RESULTS AND DISCUSSION

The present study was carried out to investigate the heterosis and types of gene action for some quantitative characters in some inbred lines of (*Zea mays*, L.) by means of diallel cross system. To achieve this target, half diallel of F_1 and F_2 crosses was studied.

For better representation and discussion of the results obtained herein, it was preferred to outline these results into two main parts, botanical attributes and yield and its components :

Botanical Attributes

A- Analysis of variance, means and heterosis :

1. F_1- generation :

The analysis of variance for each of the two seasons as well as the combined analysis for the botanical attributes is presented in Table (6). Season mean squares were significant for all traits except for plant height, indicating an overall differences between the two seasons. Also, the mean values in the second season were higher than those in the first one.

Significant genotypes mean squares were detected for all traits in the separate season as well as the combined analysis, indicating the wide diversity between the parental materials used in this study. Significant genotypes by seasons interaction mean squares were obtained for ear height, plant height, and leaf area. Such results

Table (6): Observed mean squares from analysis of variance for some botanical attributes in F_1 generation.

Source of variation	Degrees of freedom		Tasseling date			Silking date			Ear height (cm)		
	S	C	S1	S2	C	S1	S2	C	S1	S2	C
Season		1			36.68**			21.43*			2759.67**
Rep./ S	2	4	2.51	1.66	2.09	10.37	0.08	5.23	87.51	33.56	60.53
Genotype	27	27	17.76**	19.17**	34.36**	25.84**	24.53**	46.35**	1112.40**	1477.33**	2421.31**
Parent	6	6	28.78**	31.56**	59.06**	23.27**	33.64**	53.94**	1502.09**	1642.38**	3092.51**
F_1	20	20	7.95*	8.60**	13.46**	14.18**	9.30**	18.94**	254.53**	517.31**	565.01**
P. x F_1	1	1	147.81**	156.36**	304.11**	274.48**	274.48**	548.96**	15931.80**	19687.74**	35520.25**
G x S		27			2.58			4.02			168.42**
P x S		6			1.28			2.97			51.92
F_1 x S		20			3.09			4.54			206.83**
P x F_1 x S		1			0.06			0.00			99.29
Error	54	108	2.02	2.13	2.08	4.44	1.91	3.18	77.90	24.55	51.23

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C : First, second and the combined analysis, respectively.

Table (6): Cont.

Source of variation	Degrees of freedom		Plant height (cm)			Leaf area (cm^2)			Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
	S	C	S1	S2	C	S1	S2	C	S2	S2	S2	S2
Season		1			372.02			3983.86*				
Rep./ S	2	4	185.69	274.98*	230.33	98.10	401.68	249.89	3.60	3.48	0.5*	0.16
Genotype	27	27	4613.98**	4350.62**	8757.50**	37233.28**	43576.97**	77581.95**	11.96**	15.26**	0.14**	5.22**
Parent	6	6	2368.67**	2667.34**	4953.63**	27244.16**	26367.94**	53576.09**	9.91**	5.56**	0.23**	5.51**
F_1	20	20	441.21**	793.11**	996.43**	3419.16**	8034.78**	7167.68**	8.81**	11.66**	0.09**	2.47**
P. x F_1	1	1	101541.36**	85600.72**	186802.00**	773450.48**	857675.01**	1630037.51**	87.27**	145.37**	0.45**	58.48**
G x S		27			207.11**			3223.30**				
P x S		6			82.37			36.01				
F_1 x S		20			237.88**			4286.26**				
P x F_1x S		1			340.07			1087.98				
Error	54	108	135.58	80.82	108.20	1069.90	455.99	762.95	1.79	1.54	0.01	0.24

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C : First, second and the combined analysis, respectively.

indicated that the tested genotypes varied from each other, and ranked differently from season to another. However, insignificant genotypes by season interaction mean squares were detected for silking and tasseling dates, revealing that the genotypes were exposed to environmental change by nearly similar magnitude.

Significant parents mean squares were found in all traits (Table 6). Insignificant mean squares of interactions between parental inbred lines and seasons were detected for all traits. This result may reveale the high repeatability of the parental inbred lines under different seasons. The mean performance of the tested seven inbred lines at each season and as an average over two seasons are presented in Table (7).

The parental inbred line Moshtohor 75 gave the lowest mean values for leaf area and leaf angle. Meanwhile, it almost expressed moderate values for most other traits

The parental inbred line Moshtohor 33 gave the lowest mean values for tasseling and silking date, ear and plant height, stem diameter and number of leaves per plant. The parental inbred line Moshohor 107 A ranked the second of the tested parental inbred line for ear and plant height and the top for leaf angle. While, it was intermediate in other traits.

The parental inbred line Moshtohor 118 B behaved as the latest one for tasseling and silking date. It was the top of the tested inbred lines for; ear husk, stem diameter, and number of leaves per plant.

Table (7): The genotype mean performance for some botanical traits in F_1 generation.

Genotype	Tasseling date			Silking date			Ear height (cm)		
	S1	S2	C	S1	S2	C	S1	S2	C
P_1 M. 75	65.67	66.67	66.17	68.67	68.67	68.67	114.67	131.33	123.00
P_2 M. 33	61.33	62.00	61.67	66.00	65.33	65.67	70.00	76.77	73.38
P_3 M. 107A	66.67	67.00	66.83	71.00	70.00	70.50	129.67	130.97	130.32
P_4 M. 118B	68.67	69.67	69.17	72.33	75.00	73.67	99.00	96.67	97.83
P_5 M. 122A	63.00	66.00	64.50	67.33	69.33	68.33	112.67	117.17	114.92
P_6 M. 114D	62.67	63.33	63.00	66.33	68.00	67.17	83.00	87.77	85.38
P_7 G. 221D	60.00	60.33	60.17	64.67	65.00	64.83	127.33	133.77	130.55
$P_1 \times P_2$	61.00	62.67	61.83	63.33	64.00	63.67	125.90	137.00	131.45
$P_1 \times P_3$	62.00	65.33	63.67	65.33	67.33	66.33	152.07	165.00	158.53
$P_1 \times P_4$	62.00	62.00	62.00	66.00	66.67	66.33	155.83	152.50	154.17
$P_1 \times P_5$	58.67	61.67	60.17	60.67	65.00	62.83	135.83	153.57	144.70
$P_1 \times P_6$	61.33	62.67	62.00	64.00	64.00	64.00	143.50	147.43	145.47
$P_1 \times P_7$	61.00	61.00	61.00	64.33	63.33	63.83	134.30	160.00	147.15
$P_2 \times P_3$	60.33	60.33	60.33	63.00	64.00	63.50	139.73	138.77	139.25
$P_2 \times P_4$	61.33	61.33	61.33	63.67	64.33	64.00	132.00	126.10	129.05
$P_2 \times P_5$	59.00	60.00	59.50	61.33	63.00	62.17	129.63	121.67	125.65
$P_2 \times P_6$	58.00	60.67	59.33	59.00	62.00	60.50	140.00	126.67	133.33
$P_2 \times P_7$	59.33	60.33	59.83	64.00	62.33	63.17	133.20	130.00	131.60
$P_3 \times P_4$	63.00	65.50	64.25	66.67	67.33	67.00	144.00	154.90	149.45
$P_3 \times P_5$	62.33	62.67	62.50	65.00	65.67	65.33	136.00	160.33	148.17
$P_3 \times P_6$	58.67	62.33	60.50	60.33	64.67	62.50	150.00	155.17	152.58
$P_3 \times P_7$	60.67	60.67	60.67	64.33	65.33	64.83	148.33	166.00	157.17
$P_4 \times P_5$	62.00	63.00	62.50	65.67	66.67	66.17	129.17	136.83	133.00
$P_4 \times P_6$	61.00	60.00	60.50	64.00	64.67	64.33	127.90	147.83	104.42
$P_4 \times P_7$	65.00	64.67	64.83	68.00	67.33	67.67	137.33	147.33	142.33
$P_5 \times P_6$	60.33	60.67	60.50	62.67	62.00	62.33	121.90	139.00	130.45
$P_5 \times P_7$	61.00	61.33	61.17	65.00	64.33	64.67	127.23	157.00	142.12
$P_6 \times P_7$	61.67	60.00	60.83	65.00	62.33	63.67	133.03	142.67	137.85
Giza 2	60.00	62.33	61.17	62.67	65.00	63.83	157.90	165.40	161.65
TWC 310	60.33	64.67	62.50	62.67	66.33	64.50	153.83	168.83	161.33
SC 10	62.33	63.33	62.83	63.00	64.33	63.67	160.83	167.73	164.08
X	61.62	62.72	62.17	64.71	65.59	65.15	131.80	140.07	135.93
$LSD_{0.05}$	2.30	2.68	2.47	3.38	2.83	3.09	13.97	9.52	11.83
$LSD_{0.01}$	3.06	3.56	2.94	4.49	3.77	3.68	18.58	12.66	14.09

Table (7): Cont.

Genotype	Plant height (cm)			Leaf area (cm^2)			Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
	S1	S2	C	S1	S2	C	S2	S2	S2	S2
P_1 M. 75	195.00	185.00	190.00	338.00	341.07	339.53	27.17	5.37	1.93	13.17
P_2 M. 33	147.67	143.33	145.50	440.33	443.80	442.07	28.77	5.60	1.60	11.03
P_3 M. 107A	209.33	213.33	211.33	536.00	537.53	536.77	33.10	6.33	2.13	12.30
P_4 M. 118B	188.00	200.00	194.00	365.67	367.30	366.48	29.17	8.43	2.50	14.60
P_5 M. 122A	225.33	225.10	225.22	565.00	558.17	561.58	30.13	8.37	2.10	14.13
P_6 M. 114D	169.33	176.57	172.95	544.67	540.53	542.60	30.13	6.20	2.00	12.23
P_7 G. 221D	221.00	226.00	223.50	552.00	559.73	555.87	29.13	5.20	2.20	14.53
P_1 x P_2	259.40	253.10	256.25	739.70	665.00	702.35	30.63	1.27	2.20	14.73
P_1 x P_3	298.07	282.90	290.48	710.33	634.60	672.47	33.30	3.57	2.33	15.40
P_1 x P_4	279.33	271.67	275.50	709.53	705.00	707.27	28.03	4.80	2.53	16.57
P_1 x P_5	278.57	282.50	280.53	619.60	680.27	649.93	31.57	3.80	2.40	15.87
P_1 x P_6	272.23	264.00	268.12	714.13	669.77	691.95	30.53	1.47	2.50	15.43
P_1 x P_7	288.50	288.43	288.47	658.40	635.47	646.93	32.27	2.93	2.47	16.33
P_2 x P_3	291.40	261.40	276.40	669.60	753.90	711.75	32.43	1.77	2.13	13.60
P_2 x P_4	263.83	245.00	254.42	681.40	701.73	691.57	33.83	6.87	2.17	14.20
P_2 x P_5	263.47	238.07	250.77	682.80	653.50	668.15	30.83	3.07	1.90	13.40
P_2 x P_6	258.77	251.57	255.17	717.73	732.93	725.33	30.13	2.20	1.87	14.07
P_2 x P_7	265.90	249.50	257.70	666.90	706.17	686.53	30.87	0.67	2.30	13.77
P_3 x P_4	299.33	287.23	293.28	661.83	690.83	676.33	35.83	6.60	2.37	15.90
P_3 x P_5	274.70	293.17	283.93	685.40	732.20	708.80	33.10	2.20	2.23	16.13
P_3 x P_6	277.57	273.33	275.45	705.40	839.40	772.40	32.17	2.07	2.20	15.03
P_3 x P_7	278.97	295.83	287.40	722.20	766.27	744.23	34.33	2.60	2.07	15.23
P_4 x P_5	265.23	265.17	265.20	721.73	771.37	696.55	31.17	7.67	2.20	15.37
P_4 x P_6	263.50	265.60	264.55	710.93	763.17	737.05	32.13	5.10	2.30	15.33
P_4 x P_7	273.90	278.07	275.98	722.27	744.90	733.58	30.43	5.00	2.30	15.53
P_5 x P_6	269.33	263.73	266.53	729.90	728.23	729.07	33.43	4.33	2.03	14.27
P_5 x P_7	270.13	281.73	275.93	679.80	689.27	684.53	32.47	1.20	2.23	14.73
P_6 x P_7	261.03	264.17	262.60	719.07	780.93	750.00	32.73	3.53	2.20	15.57
Giza 2	279.33	289.33	284.33	690.23	735.70	712.97	28.90	3.80	2.27	15.27
TWC310	308.23	291.67	299.95	740.37	758.17	749.27	33.47	3.03	2.57	15.70
S.C 10	294.47	289.43	291.95	747.43	778.03	762.73	30.70	3.70	2.40	15.30
X	257.77	254.71	256.24	649.95	663.39	656.67	31.38	4.15	2.22	14.67
LSD $_{0.05}$	18.81	17.42	17.94	52.67	38.23	45.56	2.47	2.03	0.18	0.80
LSD $_{0.01}$	25.02	32.16	21.37	70.05	50.85	54.25	3.29	2.70	0.24	1.06

Also, it was the third inbred line for ear height, plant height and six th for leaf area.

The parental inbred line Moshtohor 122 A gave the highest mean values for plant height, leaf area in both seasons as well as the combined and it was the second for number of leaves per plant (Table 7). While, it almost expressed moderate values for most of the other traits.

The parental inbred line Moshtohor 114 D showed moderate values for most traits.

The parental inbred line Giza 221 D behaved as the earliest one for tasseling and silking dates and it was the poorest one for ear husk, plant and ear height.

Hybrid mean squares were found herein to reach the significance level in all cases Table (6), revealing overall differences between these hybrids. Significant interaction between F_1 hybrids and seasons were detected for ear height, plant height and leaf area, indicating that these hybrids behaved somewhat differently from one season to another.

For silking and tasseling date, insignificant mean squares for interaction between hybrids and season were detected , revealing that the hybrids responded to environmental change by nearly similar magnitude.

Mean performances of parental inbred lines and their F_1 hybrids, S.C. 10, T.W.C. 310 and Giza-2 at each season as well as at the combined over both seasons are presented in Table (7). The earliness of tasseling and silking dates was detected by cross (P_2 x P_5), (P_2 x P_6), (P_2 x P_7) and (P_5 x P_6) in both seasons as well as the combined analysis. Earliness in maize is favourable for escaping destructive injuries by *Sesamia cretica* Led, *Chilo simplex* But, and *Pyrausta nubilalis* Hb.

As for plant and ear heights, seven hybrids (P_1 x P_2), (P_2 x P_4), (P_2 x P_5), (P_2 x P_6), (P_2 x P_7), (P_4 x P_5) and (P_5 x P_6) gave the lowest values in both seasons and in combined analysis. However, the highest values for both traits were recorded by both crosses (P_1 x P_3), (P_3 x P_7), S.C. 10 and T.W.C. 310 in both seasons as well as the combined analysis. Plant shortness in maize decreased the lodging degree and increased the yield potentiality .

The highest values for leaf area were recorded by crosses (P_3 x P_6), (P_3 x P_7), (P_4 x P_6), (P_5 x P_6) and (P_6 x P_7) and S.C. 10 and T.W.C 310 in both seasons and the combined analysis. The high values for leaf area is the important trait to obtain the high grain yield.

The highest values for ear husk were recorded by two crosses (P_2 x P_4), and (P_4 x P_5). The high value of ear husk is protecting the grain from birds and insects.

The lowest values for leaf angle were recorded by cross (P_1 x P_4) followed by cross (P_2 x P_6) and then by cross (P_4 x P_7). The lowest value for leaf angle is the most important trait to obtain the high number of plant per area.

The highest values for stem diameter were detected in crosses (P_1 x P_4), (P_1 x P_6) and T.W.C. 310. The high value for stem diameter is the most important trait for lodging resistance in maize.

For number of leaves per plant, three crosses (P_1 x P_4), (P_1 x P_7), and (P_3 x P_5) exhibited high leaf number . The high number of leaves per plant is an important trait to obtain high grain yield in corn.

Heterosis :

Mean squares for parents vs. hybrids as an indication to average heterosis over all crosses were significant for all traits (Table 6). These results are in agreement with Beck *et al,* (1991) for ear and plant height.

F_1 mean values were significantly higher than parental means for all traits except tasseling, silking date and ear husk where the parental means were significantly higher than F_1 mean values (Table 7).

Insignificant mean squares of interaction between parent vs. crosses and season were detected for all traits. This results indicated that the heterotic effects were not affected by the seasonal changes.

Heterosis expressed as the percentage deviation of F_1 performance from its mid- parents value and better parent average value for all traits studied at both seasons and as an average over the two seasons are presented in Table (8).

As for tasseling and silking date, the hybrids tended to deviate towards earliness in both seasons. Earliness, if found in corn, is

Table (8): Percentage of heterosis over both mid- parent and better parent for some botanical traits in F_1 generation .

Characters	Tasseling date						Silking date					
	S1		S2		C		S1		S2		C	
crosses	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 x P_2$	-3.94*	-0.54	-2.59	1.08	-3.26*	0.27	-5.94**	-4.04	-4.48**	-2.04	-5.21**	-3.05
$P_1 x P_3$	-6.30**	-5.58**	-2.24	-2.00	-4.26**	-3.78*	-6.44**	-4.85	-2.89*	-1.94	-4.67*	-3.40
$P_1 x P_4$	-7.69**	-5.58**	-9.05**	-7.00**	-8.37**	-6.30**	-6.38**	-3.88	-7.19**	-2.91	-6.79**	-3.40
$P_1 x P_5$	-8.81**	-6.88**	-7.04**	-6.57**	-7.91**	-6.72**	-10.78**	-9.90**	-5.80**	-5.34**	-8.27**	-8.05**
$P_1 x P_6$	-4.42**	-2.13	-3.59*	-1.05	-4.00*	-1.59	-5.19*	-3.52	-6.34**	-5.88**	-5.77**	-4.71*
$P_1 x P_7$	-2.92	1.67	-3.94*	1.11	-3.43*	1.39	-3.50	-0.52	-5.24**	-2.56	-4.37*	-1.54
$P_2 x P_3$	-5.73**	1.63	-6.46**	-2.69	-6.10**	-2.16	-8.03**	-4.55	-5.42**	-2.04	-6.73**	-3.30
$P_2 x P_4$	-5.64**	0.00	-6.84**	-1.08	-6.24**	-0.54	-7.95**	-3.54	-8.31**	-1.53	-8.13**	-2.54
$P_2 x P_5$	-5.09**	-3.80*	-6.25**	-3.23	-5.68**	-3.51	-8.00**	-7.07**	-6.44**	-3.57*	-7.21**	-5.33*
$P_2 x P_6$	-6.45**	-5.44**	-3.19*	-2.15	-4.81**	-3.78*	-10.83**	-10.61**	-7.00**	-5.10**	-8.91**	-7.87**
$P_2 x P_7$	-2.20	-1.11	-1.36	0.00	-1.78	-0.55	-2.04	-1.03	-4.35**	-4.10*	-3.19	-2.57
$P_3 x P_4$	-6.90**	-5.50**	-4.15*	-2.24	-5.52**	-3.87*	-7.00**	-6.10*	-7.13**	-3.81*	-7.05**	-4.97*
$P_3 x P_5$	-3.86	-1.06	-5.76**	-5.05**	-4.82**	-3.10	-6.02**	-3.47*	-5.74**	-5.29**	-5.88**	-4.39*
$P_3 x P_6$	-9.78**	-6.38**	-4.35*	-1.58	-6.80**	-3.97*	-12.14**	-9.05**	-6.28**	-4.90**	-9.20**	-6.95**
$P_3 x P_7$	-4.21*	1.11	-4.71*	0.55	-4.46**	0.83	-5.16*	-0.52	-3.21*	0.51	-4.19*	0.00
$P_4 x P_5$	-5.82**	-1.59	-7.13**	-4.55*	-6.48**	-3.10	-5.97**	-2.48	-7.62**	-3.85*	-6.81**	-3.17
$P_4 x P_6$	-7.11**	-2.66	-9.77**	-5.26**	-8.45**	-3.97*	-7.69**	-3.52	-9.56**	-4.90**	-8.64**	-4.22
$P_4 x P_7$	1.04	8.33**	-0.51	7.18**	0.26	7.76**	-0.73	5.16	-3.81**	3.59*	-2.29	4.37
$P_5 x P_6$	-3.98*	-3.72*	-6.19**	-4.21*	-5.10**	-3.97*	-6.23**	-5.53	-9.71**	-8.82**	-8.00**	-7.20**
$P_5 x P_7$	-0.81	1.67	-2.90	1.66	-1.87	1.66	-1.52	0.52	-4.22**	-1.03	-2.88	-0.26
$P_6 x P_7$	-0.54	2.78	-2.97	-0.55	-1.22	1.11	-0.76	0.52	-6.27**	-4.10*	-3.53	-1.80

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C = First, second and combined analysis, respectively.
MP and BP = mid and better parent, respectively.

Table (8): Cont.

characters	Ear height						Plant height					
	S1		S2		C		S1		S2		C	
crosses	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	36.35**	79.86**	31.67**	78.46**	33.87**	79.13**	51.40**	75.67**	54.17**	76.58**	52.76**	76.12**
$P_1 \times P_3$	24.48**	32.62**	25.81**	25.99**	25.17**	28.89**	47.44**	52.86**	42.04**	52.92**	44.76**	52.89**
$P_1 \times P_4$	45.87**	57.41**	33.77**	57.76**	39.62**	57.58**	45.87**	48.58**	41.13**	46.85**	43.50**	45.00**
$P_1 \times P_5$	19.50**	20.56**	23.60**	31.07**	21.64**	25.92**	32.55**	42.86**	37.77**	52.70**	35.13**	47.65**
$P_1 \times P_6$	45.19**	72.89**	34.58**	67.98**	39.61**	70.37**	49.44**	60.77**	46.03**	49.52**	47.74**	55.03**
$P_1 \times P_7$	10.99*	17.12**	20.71**	21.83**	16.07**	19.63**	38.70**	47.95**	40.36**	55.91**	39.52**	51.83**
$P_2 \times P_3$	39.97**	99.62**	33.60*	80.76**	36.72**	89.76**	63.25**	97.34**	46.58**	82.37**	54.92**	89.97**
$P_2 \times P_4$	56.21**	88.57**	45.42**	64.26**	50.75**	75.86**	57.20**	78.67**	42.72**	70.93**	49.88**	74.86**
$P_2 \times P_5$	41.93**	85.19**	25.47**	58.49**	33.46**	71.22**	41.27**	78.42**	29.23**	66.09**	35.29**	72.35**
$P_2 \times P_6$	83.01**	100.0**	53.97**	65.00**	67.96**	81.69**	63.26**	75.24**	57.28**	75.51**	60.26**	75.37**
$P_2 \times P_7$	35.00**	90.29**	23.50**	69.34**	29.06**	79.33**	44.25**	80.07**	35.11**	74.07**	39.68**	77.11**
$P_3 \times P_4$	25.95**	45.46**	36.10**	60.24**	31.01**	52.76**	50.67**	59.22**	38.98**	43.62**	44.71**	51.18**
$P_3 \times P_5$	12.24*	20.71**	29.23**	36.84**	20.84**	28.93**	26.40**	31.23**	33.73**	37.42**	30.09**	34.35**
$P_3 \times P_6$	41.07**	80.72**	41.88**	76.80**	41.48**	78.70**	46.60**	63.92**	40.21**	54.81**	43.36**	59.27**
$P_3 \times P_7$	15.44**	16.49**	25.41**	26.75**	20.50**	20.60**	29.65**	33.26**	34.67**	38.67**	32.19**	35.99**
$P_4 \times P_5$	22.05**	30.47**	27.98**	41.55**	25.03**	35.95**	28.34**	41.08**	24.76**	32.58**	26.52**	36.70**
$P_4 \times P_6$	40.55**	54.10**	60.31**	68.44**	50.50*	61.47**	47.48**	55.61**	41.06**	50.43**	44.19**	52.96**
$P_4 \times P_7$	21.36**	38.72**	27.88**	52.41**	24.64**	45.49**	33.94**	45.69**	30.55**	39.03**	32.21**	42.26**
$P_5 \times P_6$	24.60**	46.87**	35.65**	58.37**	30.26**	52.78**	36.49**	59.06**	31.32**	49.37**	33.88**	54.11**
$P_5 \times P_7$	6.03	12.93*	25.13**	34.00**	15.79**	23.67**	21.05*	22.23**	24.91**	25.16**	22.99**	23.46**
$P_6 \times P_7$	26.50**	60.28**	28.80**	62.55**	27.68**	61.45**	33.75**	54.15**	31.24**	49.61**	32.48**	51.84**

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C = First, second and combined analysis, respectively.

MP and BP = mid and better parent, respectively.

Table (8): Cont.

characters	Leaf area (cm^2)						Leaf angle	
	S1		S2		C		S2	
crosses	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	90.07**	67.99**	69.46**	49.84**	79.72**	58.88**	9.54**	12.77**
$P_1 \times P_3$	62.55**	32.53**	44.46**	18.06**	53.48**	25.28**	10.51**	22.58**
$P_1 \times P_4$	101.67**	94.04**	99.05**	91.94**	100.35**	92.99**	-0.47	3.19
$P_1 \times P_5$	37.23**	9.66*	51.30**	21.88**	44.25**	15.73**	10.18**	16.20**
$P_1 \times P_6$	61.81**	31.11**	51.94**	23.91**	56.88**	27.53**	6.57	12.39**
$P_1 \times P_7$	47.96**	19.28**	41.09**	13.53**	44.50**	16.38**	14.62**	18.77**
$P_2 \times P_3$	37.17**	24.93**	53.65**	40.25**	45.43**	32.60**	4.85	12.75**
$P_2 \times P_4$	69.08**	54.75**	73.03**	58.12**	71.06**	56.44**	16.80**	17.61**
$P_2 \times P_5$	35.84**	20.85**	30.44**	17.08**	33.14**	18.98**	4.70	7.18**
$P_2 \times P_6$	45.73**	31.76**	48.92**	35.59**	47.33**	33.68**	2.32	4.75
$P_2 \times P_7$	34.41**	20.82**	40.74**	26.16**	37.59**	23.51**	6.62*	7.30
$P_3 \times P_4$	46.80**	23.48**	52.70**	28.52**	49.76**	26.00**	15.10**	22.86**
$P_3 \times P_5$	24.51**	21.31**	33.65**	31.18**	29.07**	26.22**	4.69	9.85**
$P_3 \times P_6$	30.55**	29.51**	55.72**	55.29**	43.12**	42.35**	1.74	6.75
$P_3 \times P_7$	32.76**	30.83**	39.67**	36.90**	36.23**	33.89**	10.34**	17.85**
$P_4 \times P_5$	55.10**	27.74**	45.09**	20.28**	50.11**	24.03**	5.12	6.86
$P_4 \times P_6$	56.19**	30.53**	68.13**	41.19**	62.15**	35.84**	8.38*	10.17**
$P_4 \times P_7$	68.31**	39.90**	60.71**	33.08**	64.49**	36.47**	4.40	4.46
$P_5 \times P_6$	31.55**	29.19**	32.56**	30.47**	32.06**	29.82**	10.95**	10.95**
$P_5 \times P_7$	21.72**	20.32**	23.32**	23.14**	22.52**	21.89**	9.96**	11.44**
$P_6 \times P_7$	31.14**	30.27**	41.95**	39.52**	36.55**	34.92**	10.46**	12.36**

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C = First, second and combined analysis, respectively.
MP and BP = mid and better parent, respectively.

Table (8): Cont.

characters	Ear husk		Stem diamter (cm)		No. of leaves/ plant	
	S2		S2		S2	
Crosses	MP	BP	BP	BP	MP	BP
P_1 x P_2	-76.90**	-77.38**	24.53**	13.79**	21.76**	11.90**
P_1 x P_3	-39.03*	-43.68**	14.75**	9.38*	20.94**	16.96**
P_1 x P_4	-30.44	-43.08**	14.29**	1.33	19.33**	13.47**
P_1 x P_5	-44.66**	-54.58**	19.01**	14.29**	16.24**	12.26**
P_1 x P_6	-74.64**	-76.34**	27.12**	25.00**	21.52**	17.22**
P_1 x P_7	44.48**	-45.34*	19.36**	12.12**	17.93**	12.39**
P_2 x P_3	-70.39**	-72.11*	14.29**	0.00	16.57**	10.57**
P_2 x P_4	-2.14	-18.58	5.69	-13.33**	10.79**	-2.74
P_2 x P_5	-56.09**	-63.35**	2.70	-9.52*	6.49*	-5.19
P_2 x P_6	-62.71**	-64.52**	3.70	-6.67	20.92**	-14.99**
P_2 x P_7	-87.65**	-88.10**	21.05	4.55	7.69**	-5.28
P_3 x P_4	-10.61	-21.74	2.16	-5.33	18.22**	8.90**
P_3 x P_5	-70.07**	-73.71**	5.51	4.69	22.07**	14.15**
P_3 x P_6	-67.02**	-67.37**	6.45	3.13	22.55**	22.22**
P_3 x P_7	-54.91**	-58.95**	-4.62	-6.06	13.54**	4.82
P_4 x P_5	-8.73	-9.09	-4.35	-12.00	6.96**	5.25
P_4 x P_6	-30.30*	-39.53**	2.22	-8.00	14.29**	5.02
P_4 x P_7	-26.65*	-40.71**	-2.13	-8.00	6.64**	6.39*
P_5 x P_6	-40.50**	-48.21**	-0.81	-3.18	8.22**	0.94
P_5 x P_7	-82.31**	-85.66**	3.88	1.52	2.79	1.38
P_6 x P_7	-38.01*	-43.01*	4.76	0.00	16.31**	7.11*

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C = First, second and combined analysis, respectively.
MP and BP = mid and better parent, respectively.

favourable for escaping destructive injuries caused by *Sesamia cretica* Led., *Chilo simplex* But, and *Pyrausta nubilialis* Hb.

