0.14**	1.01 ±0.45*	-0.66 ±0.42	1.65 ±0.18**	-0.38 ±0.72	15.62 ±0.14**	0.03 ±0.26	7.08 ±0.81**	2.33 ±0.77**	-1.93 ±0.31**	-4.25 ±1.30**
Cross # 3 (628 x 6084)	2001	14.31 ±0.10**	0.10 ±0.17	2.81 ±0.58**	-0.36 ±0.55	0.20 ±0.22	-0.18 ±0.90	16.50 ±0.16**	-0.67 ±0.29*	6.36 ±2.18**	2.23 ±0.88**	0.95 ±2.01	-5.40 ±4.22
	2002	14.07 ±0.11**	-0.50 ±0.20*	3.40 ±0.65**	0.19 ±0.61	-0.44 ±0.25	-1.17 ±1.02	13.84 ±0.18**	-0.86 ±0.32*	4.74 ±0.99**	1.11 ±0.95	-0.38 ±0.37	-5.49 ±1.57**
	Comb.	14.21 ±0.08**	-0.15 ±0.13	3.08 ±0.43**	-0.11 ±0.41	-0.08 ±0.17	-0.62 ±0.68	15.25 ±0.13**	-0.67 ±0.25*	5.59 ±0.78**	1.98 ±0.73**	0.58 ±0.31	-5.84 ±1.26**
Cross #4 (7041 x 6084)	2001	14.69 ±0.10**	-1.05 ±0.19**	3.75 ±0.62**	0.77 ±0.58	-1.57 ±0.23**	-1.85 ±1.00	15.75 ±0.15**	-0.29 ±0.27	4.27 ±2.17*	1.17 ±0.83	1.28 ±2.01	-2.17 ±4.20
	2002	14.49 ±0.13**	0.71 ±0.22**	2.49 ±0.72**	0.05 ±0.68	0.94 ±0.28**	-4.84 ±1.12**	14.10 ±0.20**	-0.15 ±0.33	2.10 ±1.07*	-2.97 ±1.02**	1.06 ±0.38**	0.05 ±1.65
	Comb.	14.61 ±0.09**	-0.31 ±0.15*	3.08 ±0.48**	0.42 ±0.45	-0.58 ±0.19**	-3.12 ±0.77**	15.03 ±0.13**	-0.23 ±0.24	3.07 ±0.75**	-0.44 ±0.70	1.19 ±0.30**	-0.98 ±1.20

	Y	Ear diameter (cm) m	a	d	aa	ad	dd	Grain yield/plant (gram) m	a	d	aa	ad	dd
Cross#1 (7 x 34)	2001	4.38 ±0.03**	-0.10 ±0.05*	1.18 ±0.17**	0.24 ±0.16	0.08 ±0.06	-0.39 ±0.27	147.5 ±3.79**	-8.35 ±6.13	190.55 ±20.09**	71.64 ±19.52**	-3.84 ±6.66	-114.58 ±30.36**
	2002	4.19 ±0.04**	0.16 ±0.05**	-0.50 ±0.19**	-1.24 ±0.18**	0.42 ±0.06**	1.39 ±0.28**	119.7 ±2.84**	13.30 ±4.47**	54.25 ±15.17**	-29.76 ±14.45*	22.74 ±4.78**	-10.64 ±23.10
	Comb.	4.30 ±0.02**	0.01 ±0.04	0.47 ±0.14**	-0.37 ±0.13**	0.22 ±0.05**	0.27 ±0.22	135.4 ±2.54**	0.14 ±4.55	132.25 ±14.32**	31.13 ±13.64*	7.02 ±4.98	-81.03 ±22.80**
Cross #2 (7 x 7041)	2001	4.53 ±0.03**	0.13 ±0.05**	1.64 ±0.16**	0.47 ±0.16**	0.22 ±0.06**	-1.41 ±0.26**	141.7 ±3.38**	-3.74 ±5.94	183.57 ±18.75**	53.68 ±17.95**	-11.17 ±8.23	-85.93 ±29.40**
	2002	4.16 ±0.04**	-0.16 ±0.06**	0.87 ±0.19**	-0.28 ±0.18	-0.22 ±0.07**	-0.85 ±0.29**	101.8 ±3.13**	21.13 ±5.12**	95.93 ±17.00**	-2.69 ±18.17	18.42 ±5.32**	-12.83 ±26.18
	Comb.	4.37 ±0.02**	0.003 ±0.04	1.28 ±0.14**	0.19 ±0.13	0.06 ±0.05	-1.21 ±0.22**	124.3 ±2.48**	8.69 ±4.61	145.50 ±14.31**	32.89 ±13.54**	2.10 ±4.89	-63.17 ±22.89**
Cross # 3 (628 x 6084)	2001	4.61 ±0.02**	-0.16 ±0.04**	1.74 ±0.15**	0.45 ±0.14**	-0.10 ±0.08	-1.34 ±0.24**	146.4 ±2.69**	23.16 ±4.18**	150.13 ±14.12**	40.79 ±13.63**	13.90 ±4.70**	-118.76 ±21.22**
	2002	4.03 ±0.03**	0.05 ±0.02*	1.09 ±0.16**	0.09 ±0.15	0.01 ±0.05	-0.11 ±0.25	85.84 ±2.54**	2.54 ±3.90	56.80 ±13.43**	-19.89 ±12.83	-1.22 ±4.07	27.49 ±20.27
	Comb.	4.38 ±0.02**	-0.07 ±0.03*	1.47 ±0.14**	0.35 ±0.13**	-0.03 ±0.05	-0.91 ±0.22**	120.0 ±2.27**	14.52 ±4.20**	111.89 ±12.98**	19.65 ±12.37	9.76 ±4.54*	-48.50 ±20.65**
Cross #4 (7041 x 6084)	2001	4.52 ±0.03**	0.38 ±0.05**	1.72 ±0.17**	0.56 ±0.16**	0.38 ±0.06**	-1.21 ±0.26**	129.8 ±2.4**	18.38 ±3.59**	131.44 ±12.53**	37.95 ±12.13**	17.87 ±3.85**	-110.43 ±18.49**
	2002	4.08 ±0.04**	0.38 ±0.06**	0.85 ±0.19**	-0.26 ±0.18	0.55 ±0.08**	0.06 ±0.28	88.00 ±2.60**	29.86 ±3.85**	52.55 ±13.71**	-34.56 ±13.07**	27.85 ±4.16**	63.80 ±20.56**
	Comb.	4.32 ±0.03**	0.38 ±0.05**	1.37 ±0.15**	0.26 ±0.14	0.44 ±0.08**	-0.89 ±0.23**	111.4 ±1.99**	23.19 ±3.56**	97.62 ±11.11**	10.52 ±10.67	22.07 ±3.82**	-40.71 ±17.43*