For tasseling date, fifteen hybrids in both seasons and seventeen in the combined analysis expressed significant negative heterotic effects relative to M.P. value. Also, nine, six and eight hybrids of the previous crosses had significant negative heterotic effects relative to the better parent in the first, second season as well as the combined analysis, respectively.

As for silking date, sixteen, twenty one and seventeen hybrids expressed significant negative heterotic effects relative to mid- parent value in the first, second season, as well as the combined analysis, respectively. However, six, twelve and eight hybrids exhibited significant negative heterotic effects relative to better parent in the same order.

Significant negative heterotic effects for earliness was previously detected by Mukherjee *et al.* (1971), Mohamed (1984), Kumar (1994), Shieh (1994), and Altinbas (1995). On the other hand, Beck *et al.* (1991) found that heterosis for days to silking was generally low.

With the exception to cross (P_5 x P_7) for ear height, all hybrids expressed significant positive heterotic effects relative to mid- parent value or better parent for ear height, plant height, and leaf area in both seasons as well as the combined analysis. Positive heterotic effects for ear height was reached by Mourad (1978), Mohamed (1984), Abo-Dheaf (1987) and Alvarez *et al.* (1993). Positive heterotic effects for plant height was reached by Kravenchcko *et al.* (1971), Yasien (1977), Mohamed (1979), Nawar *et al.* (1980), Mohamed (1984), Abo- Dheaf (1987) and Alvarez *et al.* (1993). Positive heterotic effects for leaf area was reached by Abd El- Sattar (1992) and Sheih (1994).

As for stem diameter, seven hybrids showed significant positive heterotic effects relative to mid- parent, while five of the previous crosses exhibited significant positive heterotic effects relative to better parent in the second season.

As for number of leaves per plant, all hybrids showed significant positive heterotic effects relative to mid- parent, except for cross (P_5 x P_7). Thirteen parental combination from the previous crosses had significant positive heterotic effects relative to the better parent.

2. F_2 generation :

Results in Table (9) showed the analysis of variance for botanical attributes. Mean squares for genotypes and their components were significant for all the studied traits except, mean squares of parent and parent vs. crosses for leaf angle, where insignificance was detected. Such results indicated that the tested genotypes varied from each other. F_2 mean values were significantly higher than parental inbred lines means for all traits except tasseling, silking dates and ear husk where the parental means were significantly higher than F_1 mean values (Table 10) .

Table (9): Observed mean squares from analysis of variance for some botanical traits in F_2 generation .

Source of variation	D.F	Tasseling date	Silking date	Ear height (cm)	Plant height (cm)	Leaf area (cm^2)	Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
Rep.	2	2.82	3.09	63.63	125.15	12924.83**	70.64**	3.92*	0.004	0.42
Genotype	27	13.90**	17.11**	924.20**	2533.96**	30719.43**	12.39*	10.81**	0.08**	2.85**
Parent	6	31.56**	33.64**	1635.61**	2667.36**	26367.94**	9.91	5.33**	0.23**	5.51**
Crosses	20	8.48**	9.85**	585.27**	1420.22**	15586.18**	13.74**	7.17**	0.04**	1.64**
P. vs. C.	1	16.51**	63.00**	3434.36**	24008.43**	359493.35**	0.17	116.31**	0.05**	10.98**
Error	54	1.62	2.15	93.36	176.89	2015.85	6.09	1.16	0.01	0.50

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Table (10): Mean performance for all parents and crosses studied for some botanical attributes in F_2 generation

Genotype	Tasseling date	Silking date	Ear height (cm)	Plant height (cm)	Leaf area (cm^2)	Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
P_1 M. 75	66.67	68.67	131.33	185.00	341.07	27.17	5.37	1.93	13.17
P_2 M. 33	62.00	65.33	76.77	143.33	443.80	28.77	5.60	1.60	11.03
P_3 M. 107A	67.00	70.00	130.97	213.33	537.53	33.10	6.33	2.13	12.30
P_4 M. 118B	69.67	75.00	96.67	200.00	367.30	29.17	8.43	2.50	14.60
P_5 M. 122A	66.00	69.33	117.17	225.10	558.17	30.13	8.37	2.10	14.13
P_6 M. 114D	63.33	68.00	87.77	176.57	540.53	30.13	6.20	2.00	12.23
P_7 G. 221D	60.33	65.00	133.77	226.00	559.73	29.13	5.20	2.20	14.53
$P_1 \times P_2$	64.33	66.17	126.27	230.67	601.50	27.23	1.50	2.20	13.90
$P_1 \times P_3$	66.50	69.00	132.20	243.00	512.57	32.30	4.03	2.17	13.63
$P_1 \times P_4$	63.50	67.00	131.33	251.60	632.53	29.43	4.23	2.23	14.47
$P_1 \times P_5$	64.83	68.50	117.07	225.63	556.60	28.70	7.03	2.13	14.03
$P_1 \times P_6$	62.83	65.00	140.17	256.73	643.90	28.37	4.13	2.07	14.70
$P_1 \times P_7$	66.83	69.00	122.40	216.23	561.00	27.27	5.30	2.37	13.93
$P_2 \times P_3$	63.83	68.33	115.57	226.17	545.80	30.47	3.63	2.03	13.47
$P_2 \times P_4$	64.33	66.67	108.07	211.27	629.83	28.37	3.47	2.17	13.63
$P_2 \times P_5$	63.83	66.67	108.83	215.93	584.10	32.17	1.53	2.03	13.63
$P_2 \times P_6$	61.17	64.17	120.27	231.27	619.67	31.30	2.50	2.07	14.13
$P_2 \times P_7$	63.00	67.17	109.03	201.47	570.07	26.40	3.33	2.07	12.53
$P_3 \times P_4$	66.67	69.67	135.33	250.27	751.37	30.90	4.17	2.23	14.27
$P_3 \times P_5$	64.83	67.67	127.33	232.97	609.33	31.97	3.60	1.93	13.83
$P_3 \times P_6$	63.00	65.17	141.47	254.53	740.97	32.47	3.57	2.17	14.37
$P_3 \times P_7$	63.83	66.67	156.20	288.03	739.23	34.00	3.73	2.23	15.70
$P_4 \times P_5$	66.83	69.50	112.60	220.73	647.83	27.90	7.33	2.13	13.50
$P_4 \times P_6$	61.00	63.17	136.60	254.30	702.43	31.80	4.27	2.13	14.30
$P_4 \times P_7$	63.17	65.67	148.73	265.60	763.30	27.40	2.70	2.17	15.30
$P_5 \times P_6$	63.17	64.83	115.00	219.13	598.48	29.23	5.03	2.03	13.77
$P_5 \times P_7$	63.83	66.83	118.70	224.93	624.63	28.43	4.00	2.13	13.90
$P_6 \times P_7$	62.17	65.17	109.23	207.43	581.93	28.87	1.23	1.87	12.53
Giza 2	62.33	65.00	165.40	289.33	735.70	28.90	3.80	2.27	15.27
TWC 310	64.67	66.33	168.83	291.67	758.17	33.47	3.03	2.57	15.70
SC 10	63.33	64.33	167.33	289.43	778.03	30.70	3.70	2.40	15.30
X	64.16	67.06	126.08	231.22	607.65	29.86	4.40	2.14	13.93
LSD 0.01	2.45	2.96	16.16	23.14	72.27	3.98	1.84	0.17	1.11
LSD 0.05	3.26	3.94	21.50	30.78	96.12	5.29	2.45	0.22	1.48

Results in Table (10) showed the mean performance in the F_2. With the exception of ear and plant heights and ear husk, non of the hybrids surpassed the better check variety for all traits. For all traits all crosses except cross (P_3 x P_7) exhibited short plant and ear heights and both crosses (P_4 x P_5) and (P_5 x P_6) surpassed the best check variety for stem diameter .

Remaining heterosis :

Mean squares for parents vs. F_2- hybrids as an indication of average remaining heterosis of overall crosses were significant for all the studied traits except leaf angle (Table 9).

The most desirable remaining heterotic effects were presented by two crosses (P_1 x P_4) and (P_4 x P_6) for tasseling date, four crosses (P_1 x P_6), (P_3 x P_6), (P_4 x P_6) and (P_5 x P_6) for silking date, eleven crosses (P_1 x P_2), (P_1 x P_4), (P_1 x P_5), (P_2 x P_4), (P_2 x P_7), (P_3 x P_5), (P_3 x P_6), (P_3 x P_7), (P_4 x P_5), (P_4 x P_6) and (P_4 x P_7) for leaf area, cross (P_1 x P_2) for stem diameter and three crosses (P_2 x P_3), (P_2 x P_6) and (P_3 x P_6) for number of leaves per plant (Table 11).

As for tasseling date, four and two crosses exhibited significant negative remaining heterotic effects relative to mid- and better parent average values, respectively. While, for silking date, ten and four crosses expressed significant negative remaining heterotic effects relative to mid and better parent values, respectively. Hence, it could be concluded that these crosses are valuable in breeding for earliness.

Table (11): Percentage of remaining heterosis over mid- parent and better parent for some botanical traits for F_2 generation.

Crosses	Tasseling date		Silking date		Ear height (cm)		Plant height (cm)		Leaf area (cm^2)	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	-0.001	3.76*	-1.24	1.28	21.35**	64.48**	40.51**	60.93**	53.27**	35.53**
$P_1 \times P_3$	-0.50	-0.25	-0.35	0.49	0.80	0.94	22.01**	31.35**	16.68*	-4.64
$P_1 \times P_4$	-6.85**	-4.75**	-6.73**	-2.43	15.20*	35.86**	30.87**	36.00**	78.59**	72.21**
$P_1 \times P_5$	-2.26	-1.77	-1.20	-0.24	-5.78	-0.09	10.04*	21.96**	23.79**	-0..28
$P_1 \times P_6$	-5.51**	-0.79	-4.88**	-4.41*	31.50**	103.83**	42.01**	45.40**	46.08**	19.12**
$P_1 \times P_7$	5.25**	10.77**	3.24*	6.15**	-7.66	-6.80	5.22	16.88**	24.56**	0.23
$P_2 \times P_3$	-1.03	2.96	0.98	4.59*	11.26	50.54**	26.82**	57.79**	11.24	1.54
$P_2 \times P_4$	-2.28	3.76*	-4.99**	2.04	24.62**	40.77**	23.07**	47.40**	55.30**	41.92**
$P_2 \times P_5$	-0.26	2.96	-0.99	2.04	12.24	41.77**	17.22**	50.65**	16.59*	4.65
$P_2 \times P_6$	-2.39	-1.34	-3.75*	-1.79	46.19**	56.67**	44.59**	61.35**	25.91**	14.64*
$P_2 \times P_7$	3.00	4.42*	3.07	3.33	3.58	42.03**	9.10	40.56**	13.61*	1.85
$P_3 \times P_4$	-2.44	-0.50	-3.91*	-0.48	18.90**	40.00**	21.01**	25.13**	66.08**	39.78**
$P_3 \times P_5$	-2.51	-1.77	-2.87	-2.39	2.63	8.68	6.27	9.20**	11.22	9.17
$P_3 \times P_6$	-5.50**	-0.53	-5.56**	-4.17*	29.35**	61.19**	30.56**	44.16**	37.46**	37.08**
$P_3 \times P_7$	0.26	5.80**	-1.23	2.57	18.01**	19.27**	31.12**	35.02**	34.74**	32.07**
$P_4 \times P_5$	-1.48	1.26	-3.70*	0.24	5.32	16.48*	3.85	10.37**	40.00**	16.06*
$P_4 \times P_6$	-8.27**	-3.68*	-11.65**	-7.11**	48.13**	50.52**	35.06**	44.03**	54.75**	29.95**
$P_4 \times P_7$	-2.82	4.70**	-6.19**	1.03	29.09**	53.86**	24.70**	32.80**	64.68**	36.37**
$P_5 \times P_6$	-2.32	-0.26	-5.58**	-4.66*	12.23	31.03**	9.11	24.11**	8.94	7.34
$P_5 \times P_7$	1.05	5.80**	-0.50	2.82	-5.39	1.31	-0.27	-0.07	11.75*	11.60
$P_6 \times P_7$	0.54	3.04	-2.00	0.26	-1.39	24.46**	3.06	17.48**	5.78	3.97

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Table (11): Cont.

Crosses	Leaf angle		Ear husk		Stem diameter (cm)		No. of leaves/ plant	
	MP	BP	MP	BP	MP	BP	MP	BP
P_1 x P_2	-2.63	0.24	-72.65**	-72.05**	24.51**	13.81**	14.88**	5.57
P_1 x P_3	7.19	18.89*	-31.06*	-17.96	-14.45**	1.59	7.06	3.54
P_1 x P_4	4.50	8.34	-38.65**	-21.13	0.72	-10.68**	4.20	-0.91
P_1 x P_5	0.17	5.64	2.42	31.04	5.75	1.57	2.81	-0.71
P_1 x P_6	-0.99	4.42	-28.54*	-22.99	5.89	3.35	15.75**	0.69
P_1 x P_7	-3.14	0.39	0.30	1.92	14.51**	7.59	0.60	-4.13
P_2 x P_3	-0.55	5.91	-39.12**	-35.13*	8..89*	-4.69	15.43**	9.49*
P_2 x P_4	-1.05	-1.39	-50.59**	-38.09*	5.71	-13.32**	6.37	-6.62
P_2 x P_5	10.35	11.82	-78.05**	-72.63**	9.89*	-3.19	8.35*	-3.54
P_2 x P_6	-7.38	8.81	-57.63**	-55.36**	14.83**	3.35	21.49**	15.53**
P_2 x P_7	-7.85	-8.23	-38.28**	-35.90*	8.79*	-6.05	-1.96	-13.76
P_3 x P_4	-0.75	5.94	-43.50**	-34.20*	-3.63	-10.68**	6.07	-2.28
`P_3 x P_5	1.11	6.09	-51.02**	-43.16**	-8.69*	-9.38*	4.66	-2.12
P_3 x P_6	2.69	7.75	-43.08**	-42.47**	4.84	1.59	17.12**	16.81*
P_3 x P_7	9.27	16.71*	-35.27**	-28.21	3.05	1.50	17.02**	8.03*
P_4 x P_5	-5.90	-4.34	-12.70	-12.36	-7.26*	-14.68**	-6.04	-7.53
P_4 x P_6	7.25	9.03	-41.68**	-31.18*	-5.20	-14.68**	6.58	-2.06
P_4 x P_7	-6.00	-5.95	-60.39**	-48.08**	-7.79*	-13.32**	5.03	4.80
P_5 x P_6	-2.99	-2.99	-30.90**	-18.82	-0.83	-18.68**	4.43	-2.59
P_5 x P_7	-4.05	-2.40	-41.04**	-23.08	-0.79	-3.05	-3.02	-4.36
P_6 x P_7	-2.59	-0.91	-78..37**	-76.29**	-11.10**	-15.14**	-6.35	-13.76*

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

As for plant height, fourteen and nineteen crosses showed significant positive remaining heterotic effects relative to mid- and better parent, respectively. Also, for ear height, ten and sixteen parental combinations exhibited remaining heterotic effects in the same order. The other crosses gave insignificant remain heterotic effects in both traits.

As for leaf area, seventeen and eleven crosses showed significant positive remaining heterotic effects relative to mid- and better parent values, respectively. The cross (P_1 x P_4) had the highest desirable values for these traits.

As for stem diameter, six crosses (P_1 x P_2), (P_1 x P_7), (P_2 x P_3), (P_2 x P_5), (P_2 x P_6) and (P_2 x P_7) expressed significant positive remaining heterotic effects relative to mid- parent, while, the cross (P_1 x P_2) relative to better parent.

As for number of leaves per plant, seven and four crosses exhibited significant positive remaining heterotic effects relative to mid- and better parent, respectively.

Inbreeding Depression :

Results of inbreeding depression (I.D.) in F_2 - generation for all the botanical traits, are presented in Table (12).

Ten and eleven parental combinations showed significant inbreeding depression percentage for tasseling and silking dates, respectively, indicating that the mean values in the F_1 were the earlier

Table (12): Inbreeding depression for some botanical traits in F_2 generation.

Crosses	Tasseling date	Silking date	Ear height (cm)	Plant height (cm)	Leaf area (cm^2)
$P_1 \times P_2$	-2.66	-3.39	7.83	8.86**	9.55*
$P_1 \times P_3$	-1.79	-2.48	19.88**	14.10**	19.28**
$P_1 \times P_4$	-2.42	-0.50	13.88**	7.39*	10.28*
$P_1 \times P_5$	-5.13**	-5.39**	23.77**	20.13**	18.18**
$P_1 \times P_6$	-0.27	-1.56	4.93	2.75	3.86
$P_1 \times P_7$	-9.56**	-8.95**	23.50**	25.03**	11.72*
$P_2 \times P_3$	-5.80**	-6.77**	16.72**	13.48**	27.60**
$P_2 \times P_4$	-4.89**	-3.63*	14.30**	13.77**	10.25*
$P_2 \times P_5$	-6.38**	-5.82**	10.55*	9.30*	10.62*
$P_2 \times P_6$	-0.82	-3.50	5.05	8.07*	15.45**
$P_2 \times P_7$	-4.42*	-7.76**	16.13**	19.25**	19.27**
$P_3 \times P_4$	-1.78	-3.47*	12.63**	12.87**	-8.76*
$P_3 \times P_5$	-3.46	-3.05	20.58**	20.53**	16.78**
$P_3 \times P_6$	-1.07	-0.77	8.83*	6.88*	11.73**
$P_3 \times P_7$	-5.22**	-2.04	5.90	2.64	3.53
$P_4 \times P_5$	-6.08**	-4.25*	17.71**	16.76**	3.51
$P_4 \times P_6$	-1.67	2.32	7.60	4.25	7.96*
$P_4 \times P_7$	2.32	2.47	-0.95	4.48	-2.47
$P_5 \times P_6$	-4.12*	-4.57*	17.27**	16.91**	17.82**
$P_5 \times P_7$	-4.08*	-3.89*	24.40**	20.16**	9.38*
$P_6 \times P_7$	-3.61	-4.56*	23.44**	21.48**	25.48**

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

than the F_2. These results are in general agreement with findings of Pena and Arellano (1991) for tasseling date.

Fifteen, seventeen and sixteen F_2- crosses exhibited significant positive inbreeding depression percentage for ear height, plant height, and leaf area, respectively.

b- Combining ability

1- F1 - generation :

Analysis of variance for combining ability as outlined by Griffing (1956) method- 2 model- 1 in each season and their combined data for the botanical traits is shown in Table (13). The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were significant for all the studied traits. It is evident that both additive and non- additive gene effects were involved in determining the performance of the single cross progeny. Also, when GCA/ SCA ratio was estimated, it was found that, plant height in the first season as well as the combined analysis and leaf area in both seasons as well as the combined analysis exhibited low GCA/ SCA ratios of less than unity indicating the predominance of non additive gene effects for these traits. For plant height in the second season, the ratio GCA/ SCA was about unity indicating the equal importance of both types of gene effects. On the other hand, high GCA/ SCA ratio which exceeded the unity were obtained for other traits.

Such results indicated that additive and additive x additive types of gene action were more important than non- additive gene effects in controlling these traits. The genetic variance was previously reported to be mostly due to additive types of gene action for earliness (Sotcenko, 1970; Odiemah, 1973; Mohamed, 1979; Hassaballa *et al.*, 1980; Mohamed, 1984; Sedhom, 1984; Nawar and El- Hosary, 1985a; Salem *et al.*, 1986; Abo- Dheaf, 1987; El- Hosary, 1988 (b and c); Badr, 1989; El- Hosary, 1989; Mahmoud, 1989; El- Hosary, *et al,* 1990a; Abd El- Sattar, 1992; Altinbas, 1995; and Nawar *et al.* 1995 (a and b), ear height (Odiemah, 1973; Mohamed, 1979; El- Hosary, 1986; Salem *et al.* 1986; Abo- Dheaf, 1987; El- Hosary, 1987; El- Hosary, 1988 (a and b); Badr, 1989; El- Hosary, 1989; El- Hosary *et al.* 1990a; Mahajan and Khehra, 1991; Reddy and Agrawal, 1992; and Altinbas, 1995). Plant height (Odiemah, 1973; Mohamed, 1979; El- Hosary, 1985; El- Hosary, 1986; Salem *et al.* 1986; El- Hosary, 1987; El- Hosary, 1988 (a and b); Beck *et al.* 1991; El- Hosary *et al.* 1990a; Mahajan and Khehra, 1991; Reddy and Agrawal, 1992; Damborsky *et al.* 1994; and Nawar *et al.* 1995 (a and b), leaf area (Abd El- Sattar, 1986 and 1992 and Nawar *et al.* 1995 (a and b), ear husk (El- Hosary, 1988a; El- Hosary *et al.* 1990a; and Abd El- Sattar, 1992). Stem diameter (Mahajan and Khehra, 1991). The non additive genetic variance was previously reported to be most prevalent for earliness (El-Hosary, 1985 and 1988a and Reddy and Agrawal, 1992). ear height (Kalsy and Sharma, 1970; Mohamed, 1984, El- Hosary, 1985 and 1988a, leaf area (Mahajan and Khehra, 1991, and ear husk (El- Hosary, 1985).

The mean squares of interaction between seasons and both types of combining ability were significant for ear height and leaf area. Such results showed that the magnitude of all types of gene action varied from season to another. It is fairly evident that the ratio for SCA x season/ SCA was higher that ratio of GCA x season/ GCA for ear height. This result indicated that non additive effects were more influenced by the environmental conditions than additive genetic effects of that trait. These conclusions are in well agreement with those reported by Gilbert (1958).

As for plant height the mean squares of interaction between seasons and GCA was significant. However, insignificant SCA by season mean squares were detected. Such result indicated that additive effects were more influenced by seasonal change than non-additive genetic one.

On the other hand, insignificant mean squares of interaction between season and both combining ability were obtained for tasseling and silking dates, revealing that all types of gene action did not appreciably fluctuate in magnitude from season to season. These findings confirm those obtained above from the ordinary analysis of variance. The interactions between both types of combining abilities and seasonal changes were reported to be significant for earliness, plant height, ear height (El- Hosary, 1989, for ear height and earliness).

2- F_2- generation :

The analysis of variance for combining ability in the F_2 data is presented in Table (14).

The variance associated with general combining ability GCA was significant for all traits. Also, specific combining ability mean squares were significant for all traits except leaf angel. It is evident that additive types of gene action was more important part in the total genetic variability for leaf angle. As for the other studied traits, both additive and non- additive gene effects were involved in determining the performance of single cross progeny. High GCA/ SCA ratios which exceeded the unity were detected for all these traits except leaf area. Such results indicated that additive and additive x additive types of gene action were more important than non- additive effects in controlling these traits. As for leaf area the ratio of GCA/ SCA mean squares were about unity indicating the equal importance of both types. This finding coincided with that already reached from the combining ability analysis in the F_1 data (Table 13).

General combining ability effects :

1- F1 generation :

Estimates of GCA effects ($\hat{g}_i$) for individual parental inbred lines for each trait in both seasons as well as their combined analysis are presented in Table (15). General combining ability effects estimated

Table (14): Observed mean squares of general and specific combining ability from diallel cross analysis for some botanical traits in F_2 generation .

Source of variation	D.F	Tasseling date	Silking date	Ear height (cm)	Plant height (cm)	Leaf area (cm^2)	Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
Rep.	2	2.82	3.09	63.63	125.15	12924.83**	70.65**	3.92	0.004	0.42
Genotype	27	13.90**	17.01**	924.20**	2533.96**	30719.43**	12.39*	10.81**	0.08**	2.85**
G.C.A	6	37.99**	34.99**	2016.77**	3340.29**	31274.91**	34.90**	13.37**	0.18**	4.41**
S.C.A	20	7.02**	11.99**	612.03**	2303.62**	30560.31**	5.96	10.07**	0.05**	2.40**
Error	1	1.62	2.15	93.36	176.85	2015.85	6.09	1.16	0.01	0.50
GCA/ SCA	54	5.41	2.92	3.30	1.45	1.02	5.86	1.33	3.49	1.84

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
G.C.A. refers to general combining ability .
S.C.A. refers to specific combining ability .

Table (15): Estimates of general combining ability effects for parents studied for some botanical traits.

Parents	Tasseling date			Silking date			Ear height (cm)		
	S1	S2	C	S1	S2	C	S1	S2	C
Moshtohor 75	0.41	0.84**	0.63**	0.19**	0.29	0.24	4.94**	9.00**	6.97**
Moshtohor 33	-1.33**	-1.31**	-1.32**	-1.44**	-1.64**	-1.54**	-10.21**	-18.16**	-14.19**
Moshtohor 107A	0.75**	1.08**	0.91**	0.82*	1.03**	0.92**	10.79**	11.66**	11.22**
Moshtohor 118 B	2.01**	1.64**	1.82**	2.15**	2.44**	2.29**	-0.90	-4.26**	-2.58**
Moshtohor 122A	-0.48	0.03	-0.23	-0.48	0.03	-0.23	-3.03	0.62	-1.21
Moshtohor 114D	-0.81**	-0.90**	-0.85**	-1.30**	-1.04**	-1.17**	-5.56**	-6.99**	-6.27**
Giza 221 D	-0.55*	-1.38**	-0.97**	0.07	-1.12**	-0.52*	3.97*	8.15**	6.06**
r	0.92**	0.97**	0.96**	0.82*	0.95**	0.92**	0.91**	0.97**	0.96**
L.S.D. 0.05 (g_i)	0.51	0.52	0.36	0.75	0.49	0.45	3.15	1.77	1.79
L.S.D. 0.01 (g_i)	0.67	0.69	0.48	1.00	0.66	0.59	4.18	2.35	2.36
L.S.D. 0.05 (g_i-g_j)	0.77	0.80	0.55	1.15	0.75	0.68	4.80	2.70	2.73
L.S.D. 0.01 (g_i-g_j)	1.03	1.06	0.73	1.53	1.00	0.90	6.39	3.59	3.60

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C : First, second and the combined analysis, respectively.
r = correlation coefficient between mean and general combining ability effects.

Table (15): Cont.

Parents	Plant height (cm)			Leaf area (cm^2)			Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
	S1	S2	C	S1	S2	C	S2	S2	S2	S2
Moshtohor 75	3.89	0.59	2.24	-35.66**	-61.59**	-48.63**	-1.19**	-0.58*	0.08**	0.44**
Moshtohor 33	-14.78**	-24.67**	-19.72**	-12.21*	-13.97**	-13.09**	-0.57*	-0.75**	-0.20**	-1.21**
Moshtohor 107A	11.96**	12.58**	12.27**	8.68	29.52**	19.10**	1.78**	-0.26	0.01	-0.09
Moshtohor 118 B	-1.11	0.61	-0.25	-17.74**	-23.89**	-20.81**	-0.18	2.13	0.15**	0.60**
Moshtohor 122A	4.56*	7.48**	6.02**	11.17	4.95	8.06*	0.16	0.58	-0.04	0.15
Moshtohor 114D	-10.00**	-7.97**	-8.99**	26.43**	40.99**	33.71**	0.002	-0.30	-0.05*	-0.28**
Giza 221 D	5.48*	11.38**	8.43**	19.33**	23.99**	21.66**	-0.002	-0.83**	0.05*	0.39**
r	0.90**	0.96**	0.94**	0.95**	0.90**	0.93**	0.98**	0.90**	0.84*	0.89**
L.S.D. 0.05 (g_i)	4.15	3.20	2.60	11.66	7.61	6.89	0.48	0.44	0.04	0.17
L.S.D. 0.01 (g_i)	5.52	4.26	3.43	15.50	10.12	9.11	0.63	0.59	0.05	0.23
L.S.D. 0.05 (g_i-g_j)	6.34	4.89	3.96	17.81	11.62	10.53	0.73	0.68	0.06	0.27
L.S.D. 0.01 (g_i-g_j)	8.43	6.51	5.24	23.68	15.46	13.91	0.97	0.90	0.08	0.35

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C : First, second and the combined analysis, respectively.

r = correlation coefficient between mean and general combining ability effects.

herein were found differ significantly from zero. High negative values would be of interest under all traits in question except leaf area, ear husk and number of leaves per plant where high positive effects would be useful from the breeder's point of view. The parental inbred lines M 33 and M 114D showed significant negative ($\hat{g}_i$) effects for tasseling and silking dates in both seasons as well as the combined analysis, indicating that the two parental inbred lines could be considered as good combiners for developing early genotype.

As for ear and plant height, also, the two previous inbred lines M 33 and M 114D had significant negative ($\hat{g}_i$) effects in both seasons as well as the combined analysis, suggesting the possibility of utilizing both inbred lines to improve ear height and tall varieties.

Moshtohor 107 A , Moshtohor 114 D and Giza 221 D in both seasons and the combined analysis had significantly positive general combining ability effects for leaf area. Both parental inbred lines M 75 and M 33 had significant negative ($\hat{g}_i$) effects for leaf angle, suggesting the possibility of utilizing these inbred lines to release erect leaf varieties.

M 75 , M 118B and G. 221 D gave significant positive ($\hat{g}_i$)effects for stem diameter and number of leaves per plant.

Significant correlation coefficient values between the parental performance and its ($\hat{g}_i$) effects were obtained for all traits under study (Table 15).

This finding indicated that the parental inbred lines gave a good index of intrinsic performance of their general combining ability effects. Therefore, selection among the tested parental inbred lines for initiating any proposed breeding program could be practiced either on mean performance or ($\hat{g}_i$) effects basis with similar efficiency.

F2 - generation :

The estimates of GCA effects ($\hat{g}_i$) for individual inbred lines for all botanical traits in the F_2 generation are presented in Table (16).

Results indicated that the parental inbred lines G. 221 D had desirable ($\hat{g}_i$) effects in the F_1- generation. Also, it gave the same effects of ($\hat{g}_i$) in the F_2 - generation for most the studied traits under study. It could be concluded that was the best combiner (G 221 D) for the studied traits in the F_2- generation were the same for the corresponding traits in the F_1 data (Table 15).

Also, significant correlation coefficient values between the parental performance and their ($\hat{g}_i$) effects were detected for all the studied traits except for leaf area. This finding indicated that intrinsic performance of inbred lines gave a good index of their general combining ability effects. This finding confirms that reached above for ($\hat{g}_i$) effects in the F_1- generation (Table 15).

Specific combining ability effects (S_{ij}) :

F1 - generation :

Specific combining ability effects of the parental combinations were estimated for all the studied traits in both seasons as well as the combined analysis (Table 17).

Table (16): Estimates of general combining ability effects for parents studied for some botanical traits in F_2 generation.

Parents	Tasseling date	Silking date	Ear height (cm)	Plant height (cm)	Leaf area (cm^2)	Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
Moshtohor 75	0.92**	0.43	6.54**	-0.59	-60.30**	-1.14*	0.10	0.02	0.09
Moshtohor 33	-1.04**	-0.92**	-14.64**	-21.75**	-32.71**	-0.49	-0.92**	-0.12**	-0.75**
Moshtohor 107A	0.98**	0.93**	10.68**	13.60**	26.82**	2.27**	-0.07	0.02	-0.03
Moshtohor 118-B	1.22**	1.51**	-0.81	6.06*	14.33	-0.42	0.78**	0.13**	0.50**
Moshtohor 122A	0.61**	0.51	-4.38	-1.08	0.49	0.09	1.03**	-0.03	0.09
Moshtohor 114D	-1.54**	-1.62**	-3.89*	-2.52	26.17**	0.49	-0.32	-0.06**	-0.21
Giza 221 D	-1.15**	-0.84**	6.51**	6.28*	25.19**	-0.81	-0.59**	0.04*	0.31*
r	0.90**	0.80*	0.88*	0.81*	0.69	0.97*	0.84*	0.91*	0.93*
L.S.D. 0.05 (g_i)	0.45	0.52	3.44	4.74	16.00	0.88	0.38	0.04	0.25
L.S.D. 0.01 (g_i)	0.60	0.70	4.58	6.30	21.28	1.17	0.51	0.05	0.33
L.S.D. 0.05 (g_i-g_j)	0.69	0.80	5.26	7.24	24.44	1.34	0.59	0.06	0.38
L.S.D. 0.01 (g_i-g_j)	0.92	1.06	6.99	9.63	32.50	1.79	0.78	0.08	0.51

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
r = correlation coefficient between parental mean and general combining ability effects.

Table (17): Estimates of specific combining ability effects for some botanical traits in F_1 - generation.

Crosses	Tasseling date			Silking date			Ear height (cm)		
	S1	S2	C	S1	S2	C	S1	S2	C
$P_1 \times P_2$	0.21	0.50	0.35	-0.32	-0.29	-0.31	2.13	9.02**	5.57*
$P_1 \times P_3$	-0.86	0.77	-0.04	-0.58	0.38	-0.10	7.30	7.20**	7.25**
$P_1 \times P_4$	-2.12**	-3.12**	-2.62**	-1.25	-1.69**	-1.47**	22.76**	10.62**	16.69**
$P_1 \times P_5$	-2.97**	-1.84**	-2.41**	-3.95**	-0.95	-2.45**	4.88	6.81**	5.84**
$P_1 \times P_6$	0.03	0.09	0.06	0.19	-0.88	-0.34	15.08**	8.28**	11.68**
$P_1 \times P_7$	-0.57	-1.10	-0.83	-0.84	-1.47*	-1.16*	-3.65	5.71*	1.03
$P_2 \times P_3$	-0.79	-2.08**	-1.43**	-1.29	-1.03	-1.16*	10.11*	8.12**	9.12**
$P_2 \times P_4$	-1.05	-1.63*	-1.34**	-1.95*	-2.10**	-2.03**	14.07**	11.38**	12.72**
$P_2 \times P_5$	-0.90	-1.36*	-1.13*	-1.66	-1.03	-1.34*	13.83**	2.07	7.95**
$P_2 \times P_6$	-1.56*	0.24	-0.66	-3.18**	-0.95	-2.07**	26.72**	14.67**	20.70**
$P_2 \times P_7$	-0.49	0.38	-0.05	0.45	-0.55	-0.05	10.39**	2.87	6.63**
$P_3 \times P_4$	-1.45	0.14	-0.66	-1.21	-1.77	-1.49**	5.07	10.36**	7.71**
$P_3 \times P_5$	0.36	-1.08	-0.36	-0.25	-1.03	-0.64	-0.81	10.91**	5.05*
$P_3 \times P_6$	-2.97**	-0.49	-1.73**	-4.10**	-0.95	-2.53**	15.72**	13.35**	14.54**
$P_3 \times P_7$	-1.23	-1.67*	-1.45**	-1.47	-0.21	-0.84	4.53	9.05**	6.79**
$P_4 \times P_5$	-1.23	-1.30*	-1.27**	-0.92	-1.44*	-1.18*	4.05	3.33	3.69
$P_4 \times P_6$	-1.90**	-3.38**	-2.64**	-1.77	-2.36**	-2.07**	5.32	21.94**	13.63**
$P_4 \times P_7$	1.84**	1.77**	1.81**	0.86	0.38	0.62	5.22	6.30**	5.76*
$P_5 \times P_6$	-0.08	-1.10	-0.59	-0.47	-2.62**	-1.55**	1.44	8.22**	4.83*
$P_5 \times P_7$	0.32	0.05	0.19	0.49	-0.21	0.14	-2.76	11.09**	4.17
$P_6 \times P_7$	1.32*	-0.36	0.48	1.31	-1.14	0.08	5.58	4.36	4.97*
LSD 0.05	1.25	1.29	0.89	1.86	1.22	1.10	7.78	4.37	4.42
LSD 0.01	1.67	1.71	1.18	2.47	1.62	1.45	10.35	5.81	5.84
LSD 0.05 (S_{ii}-S_{ik})	2.19	2.25	1.55	3.25	2.13	1.92	13.59	7.63	7.71
LSD 0.01 (S_{ii}-S_{ik})	2.91	2.99	2.05	4.32	2.83	2.54	18.07	10.15	10.20
LSD 0.05 (S_{ii}-S_{kl})	2.05	2.10	1.45	3.04	1.99	1.80	12.71	7.14	7.22
LSD 0.01 (S_{ii}-S_{kl})	2.72	2.80	1.92	4.04	2.65	2.38	16.91	9.49	9.54

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C = first, second and combined analysis , respectively.

Table (17) : Cont.

Crosses	Plant height (cm)			Leaf area (cm^2)			Leaf angle	Ear husk	Stem diameter	No. of leaves/ plant
	S1	S2	C	S1	S2	C	S2	S2	S2	S2
$P_1 \times P_2$	16.40**	26.26**	21.33**	143.90**	87.24*	115.62**	-0.86	-1.96**	0.14**	0.75**
$P_1 \times P_3$	28.33**	18.82**	23.58**	93.74**	13.35	53.54**	1.12	0.31	0.05	0.12
$P_1 \times P_4$	22.66**	19.56**	21.11**	119.40**	137.2**	128.3**	-2.86**	-0.67	0.18**	0.68**
$P_1 \times P_5$	16.23**	23.52**	19.88**	0.51	83.58*	42.05**	1.08	-0.28	0.17**	0.46*
$P_1 \times P_6$	24.46**	20.47**	22.46**	79.79**	37.05*	58.42**	0.12	-1.87**	0.25**	0.54*
$P_1 \times P_7$	25.24**	25.55**	25.40**	31.15*	19.75*	25.45**	1.83**	0.43	0.17**	0.62**
$P_2 \times P_3$	40.33**	22.57**	31.45**	29.55*	85.03*	57.29**	-0.08	-1.87**	0.13*	0.41
$P_2 \times P_4$	25.83**	18.15**	21.99**	67.76**	86.27*	77.02**	2.61**	1.02	0.09	0.41
$P_2 \times P_5$	19.80**	4.34	12.07**	40.25**	9.20	24.72**	0.02	-1.39*	-0.05	0.08
$P_2 \times P_6$	29.66**	33.29**	31.48**	59.93**	52.59*	56.26**	-0.61	-1.52**	-0.10	1.26**
$P_2 \times P_7$	21.31**	11.87**	16.59**	16.19	42.83*	29.51**	0.10	-1.55**	0.29**	0.15
$P_3 \times P_4$	34.60**	23.13**	28.87**	27.31	31.88*	29.59**	2.21**	0.71	0.07	0.81**
$P_3 \times P_5$	4.30	22.20**	13.25**	21.97	44.40*	33.18**	-0.12	-2.30**	0.07	1.52**
$P_3 \times P_6$	21.72**	17.81**	19.77**	26.71	115.6**	71.14**	-0.98	-1.69**	0.01	0.93**
$P_3 \times P_7$	7.64	20.96**	14.30**	50.61**	59.44*	55.02**	1.16	-0.33	-0.16**	0.32
$P_4 \times P_5$	7.90	6.18	7.04*	84.71**	36.98*	60.85**	-0.77	0.96	-0.42**	-0.18
$P_4 \times P_6$	20.72**	22.06**	21.38**	58.66**	92.74*	75.70**	0.27	-0.87	0.04	0.63**
$P_4 \times P_7$	15.64**	15.17**	15.40**	127.1**	91.48*	109.3**	-1.45	-0.14	-0.01	0.02
$P_5 \times P_6$	20.89**	13.32**	17.11**	48.72**	28.97*	38.84**	1.98**	-0.24	-0.10	0.04
$P_5 \times P_7$	6.21	11.96**	9.09**	5.71	7.00	6.36	0.99	-2.54**	0.06	-0.31
$P_6 \times P_7$	11.66*	9.85*	10.76**	29.73*	62.63*	46.18**	0.53	0.003	0.10	1.04**
LSD 0.05	10.27	7.93	6.42	28.85	18.83	17.05	1.18	1.09	0.14	0.43
LSD 0.01	13.66	10.54	8.49	38.37	25.05	22.54	1.57	1.46	0.15	0.57
LSD 0.05 (S_{ii}-S_{ik})	17.93	13.84	11.21	50.36	32.88	29.77	2.06	1.91	0.18	0.79
LSD 0.01 (S_{ii}-S_{ik})	23.84	18.41	14.82	66.98	43.73	39.35	2.74	2.54	0.24	1.05
LSD 0.05 (S_{ii}-S_{kl})	16.77	12.95	10.49	47.11	30.75	27.85	1.93	1.79	0.17	0.74
LSD 0.01 (S_{ii}-S_{kl})	22.30	17.22	13.86	62.65	40.90	36.81	2.56	2.38	0.22	0.98

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C = first, second and combined analysis , respectively.

As for tasseling date, four, eight and nine crosses exhibited significantly negative $(\hat{S}_{ij})$ effects in the first, second season as well as the combined analysis, respectively. Results indicated that the crosses (P_1 x P_4), (P_4 x P_6), and (P_1 x P_5) had the best desirable $(\hat{S}_{ij})$ values in the combined analysis. The other crosses gave either significantly positive or insignificant $(\hat{S}_{ij})$ effects in the combined data.

With regard to silking date, four, six and twelve crosses expressed significant negative $(\hat{S}_{ij})$ effects in the first, second seasons as well as the combined analysis , respectively. Also, results indicated that the crosses (P_3 x P_6), (P_1 x P_5), (P_1 x P_4), (P_2 x P_6), and (P_4 x P_6) gave the highest desirable $(\hat{S}_{ij})$ values in the combined analysis. The other crosses had insignificant $(\hat{S}_{ij})$ effects in the combined analysis .

Eight, seventeen, and eighteen crosses had significantly positive $(\hat{S}_{ij})$ effects for ear height in the first, second seasons as well as the combined analysis .

As for plant height, all crosses expressed significant $(\hat{S}_{ij})$ effects in both seasons and the combined analysis, except for crosses (P_3 x P_5), (P_3 x P_7), (P_4 x P_5), and (P_5 x P_7) in the first season where insignificant $(\hat{S}_{ij})$ effects were detected .

As for leaf area, fifteen, eighteen and twenty crosses exhibited significant positive $(\hat{S}_{ij})$ effects in the first, second seasons as well as the combined analysis , respectively. The cross (P_1 x P_4) gave the highest $(\hat{S}_{ij})$ effects followed by cross (P_1 x P_2) and then by cross (P_4 x P_7) for that trait in the combined analysis .

The cross (P_1 x P_4) had significant negative ($\hat{S}_{ij}$) effects for leaf angle. Therefore, this cross might be of prime importance in breeding programs for realizing erect leaf varieties .

Nine crosses exhibited significant negative ($\hat{S}_{ij}$) effects for ear husk. The other crosses expressed insignificant ($\hat{S}_{ij}$) effects.

As for stem diameter, seven crosses showed significant positive ($\hat{S}_{ij}$) effects. However, two crosses gave significant negative ($\hat{S}_{ij}$) effects. The other crosses gave insignificant ($\hat{S}_{ij}$) effects .

F2 - generation :

Specific combining ability effects of the parental combinations were estimated for all the studied traits in the F_2- generation (Table 18).

Three, five, two, three, ten, three, four, and six crosses had desirable ($\hat{S}_{ij}$) effects for tasseling date, silking date, ear height, plant height, leaf area, ear husk, stem diameter and number of leaves per plant, respectively. In these traits one or more of the previous crosses had significant desirable ($\hat{s}_{ij}$) effects in the F_1 generation . The mentioned combinations might be of interest in breeding programs aimed at producing inbred lines for good combinations involved at least one good combiner.

Genetic components and heritability :

Hayman's diallel cross analysis is based on several assumptions: These are :

Table (18): Estimates of specific combining ability effects for some botanical traits in F_2 generation .

Crosses	Tasseling date	Silking date	Ear height (cm)	Plant height (cm)	Leaf area (cm^2)	Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
$P_1 \times P_2$	0.22	-0.61	12.71**	28.11**	102.89**	-0.87	-2.19**	0.20**	0.79*
$P_1 \times P_3$	0.37	0.37	-6.67	5.09	-45.57*	1.43	-0.50	0.02	-0.20
$P_1 \times P_4$	-2.88**	-2.20**	3.95	21.23**	86.89**	1.25	-1.15*	-0.03	0.10
$P_1 \times P_5$	-0.93	0.30	-6.75	2.40	24.80	0.02	1.40**	0.04	0.08
$P_1 \times P_6$	-0.78	-1.07	15.86**	34.95**	86.42**	-0.72	-0.15	-0.001	1.05**
$P_1 \times P_7$	2.83**	2.15**	-12.30**	-14.35*	4.49	-0.53	1.29**	0.20**	-0.24
$P_2 \times P_3$	-0.34	1.06	-2.13	9.42	-39.93*	-1.05	0.12	0.03	0.48
$P_2 \times P_4$	-0.08	-1.19	1.85	2.06	56.59**	-0.46	-0.90	0.05	0.12
$P_2 \times P_5$	0.03	-0.19	6.19	13.86*	24.70	2.83*	-3.08**	0.08	0.53
$P_2 \times P_6$	-0.49	-0.56	17.13**	30.64**	34.59	1.56	-0.76	0.14**	1.33**
$P_2 \times P_7$	0.96	1.67*	-4.50	-7.96	-14.03	-2.04	0.34	0.04	-0.79*
$P_3 \times P_4$	0.24	-0.04	3.81	5.70	118.60**	-0.69	-1.04	-0.03	0.03
$P_3 \times P_5$	-0.99	-1.04	-0.62	-4.46	-9.59	-0.13	-1.86**	-0.16**	0.01
$P_3 \times P_6$	-0.67	-1.41*	13.02**	-18.55**	96.36**	-0.03	-0.54	0.10*	0.84**
$P_3 \times P_7$	-0.23	-0.69	17.36**	43.25**	95.60**	2.80*	-0.11	0.07	1.65**
$P_4 \times P_5$	0.77	0.22	-3.87	-9.16	41.40*	-1.51	1.03*	-0.08	-0.86**
$P_4 \times P_6$	-2.91**	-3.98**	19.64**	25.86**	70.32**	1.99	-0.69	-0.05	0.24
$P_4 \times P_7$	-1.13*	-2.26**	21.38**	28.36**	132.16**	-1.11	-1.99**	-0.12**	0.72*
$P_5 \times P_6$	-0.13	-1.32*	-1.61	-2.17	-19.80	-1.08	-0.17	0.01	0.12
$P_5 \times P_7$	0.14	-0.09	-5.09	-5.17	7.34	-0.58	-0.94	0.01	-0.27
$P_6 \times P_7$	0.63	0.37	-15.04**	-21.23**	-61.04**	-0.56	-2.36**	-0.22**	-1.34**
LSD 0.05	1.12	1.29	8.52	11.73	39.60	2.18	0.95	0.09	0.62
LSD 0.01	1.50	1.72	11.33	15.60	52.66	2.90	1.26	0.12	0.83
LSD 0.05 ($S_{ij}-S_{ik}$)	1.96	2.26	14.88	20.47	69.13	3.78	1.66	0.16	3.80
LSD 0.01 ($S_{ij}-S_{ik}$)	2.61	3.01	19.78	27.23	91.94	5.05	2.21	0.21	5.05
LSD 0.05 ($S_{ij}-S_{kl}$)	1.84	2.11	13.92	19.15	64.66	3.55	1.55	0.15	3.55
LSD 0.01 ($S_{ij}-S_{kl}$)	2.44	2.81	18.51	25.47	86.00	4.73	2.06	0.20	4.73

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

1- Diploid segregation, corn is diploid and segregation in a diploid manner logically took place.

2- Homozygous parents, the parental inbred lines were assumed to be homozygous.

3- No reciprocal differences in this study,

4- No genotypic by environmental interaction within location and/ or year, this assumption was not verified when tested as the genotype x year interaction was recorded.

5- No epistasis,

6- No multiple alleles, and

7- Uncorrelated gene distribution.

To test the validity of these assumptions, therefore, two main testes were employed. First of them was t^2 value. This value of t^2 is presented in Table (19). Insignificant t^2 values were detected for all traits except ear height, plant height and leaf area in both seasons, and leaf angle and ear husk in the second season (Table 19).

The second employed test was the analysis (Wr, Vr) regression. In this test the regression coefficient is expected to be significantly different from zero but not from unity if all assumptions are satisfied (Jinks and Hayman, 1953). Significant regression lines from zero but not from unity were detected for all traits except plant height and leaf area in both seasons, ear height in the first season, leaf angle and ear husk in the second season.

Table (19): Estimate of genetic components of variation in dialllel maize crosses in F_1 for some botanical traits during 1995/ 96.

Characters / Components	Tasseling date		Silking date		Ear height (cm)		Plant height (cm)	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
D	8.91**	9.81**	6.21*	10.60**	474.62**	539.16**	743.77**	859.86**
H_1	13.08**	12.32**	19.07**	13.28**	1000.83**	839.32**	4298.16**	3382.44**
H_2	10.53**	10.99**	15.82**	11.69**	811.90**	788.56**	4003.73**	3267.79**
h^2	27.25**	28.83**	50.46**	50.91**	2959.92**	3669.45**	18924.06**	15957.82**
F	7.13*	6.24	3.16+	4.74	509.36**	152.84	751.19	335.62
E	0.68	0.71	1.55*	0.62	26.08	8.29	45.79	29.25
(H_1/ D) ½	1.21	1.12	1.75	1.12	1.45	1.25	2.40	1.98
$(H_2/ 4 H_1)$	0.20	0.22	0.21	0.22	0.20	0.24	0.23	0.24
K_D/ K_R	1.99	1.79	1.34	1.5	2.17	1.26	1.53	1.22
h^2/ H_2	2.59	2.62	3.19	4.35	3.65	4.65	4.73	4.88
h (ns)	0.40	0.42	0.36	0.51	0.25	0.52	0.12	0.27
r	0.72	0.79*	0.93**	0.90**	-0.98**	-0.95**	-0.99**	-0.98**
t^2	0.09	0.75	0.02	2.22	14.96**	3.36**	2.93*	10.17**

+, * and ** denote significant differences from zero at 0.10, 0.05 and 0.01 levels of probability, respectively.
r = correlation coefficient between mean performance (Yr) and order of dominance (Wr + Vr).

Table (19): Cont.

Characters components	Leaf area (cm^2)		Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
	S1	S2	S2	S2	S2	S2
D	8736.32**	8637.96	2.68**	1.32+	0.07+	1.76**
H_1	39455.24**	39363.92**	8.05**	10.46**	0.10**	3.60**
H_2	34723.78**	36540.16**	8.32**	9.04**	0.07**	3.02**
h^2	144148.28**	159958.52**	15.98*	26.86**	0.08**	10.87**
F	12476.90*	6754.98	-0.75	-2.62+	0.06**	0.79**
E	345.07	151.35	0.62*	0.54	0.01*	0.08**
(H_1/ D) ½	2.13	2.13	1.73	2.82	1.19	1.43
$(H_2/ 4 H_1)$	0.22	0.23	0.26	0.22	0.17	0.21
K_D/ K_R	2.01	1.45	0.85	0.48	1.97	1.38
h^2/ H_2	4.15	4.38	1.92	2.97	1.21	3.60
h (ns)	0.05	0.20	0.37	0.49	0.53	0.48
r	-0.98**	-0.93**	-0.64	0.49	-0.78*	-0.84*
t^2	29.04**	23.77**	5.63**	4.22*	0.01	1.53

+, * and ** denote significant differences from zero at 0.10, 0.05 and 0.01 levels of probability, respectively.
r = correlation coefficient between mean performance (Yr) and order of dominance (Wr + Vr).

As for exceptional cases, regression of less than unity were obtained, indicating that the assumption of genic interaction was not satisfied in the data. However, the estimation of population parameters could be possible with such partial fulfillment (Hayman 1954 b) for more information about the genetical behaviour of the agronomic traits under study.

F_1 - generation :

The estimated parameters for all the traits were presented in Table (19). Appreciable values for both additive ($\hat{D}$) and dominance ($\hat{H}_1$) components were obtained for all traits, indicating that both additive and dominance types of gene action were involved in determining the performance of single cross progeny in all traits. This finding is in agreement with that reached in Table (13).

The ($\hat{H}_1$) component was found to express the higher magnitude relative to the corresponding ($\hat{D}$) ones (Table 19). For all traits, which exhibited high GCA/ SCA ratios which exceeded the unity from combining ability analysis contradicted with that obtained from Hayman analysis. This contradiction between both types of analysis might be a logical result because of the presence of complementary type of non-allelic interaction which inflated the ratio of ($\hat{H}_1$) to ($\hat{D}$), Hayman (1954 b) and Mather and Jinks (1971). Also, dominance may has a role in GCA estimates as emphasized by Jinks (1955).

The various size of ($\hat{D}$) and ($\hat{H}_1$) estimated as $[\hat{H}_1/\hat{D}]^{1/2}$ can be used as a weight measure of the average degree of dominance at each locus, showing the presence of over- dominance for all traits. Similar results were obtained by [Odiemah (1973), Mohamed (1984), El- Hosary (1988 b and c), El- Hosary *et al,* (1990a) for earliness], [Mohamed (1979), El- Hosary (1987), Altinbas (1995) for ear height], [El- Hosary (1987), Mahajan *et al,* (1992) and Damborsky *et al.* (1994) for plant height], [Abd El- Sattar (1986) and Nawar *et al.*, (1995 a and b) for leaf area], [El- Hosary *et al.* (1990a) for ear husk] and [Mahajan and Khehra (1991) for stem diameter].

The smaller ($\hat{H}_2$) than ($\hat{H}_1$) was detected for tasseling date, silking date, ear height and leaf area in the first season and ear husk, stem diameter and number of leaves per plant in the second season, indicating that the positive μ and negative V alleles frequency at the loci for these traits are not equal proportion in the parents. This was reflected in the estimates of covariance of additive and dominance effects ($\hat{F}$) which were significantly positive in these cases except for ear husk. Positive estimates of ($\hat{F}$) indicate the excess of dominant alleles, while the negative estimates indicate the excess of recessive alleles. Also, the values of $\hat{H}_2/ 4 \hat{H}_1$ were slightly below the maximum values of 0.25 which arises when μ = V = 0.5 over all loci for the previous cases, indicating that the positive and negative alleles were not equally distributed among the parents. The same conclusion could again be drawn from the corresponding proportion $(4\hat{D}\hat{H}_1)^{1/2} + \hat{F}/ (4\hat{D}\hat{H}_1)^{1/2} - \hat{F}$.

The over all dominance effects of heterozygous loci ($\hat{h}^2$) were estimated. Significant ($\hat{h}^2$) values were detected for all traits, indicating that dominance was unidirectional. This finding confirms the results reached above for parent vs. crosses shown in Table (6).

The correlation coefficient values between parental mean (Yr) and (Wr + Vr) for each array were significantly positive for silking date in both seasons and tasseling date in the second season, indicating that decreasers genes were dominant over increasers (Table 19). This indicates that earliness was dominant over lateness.

The appreciable negative correlation coefficient between (Yr) and (Wr + Vr) were obtained for ear height, plant height in both seasons, stem diameter and number of leaves per plant in the second season. This indicates that increasers genes were dominant over decreasers. This result indicate that taller of ear and plant height, increaser of stem diameter and larger number of leaves were dominant over shorter, low ear height, small stem diameter and fewer number of leaves per plant.

Heritability :

Heritability estimates in narrow sense for all traits are presented in Table (19). Moderate heritability values in narrow sense were detected for all traits except plant height, and leaf area in both seasons and ear height in the first season where low values were detected, indicating that both additive and dominance types of gene action were involving in determining the performance of these traits. This finding supported the previous results of genetic components (Table 19). Therefore, the bulk method program to improve these traits might be quite promising .

F2- generation :

The estimated parameters for all the studied traits in the F_2 are presented in Table (20). With the exception of leaf angle and ear husk, the additive component $(\hat{D})$ reached the significance level of probability. This finding is in partial harmony with that reached above in Table (14). Only with the exception of two traits, insignificant $(\hat{D})$ value inspite of appreciable GCA was detected. Dominance may has a role in GCA value as emphasized by Jinks (1955). Moreover, the estimated t^2 was significant for leaf angle (Table 20). In addition, the regression coefficient of parental offspring covariance (Wr) on the parental array variance (Vr) was found to be less than unity for ear husk and leaf angle. Therefore, the contradiction in magnitude detected between $(\hat{D})$ and GCA estimates for both traits could be attributed to the great role of both allelic and non- allelic gene types of the expression of both traits.

Significant values for estimated dominance $(\hat{H}_1)$ were obtained for all traits. Values of $(\hat{H}_1)$ were larger in magnitude than the respective $(\hat{D})$ ones for all traits. This result revealed that non- additive type of gene action was the most prevalent genic component for these traits. This finding supported the previous results of genetic components in the F_1 (Table 19) and combining ability in (Table 14).

The relative size of $(\hat{D})$ and $(\hat{H}_1)$ estimates as $(\hat{H}_1/\hat{D})^{1/2}$ which can be used as a weighed measure of the average degree of dominance at each locus, showed the presence of over dominance for all traits except

Table (20): Estimates of genetic components of variation in a diallel maize cross for some botanical traits in F_2 generation.

Characters / components	Tasseling date	Silking date	Ear height (cm)	Plant height (cm)	Leaf area (cm^2)	Leaf angle	Ear husk	Stem diameter (cm)	No. of leaves/ plant
D	9.96**	10.48**	514.44**	830.77**	7987.50**	1.27+	1.36	0.07**	1.67**
H_1	34.05*	59.41**	2833.65**	9760.36**	126834.70**	-2.43	35.84**	0.28**	10.36**
H_2	21.42	34.89*	2077.83**	7976.13**	99123.75**	2.50	33.53**	0.16**	8.04**
h^2	4.70	37.02**	2141.31**	17118.64**	257313.53**	-27.72**	81.05**	-0.01	5.94**
F	16.76*	24.09**	887.55**	1631.83+	20419.57+	-9.36**	-0.17	0.17**	3.73*
E	0.56	0.73	30.77	58.35	801.82	2.03	0.42	0.003	0.16
$(H_1/D)^{1/2}$	0.92	1.19	1.17	1.71	1.99	0.69	2.57	0.99	1.24
$(H_2/4H_1)$	0.16	0.15	0.18	0.20	0.20	-0.26	0.23	0.14	0.19
K_D/K_R	2.67	2.87	2.16	1.80	1.95	-0.46	0.98	3.90	2.63
h^2/H_2	0.22	1.06	1.03	2.15	2.60	-11.10	2.42	-0.08	0.74
h (ns)	0.84	0.88	0.86	0.89	0.91	0.09	0.82	0.77	0.44
r	0.46	0.88**	-0.52	-0.37	-0.67	-0.61	0.87*	-0.48	-0.19
t^2	0.03	0.27	1.56	1.42	3.07*	3.41*	1.17	0.29	0.90

+, * and ** denote significant differences from zero at 0.10, 0.05 and 0.01 levels of probability, respectively.

r = correlation coefficient between parental mean performance (Ẏr) and order of dominance (Wr + Vr).

tasseling date and stem diameter which had a complete dominance. This result is in agreement with those reached in the F_1 data (Table 19).

The overall dominance effects of heterozygous loci ($\hat{h}^2$) were estimated. Significant ($\hat{h}^2$) values were obtained for all traits except tasseling date and stem diameter, indicating that the effect of dominance was due to heterozygosity and that dominance was unidirectional. This result is in general agreement with that reached in the F_1 data (Table 19) and parent vs. crosses (Table 9).