*,**significant at 0.05 and 0.01 levels of probability, respectively.

While, the dominance gene effects (d) were highly significant and larger in magnitude than the corresponding values of additive effects (a) In the four crosses. This suggests that the major role of dominance gene action in the inheritance of these traits with respect to the four crosses and the higher frequency of dominance genes In the parental lines, which involved in these crosses for these traits. This fact may explain the presence of heterobilitosis in these crosses and reduction of F_2 generations than their F_1 hybrids mean in these crosses with respect to these traits. These results are in accordance with what reported by Nawar (1985) and Reddy and Agrawal (1992), who found that the non-additive Including dominance genetic effects had an important role In the Inheritance of silking date; Ochieng and Compton (1994) and Malvar *et al.* (1996) for grain yield; Mousa (1997) for no. of grains/row; Geetha and Jayaraman (2000) and El-Shouny *et al.* (2003) for no. of kernel/row, no. of rows/ear and grain yield. However, at least one type of epistatic gene action which involved additive x additive (aa), dominance x dominance (dd) and additive x dominance (ad) was significant in each cross for these traits, indicating the importance of non- allelic Interactions (epistasis) In the Inheritance of these traits. These results could be confirmed by Daune and Hallauer (1997), El-Kady *et al.* (2002) and Mosa (2003). In general, it could be concluded that the production of F_1 hybrids is the best breeding program for improvement of maize production.

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تقييم بعض هجن الذرة الشامية المبشرة لسلوكها الوراثى فى بعض الصفات الهامة

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لدراسة طبيعة الفعل الجينى للمحصول ومكوناته من خلال أربعة من هجن الذرة الشامية البيضاء ، تم تقييم ستة عشائر (الآباء ، الجيل الأول ، الجيل الثانى ، الهجن الرجعية) لأربعة من الهجن المبشرة فى صفات تاريخ ظهور الحريرة ، طول النبات ، إرتفاع الكوز ، عدد الحبوب بالصف ، عدد الصفوف بالكوز ، طول الكوز ، قطر الكوز ، محصول الحبوب للنبات خلال موسمين متتاليين. وهذه الهجن هى:
Sd7 x L.7041 ,Sd.7 x Sd.34, L.7041 x L.8084, Gz.628 x L.8084 وقد أشارت النتائج المتحصل عليها بوجود إختلاف عالى المعنوية بين الهجن المدروسة وكذلك العشائر داخل الهجن فى كل الصفات المدروسة. علاوة على ذلك فإن تداخل كل من الهجن والعشائر داخل الهجن مع المواسم الزراعية كان عالى المعنوية فى كل الصفات مما يشير إلى أن هذه الهجن والعشائر تسلك سلوكا مختلفا بإختلاف الظروف البيئية. إضافة إلى ذلك أشارت النتائج ان الفعل الجينى السيادى يلعب الدور الرئيسى فى التعبير الوراثى لهذه الصفات ، وأيضا معظم الصفات هذه تتأثر بواحد أو أكثر من طرز الفعل الجينى التفوقى والتى تشمل إضافة X إضافة ، إضافة X سيادة ، سيادة X سيادة مما يشير إلى دور التداخل بين العوامل الغير أليلية فى توريث هذه الصفات. ومن النتائج السابقة فإنه من الممكن أن نستخلص أن إنتاج الهجن هو طريقة التربية المثلى لتحسين إنتاجية الذرة الشامية.