The average frequency of negative vs. positive alleles in parental population was obtained by estimating the ratio ($\hat{H}_2/ 4 \hat{H}_1$). Values largely deviating from one quarter were obtained for all traits except leaf angle and ear husk, revealing that negative and positive alleles were unequally distributed among the parents. Significant positive ($\hat{F}$) values appeared for the previous traits except leaf angle and ear husk, revealing asymmetry with dominance alleles being more frequent.

The same conclusion could be again drawn from the corresponding proportion $(\hat{D}\hat{H}_1)^{1/2} + \hat{F} / (\hat{D}\hat{H}_1)^{1/2} - \hat{F}$. This finding is in general agreement with the results obtained from F_1 data (Table 19).

The correlation coefficient values between parental mean (Yr) and (Wr + Vr) for each array were significantly positive for silking date and ear husk, indication that decreasers genes were dominant over increasers (Table 20). This indicates that earliness was dominant over lateness. This result supported the previous results obtained in the F_1 data (Table 19).

High heritability estimates in narrow sense were obtained in all traits, except number of leaves per plant and leaf angle where moderate or low values were detected, respectively.

Graphical analysis :

F_1- generation :

The data obtained herein were also subjected to genetic analysis by means of diallel cross graphs as constructed by Jinks (1954).

The regression of parent- offspring covariance (Wr) on parental array variance (Vr) and their limiting parabola of the seven parental (inbred lines) diallel crosses for all the studied traits in the F_1 at both seasons are illustrated in Fig. 1- 14. With the exception of tasseling date, in both seasons, silking date in the first season, ear height, stem diameter, and number of leaves per plant in the second season, the slope of the regression lines deviate significantly from unity, indicating that complementary type of epistasis was involved.

As for the exceptional cases, regression slopes did not differ significantly from unity. This result might reveal that the genetic system could be deduced to be additive without the complication of non allelic interaction.

The regression lines were found to intersect the (Wr) axis above the origin for tasseling date in the second season, suggesting partial dominance. Similar results were obtained by Odiemh (1973) for ear height and silking date, Salem *et al,* (1986) for silking date, ear height and plant height and El- Hosary *et al,* (1990a) for plant height.

As for tasseling date in the first season, silking date, and ear height in the second season, the regression lines passed through the origin revealing the complete dominance for these cases. Similar results were obtained by Kalsy and Sharma (1970) for silking date and Mokbel (1988) for ear height and plant height.

The position of the actual regression lines was shifted to the right of unit slope line and below the origin for other traits, indicating a case of over- dominance in the inheritance of these traits. This finding agrees with the results presented in Table (19).

The array points were significantly scattered along the regression lines for all the studied traits, revealing genetic diversity among the parents.

The parental inbred lines (P_2) and (P_6) for tasseling date in both seasons, (P_5) for ear height and plant height in the first season and leaf area in both seasons, (P_1) for ear height in the second season, (P_7) for plant height in the second season, (P_3) for leaf angle and stem diameter in the second season, (P_6) for ear husk in the second season, (P_7) for silking date in the first season and (P_2) for silking date in the second season and (P_4) for number of leaves per plant in the second season seemed to carry most of dominant genes responsible for these traits. However, (P_4) for tasseling date in both seasons, silking date and leaf angle in the second season, (P_3) for silking date in the first season and number of leaves per plant in the second season, (P_2) for plant height in both seasons, ear height in the first season, leaf area and stem diameter in the second season, (P_6) for ear height in the second season, (P_5) for ear husk in the second season possessed more recessive genes for the previous traits.

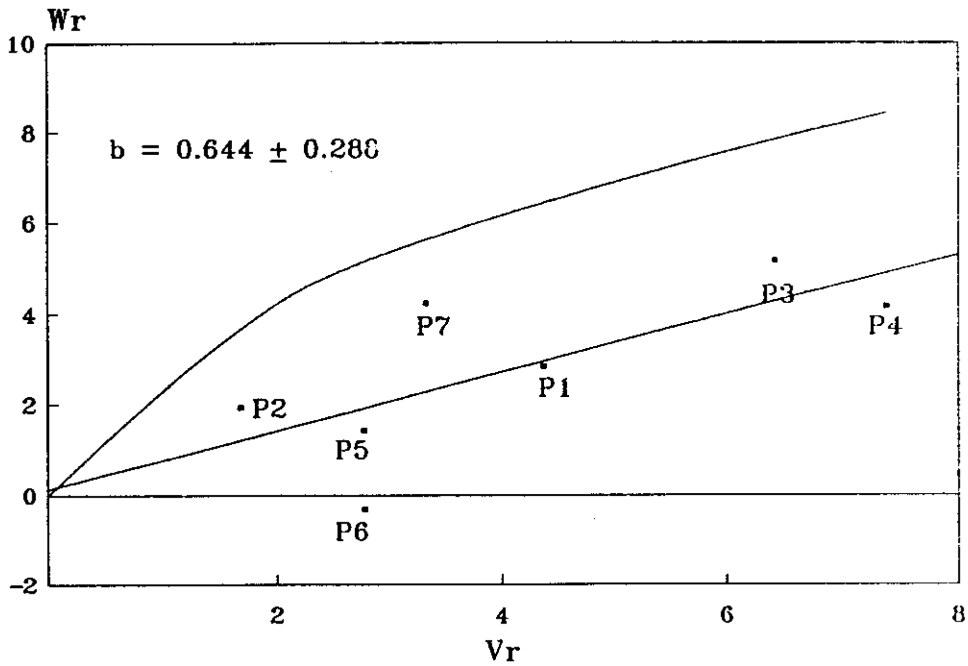

Fig. 1: Vr and Wr graph for tasseling date of F_1 S_1

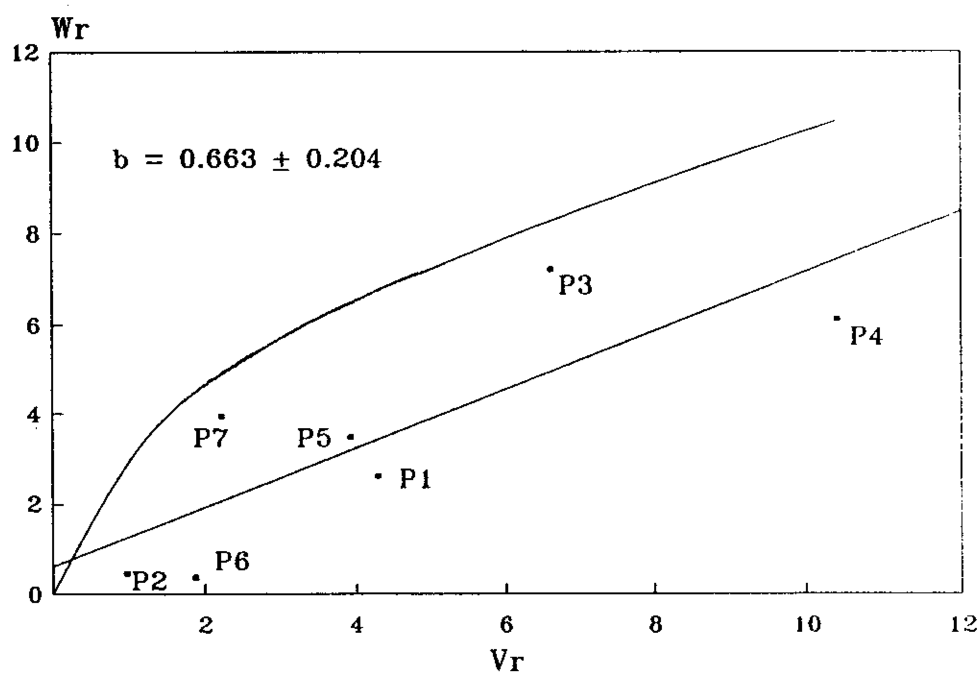

Fig. 2: Vr and Wr graph for tasseling date of F_1 S_2

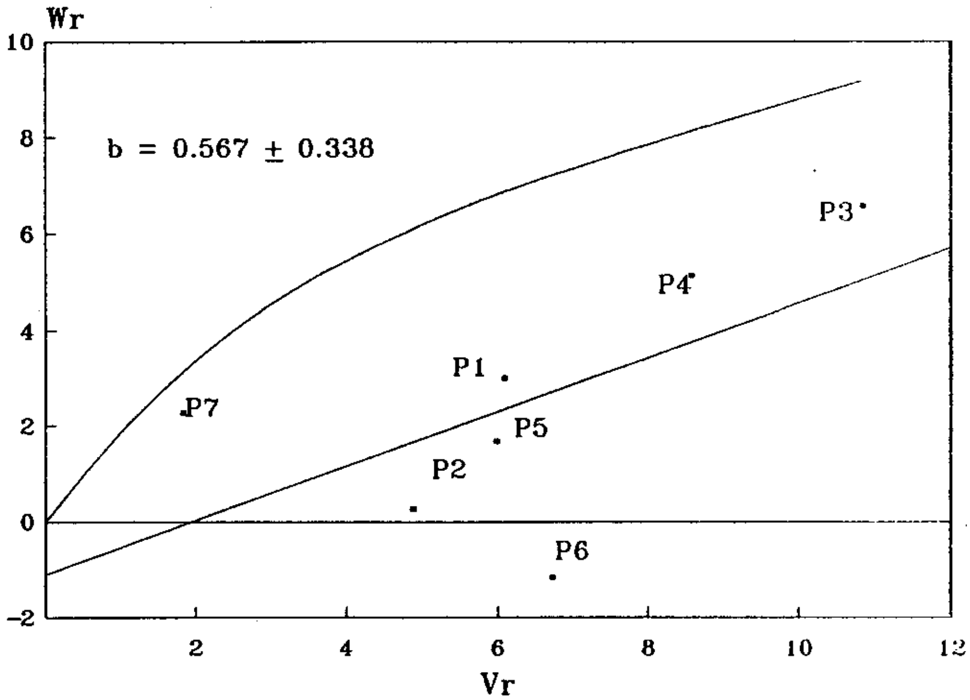

Fig. 3: Vr and Wr. graph for silking date of F_1 S_1

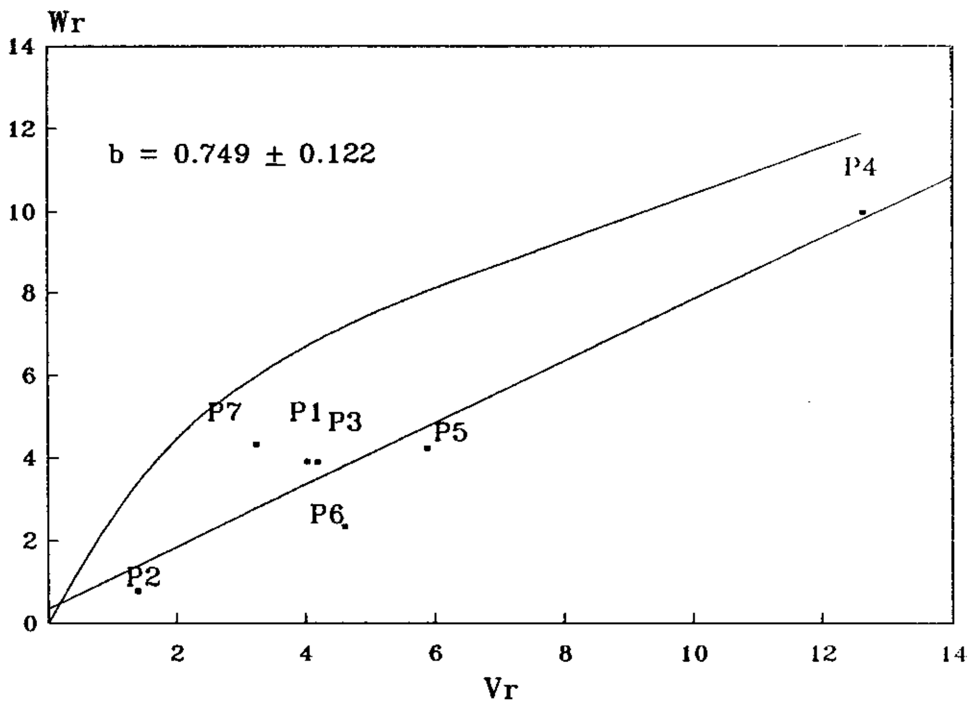

Fig. 4: Vr and Wr. graph for silking date of F_1 S_2

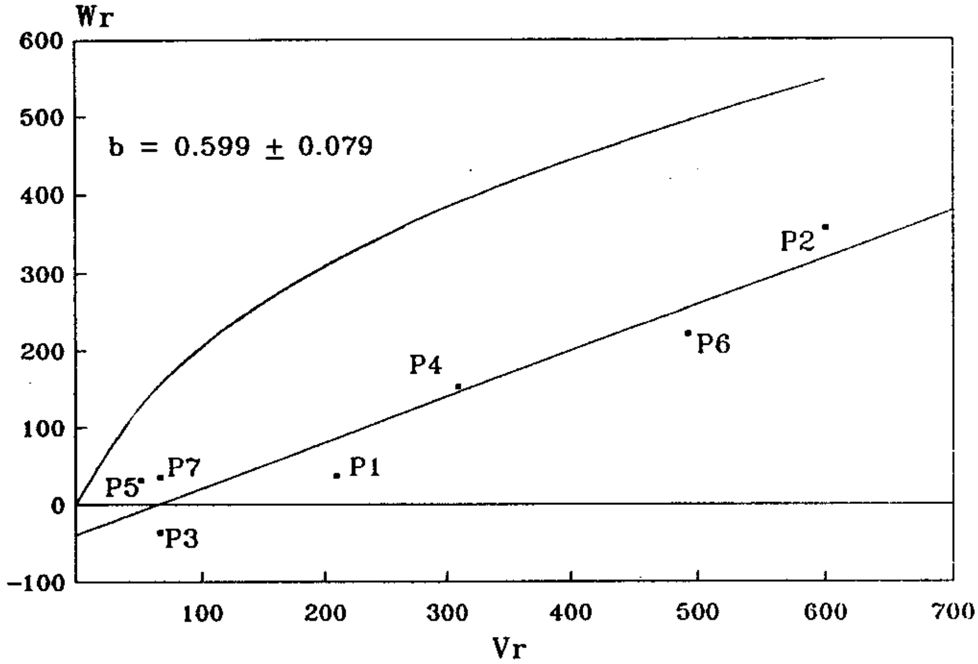

Fig. 5: Vr and Wr graph for ear height (cm) of F_1 S_1

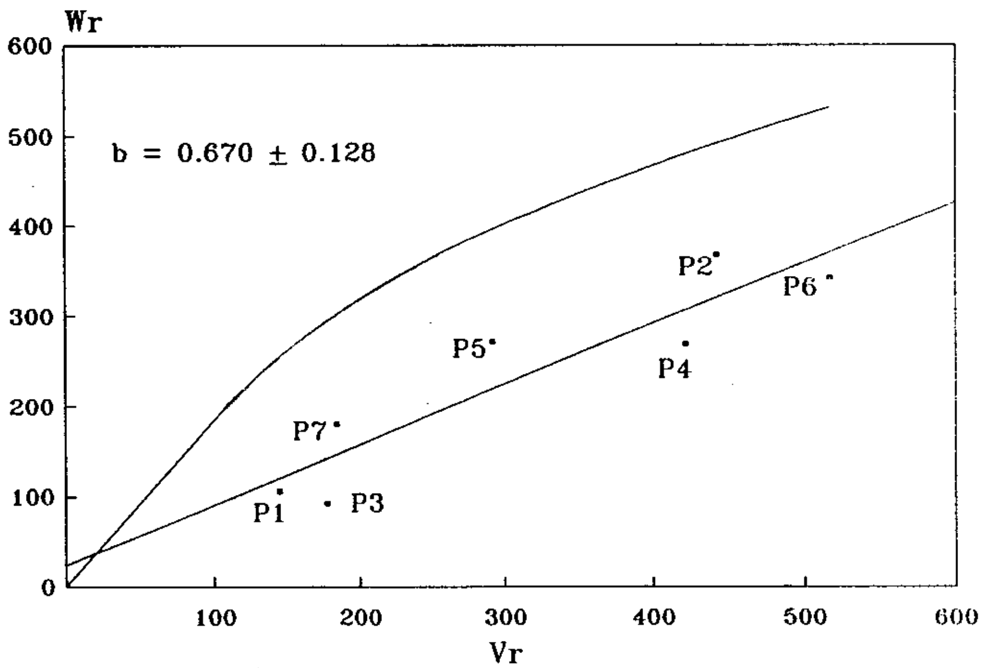

Fig. 6: Vr and Wr graph for ear height (cm) of F_1 S_2

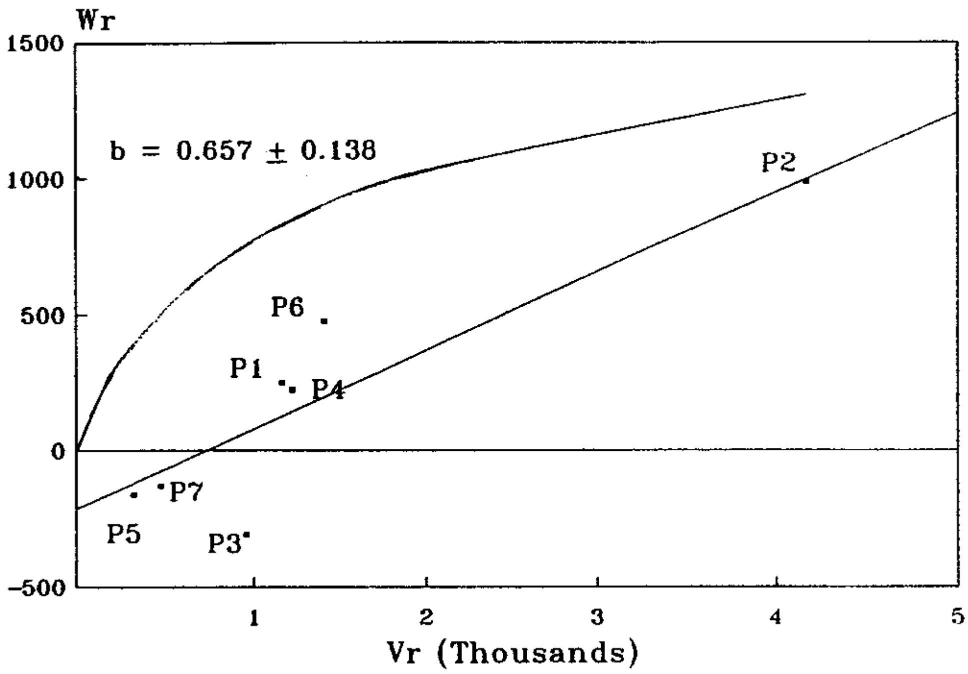

Fig. 7: Vr and Wr graph for plant height (cm) of F_1 S_1

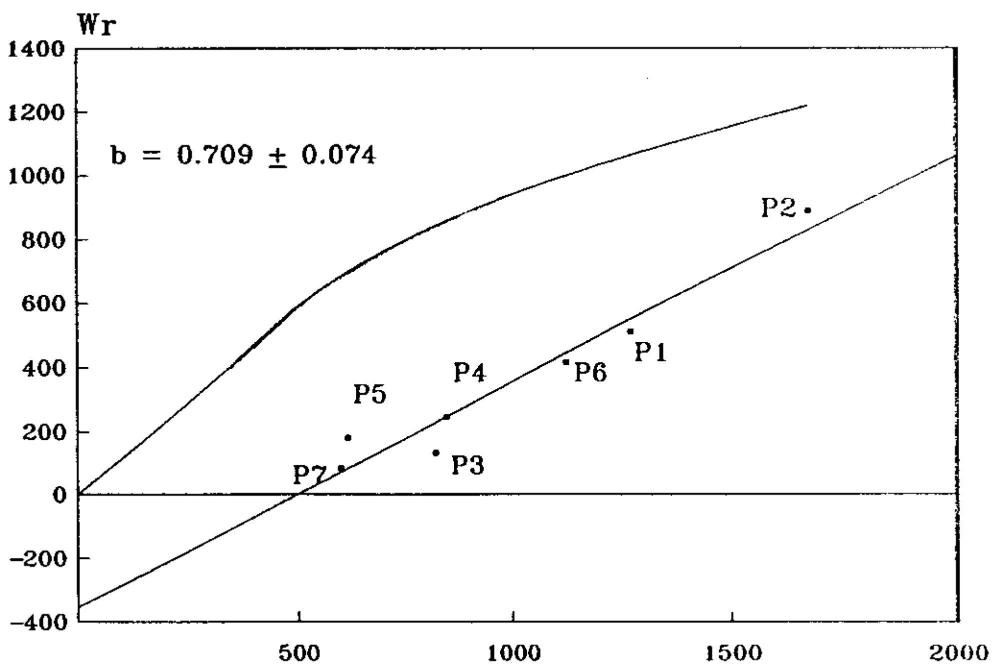

Fig. 8: Vr and Wr graph for plant height (cm) of F_1 S_2

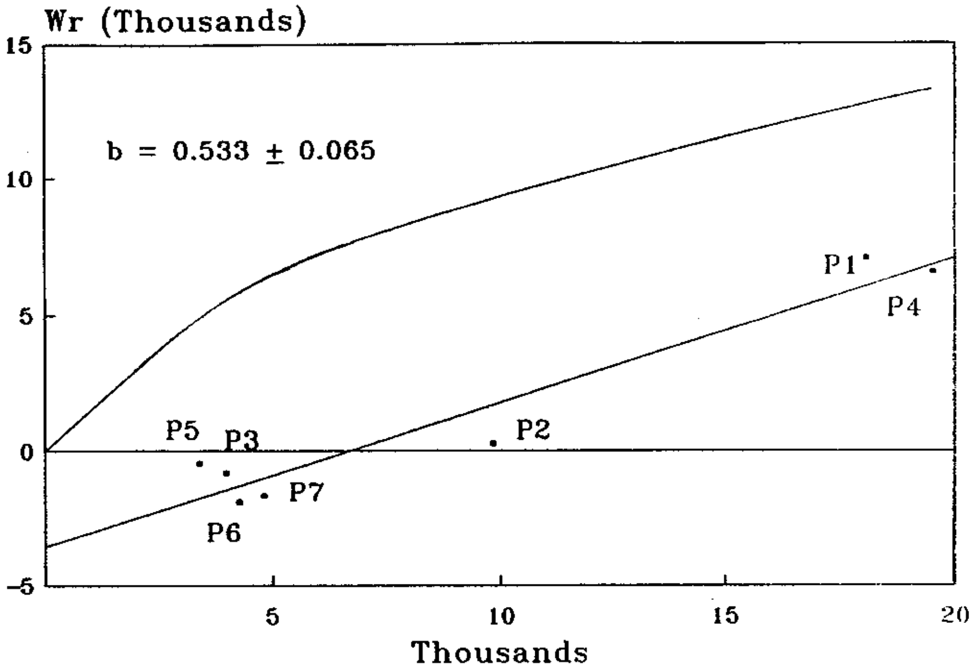

Fig. 9: Vr and Wr graph for leaf area (cm^2) of F_1 S_1

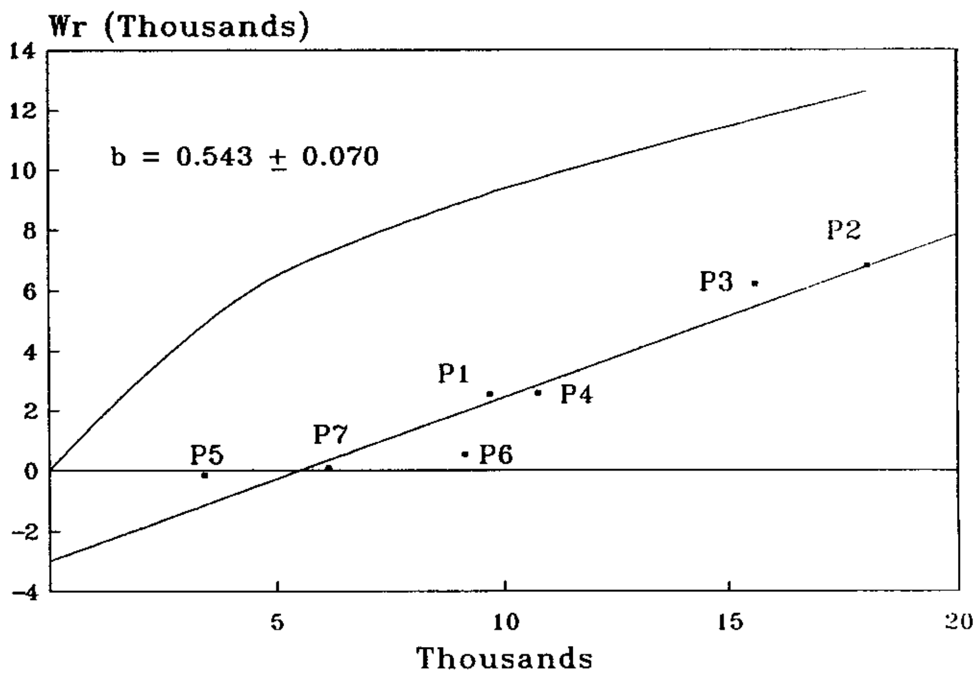

Fig. 10: Vr and Wr graph for leaf area (cm^2) of F_1 S_2

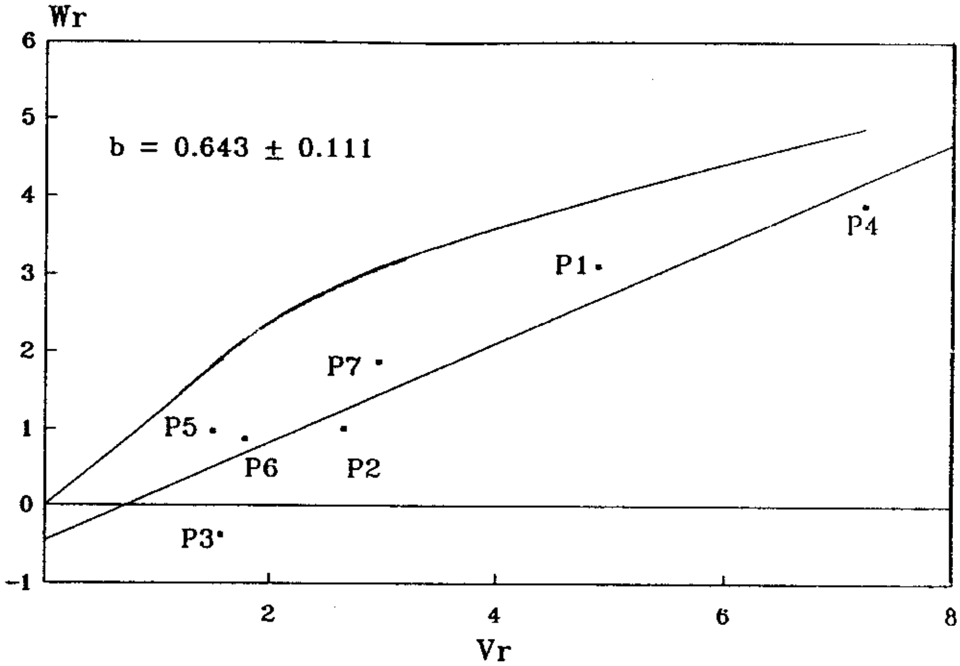

Fig. 11: Vr and Wr graph for leaf angle of F_1 S_1

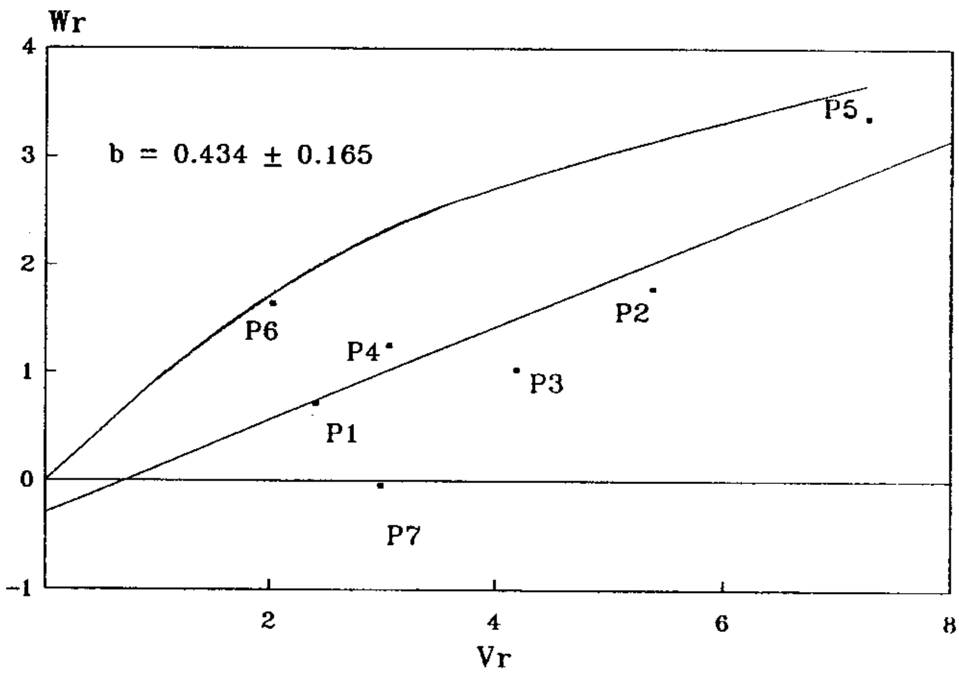

Fig. 12: Vr and Wr graph for ear husk F_1 S_2

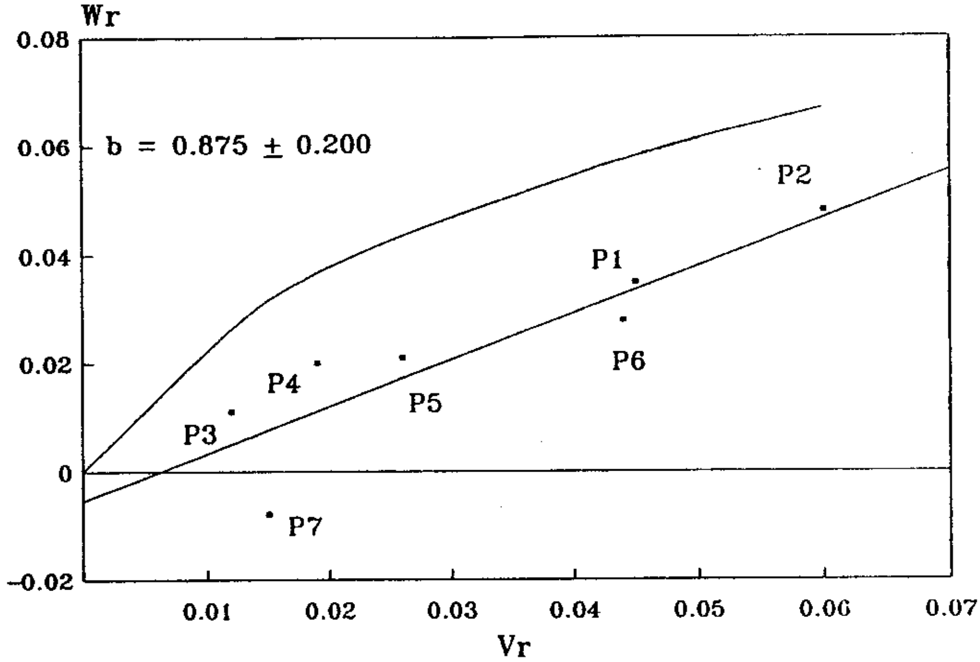

Fig. 13: Vr and Wr graph for stem diameter of F_1 S_2

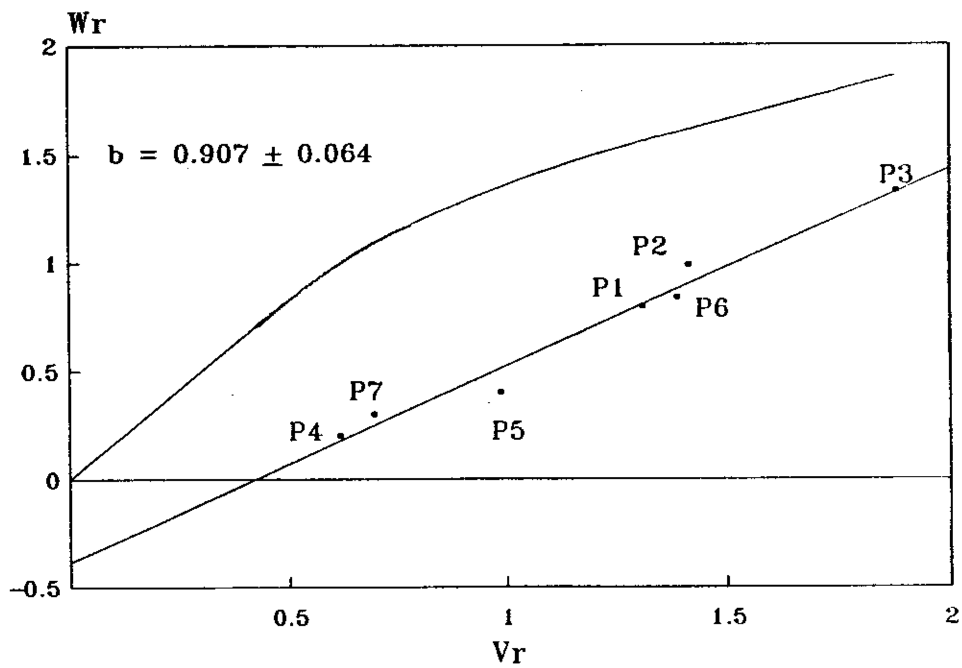

Fig. 14: Vr and Wr graph for number of leaves/ plant of F_1 S_2

F_2- generation :

The regression of parent- offspring covariance (Wr) on parental array variances (Vr) and their limiting parabola for all the studied traits in the F_2 are illustrated in Fig. 15- 23.

With the exception of ear height, plant height, leaf area, leaf angle, and number of leaves per plant, the slope of the regression lines did not deviate significantly from unity. This result might reveal that the genetic system could be deduced to be additive without the complication of non allelic interaction. Only exceptional cases, regression slopes differed from unity, indicating that complementary type of epistasis was involved.

The regression lines were found to intersect the (Wr) axis above the origin for silking date, ear height, revealing partial dominance. Similar results were obtained by Odiemah (1973) for silking date, Similar results were reported by Salem *et al,* (1986) for ear and plant height and El- Hosary *et al,* (1990a) for plant height.

As for plant height and number of leaves per plant, the regression lines passed through the origin indicating complete dominance.

As for other traits, the regression lines intersected below the origin suggesting a case of over- dominance in the inheritance of these traits.

The array points were significantly scattered along the regression line for all traits, revealing genetic diversity among the parents and in harmony with the results obtained herein for degree of dominance presented in Table (20).

The parental inbred lines (P_6), (P_6), (P_1), (P_5), (P_5), (P_3), (P_3), (P_5) and (P_5) for tasseling date, silking date, ear height, plant height, leaf area, leaf angle, ear husk, stem diameter and number of leaves per plant, respectively, seemed to carry most of dominant genes responsible for these traits. Also, (P_4), (P_4), (P_6), (P_7), (P_4), (P_7), (P_5), (P_2) and (P_7) possessed more recessive genes for the same order.

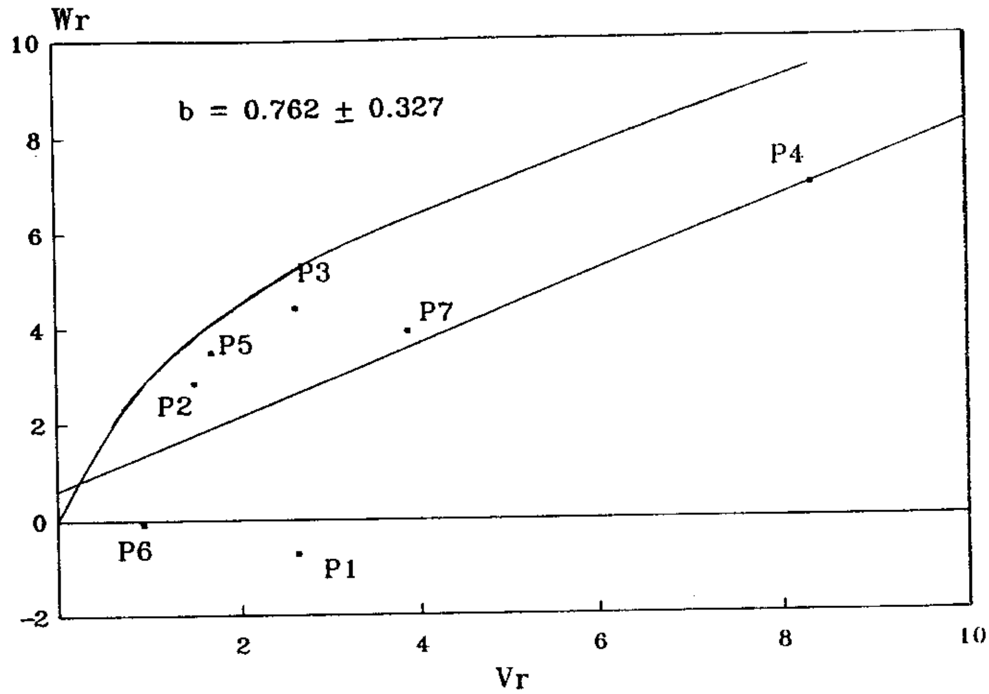

Fig. 15: Vr and Wr graph for tasseling date .of F_2

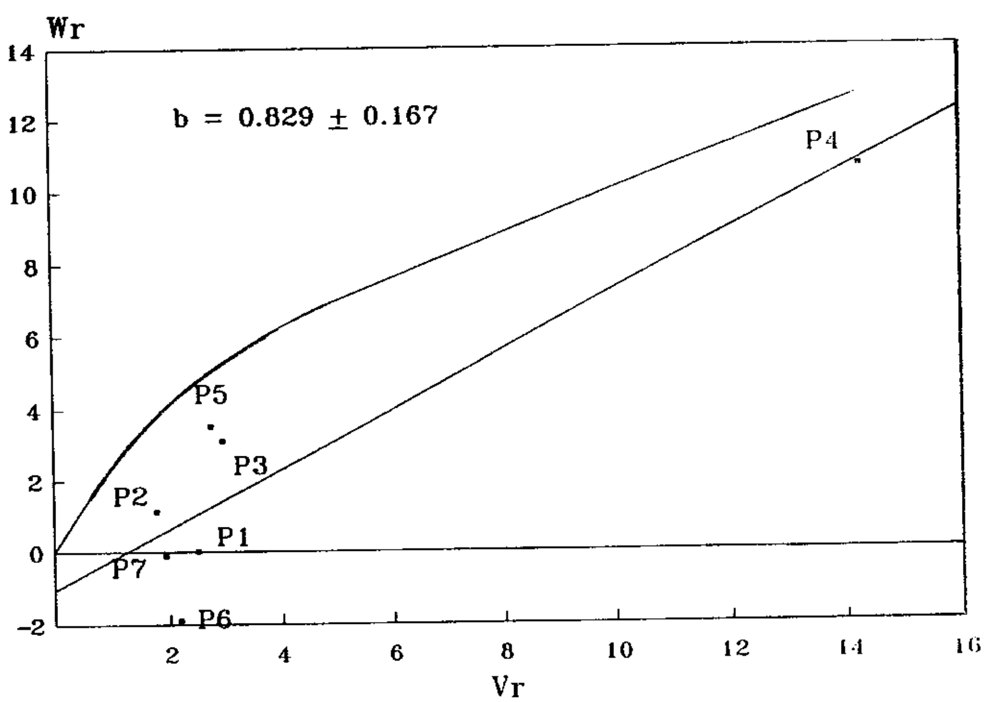

Fig. 16: Vr and Wr graph for silking date of F_2

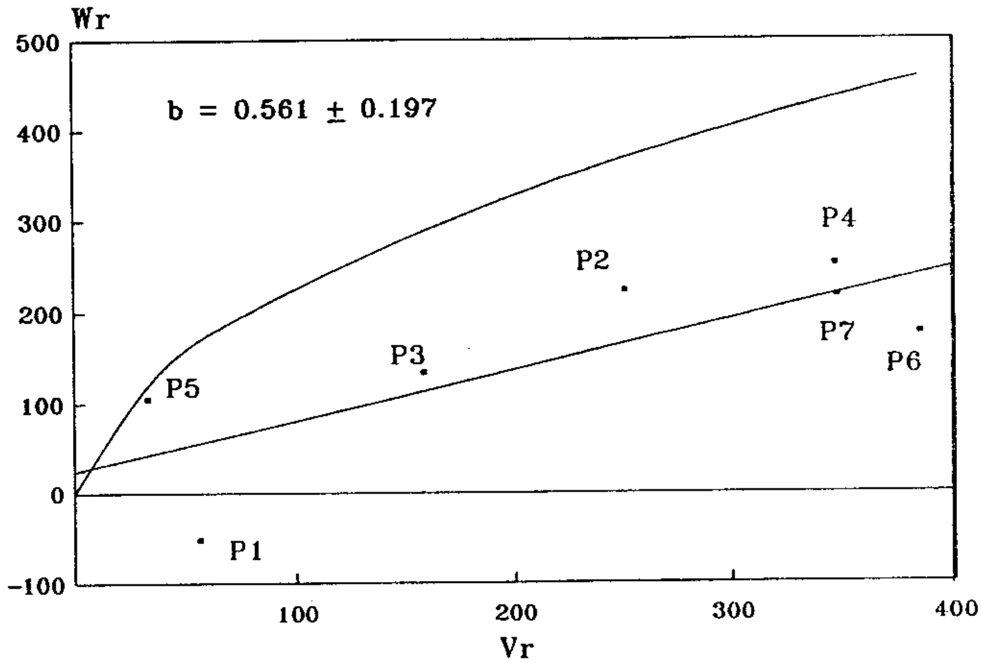

Fig. 17: Vr and Wr graph for ear height (cm) of F_2

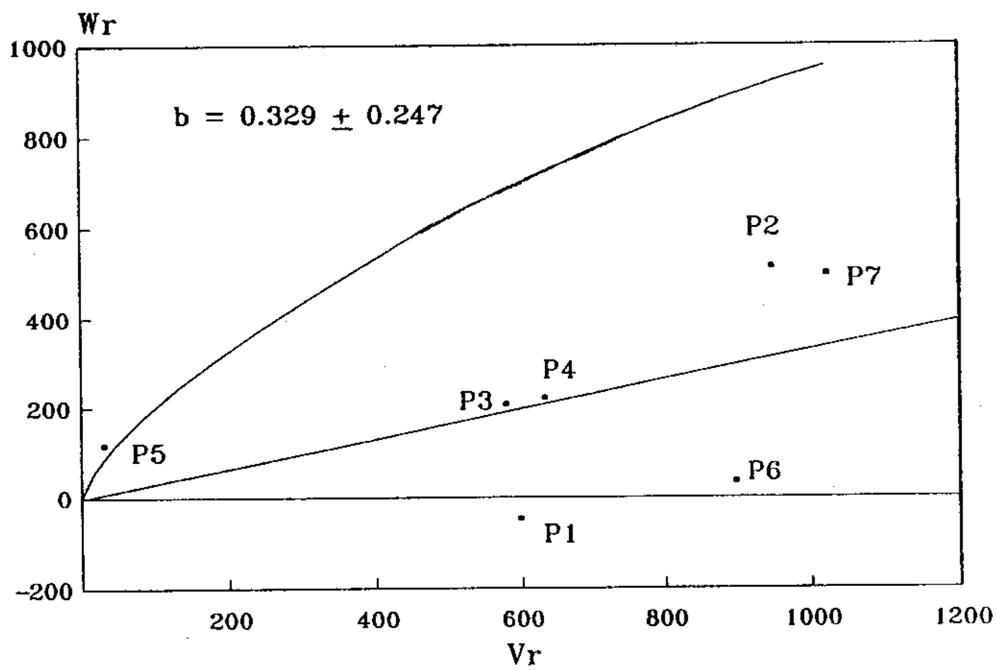

Fig. 18: Vr and Wr graph for plant height (cm) of F_2

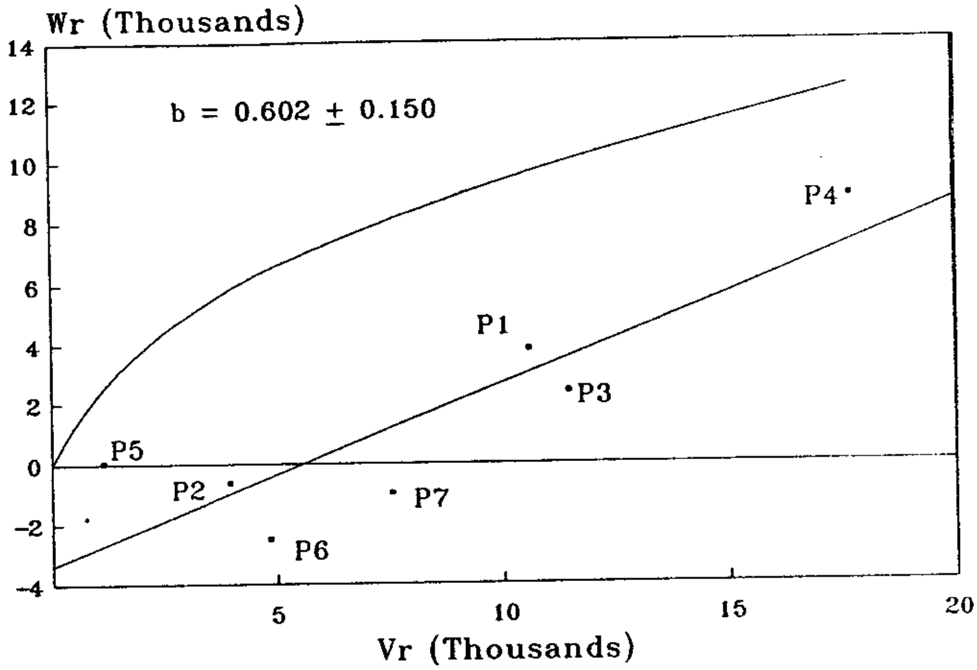

Fig. 19: Vr and Wr graph for leaf area (cm^2) of F_2

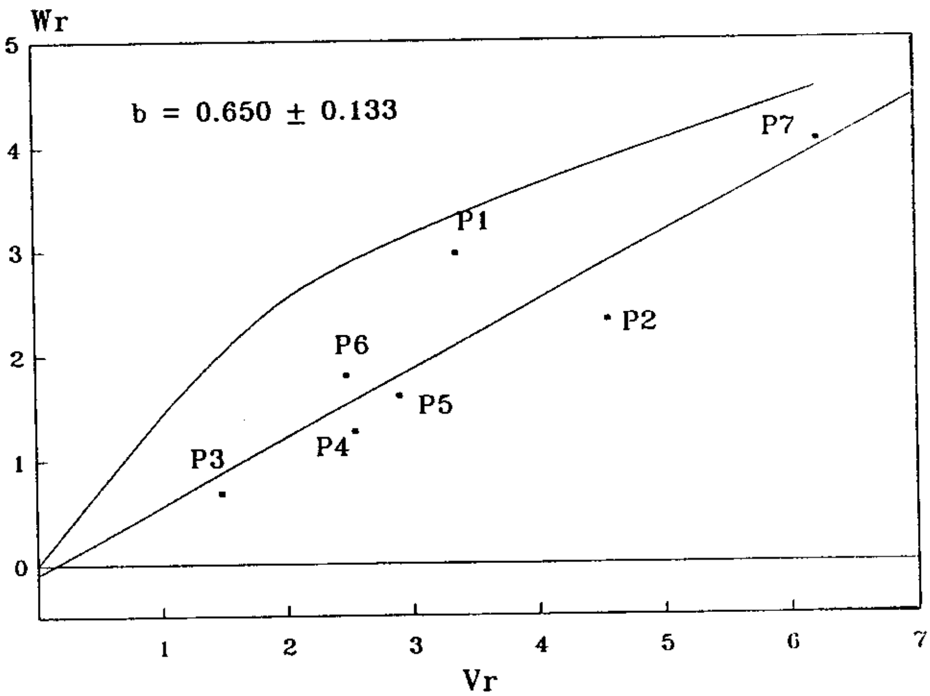

Fig. 20: Vr and Wr graph for leaf angle of F_2

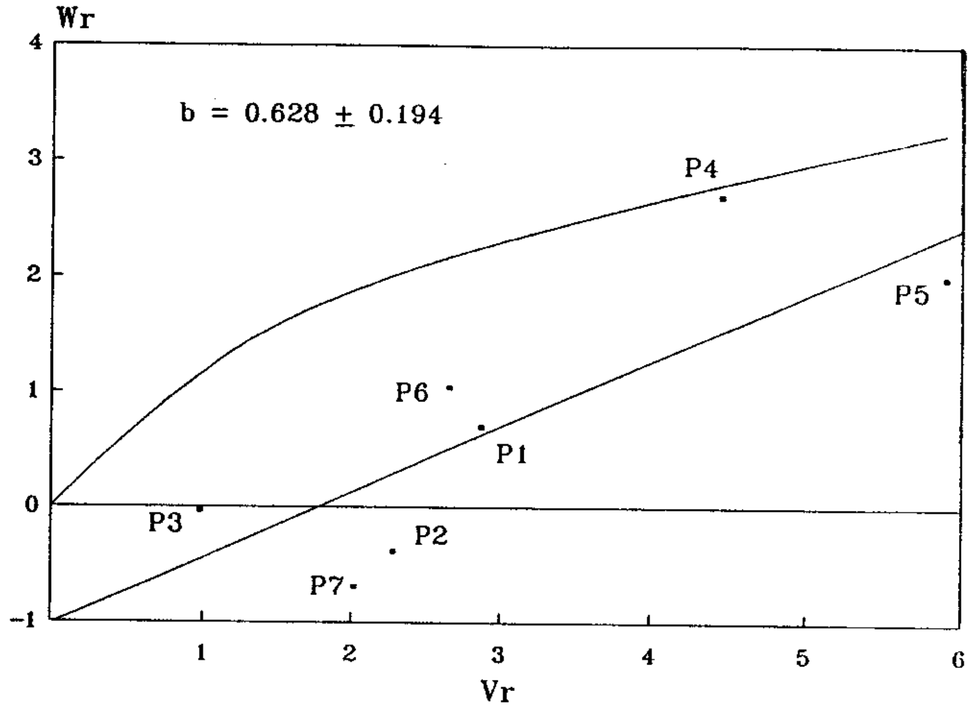

Fig. 21: Vr and Wr graph for ear husk of F_2

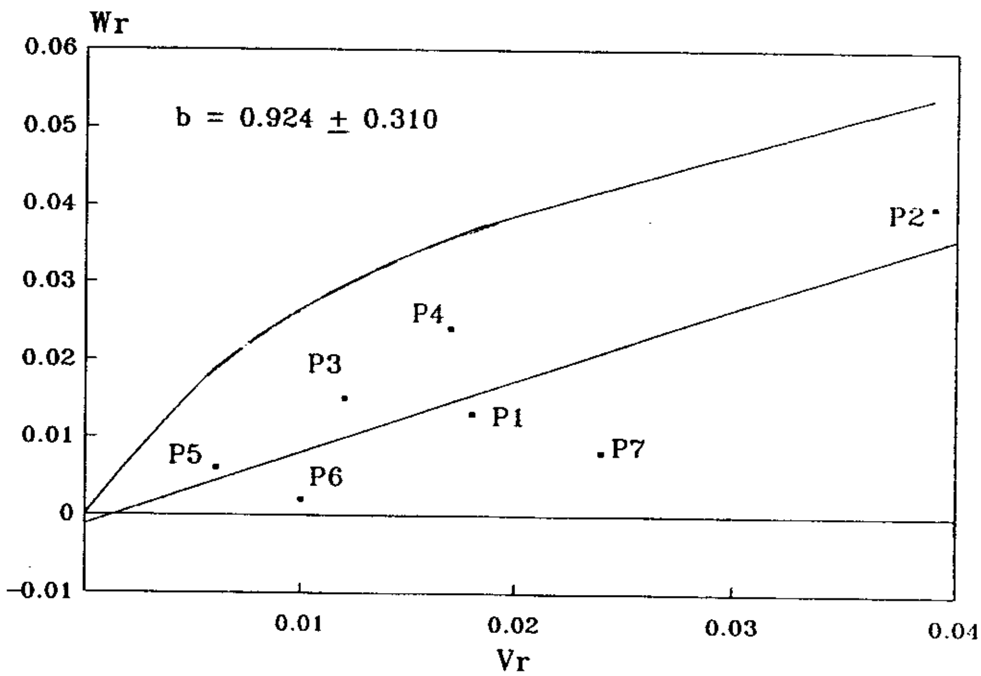

Fig. 22: Vr and Wr graph for stem diameter (cm) of F_2

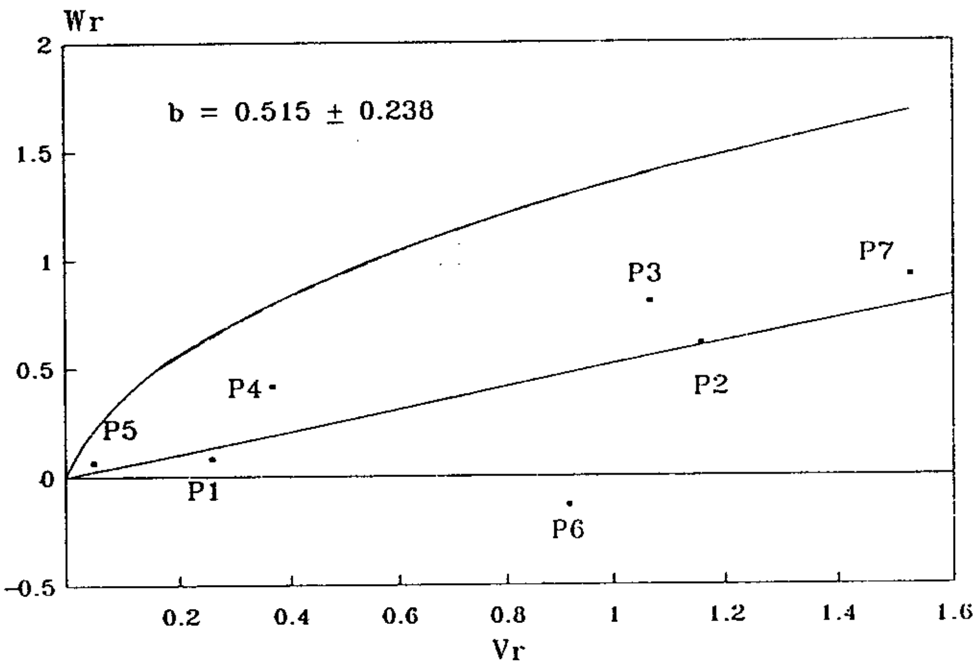

Fig. 23: Vr and Wr graph for No. of leaves/ plant of F_2

B- Yield and yield components :

A Analysis of variance, means and heterosis :

1- F1 - generation :

Pertinent portions of analysis of variance for all the traits studied in each season and the combined data are presented in Table (21).

Season mean squares for all the studied traits were significant for number of ears per plant, number of rows per ear, number of kernels per row and 100- kernel weight, indicating overall differences between seasons. For the four traits, mean values for the second season were higher than the corresponding ones. Insignificant season mean squares were detected for other traits.

With the exception of the number of ears per plant in the first season, significant genotypes were detected for all traits. Significant genotypes by seasons interaction mean squares were obtained for all traits except ear length and shelling percentage. Such results indicated that the tested genotypes varied from each other and ranked differently from season to another.

With the exception of number of ears per plant, significant mean squares due to parents were detected for all traits. These findings indicate that parental inbred lines differed in their performance for all traits. Insignificant mean squares due to interaction between parental inbred lines and season were detected for all traits except number of kernels per row.

Table (21): Observed mean squares from analysis of variance for yield and yield components in F_1 generation.

Source of variation	Degrees of freedom		No. of ears/ plant			Ear length (cm)			Ear diameter (cm)			No. of rows/ ear		
	S	C	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
Season		1			1.70**			5.94			0.06			2.65**
Rep./ S	2	4	0.01	0.03	0.02	10.99**	0.47	5.73**	0.23*	0.07	0.15*	0.10	0.02	0.06
Genotype	27	27	0.01	0.14**	0.08**	15.14**	18.10**	31.89**	0.95**	1.01**	1.88**	5.73**	8.68**	13.82**
Parent	6	6	0.05**	0.03	0.03	7.29**	15.18**	21.35**	0.87**	1.12**	1.96**	7.46**	10.13**	17.43**
F_1	20	20	0.01	0.14**	0.08**	5.32**	3.06*	7.02**	0.08	0.25**	0.22**	1.85**	2.40**	3.68**
P. x F_1	1	1	0.01	0.69**	0.28**	258.44**	336.50**	592.37**	18.95**	15.70**	34.57**	72.97**	125.89**	195.00**
G x S		27			0.07**			1.35			0.09*			0.59*
P x S		6			0.01			1.13			0.03			0.16
F_1 x S		20			0.07**			1.36			0.11**			0.58*
P x F_1 x S		1			0.42**			2.57			0.08			3.55**
Error	54	108	0.01	0.05	0.03	1.57	1.66	1.62	0.07	0.03	0.05	0.31	0.35	0.33

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C : First, second and the combined analysis, respectively.

Table (21): Cont.

Source of variation	Degrees of freedom		No. of kernels/ row			100- kerenl weight (gm)			Grain yield/ plant (gm)			Shelling %		
	S	C	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
Season		1			27.12**			928.72**			3.01			6.37
Rep./ S	2	4	4.44	0.40	2.42	3.69	10.17	6.93	673.58	391.37	532.48	28.55*	0.25	14.40
Genotype	27	27	236.71**	256.03**	481.24**	90.03**	34.35**	95.92**	9924.19**	10558.56**	19857.81**	175.38**	108.46**	267.63**
Parent	6	6	112.71**	129.19**	234.99**	33.15**	34.16**	65.36**	1703.93**	2307.14**	3782.32**	276.11**	254.81**	507.88**
F_1	20	20	34.23**	21.07**	42.39**	20.12**	24.77**	26.25**	967.47**	2089.83**	2284.40**	10.88	6.32	10.16
P. x F_1	1	1	5030.36**	5716.19**	10735.60**	1829.53**	227.05**	1672.80**	238380.6**	229441.65**	467779.11**	2861.0**	1273.05**	3975.48**
G x S		27			11.50**			28.46**			624.93**			16.20
P x S		6			6.91*			1.96			228.75			23.05
F_1 x S		20			12.91**			18.65**			772.90**			7.03
P x F_1 x S		1			10.95			383.78**			42.70			158.57**
Error	54	108	3.85	2.19	3.02	4.17	6.62	5.39	221.19	388.27	304.73	6.40	19.67	13.04

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C : First, second and the combined analysis, respectively.

This result may reveal the high repeatability of the parental inbred lines from one season to another. The mean performance of the tested seven inbred lines at each season and as an average over the two seasons are presented in Table (22).

The parental inbred line Moshtohor 75 gave the lowest mean values for ear length and high shelling percentage. Meanwhile, it almost expressed moderate values for other traits.

The parental inbred line Moshtohor 33 gave the lowest mean values for number of ears per plant and 100- kernel weight. Meanwhile, it was around the average of the parental inbred lines for the other traits.

The parental inbred line Moshtohor 107 A showed low mean values for number of ears per plant, ear diameter, and high shelling percentage.

Moshtohor 118 B showed the lowest mean values for number of rows per ear, number of kernels per row, shelling percentage and grain yield per plant, Meanwhile, it was around the average of the parental inbred lines for the rest of traits.

The inbred line Moshtohor 122 A was the best performing parental inbred lines for ear length and 100- kernel weight and ranked the second for grain yield per plant. While, it was intermediate in the other traits.

Moshtohor 114 D exhibited either moderate or low mean values in all traits.

Giza 221 D was the best performing for grain yield per plant, number of kernels per row, number of rows/ ear and ear diameter. Also, it expressed either high or moderate for other traits.

Hybrid mean squares were found herein to reach the significance level in all cases except ear diameter and number of ears/ plant in the first season and shelling percentage in both seasons and the combined analysis, revealing overall differences between these hybrids. Significant interaction between F_1 hybrids and season were detected for all traits except ear length and shelling percentage, indicating that these hybrids behaved somewhat differently from one season to another.

The mean performances of the tested twenty one hybrids at separate seasons as well as the combined analysis , are presented in Table (22).

The hybrid (P_3 x P_4) had the highest number of ears per plant followed by the two crosses (P_3 x P_6) and (P_5 x P_6) in the second season. While, cross (P_1 x P_6) gave the highest number of ears per plant followed by T.W.C. 310 and then cross (P_1 x P_5) at the combined analysis .

The T.W.C. , (P_2 x P_3) and (P_3 x P_5) had the highest mean value for ear length at the combined analysis.

Table (22): The genotype mean performance for yield and its components in F1 - generation.

Genotype	No. of ears/ plant			Ear length (cm)			Ear diameter (cm)			No. of rows/ ear		
	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
P_1 M. 75	1.00	1.00	1.00	12.27	11.77	12.02	3.50	3.43	3.47	13.00	13.03	13.02
P_2 M. 33	1.00	1.00	1.00	12.67	11.83	12.25	3.27	3.13	3.20	12.03	11.83	11.93
P_3 M. 107A	1.00	1.00	1.00	13.30	13.50	13.40	2.97	3.13	3.05	11.00	10.23	10.62
P_4 M. 118B	1.07	1.23	1.15	14.67	15.77	15.22	3.33	3.43	3.38	9.07	8.50	8.78
P_5 M. 122A	1.10	1.20	1.15	16.43	16.77	16.60	3.93	3.90	3.92	13.13	13.27	13.20
P_6 M. 114D	1.07	1.00	1.03	13.00	11.67	12.33	3.80	3.93	3.87	12.97	12.63	12.80
P_7 G. 221D	1.07	1.07	1.07	15.40	16.07	15.73	4.60	4.87	4.73	13.47	13.40	13.43
$P_1 \times P_2$	1.00	1.02	1.10	16.07	18.20	17.13	4.77	4.47	4.62	14.53	14.07	14.30
$P_1 \times P_3$	1.00	1.07	1.03	19.47	18.00	18.73	4.40	4.30	4.35	12.67	13.33	13.00
$P_1 \times P_4$	1.00	1.57	1.28	16.73	16.93	16.83	4.93	4.67	4.80	14.50	15.07	14.78
$P_1 \times P_5$	1.00	1.60	1.30	19.13	18.33	18.73	4.83	4.60	4.72	14.30	15.20	14.75
$P_1 \times P_6$	1.23	1.47	1.35	16.87	16.80	16.83	4.80	4.97	4.88	14.00	15.40	14.70
$P_1 \times P_7$	1.03	1.13	1.08	17.10	17.20	17.15	4.73	4.63	4.68	14.00	15.47	14.73
$P_2 \times P_3$	1.00	1.27	1.13	21.33	20.13	20.73	4.50	4.37	4.43	12.87	13.23	13.05
$P_2 \times P_4$	1.00	1.00	1.00	18.77	19.60	19.18	4.77	4.83	4.80	15.20	14.67	14.93
$P_2 \times P_5$	1.00	1.00	1.00	18.07	18.93	18.50	4.67	4.57	4.62	16.00	16.10	16.05
$P_2 \times P_6$	1.07	1.00	1.03	17.97	18.20	18.08	5.00	5.07	5.03	15.23	15.47	15.35
$P_2 \times P_7$	1.00	1.30	1.15	16.27	18.47	17.37	4.67	4.67	4.67	13.87	13.50	13.68
$P_3 \times P_4$	1.00	1.57	1.28	18.33	19.33	18.83	4.77	4.40	4.58	14.00	13.97	13.98
$P_3 \times P_5$	1.07	1.47	1.27	19.70	20.73	20.22	4.63	4.43	4.53	14.77	14.90	14.83
$P_3 \times P_6$	1.00	1.53	1.27	18.97	19.20	19.08	4.47	4.47	4.47	13.97	14.40	14.18
$P_3 \times P_7$	1.07	1.33	1.20	19.17	19.60	19.38	4.60	4.33	4.47	13.13	13.77	13.45
$P_4 \times P_5$	1.00	1.27	1.13	18.17	18.33	18.25	4.83	4.77	4.80	14.13	14.47	14.30
$P_4 \times P_6$	1.00	1.37	1.18	17.90	18.27	18.08	4.73	5.00	4.87	15.07	16.17	15.62
$P_4 \times P_7$	1.00	1.23	1.12	17.53	18.00	17.77	4.97	4.70	4.83	13.93	13.50	13.72
$P_5 \times P_6$	1.00	1.53	1.27	17.13	18.27	17.70	4.77	4.83	4.80	14.10	15.27	14.68
$P_5 \times P_7$	1.00	1.00	1.00	17.40	19.03	18.22	4.83	4.97	4.90	14.60	14.57	14.58
$P_6 \times P_7$	1.00	1.00	1.00	16.20	17.60	16.90	4.57	5.43	5.00	14.33	15.50	14.92
Giza 2	1.00	1.07	1.03	18.47	18.20	18.33	4.77	4.70	4.73	12.33	13.20	12.77
TWC310	1.17	1.47	1.32	20.40	21.23	20.82	4.83	4.67	4.75	13.10	12.77	12.93
S C 10	1.07	1.30	1.18	19.13	20.40	19.77	4.60	4.73	4.67	12.90	12.77	12.83
X	1.03	1.23	1.13	17.23	17.62	17.43	4.48	4.46	4.47	13.62	13.86	13.74
$LSD_{0.05}$	0.16	0.35	0.27	2.04	2.06	2.03	0.43	0.29	0.36	0.89	0.95	0.91
$LSD_{0.01}$	0.21	0.46	0.32	2.71	2.74	2.42	0.57	0.38	0.43	1.18	1.27	1.08

Table (22): Cont.

Genotype	No. of kernels per row			100- kernel weight			Grain yield per plant			Shelling percentage		
	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
P_1 M. 75	24.67	26.77	25.72	20.00	21.40	20.70	61.07	70.57	65.82	74.60	75.47	75.03
P_2 M. 33	25.27	22.10	23.68	17.30	17.43	17.37	50.17	43.40	46.78	67.40	64.90	66.15
P_3 M. 107A	18.27	17.13	17.70	22.00	23.80	22.90	42.57	39.57	41.07	73.67	79.90	76.78
P_4 M. 118B	11.97	11.00	11.48	25.00	26.17	25.58	27.27	27.40	27.33	47.00	51.53	49.27
P_5 M. 122A	18.43	21.60	20.02	26.67	27.83	27.25	63.30	89.40	76.35	64.67	71.33	68.00
P_6 M. 114D	20.00	19.07	19.53	24.00	22.97	23.48	63.17	52.40	57.78	66.43	72.87	69.65
P_7 G. 221D	30.90	31.27	31.08	25.33	24.43	24.88	103.87	102.77	103.32	73.67	72.27	72.97
$P_1 \times P_2$	37.43	37.70	37.57	32.30	27.77	30.03	167.50	165.00	166.25	79.47	80.07	79.77
$P_1 \times P_3$	44.40	40.07	42.23	30.03	24.50	27.27	162.60	132.07	147.33	79.40	81.57	80.48
$P_1 \times P_4$	37.43	42.80	40.12	33.10	22.83	27.97	174.47	202.57	188.52	76.23	79.93	78.08
$P_1 \times P_5$	45.33	40.53	42.93	34.70	27.53	31.12	216.17	218.20	217.18	82.10	80.93	81.52
$P_1 \times P_6$	40.43	39.90	40.17	32.50	26.13	29.32	184.30	196.67	190.48	81.97	77.80	79.88
$P_1 \times P_7$	38.67	41.07	40.02	34.23	24.40	29.32	176.57	159.80	168.18	81.60	79.20	80.40
$P_2 \times P_3$	39.97	41.83	40.90	35.97	26.13	31.05	181.53	160.03	170.78	78.63	76.20	77.42
$P_2 \times P_4$	39.43	45.17	42.30	30.97	25.87	28.42	178.57	164.33	171.45	79.90	77.37	78.63
$P_2 \times P_5$	34.50	39.10	36.80	28.90	24.60	26.75	151.87	148.63	150.25	80.23	77.40	78.82
$P_2 \times P_6$	38.40	36.60	37.50	31.23	28.53	29.88	184.70	154.80	169.75	81.83	77.17	79.50
$P_2 \times P_7$	32.73	36.00	34.37	37.93	30.63	34.28	164.20	176.13	170.17	76.97	76.77	76.87
$P_3 \times P_4$	41.90	44.00	42.95	32.67	30.13	31.40	183.47	230.27	206.87	76.47	78.03	77.25
$P_3 \times P_5$	40.67	44.33	42.50	34.40	26.60	30.50	209.10	227.20	218.15	82.03	79.60	80.82
$P_3 \times P_6$	44.17	44.10	44.13	36.63	22.93	29.78	216.10	190.07	203.08	82.63	79.13	80.88
$P_3 \times P_7$	41.43	40.60	41.02	38.03	27.17	32.60	208.40	184.10	196.25	81.10	80.40	81.25
$P_4 \times P_5$	36.00	37.67	36.83	37.50	26.93	32.22	183.20	166.83	175.02	80.73	79.27	80.00
$P_4 \times P_6$	39.17	41.03	40.10	31.10	26.50	28.80	176.30	203.07	189.68	82.47	79.20	80.83
$P_4 \times P_7$	40.30	38.40	39.35	35.10	29.63	32.37	188.60	170.43	179.52	79.60	78.47	79.03
$P_5 \times P_6$	39.83	40.10	39.97	31.90	27.60	29.75	172.37	206.60	189.48	80.73	79.73	80.23
$P_5 \times P_7$	38.33	38.20	38.27	33.53	35.13	34.33	180.03	185.23	182.63	81.27	77.13	79.20
$P_6 \times P_7$	32.97	37.67	35.32	34.50	30.27	32.38	157.70	169.10	163.40	79.97	78.23	79.10
Giza 2	36.00	36.67	36.33	32.40	32.17	32.28	136.87	155.47	146.17	76.67	76.33	76.50
TWC310	39.67	39.83	39.75	33.73	43.40	34.07	196.40	208.20	202.30	80.17	77.90	79.03
S C 10	40.43	38.83	39.63	38.23	37.50	37.87	199.80	212.07	205.93	81.33	79.73	80.53
X	35.14	35.84	35.49	31.35	27.60	29.22	153.62	155.24	154.43	77.13	76.64	76.88
$LSD_{0.05}$	3.16	2.44	2.80	3.39	4.35	3.86	24.81	32.13	28.42	4.01	6.93	5.61
$LSD_{0.01}$	4.20	3.25	3.33	4.51	5.79	4.60	33.00	42.73	33.84	5.34	9.21	6.68

The cross (P_2 x P_6) exhibited significant superiority over T.W.C. 310 and S.C. 10 for ear diameter in the combined analysis. Also, eleven crosses had the highest values relative to the check varieties for this traits.

Seventeen, nine and fifteen crosses showed superiority over the check varieties for number of rows per ear in first, second season as well as the combined analysis, respectively.

The four crosses (P_1 x P_5), (P_3 x P_4), (P_3 x P_5) and (P_3 x P_6) had higher number of kernels per row when compared with the best check variety.

None of the hybrids showed superiority over the check varieties for 100- kernel weight in the combined analysis.

The four crosses (P_1 x P_5), (P_3 x P_5), (P_3 x P_7) and (P_4 x P_6) had the highest shelling percentage.

For grain yield per plant, the hybrid (P_3 x P_5) gave the highest mean value followed by cross (P_1 x P_5) at the combined analysis. Also, four, three and two crosses expressed high mean values when compared with the check variety in the first, second as well as the combined analysis (Table 22). The fluctuation of hybrids from one season to another were detected for most traits. These results may be due to significance of the interaction between hybrids and season (Table 21).

Heterosis :

Mean square for parent vs. crosses as an indication to average heterosis over all crosses was significant for all cases.

F_1 mean values were significantly higher than parental means for yield and yield components. Significant mean squares of interaction between parents vs. hybrids by seasons were obtained for all traits, except ear length, and diameter, number of kernels per row and grain yield/ plant revealing that grand means of parental inbred lines and their F_1 hybrids differed from season to another.

Heterosis expressed as the percentage deviation of F_1 mean performance from its mid- parent and better parent average value for all traits studied at both seasons and average over the two seasons are presented in Table (23).

As for number of ears per plant, seven hybrids expressed significant positive heterotic effects relative to mid- parent in the second season. While, the three crosses (P_1 x P_5), (P_1 x P_6) and (P_3 x P_6) exhibited significant positive heterotic effects relative to the better parent in the second season. Also, the cross (P_1 x P_6) had significant positive heterotic effects relative to mid- parent or better parent in the combined data over both seasons. Similar results were obtained by Nawar *et al.* (1980), Abo- Dheaf (1987) and Abd El- Sattar (1992).

As for ear length, ear diameter, number of rows per ear, number of kernels per row and grain yield per plant , all parental combinations

Table (23): Percentage of heterosis over both mid- parent and better parent for yield and its components in F_1 generation .

Characters	No. of ears/ plant						Ear length (cm)					
	S1		S2		C		S1		S2		C	
Crosses	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	0.00	0.00	20.00	20.00	10.00	10.00	28.88**	26.84**	54.24**	53.80**	41.21**	39.86**
$P_1 \times P_3$	0.00	0.00	6.67	6.67	3.33	3.33	52.28**	46.37**	42.48**	33.33**	47.41**	39.80**
$P_1 \times P_4$	-3.23	-6.25	40.30**	27.03	19.38	11.59	24.26**	14.09	23.00**	7.40	23.62**	10.62
$P_1 \times P_5$	-4.76	-9.09	45.46**	33.33*	20.93	13.04	33.33**	16.43	28.51**	9.34	30.93**	12.86*
$P_1 \times P_6$	19.35	15.63*	46.67**	46.67**	32.79**	30.65*	33.51**	29.74**	43.39**	42.78**	38.26**	36.49**
$P_1 \times P_7$	0.00	-3.13	9.68	6.25	4.84	1.56	23.61**	11.04	23.59**	7.05	23.60**	9.00
$P_2 \times P_3$	0.00	0.00	26.67	26.67	13.33	13.33	64.31**	60.40**	58.95**	49.14**	61.66**	54.73**
$P_2 \times P_4$	-3.23	-6.25	-10.45	-18.92	-6.98	-13.04	37.32**	27.96**	42.03**	24.31**	39.68**	26.07**
$P_2 \times P_5$	-4.76	-9.09	-9.09	-16.67	-6.98	-13.04	24.17**	9.94	32.40**	12.92*	28.25**	11.45
$P_2 \times P_6$	3.23	0.00	0.00	0.00	1.64	0.00	40.00**	38.21**	54.89**	53.80**	47.12**	46.62**
$P_2 \times P_7$	-3.23	-6.25	25.81	21.88	11.29	7.81	15.91*	5.63	32.38**	14.94*	24.12**	10.38
$P_3 \times P_4$	-3.23	-6.25	40.30**	27.03	19.38	11.59	31.11**	25.00**	32.12**	22.62**	31.62**	23.77**
$P_3 \times P_5$	1.59	-3.03	33.33*	22.22	17.83	10.15	32.51**	19.88**	37.00**	23.66**	34.78**	21.79**
$P_3 \times P_6$	-3.23	-6.25	53.33**	53.33**	24.59*	22.58	44.23**	42.61**	52.58**	42.22**	48.32**	42.41**
$P_3 \times P_7$	3.23	0.00	29.03	25.00	16.13	12.50	33.57**	24.46**	32.58**	21.99**	33.07**	23.20**
$P_4 \times P_5$	-7.69	-9.09	4.11	2.70	-1.45	-1.45	16.83**	10.55	12.71*	9.34	14.72*	9.94
$P_4 \times P_6$	-6.25	-6.25	22.39	10.81	8.40	2.90	29.40**	22.05**	33.17**	15.86*	31.28**	18.84**
$P_4 \times P_7$	-6.25	-6.25	7.25	0.00	0.75	-2.90	16.63**	13.85*	13.09*	12.03	14.81*	12.92
$P_5 \times P_6$	-7.69	-9.09	39.39**	27.78	16.03	10.15	16.42**	4.26	28.49**	8.95	22.35**	6.63
$P_5 \times P_7$	-7.69	-9.09	-11.77	-16.67	-9.77	-13.04	9.32	5.88	15.94*	13.52*	12.68*	9.74
$P_6 \times P_7$	-6.25	-6.25	-3.23	-6.25	-4.76	-6.25	14.09*	5.20	26.92**	9.54	20.43**	7.42

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C = First, second and combined analysis, respectively.

MP and BP = mid and better parent, respectively.

Table (23): Cont .

Characters	Ear diameter (cm)						No. of rows/ ear					
	S1		S2		C		S1		S2		C	
crosses	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
P_1 x P_2	40.89**	36.19**	36.04**	30.10**	38.50**	33.17**	16.11**	11.80**	13.14**	7.93*	14.63**	9.86**
P_1 x P_3	36.08**	25.71**	30.96**	25.24**	33.50**	25.48**	5.56	-2.56	14.61**	2.30	10.01**	-0.13
P_1 x P_4	44.39**	40.95**	35.92**	35.92**	40.15**	38.46**	31.42**	11.54**	39.94**	15.60**	35.63**	13.57**
P_1 x P_5	30.05**	22.88**	25.46**	17.95**	27.67**	20.43**	9.44**	8.88*	15.59**	14.57**	12.52**	11.74**
P_1 x P_6	31.51**	26.32**	34.84**	26.27**	33.18**	26.29**	7.83*	7.69*	20.00**	18.16**	13.88**	12.93**
P_1 x P_7	16.87**	2.90	11.65**	-4.80	14.23**	-1.06	5.79	3.96	17.02**	15.42**	11.41**	9.68**
P_2 x P_3	44.39**	37.76**	39.36**	39.36**	41.87**	38.54**	11.72**	6.93	19.94**	11.83**	15.74**	9.36*
P_2 x P_4	44.44**	43.00**	47.21**	40.78**	45.82**	41.87**	44.08**	26.32**	44.26**	23.94**	44.17**	25.14**
P_2 x P_5	29.63**	18.64**	29.86**	17.09**	29.74**	17.87**	27.15**	21.83**	28.29**	21.36**	27.72**	21.59**
P_2 x P_6	41.51**	31.58**	43.40**	28.81**	42.45**	30.17**	21.87**	17.48**	26.43**	22.43**	24.12**	19.92**
P_2 x P_7	18.64**	1.45	16.67**	-4.11	17.65**	-1.41	8.76**	2.97	7.00*	0.75	7.88*	1.86
P_3 x P_4	51.32**	43.00**	34.01**	28.16**	42.49**	35.47**	39.54**	27.27**	49.11**	36.48**	44.16**	31.71**
P_3 x P_5	34.30**	17.80**	26.07**	13.68**	30.14**	15.75**	22.38**	12.44**	26.81**	12.31**	24.56**	12.37**
P_3 x P_6	32.02**	17.54**	26.42**	13.56**	29.16**	15.52**	16.55**	7.71*	25.95**	13.98**	21.14**	10.81**
P_3 x P_7	21.59**	0.00	8.33*	-10.96**	14.78**	-5.63	7.36*	-2.48	16.50**	2.74	11.85**	0.12
P_4 x P_5	33.03**	22.88**	30.00**	22.22**	31.51**	22.55**	27.33**	7.61*	32.93**	9.05*	30.10**	8.33*
P_4 x P_6	32.71**	24.56**	35.75**	27.12**	34.25**	25.86**	36.76**	16.20**	53.00**	27.97**	44.71**	22.01**
P_4 x P_7	25.21**	7.97	13.25**	-3.43	19.10**	2.11	23.67**	3.47	23.29**	0.75	23.48**	2.11
P_5 x P_6	23.28**	21.19**	23.40**	22.88**	23.34**	22.55**	8.05*	7.36*	17.89**	15.08**	12.95**	11.24**
P_5 x P_7	13.28**	5.07	13.31**	2.06	13.30**	3.52	9.77**	8.42*	9.25**	8.71*	9.51**	8.56*
P_6 x P_7	8.73**	-0.73	23.49**	11.64**	16.28**	5.63	8.45**	6.44	19.08**	15.67**	13.72**	11.04**

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C = First, second and combined analysis, respectively.

MP and BP = mid and better parent, respectively.

Table (23): Cont .

Characters	No. of kernels/ row						100- kernel weight					
	S1		S2		C		S1		S2		C	
crosses	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	49.93**	48.15**	54.30**	40.85**	52.09**	46.08**	73.19**	61.50**	43.00**	29.75**	57.79**	45.09**
$P_1 \times P_3$	106.83**	80.00**	82.54**	49.69**	94.55**	64.23**	43.02**	36.52**	8.41	2.94	25.08**	19.07*
$P_1 \times P_4$	104.37**	51.76**	126.66**	59.90**	115.68**	56.00**	47.11**	32.40**	-3.99	-12.74	20.85**	9.32
$P_1 \times P_5$	110.36**	83.78**	67.61**	51.43**	87.76**	66.95**	48.71**	30.13**	11.85	-1.08	29.79**	14.19*
$P_1 \times P_6$	81.05**	63.92**	74.11**	49.07**	77.53**	56.19**	47.73**	35.42**	17.81*	13.79	32.71**	24.84**
$P_1 \times P_7$	40.25**	26.11**	41.53**	31.34**	40.90**	28.74**	51.03**	35.13**	6.47	-0.14	28.63**	17.82*
$P_2 \times P_3$	83.61**	58.18**	113.25**	89.29**	97.66**	72.70**	83.04**	63.49**	26.76**	9.80	54.22**	35.59**
$P_2 \times P_4$	111.82**	56.07**	172.91**	104.37**	140.57**	78.61**	46.41**	23.87**	18.65*	-1.15	32.32**	11.08
$P_2 \times P_5$	57.90**	36.54**	78.95**	76.92**	68.42**	55.38**	31.46**	8.38**	8.69	-11.62	19.91**	-1.84
$P_2 \times P_6$	69.66**	51.98**	77.81**	65.61**	73.54**	58.34**	51.25**	30.14**	41.25**	24.24*	46.31**	27.25**
$P_2 \times P_7$	16.56**	5.93	34.92**	15.14**	25.50**	10.56*	77.95**	49.74**	46.34**	25.38**	62.29**	37.78**
$P_3 \times P_4$	177.18**	129.38**	212.80**	156.81**	194.35**	142.66**	39.01**	30.67**	20.61**	15.16	29.53**	22.74**
$P_3 \times P_5$	121.62**	120.62**	128.92**	105.25**	125.37**	112.32**	41.37**	29.00**	3.03	-4.43	21.64**	11.93
$P_3 \times P_6$	130.84**	120.83**	143.65**	131.29**	137.06**	125.94**	59.28**	52.64**	-1.92	-3.64	28.42**	26.83**
$P_3 \times P_7$	68.54**	34.09**	67.77**	29.85**	68.16**	31.96**	60.70**	50.13**	12.65	11.19	36.45**	31.01**
$P_4 \times P_5$	136.84**	95.30**	131.08**	74.38**	133.86**	84.01**	45.16**	40.63**	-0.25	-3.23	21.96**	18.23**
$P_4 \times P_6$	145.05**	95.83**	172.95**	115.21**	158.57**	105.29**	26.94**	24.40**	7.87	1.27	17.39*	12.57
$P_4 \times P_7$	88.03**	30.42**	81.70**	22.81**	84.89**	26.60**	39.47**	38.55**	17.13*	13.25	28.27**	26.52**
$P_5 \times P_6$	107.29**	99.17**	97.21**	85.65**	102.11**	99.67**	25.92**	19.63**	8.66	-0.84	17.28**	9.17
$P_5 \times P_7$	55.41**	24.06**	44.52**	22.18**	49.77**	23.11**	28.97**	25.75**	34.44**	26.23**	31.71**	25.99**
$P_6 \times P_7$	29.54**	6.69	49.67**	20.47**	39.55**	13.62*	39.87**	36.18**	27.71**	23.87**	33.91**	30.14**

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C = First, second and combined analysis, respectively.
MP and BP = mid and better parent, respectively.

Table (23): Cont .

Characters	Grain yield/ plant (gm)						Shelling %					
	S1		S2		C		S1		S2		C	
crosses	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	201.17**	174.29**	189.56**	133.82**	195.29**	152.60**	11.93**	6.52*	14.08**	6.10	13.00**	6.31
$P_1 \times P_3$	213.80**	166.27**	139.83**	87.15**	175.69**	123.85**	7.10**	6.43*	5.00	2.09	6.03	4.82
$P_1 \times P_4$	295.02**	185.70**	313.54**	187.06**	304.76**	186.43**	25.38**	2.19	25.88**	5.92	25.64**	4.07
$P_1 \times P_5$	247.63**	241.50**	172.81**	144.07**	205.53**	184.46**	17.90**	10.05**	10.26*	7.24	13.98**	8.64*
$P_1 \times P_6$	196.70**	191.77**	219.87**	178.70**	208.23**	189.42**	16.24**	9.88**	4.90	3.09	10.43**	6.46
$P_1 \times P_7$	114.11**	69.99**	84.39**	55.50**	98.88**	62.78**	10.07**	9.38**	7.22	4.95	8.65*	7.15
$P_2 \times P_3$	291.52**	261.86**	285.78**	268.74**	288.81**	265.05**	11.48**	6.74*	5.25	-4.63	8.33*	0.83
$P_2 \times P_4$	361.21**	255.95**	364.22**	278.65**	362.65**	266.48**	39.69**	18.55**	32.89**	19.21**	36.26**	18.87**
$P_2 \times P_5$	167.69**	139.92**	123.85**	66.26**	144.04**	96.79**	21.50**	19.04**	13.63**	8.51	17.51**	15.91**
$P_2 \times P_6$	225.94**	192.40**	223.17**	195.42**	224.67**	193.77**	22.29**	21.41**	12.03*	5.90	17.08**	14.14**
$P_2 \times P_7$	113.20**	58.09**	141.00**	71.39**	126.74**	64.70**	9.12**	4.48	11.93*	6.23	10.51**	5.35
$P_3 \times P_4$	425.44**	331.01**	587.71**	481.97**	504.87**	403.73**	26.74**	3.80	18.74**	-2.34	22.57**	0.61
$P_3 \times P_5$	295.03**	230.33**	252.34**	154.14**	271.58**	185.72**	18.60**	11.36**	5.27	-0.38	11.64**	5.25
$P_3 \times P_6$	308.76**	242.11**	313.34**	262.72**	310.89**	251.46**	17.96**	12.17**	3.60	-0.96	10.47**	5.34
$P_3 \times P_7$	184.64**	100.64**	158.69**	79.14**	171.85**	89.95**	10.09**	10.09**	5.67	0.63	7.85*	5.17
$P_4 \times P_5$	304.56**	189.42**	185.67**	86.61**	237.59**	129.23**	44.60**	24.85**	29.03**	11.12*	36.44**	17.65**
$P_4 \times P_6$	289.90**	179.10**	408.94**	287.53**	345.70**	228.27**	45.40**	24.13**	27.33**	8.69	35.95**	16.06**
$P_4 \times P_7$	187.65**	81.58**	161.87**	65.85**	174.81**	73.75**	31.93**	8.05**	26.76**	8.58	29.32**	8.31*
$P_5 \times P_6$	172.59**	172.30**	191.40**	131.10**	182.53**	148.18**	23.16**	21.53**	10.59*	9.42	16.58**	15.20**
$P_5 \times P_7$	115.39**	73.33**	92.78**	80.25**	103.30**	76.77**	17.49**	10.32**	7.43	6.73	12.37**	8.54*
$P_6 \times P_7$	88.83**	51.83**	117.96**	64.55**	102.86**	58.16**	14.16**	8.55**	7.81	7.37	10.93**	8.41*

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C = First, second and combined analysis, respectively.
MP and BP = mid and better parent, respectively.

had significant positive heterotic effects relative to mid- parent in the first, second season as well as the combined analysis.

As for ear length, twelve , fourteen and twelve hybrids had significant positive heterotic effects relative to the better parent in the first, second season and the combined data over their parents, respectively. The cross (P_2 x P_3) followed by cross (P_2 x P_6) showed high desirable heterotic effects for this traits. Significant positive heterotic effects for ear length was also reported by Krolikowski (1969), Kravenchko *et al.* (1971), Mohamed (1979), Nawar *et al.* (1980), Mohamed (1984) and Abo- Dheaf (1987).

Concerning ear diameter, fifteen, seventeen and fifteen crosses significantly exceeded the better parent in the first, second season as well as the combined analysis, respectively. The crosses (P_1 x P_2), (P_1 x P_4), (P_2 x P_3), (P_2 x P_4), (P_2 x P_6) and (P_3 x P_4) had the most desirable heterotic effects for this trait.

Significant positive heterotic effects for ear diameter was reached before by (Yasien, 1977; Mourad, 1978; Mohamed, 1979; Nawar *et al.*, 1980; Mohamed, 1984; and Abo- Dheaf, 1987).

As for number of rows per ear, fourteen, seventeen and seventeen parental combinations significantly exceeded the better parent in the first, second season and combined analysis, respectively. The crosses (P_3 x P_4), (P_2 x P_4), (P_2 x P_5), and (P_4 x P_6) showed the high desirable heterotic effects for this trait. These results are in agreement with findings of Mohamed (1979), Nawar *et al.* (1980) and Mohamed (1984).

As for the number of kernels per row, all hybrids exhibited significant positive heterotic effects relative to the better parent in the first, second, as well as the combined analysis, respectively, except both crosses (P_2 x P_7) and (P_6 x P_7) in the first season which had insignificant effects. The crosses (P_3 x P_4), (P_3 x P_6), (P_3 x P_5), (P_4 x P_6), (P_5 x P_6), and (P_4 x P_5) had the most desirable heterotic effects for kernels/ row. Significant positive heterotic effects for number of kernels per row was reached before by Kravenchko *et al.* (1971), Yasien (1977), Mohamed (1979), Alvarez *et al.* (1993) and Shieh (1994).

As for 100- kernel weight, all crosses exhibited significant positive heterotic effects relative to mid- parent or better parent in the first season. While, ten crosses expressed significant positive heterotic effects relative to mid- parent and five of these crosses exhibited significant positive heterotic effects relative to the better parent in the second season. In the combined analysis, twenty one crosses and fifteen crosses exhibited significant positive heterotic effects relative to mid- parent and the better parent, respectively. The crosses (P_1 x P_2), (P_2 x P_3) , (P_3 x P_7), and (P_2 x P_6) had the most desirable heterotic effects for that trait. Significant positive heterotic effects for 100- kernel weight was reached before by Kravenchko *et al.* (1971), Mourad (1978), Mohamed (1979) and Abo- Dheaf (1987).

As for shelling percentage, out of the twenty one (all crosses), twelve and twenty crosses expressed significant positive heterotic effects relative to mid- parent in the first, second season as well as the combined analysis, respectively. While, eighteen, two and ten parental combinations from the previous crosses had significant positive heterotic effects relative to the better parent in the same order.

Concerning grain yield per plant, all crosses significantly exceeded their respective mid- parent or better parent in each season and the combined analysis. The crosses (P_3 x P_4), (P_2 x P_3), (P_2 x P_4), (P_3 x P_6), (P_4 x P_6) and (P_2 x P_6) had the most desirable heterotic effects for grain yield per plant (Table 23). These hybrids exhibited heterosis for three or more of traits contributing to grain yield. The heterotic magnitude, however, differed from one season to another and from case to case. These findings agree with the general trend where the expression of heterosis for a complex trait could be explained on the basis of its components, since the value recorded for a complex trait is always a function of its components. It could be concluded that these crosses would be efficient and prospective in corn breeding programs for improving grain yield per plant. Significant positive heterotic effects relative to the higher yielding parent were also reached before by Krolikowski (1969), El- Rouby and Galal (1972), Major *et al.* (1972), Krolikowski (1973), Paterniani (1980), Gerrish (1983), Debnath (1984), Beck *et al.* (1990), Odiemah (1992), Alvarez *et al.* (1993), Kumar (1994), Altinbas (1995) and Mufti and Rao (1995).

Heterosis of grain yield per plant expressed as the percentage deviation of F_1 mean performance from Giza-2, T.W.C. 310 and S.C. 10 in both seasons as well as the combined analysis, is presented in Table (24).

Nineteen, eight and twelve crosses exhibited significantly heterotic effects from Giza 2 in the first, second season as well as the combined analysis, respectively, for grain yield per plant.

None of all crosses significantly surpassed either T.W.C 310 or S.C. 10. Five, ten and nine crosses expressed significantly negative heterotic effects relative to T.W.C. 310 in the first, second season as well as the combined analysis, respectively. Also, seven, nine, and nine crosses had significantly negative heterotic effects relative to S.C. 10 in the same order. Meanwhile, the other crosses had insignificant useful heterotic effects relative to either T.W.C. 310 or S.C. 10. Insignificant useful heterotic effects in these crosses revealed that a hybrid program based on these material may be useful for testing under different locations and years. The two crosses (P_1 x P_5) and (P_3 x P_5) outyielded the check S.C. 10 by 5.7 % . Hence, it could be concluded that these crosses may be useful for improving grain yield of maize. Many investigators reported high heterosis for yield in maize, i.e. Borov (1966), El- Rouby and Galal (1972), Paterniani (1980), El- Hosary (1988a), El- Hosary *et al.* (1990a) and Abd El- Sattar (1992).

Prediction of double cross yield :

Prediction of double cross yield helps the plant breeder to choose the best double cross in hybrid maize breeding programs, Mohamed

Table (24): Percentage of heterosis over check varieties Giza 2, hybrid T.W.C. 310 and S.C. 10 for the grain yield.

No.	Crosses	S1			S2			C		
		Giza 2	T.W.C. 310	SC 10	Giza 2	T.W.C. 310	SC 10	Giza 2	T.W.C. 310	SC 10
1	$P_1 \times P_2$	22.88*	-17.25*	-16.17*	6.13	-20.75**	-22.19**	13.74	-17.82*	-19.27**
2	$P_1 \times P_3$	18.80*	-20.79**	-18.62**	-15.05	-36.57**	-37.72**	0.80	-27.17**	-28.46**
3	$P_1 \times P_4$	27.47**	-12.57	-12.68**	30.30**	-2.71	-4.48	28.97**	-6.81	-8.46
4	$P_1 \times P_5$	57.94**	9.14	8.19	40.35**	4.80	2.89	48.59**	7.36	5.46
5	$P_1 \times P_6$	34.66**	-6.57	-7.76	26.50*	-5.54	-7.26	30.32**	-5.84	-7.50
6	$P_1 \times P_7$	29.01**	-11.23	-11.63	2.79	-23.25**	-24.65**	15.06	-16.86*	-18.33*
7	$P_2 \times P_3$	32.64**	-8.19	-9.14	2.94	-23.14**	-24.54**	16.84	-15.58*	-17.07**
8	$P_2 \times P_4$	30.47**	-9.99	-10.63	5.70	-21.07**	-22.51	17.30	-15.25*	-22.51**
9	$P_2 \times P_5$	10.96	-29.32**	-23.99**	-4.40	-28.61**	-29.91**	2.79	-25.72**	-27.04**
10	$P_2 \times P_6$	34.95**	-6.33	-7.56	-0.43	-25.65**	-27.00**	16.13	-16.09*	-17.57*
11	$P_2 \times P_7$	19.97*	-19.61*	-17.82**	13.29	-15.40	-16.95*	16.42	-15.88*	-17.37*
12	$P_3 \times P_4$	34.05**	-7.05	-8.18	48.11**	10.60	8.58	41.53**	2.26	0.45
13	$P_3 \times P_5$	52.78**	6.07	4.66	46.14**	9.13	7.14	49.25**	7.84	5.93
14	$P_3 \times P_6$	57.89**	9.12	8.16	22.26*	-8.71	-10.37	38.93**	0.39	-1.38
15	$P_3 \times P_7$	52.27**	5.76	4.30	18.42	-11.58	-13.19	34.26**	-2.99	-4.70
16	$P_4 \times P_5$	33.85**	-7.21	-8.31	7.31	-19.87**	-21.33	19.73*	-13.49	-15.01
17	$P_4 \times P_6$	28.81**	-11.40	-11.76	30.62**	-2.47	-4.24	29.77**	-6.24	-7.89
18	$P_4 \times P_7$	37.80**	-4.14	-5.61	9.63	-18.14*	-19.63*	22.82*	-11.26	-12.82
19	$P_5 \times P_6$	25.94**	-13.94	-13.73*	32.89**	-0.77	-2.58	29.63**	-6.34	-7.99
20	$P_5 \times P_7$	31.54**	-9.09	-9.89	19.15	-11.03	-12.65	24.95*	-9.72	-11.31
21	$P_6 \times P_7$	15.22	-24.54**	-21.07**	8.77	-18.78*	-20.26**	11.79	-19.23**	-20.65**

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

(1984) and others reported good correlation between the prediction and the actual double crosses yield.

In the present investigation 105 double crosses may be obtained. The results indicated that the best three double crosses were (P_1 x P_3)(P_4 x P_5), (P_1 x P_3)(P_5 x P_6) and (P_3 x P_6)(P_4 x P_5). These double crosses gave 207.68, 207.22 and 201.05 (gm) grain yield per plant in the combined analysis. However, S.C. 10 gave 205.93 (gm) of grain yield per plant in the combined analysis .

Hence, it could be concluded that these previous double crosses may offer a possibility for increasing grain yield of maize. The two single crosses (P_5 x P_6) and (P_3 x P_6) were the best hybrids for using as females in production of double crosses where they gave the highest grain yield mean values. Moreover, the differences between dates of tasseling and silking among these single crosses were very small, indicating the possibility of double cross production for the practical use.

2- F2- generation :

Results in Table (25) showed the analysis of variance for yield and yield components. With the exception of crosses mean squares for shelling percentage, genotypes mean squares and their components were significant for all the studied traits, indicating the wide diversity among the parental materials used in this study.

Table (25): Observed mean squares from analysis of variance for yield and its components in F_2 generation .

Source of variation	D.F	No. of ears/ plant	Ear length (cm)	Ear diameter (cm)	No. of rows/ ear	No. of kernels/ row	100- kernel weight (gm)	Gain yield/ plant (gm)	Shelling %
Rep.	2	0.02	1.65	0.01	0.52	3.26	11.67	247.92	1.43
Genotype	27	0.09**	13.25**	0.69**	5.80**	141.16**	19.83**	5821.13**	98.74**
Parent	6	0.03*	15.18**	1.12**	10.13**	129.19**	34.60**	2307.14**	254.98**
Crosses	20	0.08**	9.25**	0.34**	2.04**	48.27**	15.38**	3228.66**	28.19
P. vs. C.	1	0.65**	81.60**	5.14**	55.07**	2070.88**	20.23*	78754.50**	572.41**
Error	54	0.01	1.18	0.04	0.47	5.50	3.92	309.08	25.12

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Results in Table (26) showed the mean performance of F_2. With the exception of the number of rows per ear, non of the hybrids surpassed the high check varieties for all traits. As for other traits, the crosses (P_1 x P_4), (P_1 x P_6), (P_2 x P_4), (P_2 x P_5), (P_2 x P_7) and (P_3 x P_6) surpassed the best check variety S.C. 10 . This result may be due to inbreeding depression in the F_2- generation .

Remaining heterosis :

Mean squares for parent vs. F_2 - hybrids as an indication to average remaining heterosis of overall crosses was significant for all the studied traits (Table 25).

Results in Table (27) showed the remaining heterosis values relative of mid- and better parent for yield and yield components in the F_2- generation.

Fourteen, twelve, sixteen, seventeen, eighteen, five, six and eighteen parental combinations exhibited significant positive remaining heterotic effects relative to mid- parent value for number of ears/ plant, ear length, ear diameter, number of rows/ ear, number of kernels/ row, 100- kernels weight, shelling % and grain yield/ plant, respectively. Also, six, eight, eleven, six, sixteen, three, zero and fifteen F_2- hybrids expressed significant positive remaining heterotic effects relative to the better parent in the same order. The crosses (P_1 x P_2), (P_1 x P_4), (P_1 x P_6), (P_2 x P_3), (P_2 x P_4), (P_2 x P_5), ((P_3 x P_4) (P_3 x P_6) and (P_4 x P_6) showed the highest remaining heterosis for grain yield per plant.

Table (26): Mean performance for all parents and crosses studied for yield and its components in F_2 generation

Genotype	No. of ears/ plant	Ear length (cm)	Ear diameter (cm)	No. of rows/ ear	No. of kernels/ row	100-kernel weight (gm)	Grain yield/ plant (gm)	Shelling percentage
P_1 M. 75	1.00	11.77	3.43	13.03	26.77	21.40	70.57	75.47
P_2 M. 33	1.00	11.83	3.13	11.83	22.10	17.43	43.40	64.90
P_3 M. 107A	1.00	13.50	3.13	10.23	17.13	23.80	39.57	79.90
P_4 M. 118B	1.23	15.77	3.43	8.50	11.00	26.17	27.40	51.53
P_5 M. 122A	1.20	16.77	3.90	13.27	21.60	27.83	89.40	71.33
P_6 M. 114D	1.00	11.67	3.93	12.63	19.07	22.97	52.40	72.87
P_7 G. 221D	1.07	16.07	4.87	13.40	31.27	24.43	102.77	72.27
$P_1 \times P_2$	1.13	16.33	4.47	14.07	34.40	27.43	141.73	75.67
$P_1 \times P_3$	1.03	15.33	3.60	12.93	31.50	22.10	89.93	78.13
$P_1 \times P_4$	1.30	16.00	4.57	13.87	34.73	25.33	146.63	75.07
$P_1 \times P_5$	1.20	14.33	4.20	13.63	30.57	24.47	113.20	76.67
$P_1 \times P_6$	1.23	16.57	4.73	14.33	36.33	30.10	175.57	77.60
$P_1 \times P_7$	1.20	12.20	4.00	13.20	24.97	24.10	91.07	75.57
$P_2 \times P_3$	1.13	17.67	3.73	11.77	30.97	23.73	92.10	75.60
$P_2 \times P_4$	1.33	15.67	4.17	14.47	29.80	22.17	116.83	72.50
$P_2 \times P_5$	1.27	17.43	4.50	15.23	33.87	24.47	147.17	76.80
$P_2 \times P_6$	1.20	17.77	4.40	13.77	35.57	24.23	132.77	74.07
$P_2 \times P_7$	1.07	14.83	4.23	14.20	27.03	23.23	90.87	65.33
$P_3 \times P_4$	1.47	16.50	4.07	13.20	33.00	22.17	128.53	72.10
$P_3 \times P_5$	1.67	18.23	3.93	13.43	31.13	23.43	143.93	77.23
$P_3 \times P_6$	1.47	17.70	4.57	14.13	37.30	25.53	177.40	78.03
$P_3 \times P_7$	1.33	19.27	4.57	13.40	39.67	29.50	182.57	79.13
$P_4 \times P_5$	1.13	13.77	3.90	13.67	28.10	20.73	86.70	78.10
$P_4 \times P_6$	1.30	17.30	4.60	14.50	37.83	24.30	159.30	78.07
$P_4 \times P_7$	1.40	17.37	4.57	13.37	37.97	25.30	163.67	78.40
$P_5 \times P_6$	1.47	15.60	4.50	14.30	32.47	25.33	155.03	77.50
$P_5 \times P_7$	1.33	16.67	4.43	14.50	33.57	24.07	144.63	74.63
$P_6 \times P_7$	1.10	13.37	3.77	12.00	26.83	24.47	81.83	75.50
Giza 2	1.07	18.20	4.70	13.20	36.67	32.17	155.47	76.33
TWC 310	1.47	21.23	4.67	12.77	39.83	34.40	208.20	77.90
S C 10	1.30	20.40	4.73	12.77	38.83	37.50	212.07	79.73
X	1.23	16.04	4.18	13.21	30.71	25.30	121.38	74.64
LSD 0.01	0.20	1.74	0.30	1.09	3.74	3.51	29.20	7.81
LSD 0.05	0.27	2.31	0.40	1.45	4.97	4.67	38.83	10.39

Table (27): Percentage of remaining heterosis over mid and better parent for yield and its components for F_2 - generation .

Crosses	No. of ears/ plant		Ear length (cm)		Ear daimeter (cm)		No. of rows/ ear	
	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	13.30	13.30	38.42**	38.38**	36.06**	30.12**	13.14**	7.93
$P_1 \times P_3$	3.30	3.30	21.36**	13.58*	9.66*	4.86	11.18**	-0.77
$P_1 \times P_4$	16.38*	5.43	16.22**	1.48	33.03**	33.03**	28.80**	6.40
$P_1 \times P_5$	9.09	0.00	0.46	-14.52*	14.57**	7.69	3.67	2.76
$P_1 \times P_6$	23.30**	23.30*	41.39**	22.85**	28.51**	20.34**	11.69**	9.98
$P_1 \times P_7$	15.98*	12.47	-12.34*	-24.07**	-3.61	-17.81**	-0.12	-1.49
$P_2 \times P_3$	13.30	13.30	39.47**	30.87**	19.15**	19.15**	6.65	-0.56
$P_2 \times P_4$	19.34**	8.11	13.53*	-0.63	26.93**	21.38**	42.31**	22.26**
$P_2 \times P_5$	15.18*	5.58	21.91	3.97**	27.99**	15.39**	21.38**	9.05*
$P_2 \times P_6$	20.00*	20.00	51.21**	50.15**	24.54**	11.87**	12.54**	8.98*
$P_2 \times P_7$	3.19	3.19	6.33	-7.68	5.83	-13.03**	12.56**	5.97
$P_3 \times P_4$	23.86**	18.98*	12.75*	4.65	23.88**	18.47**	40.94**	28.99**
$P_3 \times P_5$	51.55**	38.92**	20.48**	8.74	11.86**	0.85	14.32**	1.25
$P_3 \times P_6$	46.70**	46.70**	40.66**	31.11**	29.27**	16.12**	23.62**	11.87*
$P_3 \times P_7$	29.92**	24.93*	30.32**	19.92**	14.18**	-6.16	13.41**	0.00
$P_4 \times P_5$	-6.90	-8.11	-15.37**	-17.89	6.38	0.00	25.58**	3.02
$P_4 \times P_6$	16.38*	5.43	26.12**	9.72	24.90**	16.96**	37.23**	14.78**
$P_4 \times P_7$	21.74*	13.54	9.11	8.17	10.05**	-6.16	22.07**	-0.25
$P_5 \times P_6$	33.36**	22.25**	9.73	-6.96	14.91**	14.42**	10.43**	7.79
$P_5 \times P_7$	17.55*	11.08	1.52	-0.60	1.14	-8.92**	8.75*	8.21
$P_6 \times P_7$	6.38	3.09	-3.61	-16.80*	-14.39**	-22.60**	-7.81*	-10.45*

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Table (27): Cont.

Crosses	No. of kernels/ row		100- kernel weight (gm)		Grain yield/ plant (gm)		Shelling percentage	
	MP	BP	MP	BP	MP	BP	MP	BP
$P_1 \times P_2$	40.79**	28.52**	41.29**	28.19**	148.73**	100.85**	7.81	0.27
$P_1 \times P_3$	43.51**	17.68*	-2.21	-7.14	63.32**	27.44	0.58	-2.21
$P_1 \times P_4$	83.94**	29.76**	6.52	-3.19	199.36**	107.79**	18.22**	-0.53
$P_1 \times P_5$	26.40**	14.20	-0.61	-12.09*	41.53**	26.62	4.45	1.59
$P_1 \times P_6$	58.54**	35.74**	35.69**	31.06*	185.55**	148.80**	4.63	2.83
$P_1 \times P_7$	-13.96*	-20.15**	5.17	-1.36	5.08	-11.39	2.30	0.13
$P_2 \times P_3$	57.87**	40.12**	15.12*	-0.28	122.02**	112.21**	4.42	-5.38
$P_2 \times P_4$	80.06**	34.84**	1.68	-15.29*	230.04**	169.20**	24.54**	11.71
$P_2 \times P_5$	55.00**	53.24**	8.10	-12.09*	121.64**	64.62**	12.75*	7.66
$P_2 \times P_6$	72.80**	60.94**	19.97**	5.51	177.18**	153.37**	7.53	1.65
$P_2 \times P_7$	1.31	-13.54*	11.00	-4.91	24.33	-11.58	-4.74	-9.60
$P_3 \times P_4$	134.61**	92.61**	-11.27*	-15.29*	283.88**	224.85**	9.71	-9.76
$P_3 \times P_5$	60.76**	44.13**	-9.23	-15.81**	123.21**	61.00**	2.14	-3.34
$P_3 \times P_6$	106.08**	95.63**	9.20	7.28	285.80**	238.55**	-1.87	-2.34
$P_3 \times P_7$	63.91**	26.87**	22.33**	20.74**	156.53**	77.65**	4.01	-0.96
$P_4 \times P_5$	72.39**	30.09**	-23.21**	-25.51**	48.46*	-3.02	27.13**	9.49
$P_4 \times P_6$	151.67**	75.15**	-1.09	-7.14	299.25**	204.01**	25.51**	7.14
$P_4 \times P_7$	79.66**	21.00**	0.00	-3.31	151.47**	59.26**	21.05**	8.49
$P_5 \times P_6$	59.68**	50.31**	-0.26	-8.98	118.66**	73.42**	7.49	6.36
$P_5 \times P_7$	26.99**	7.36	-7.91	-13.53*	50.53**	40.74**	3.95	3.27
$P_6 \times P_7$	6.62	-14.18*	3.24	0.14	5.48	-20.37	4.04	3.61

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Also, these crosses gave significant positive heterotic effects in two or more of yield components.

Inbreeding Depression :

Results of inbreeding depression in F_2 - generation for yield and yield components are presented in Table (28).

As for the number of ears per plant, the cross (P_1 x P_5) gave significant positive inbreeding depression, while, both crosses (P_2 x P_4) and (P_5 x P_7) showed significant negative (I.D.) percentage. The other crosses showed insignificant (I.D.).

Twelve, twelve, nine, seventeen, six, one and thirteen crosses showed significant positive (I.D.) for ear length, ear diameter, number of rows per ear, number of kernels per row, 100- kernels weight, shelling percentage and grain yield per plant, respectively. Significant positive inbreeding depression value (I.D.) for these traits, indicated that the mean values in the F_1 were higher than the F_2.

Results also showed significant positive estimates for both heterosis and inbreeding depression for most of plant yield and its components. Both of the heterosis and inbreeding depression effects are two sides for the same particular phenomenon. Therefore, it is logically to expect that heterosis in F_1 will be accompanied by appreciable reduction in F_2- performance. Similar results were reported by Pena and Arellano (1991).

Yield and yield components :

Combining ability :

1- F1- generation :

Analysis of variance for combining ability as outlined by Griffing's (1956) method-2 model-1 in each season and their combined data for yield components are shown in Table (29).

The variances associated with the general and specific combining ability were significant for all traits studied except number of ears per plant in the first season, It is evident that both additive and non-additive gene effects were involved in determining the performance of single cross progeny. Also, when using GCA/ SCA ratio, it was found that, ear length, number of kernels per row, and grain yield per plant in both seasons as well as in the combined analysis, ear diameter and shelling percentage in the first season and 100- kernels weight in the first season and the combined analysis, exhibited low GCA/ SCA ratio of less than unity indicating the predominance of non- additive gene action in the inheritance of such cases. While, the magnitude of additive and non- additive types of gene action were similar for number of ears per plant in the second season and the combined data, number of rows per ear in both seasons as well as the combined data, and shelling percentage in the combined data.

On the other hand, high GCA/ SCA ratios which exceeded than the unity were detected for other cases (Table 29). Such results indicated that additive and additive by additive types of gene action

Table (29): Observed mean squares for general and specific combining abilities from diallel cross analysis for yield and yield components in F_1 generation.

Source of variation	Degrees of freedom		No. of ears/ plant			Ear length (cm)			Ear diameter (cm)			No. of rows/ ear		
	S	C	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
Genotypes	27	27	0.01	0.14**	0.08**	15.14**	18.10**	31.89**	0.95**	1.01**	1.88**	5.73**	8.68**	13.82**
G.C.A	6	6	0.01	0.13*	0.08**	9.37**	14.83**	22.64**	0.58**	1.38**	1.80**	5.35**	9.92**	14.39**
S.C.A	21	21	0.01	0.14**	0.08**	16.78**	19.04**	34.53**	1.06**	0.91**	1.90**	5.84**	8.33**	13.66**
G x S		27			0.07**			1.35			0.09*			0.59*
G.C.A. x S		6			0.06*			1.56			0.17**			0.87*
S.C.A x S		21			0.07**			1.29			0.07			0.51
Error	54	108	0.01	0.05	0.03	1.57	1.66	1.62	0.07	0.03	0.05	0.31	0.35	0.33
GCA/ SCA			0.55	0.97	1.00	0.56	0.78	0.66	0.55	1.52	0.95	0.92	1.19	1.05

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C : First, second and the combined analysis, respectively.

Table (29): Cont.

Source of variation	Degrees of freedom		No. of kernels/ row			100- kerenl weight (gm)			Grain yield/ plant (gm)			Shelling %		
	S	C	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
Genotypes	27	27	236.71**	256.03**	481.24**	90.03**	34.35**	95.92**	9924.19**	10558.56**	19857.81**	175.38**	108.46**	267.63**
G.C.A	6	6	49.98**	27.26**	73.24**	39.04**	46.38**	80.78**	1069.75**	2267.05**	2787.49**	149.69**	141.82**	277.31**
S.C.A	21	21	290.06**	321.39**	597.81**	104.60**	30.91**	100.25**	12454.02**	12927.55**	24735.05**	182.71**	98.92**	264.86**
G x S		27			11.50			28.46**			624.93**			16.20
G.C.A. x S		6			4.01			4.63			549.37			14.20
S.C.A x S		21			13.64**			35.27**			646.54**			16.78
Error	54	108	3.85	2.19	3.02	4.17	6.62	5.39	221.19	388.27	304.73	6.40	19.67	13.04
GCA/ SCA			0.17	0.09	0.12	0.37	1.50	0.81	0.09	0.18	0.11	0.82	1.43	1.05

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C : First, second and the combined analysis, respectively.

were more important than non- additive gene effects controlling in these traits.

The genetic variance was previously reported to be mostly due to additive type of gene action, for number of ear per plant [Abo- Dheaf (1987), Mahmoud (1989) and El- Hosary *et al.* (1990a)], for ear length, [Salem *et al.* (1986) and El- Hosary *et al.* (1990a)], for ear diameter [Mahmoud (1989) and El- Hosary *et al.* (1990a)], for number of rows per ear [Abo- Dheaf (1987), Mahmoud (1989) and El- Hosary *et al.* (1990a), for number of kernels per row [Salem *et al.* (1986), and El- Hosary *et al.* (1990a)], for 100- kernel weight [Salem *et al.* (1986), Mahmoud (1989) and El- Hosary *et al.* (1990a)], for grain yield per plant [Sotcenko (1970), El- Rouby and Galal (1972), Salem *et al.* (1986) and El- Hosary *et al.* (1990a)].

The mean squares of the interaction between season and both types of combining ability were significant for number of ears per plant. Such results showed that the magnitude of all types of gene action varied from one season to another. The mean squares of interaction between seasons and GCA were significant for ear diameter and number of rows per ear, revealing that additive types of gene action was much more influenced by the seasonal changes than non- additive genetic effects in both traits. As for the number of kernels per row, 100- kernels weight and grain yield per plant, however, the mean squares of interaction between SCA by season were significant, indicating that non- additive gene effects were more influenced by the environments condition than additive genetic effects in these traits. These conclusions are in well agreement with those reported by Gilbert (1958).

As for ear length, insignificant mean squares of interaction between both GCA and SCA with season were detected, revealing that the high repeatability of the tested genotypes under different seasons and all types of gene action did not appreciably fluctuate in magnitude from one season to another. These findings confirm those obtained above from the ordinary analysis of variance.

The interactions between both types of combining ability and seasonal changes were reported to be significant for grain yield by El-Hosary (1985), Nawar (1985a), Badr (1989) and El- Hosary (1989). It, however, did not reach the significance level for ear length, ear diameter, number of ear per row and number of kernels per row by Salem *et al.* (1986).

2- F2 - generation :

The analysis of variance for combining ability in the F_2 data is presented in Table (30).

General and specific combining ability mean squares were significant for all traits, indicating that both additive and non-additive types of gene action were involved in determining the performance of single cross progeny. To reveal the nature of genetic variance which had the great role, GCA/ SCA ratio was estimated. As for number of ears per plant, ear diameter, shelling percentage and number of rows per

Table (30): Observed mean squares of general and specific combining ability from diallel cross analysis for yield and its components in F_2 generation .

Source of variation	D.F	No. of ears/ plant	Ear length (cm)	Ear diameter (cm)	No. of rows/ ear	No. of kernels/ row	100- kernel weight (gm)	Gain yield/ plant (gm)	Shelling %
Rep.	2	0.02	1.65	0.01	0.51	3.26	11.67	247.92	1.43
Genotype	27	0.09**	13.25**	0.69**	5.80**	141.16**	19.83**	5821.13**	98.74**
G.C.A	6	0.11**	11.37**	0.80**	6.72**	30.79**	15.78**	1418.51**	172.72**
S.C.A	21	0.08**	13.79**	0.66**	5.54**	172.70**	20.99**	7079.03**	77.60**
Error	54	0.01	1.18	0.04	0.47	5.50	3.92	309.08	25.12
GCA/ SCA		1.28	0.83	1.23	1.21	0.18	0.75	0.20	2.23

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
G.C.A. refers to general combining ability .
S.C.A. refers to specific combining ability .

ear, values of ratio exceeding larger than the unity were obtained for these traits. Thus, the largest part of the total genetic variability was due to additive and additive by additive gene effects. As for the other traits, low values of less than unity were obtained, indicating the major role of the non- additive of gene action in these traits.

GCA/ SCA ratios were higher in magnitude in F_2 than F_1 - generation for most traits, revealing that the additive and additive by additive gene effects were increased and non-additive gene effects were also reduced in the F_2 - generation.

General combining ability effects :

1- F1 - generation :

Estimates of GCA effects ($\hat{g}_i$) for individual parental line in each trait in both seasons as well as their combined analysis are presented in Table (31). General combining ability effects computed herein were found to differ significantly from zero in most cases. High positive values would be of interest for all traits in question.

The parental inbred line Moshtohor 75 expressed significant positive ($\hat{g}_i$) effects for number of kernels per row and shelling percentage in both seasons as well as the combined analysis, also number of rows per ear in the second season and the combined analysis. However, it gave undesirable ($\hat{g}_i$) effects for ear length and 100- kernel weight in both seasons as well as the combined analysis, and ear diameter in the second season and the combined analysis.

Table (31): Estimates of general combining ability effects for parents studied for yield and yield components in F_1- generation.

Source of variation	No. of ears/ plant		Ear length (cm)			Ear diameter (cm)			No. of rows/ ear		
	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
Moshtohor 75	0.02	0.01	-0.68**	-1.11**	-0.90**	-0.02	-0.11**	-0.06*	0.04	0.32**	0.18*
Moshtohor 33	-0.12**	-0.07**	-0.24	-0.20	-0.22	-0.08	-0.14**	-0.11**	0.23*	-0.11	0.06
Moshtohor 107A	0.05	0.02	0.84**	0.55*	0.70**	-0.26**	-0.33**	-0.29**	-0.70**	-0.85**	-0.77**
Moshtohor 118 B	0.07	0.03	0.09	0.33	0.21	0.01	-0.03	-0.01	-0.52**	-0.76**	-0.64**
Moshtohor 122A	0.05	0.03	0.72**	0.91**	0.81**	0.09	0.05	0.07	0.50**	0.59**	0.55**
Moshtohor 114D	0.01	0.02	-0.55*	-0.82**	-0.68**	0.04	0.24**	0.14**	0.33**	0.64**	0.49**
Giza 221 D	-0.08*	-0.04	-0.17	0.34	0.08	0.22**	0.33**	0.27**	0.13	0.16	0.14
r	0.49	0.43	0.55	0.83*	0.74*	0.94**	0.91**	0.93**	0.79*	0.88**	0.86*
L.S.D. 0.05 (g_i)	0.08	0.04	0.45	0.46	0.32	0.09	0.07	0.06	0.20	0.21	0.14
L.S.D. 0.01 (g_i)	0.10	0.06	0.59	0.61	0.42	0.12	0.09	0.07	0.27	0.28	0.19
L.S.D. 0.05 (g_i-g_j)	0.12	0.06	0.68	0.70	0.49	0.14	0.10	0.09	0.30	0.32	0.22
L.S.D. 0.01 (g_i-g_j)	0.16	0.08	0.91	0.93	0.64	0.19	0.13	0.11	0.40	0.43	0.29

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C : First, second and the combined analysis, respectively.

r = correlation coefficient between mean and general combining ability effects.

Table (31) : Cont.

Source of variation	No. of kernels/ row			100- kerenl weight (gm)			Grain yield/ plant (gm)			Shelling %		
	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
Moshtohor 75	1.69**	1.23**	1.46**	-1.22**	-1.59**	-1.40**	-0.51	0.55	0.02	1.65**	2.05**	1.85**
Moshtohor 33	-0.57	-0.44	-0.50*	-1.77**	-1.32**	-1.55**	-8.85**	-17.19**	-13.02**	-0.36	-1.91*	-1.14*
Moshtohor 107A	1.22**	0.52	0.87**	0.43	-0.58	-0.07	4.22	-0.84	1.69	1.39**	2.53**	1.96**
Moshtohor 118 B	-2.21**	-1.49**	-1.85**	0.29	0.44	0.36	-7.69**	-2.02	-4.85*	-5.08**	-4.07**	-4.57**
Moshtohor 122A	-0.73*	-0.15	-0.44*	0.71	1.54**	1.12**	3.45	13.45**	8.45**	0.15	0.53	0.34
Moshtohor 114D	-0.35	-0.78**	-0.56*	-0.22	-0.26	-0.24	1.05	1.63	1.34	0.82	0.56	0.69
Giza 221 D	0.94**	1.11**	1.02**	1.79**	1.76**	1.78**	8.32**	4.43	6.38**	1.42**	0.31	0.86
r	0.64	0.82*	0.73	0.85*	0.78*	0.86*	0.72	0.62	0.66	0.97**	0.98**	0.99**
L.S.D. 0.05 (g_i)	0.70	0.83	0.43	0.73	0.92	0.58	5.30	7.02	4.35	0.90	1.58	0.90
L.S.D. 0.01 (g_i)	0.93	0.70	0.57	0.97	1.22	0.77	7.05	9.34	5.76	1.20	2.10	1.19
L.S.D. 0.05 (g_i-g_j)	1.07	0.81	0.66	1.11	1.40	0.89	8.10	10.73	6.65	1.38	2.41	1.38
L.S.D. 0.01 (g_i-g_j)	1.42	1.07	0.87	1.48	1.86	1.17	10.77	14.27	8.79	1.83	3.21	1.82

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

S1, S2 and C : First, second and the combined analysis, respectively.

r = correlation coefficient between mean and general combining ability effects.

The parental inbred line Moshtohor 33 and 118 B gave either significant negative or insignificant ($\hat{g}_i$) effects for all traits. Also, these inbred lines behaved as poor lines for grain yield per plant.

The parental inbred line Moshtohor 107A expressed significant positive ($\hat{g}_i$) effects for ear length and shelling percentage in both seasons as well as the combined analysis and number of kernels per row in the first season and the combined analysis. Also, it gave either negative significant or insignificant ($\hat{g}_i$) effects for other traits.

The parental inbred line Moshtohor 122 A exhibited significant positive ($\hat{g}_i$) effects for 100- kernels weight and grain yield per plant in the second season and the combined analysis, number of rows per ear and ear length in both seasons as well as the combined analysis and ear diameter in the combined analysis. Moreover, such inbred line M. 122A seemed to be the first best combiner for grain yield per plant, ear length and number of rows per ear.

The parental inbred line Moshtohor 114 D was the second best combiner for ear diameter and number of rows per ear. Moreover, it gave either significant negative value or insignificant ($\hat{g}_i$) effect for other traits.

The parental inbred line Giza 221 D had the highest positive ($\hat{g}_i$) effect for ear diameter, number of kernels per row and 100- kernel weight in both seasons as well as the combined analysis, grain yield per plant in the first season as well as the combined data and shelling percentage in the first season. Moreover, such inbred line seemed to be the first best combiner for ear diameter and 100- kernels weight. Also, it was the second best combiner for number of kernels per row and grain yield per plant.

In most traits, the values of $(\hat{g}_i)$ effects were mostly different from one season to another. This finding coincided with that reached above where significant GCA by season mean squares were detected (Table 29).

Significant correlation coefficient values between the parental performance and its $(\hat{g}_i)$ effects were obtained for ear diameter, number of rows per ear, 100- kernels weight and shelling percentage in both seasons as well as the combined analysis , ear length in the second season and the combined analysis and number of kernels per row in the second season (Table 31). This finding indicates that the intrinsic performance of parental inbred lines gave a good index of their general combining ability effects. Therefore, selection within the tested parental inbred lines for initiating any proposed breeding program could be practiced either on mean performance or $(\hat{g}_i)$ effects basis with similar efficiency. As for other cases, insignificant coefficient values were detected between the two variables. It could be concluded that the non- additive type of gene action had the greatest role in the expression of these cases which are in complete agreement with the findings reached above in (Table 29).

F_2- generation :

Estimates of GCA effects $(\hat{g}_i)$ for individual parent for the studied traits in the F_2 are presented in Table (32).

Table (32): Estimates of general combining ability effects for parents studied for yield and yield components in F_2 generation.

Parent	No. of ears/ plant	Ear length (cm)	Ear diameter (cm)	No. of rows/ ear	No. of kernels/ row	100- kernel weight (gm)	Gain yield/ plant (gm)	Shelling %
Moshtohor 75	-0.08**	-1.18**	-0.06	0.24	0.78	0.22	-1.26	1.70
Moshtohor 33	-0.07**	-0.17	-0.13**	0.13	-0.35	-1.58**	-11.37**	-2.73**
Moshtohor 107A	0.03	0.75**	-0.25**	-0.74**	-0.13	-0.04	-1.89	2.86**
Moshtohor 118 B	0.07**	0.36	-0.02	-0.66**	-1.73**	-0.23	-6.01	-4.11**
Moshtohor 122A	0.08**	0.52**	0.04	0.59**	-0.68	0.44	6.55*	1.06
Moshtohor 114D	-0.003	-0.37	0.17**	0.26*	0.61	0.61	8.46**	1.36
Giza 221 D	-0.03	0.10	0.26**	0.17	1.51**	0.57	5.51	-0.13
r	0.76*	0.66	0.93**	0.90**	0.85**	0.69	0.64	0.95*
L.S.D. 0.05 (g_i)	0.04	0.39	0.07	0.24	0.84	0.71	6.27	1.79
L.S.D. 0.01 (g_i)	0.05	0.51	0.09	0.32	1.11	0.94	8.33	2.38
L.S.D. 0.05 (g_i-g_j)	0.06	0.59	0.10	0.37	1.28	1.08	9.57	2.73
L.S.D. 0.01 (g_i-g_j)	0.08	0.79	0.14	0.50	1.70	1.43	12.73	3.63

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
r = correlation between parental mean and general combining ability effects.

Results indicated that the parental inbred line Moshtohor 122 A showed significant positive $(\hat{g}_i)$ effects in the F_1 and F_2 for ear length, number of rows per ear, and grain yield per plant. It could be concluded that the best combiner for the previous studied traits in the F_2 generation were the same for the corresponding traits in the F_1 (Table 31). The parental inbred lines M. 118 B and M. 122 A for number of ears per plant and M. 107 A for shelling percentage, M 114 D for ear diameter, number of rows/ ear and grain yield per plant and G 221 D for ear diameter and number of kernels per row showed significant positive $(\hat{g}_i)$ effects.

Significant correlation coefficient values between the parental performance and its $(\hat{g}_i)$ effects were detected for number of ears per plant, ear diameter , number of rows per ear, number of kernels per row and shelling percentage. This finding indicated that intrinsic performance of parental inbred lines gave a good index of their general combining ability effects. Also, low correlation coefficient values were detected between the two variables for other traits. Such results might add another proof to both types of genetic variances to be important in these traits and coincides with the findings reached above (Table 29).

Specific combining ability effects :

1- F_1 - generation :

Specific combining ability effects were only estimated whenever significant SCA variances were obtained (Table 33).

Table (33): Specific combining ability effects for yield and its components in F_1 - generation .

Crosses	No. of ears/ plant			Ear length (cm)			Ear diameter (cm)			No. of rows/ ear		
	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
P_1 x P_2	-0.020	0.07	0.03	-0.01	2.14**	1.06**	0.41**	0.28**	0.35**	0.56*	-0.11	0.22
P_1 x P_3	-0.020	-0.23*	-0.13*	2.30**	1.18*	1.74**	0.22	0.30**	0.26**	-0.38	-0.11	-0.24
P_1 x P_4	-0.020	0.24*	0.11*	0.33	0.34	0.33	0.49**	0.37**	0.43**	1.28**	1.54**	1.41**
P_1 x P_5	-0.040	0.30**	0.13*	2.09**	1.16*	1.63**	0.31**	0.22**	0.27**	0.06	0.32	0.19
P_1 x P_6	0.180**	0.21*	0.19**	1.10	1.35*	1.22**	0.33**	0.41**	0.36**	-0.07	0.47	0.20
P_1 x P_7	-0.001	-0.04	-0.02	0.95	0.60	0.77	0.08	-0.02	0.03	0.13	1.03**	0.58**
P_2 x P_3	-0.001	0.11	0.06	3.74**	2.40**	3.07**	0.38**	0.40**	0.39**	-0.38	0.23	-0.08
P_2 x P_4	-0.001	-0.18	-0.09	1.93**	2.09**	2.01**	0.39**	0.57**	0.48**	1.78**	1.58**	1.68**
P_2 x P_5	-0.020	-0.16	-0.09	0.59	0.85	0.72	0.20	0.22**	0.21**	1.56**	1.66**	1.61**
P_2 x P_6	0.030	-0.12	-0.04	1.76**	1.84**	1.80**	0.59**	0.53**	0.56**	0.96**	0.97**	0.97**
P_2 x P_7	-0.010	0.27**	0.13*	-0.32	0.96	0.32	0.08	0.04	0.06	-0.20	-0.51	-0.35*
P_3 x P_4	-0.010	0.22*	0.11*	0.41	1.07	0.74	0.57**	0.32**	0.44**	1.51**	1.61**	1.56**
P_3 x P_5	0.040	0.14	0.09	1.14*	1.90**	1.52**	0.35**	0.27**	0.31**	1.26**	1.19**	1.22**
P_3 x P_6	-0.040	0.25*	0.11*	1.68**	2.09**	1.88**	0.24*	0.12	0.18*	0.63*	0.64*	0.64**
P_3 x P_7	-0.050	0.14	0.09	1.50**	1.33*	1.42**	0.19	-0.11	0.04	-0.01	0.50	0.25
P_4 x P_5	-0.020	-0.08	-0.05	0.36	-0.28	0.04	0.28*	0.31**	0.30**	0.45	0.67*	0.56**
P_4 x P_6	-0.040	0.06	0.01	1.37*	1.37*	1.37**	0.24*	0.36**	0.30**	1.55**	2.33**	1.94**
P_4 x P_7	-0.020	0.01	-0.01	0.62	-0.04	0.29	0.29*	-0.04	0.13	0.62*	0.14	0.38*
P_5 x P_6	-0.060	0.25*	0.10	-0.03	0.80	0.38	0.19	0.11	0.15*	-0.44	0.07	-0.18
P_5 x P_7	-0.030	-0.20*	-0.12*	-0.15	0.42	0.13	0.07	0.15	0.11	0.27	-0.15	0.06
P_6 x P_7	-0.050	-0.16	-0.11*	-0.08	0.70	0.31	-0.14	0.43**	0.15*	0.17	0.74**	0.46*
LSD 0.05	0.090	0.19	0.10	1.11	1.14	0.78	0.23	0.16	0.14	0.49	0.52	0.35
LSD 0.01	0.110	0.25	0.14	1.47	1.51	1.04	0.30	0.21	0.18	0.66	0.69	0.47
LSD 0.05 (S_{ii}-S_{ik})	0.150	0.33	0.18	1.93	1.98	1.37	0.40	0.28	0.24	0.86	0.91	0.62
LSD 0.01 (S_{ii}-S_{ik})	0.200	0.44	0.24	2.57	2.64	1.81	0.53	0.37	0.32	1.14	1.21	0.82
LSD 0.05 (S_{ii}-S_{kl})	0.140	0.31	0.17	1.81	1.86	1.28	0.37	0.26	0.23	0.81	0.85	0.58
LSD 0.01 (S_{ii}-S_{kl})	0.810	0.41	0.22	2.40	2.47	1.69	0.50	0.35	0.30	1.07	1.13	0.77

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C = First, second and combined analysis, respectively.

Table (33): Cont.

Crosses	No. of kernels/ row			100- kernel weight (gm)			Grain yield/ plant (gm)			Sheling %		
	S1	S2	C	S1	S2	C	S1	S2	C	S1	S2	C
$P_1 \times P_2$	1.54	1.34*	1.44**	4.31**	4.39**	4.35**	25.82**	30.33**	28.08**	1.29	3.43	2.36*
$P_1 \times P_3$	6.73**	2.75**	4.74**	-0.16	0.38	0.11	7.85	-18.95*	-0.02	-0.53	0.49	-0.02
$P_1 \times P_4$	3.19**	7.50**	5.35**	3.05**	-2.30*	0.38	31.62**	52.73**	42.18**	2.77*	5.46**	4.11**
$P_1 \times P_5$	9.61**	3.89**	6.75**	4.23**	1.30	2.77**	62.19**	52.89**	57.54**	3.41**	1.86	2.63*
$P_1 \times P_6$	4.33**	3.88**	4.10**	2.96**	1.70	2.33**	32.72**	43.18**	37.95**	2.61*	-1.31	0.65
$P_1 \times P_7$	1.57	3.17**	2.37**	2.68**	-2.06	0.31	17.71**	3.51	10.61	1.64	0.34	0.99
$P_2 \times P_3$	4.55**	6.18**	5.37**	6.33**	1.74	4.04**	35.12**	26.76**	30.94**	0.72	-0.92	-0.10
$P_2 \times P_4$	7.45**	11.53**	9.49**	1.47	0.46	0.97	44.06**	32.24**	38.15**	8.45**	6.85**	7.65**
$P_2 \times P_5$	1.03	4.12**	2.58**	-1.02	-1.90	-1.46*	6.23	1.07	3.65	3.56**	2.29	2.92**
$P_2 \times P_6$	4.55**	2.25**	3.40**	2.25*	3.83**	3.04**	41.45**	19.06*	30.26**	4.49**	2.02	3.26**
$P_2 \times P_7$	-2.40**	-0.24	-1.32*	6.93**	3.91**	5.42**	13.68*	37.59**	25.64**	-0.98	1.87	0.45
$P_3 \times P_4$	8.13**	9.41**	8.77**	0.97	3.99**	2.48**	35.89**	81.82**	58.86**	3.27**	3.08	3.17**
$P_3 \times P_5$	5.41**	8.40**	6.91**	2.28*	-0.64	0.82	50.39**	63.29**	56.84**	3.61**	0.04	1.83
$P_3 \times P_6$	8.53**	8.79**	8.66**	5.44**	-2.51*	1.47*	59.78**	37.98**	48.88**	3.54**	-0.45	1.54
$P_3 \times P_7$	4.51**	3.41**	3.96**	4.83**	-0.30	2.26**	44.81**	29.21**	37.01**	1.41	1.07	1.24
$P_4 \times P_5$	4.18**	3.75**	3.97**	5.52**	-1.33	2.10**	36.40**	4.10	20.25**	8.77**	6.31**	7.54**
$P_4 \times P_6$	6.97**	7.74**	7.35**	0.05	0.04	0.05	31.89**	52.15**	42.02**	9.84**	6.22**	8.03**
$P_4 \times P_7$	6.81**	3.22**	5.02**	2.04*	1.15	1.59*	36.92**	16.71	26.82**	6.37**	5.73**	6.05**
$P_5 \times P_6$	6.15**	5.47**	5.81**	0.43	0.04	0.24	16.83*	40.22**	28.52**	2.88*	2.15	2.51*
$P_5 \times P_7$	3.36**	1.68*	2.52**	0.05	5.56**	2.80**	17.22*	16.05	16.64**	2.81*	-0.20	1.31
$P_6 \times P_7$	-2.39**	1.77**	-0.31**	1.95*	2.49*	2.22*	-2.72	11.74	4.51	0.84	0.87	0.86
LSD 0.05	1.73	1.31	1.07	1.80	2.27	1.43	13.12	17.38	10.78	2.23	3.91	2.23
LSD 0.01	2.30	1.74	1.42	2.39	3.02	1.90	17.45	23.11	14.24	2.97	5.20	2.95
LSD0.05 ($S_{ii}-S_{ik}$)	3.02	2.28	1.87	3.14	3.96	2.50	22.90	30.34	18.81	3.89	6.83	3.89
LSD0.01 ($S_{ii}-S_{ik}$)	4.02	3.03	2.48	4.18	5.27	3.31	30.45	40.45	24.87	5.18	9.08	5.14
LSD0.05 ($S_{ii}-S_{kl}$)	2.82	2.13	1.75	2.94	3.71	2.34	21.42	28.9	17.60	3.64	6.39	3.64
LSD0.01 ($S_{ii}-S_{kl}$)	3.76	2.84	2.31	3.91	4.93	3.10	28.49	37.74	23.26	4.85	8.50	4.81

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S1, S2 and C = First, second and combined analysis, respectively.

Six hybrids had significant positive ($\hat{S}_{ij}$) effects for number of ears per plant in the second season and the combined analysis. The cross (P_1 x P_6) had the highest ($\hat{S}_{ij}$) effects for this trait followed by cross (P_1 x P_5) in the combined analysis.

As for ear length, nine, eleven, and eleven hybrids expressed significant positive ($\hat{S}_{ij}$) effects in the first, second seasons as well as the combined analysis. respectively. The cross (P_2 x P_3) gave the highest ($\hat{S}_{ij}$) effects followed by the cross (P_2 x P_4) in the combined analysis.

Thirteen, fourteen, and sixteen hybrids had significant positive ($\hat{S}_{ij}$) effects for ear diameter in the first, second season as well as the combined analysis, respectively. The other crosses expressed insignificant ($\hat{S}_{ij}$) effects for this trait.

Ten, eleven, and twelve hybrids exhibited significant positive ($\hat{S}_{ij}$) effects for number of rows per ear in the first, second season as well as the combined analysis, respectively. The crosses (P_4 x P_6), (P_2 x P_4) and (P_2 x P_5) gave the highest SCA effects in the combined analysis.

With the exception of cross (P_2 x P_7) in both seasons and the combined analysis, cross (P_6 x P_7) in the first season and the combined analysis and three crosses (P_1 x P_2), (P_1 x P_7) and (P_2 x P_5) in the first season, all crosses expressed significant positive ($\hat{S}_{ij}$) effects for number of kernels per row in both seasons as well as the combined analysis. The cross ($P_2 \times P_4$) gave the highest SCA effects followed by cross ($P_3 \times P_4$) and then by cross ($P_3 \times P_6$) for this trait.

As for 100- kernels weight, fourteen, six and thirteen hybrids showed significant positive ($\hat{S}_{ij}$) effects in the first, second season as well as the combined analysis, respectively. The other crosses exhibited either significant negative or insignificant ($\hat{S}_{ij}$) effect for this trait. The cross ($P_2 \times P_7$) had the highest desirable SCA effects for this trait in the combined analysis.

As for shelling percentage, fourteen, five, and eleven, parental combinations showed significant positive ($\hat{S}_{ij}$) effects in the first, second season as well as the combined analysis , respectively. The crosses ($P_4 \times P_6$), ($P_4 \times P_5$) and ($P_4 \times P_7$) gave the highest SCA effects in the combined analysis in this trait.

With regard to grain yield per plant, eighteen, fourteen, and seventeen parental combination showed significantly positive ($\hat{S}_{ij}$) effects in the first, second seasons and their combined analysis, respectively. In conclusion, the best combinations were ($P_3 \times P_4$) , ($P_1 \times P_5$), ($P_3 \times P_5$), ($P_1 \times P_4$) and ($P_4 \times P_6$) in the combined analysis. These crosses also had the highest mean values in the combined analysis. It could be concluded that the previous crosses seemed to be the best combinations, where it had significant SCA effects for grain yield per plant as well as most of the yield components over the two seasons.

In these crosses showing high specific combining ability involving only one good combiner, such combinations would show desirable transgressive segregates, providing that the additive genetic system present in the good combiner as well as the complementary and epistatic effects present in cross, act in the same direction to reduce undesirable plant characteristics and maximize the character in view. Therefore, the previous crosses might be of prime importance in breeding program for traditional breeding procedures.

In most traits, the values of SCA effects were mostly different from one season to another. This finding coincided with that reached above where significant SCA by season mean squares were detected (Table 29).

F2 - generation :

Specific combining ability effects of the parental combinations were estimated for all the studied traits in the F_2 - generation (Table 34). The most desirable inter-and intra- allelic interactions were represented by six, eleven, twelve, nine, twelve, three, five and fourteen hybrids for number of ears per plant, ear length, ear diameter, number of rows per ear, number of kernels per row, 100- kernel weight, shelling percentage and grain yield per plant, respectively. The cross (P_3 x P_7) gave the highest SCA effects followed by cross (P_3 x P_6) and then by cross (P_4 x P_7) for grain yield per plant and some of its components. In these traits, one or more of the previous crosses had significant positive SCA effects in the F_1- generation. The mentioned combinations might be of interest in breeding programs aimed at

Table (34): Estimates of specific combining ability effects for yield and its components in F_2 generation .

Crosses	No. of ears/ plant	Ear length (cm)	Ear diameter (cm)	No. of rows/ ear	No. of kernels/ row	100-kernel weight (gm)	Grain yield/ plant (gm)	Shelling %
$P_1 \times P_2$	0.06	2.07**	0.54**	0.45	4.10**	4.50**	40.53**	2.40
$P_1 \times P_3$	-0.15**	0.15	-0.22*	0.19	0.97	-2.38*	-20.75**	-0.72
$P_1 \times P_4$	0.09	1.21*	0.53**	1.04**	5.81**	1.05	40.08**	3.19
$P_1 \times P_5$	-0.02	-0.62	0.10	-0.44	0.59	-0.49	-5.91	-0.38
$P_1 \times P_6$	0.09	2.50**	0.51**	0.59	5.07**	4.97**	54.54**	0.25
$P_1 \times P_7$	0.08	-2.34**	-0.32**	-0.45	-7.20**	-0.99	-27.01**	-0.29
$P_2 \times P_3$	-0.05	1.47**	-0.01	-0.88**	1.57	1.05	-8.47	1.18
$P_2 \times P_4$	0.12*	-0.13	0.20*	1.74**	2.01	-0.32	20.39*	5.05*
$P_2 \times P_5$	0.04	1.48**	0.48**	1.26**	5.02**	1.31	38.17**	4.18*
$P_2 \times P_6$	0.05	2.69**	0.25**	0.13	5.44**	0.91	21.85**	1.15
$P_2 \times P_7$	-0.06	-0.71	-0.02	0.65*	-3.99**	-0.05	-17.10	-6.09**
$P_3 \times P_4$	0.14**	-0.22	0.22*	1.35**	4.99**	-1.87*	22.61**	-0.94
$P_3 \times P_5$	0.33**	1.35**	0.03	0.33	2.07	-1.27	25.45**	-0.97
$P_3 \times P_6$	0.21**	1.70**	0.53**	1.37**	6.95**	0.66	57.01**	-0.47
$P_3 \times P_7$	0.10	2.80**	0.43**	0.72*	8.42**	4.67**	65.12**	2.12
$P_4 \times P_5$	-0.23**	-2.72**	-0.23**	0.48	0.63	-3.78**	-27.66**	6.87**
$P_4 \times P_6$	0.01	1.69**	0.34**	1.65**	9.08**	-0.38	43.03**	6.54**
$P_4 \times P_7$	0.13*	1.29**	0.21*	0.61*	8.32**	0.66	50.35**	8.36**
$P_5 \times P_6$	0.17**	-0.17	0.18*	0.20	2.66*	-0.02	26.21*	0.80
$P_5 \times P_7$	0.06	0.44	0.02	0.49	2.86**	-1.25	18.76*	-0.58
$P_6 \times P_7$	-0.10	-1.98**	-0.78**	-1.67**	-5.16**	-1.02	-45.96**	-0.01
LSD 0.05	0.10	0.96	0.17	0.60	2.07	1.75	15.51	4.42
LSD 0.01	0.13	1.27	0.22	0.80	2.75	2.32	20.62	5.88
LSD 0.05 $(S_{ii}-S_{ik})$	0.18	1.67	0.03	1.05	3.61	3.05	27.07	7.72
LSD 0.01 $(S_{ii}-S_{ik})$	0.24	2.22	0.39	1.40	4.80	4.05	36.00	10.26
LSD 0.05 $(S_{ii}-S_{kl})$	0.17	1.56	0.27	0.99	3.38	2.85	25.32	7.22
LSD 0.01 $(S_{ii}-S_{kl})$	0.22	2.08	0.36	1.31	4.49	3.79	33.67	9.60

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

producing good inbred lines as most combinations involved at least one good combiner.

Genetic components and heritability :

Data were subjected to the diallel cross analysis suggested by Hayman (1954b) for more information about the genetical behaviour of the yield and its components.

1- F1 - generation :

The components of genetic variation and their proportions for yield and yield components in both seasons are given in Table (35). With the exception of ear length in the first season, the additive component ($\hat{D}$) reached the significant level for all the studied traits, suggesting the additive gene action plays an important role in the inheritance of these characters. This finding is in accordance with that reached above in Table (29). Similar results were previously obtained by Sotcenko (1970), El- Rouby and Galal (1972), Salem *et al.* (1986), Abo- Dheaf (1987), Mahmoud (1989) and El- Hosary *et al.* (1990a).

As for ear length in the first season, insignificant ($\hat{D}$) value inspite of a highly significant GCA estimate was obtained. Dominance may has a role in GCA estimate as emphasized by Jinks (1955). Moreover, t he computed t^2 was found in this trait to be significant, revealing the presence of complementary type of epistasis. Complementary types of epistasis generally decreased (Wr) disproportionally more than (Vr) leading to inflation on the relative

Table (35): Estimate of genetic components of variation in a dialllel maize crosses in F_1 for yield and yield components during 1995/ 96.

Characters components	No. of ears/ plant	Ear length (cm)		Ear diameter (cm)		No. of rows/ ear	
	S2	S1	S2	S1	S2	S1	S2
D	-0.01*	1.80	4.52**	0.27**	0.36**	2.38**	3.26**
H_1	0.14**	15.27**	16.33**	0.90**	0.82**	6.49**	8.23**
H_2	0.12**	12.75**	13.90**	0.79**	0.71**	4.83**	6.79**
h^2	0.12**	47.91**	62.52**	3.52**	2.92**	13.57**	23.38**
F	-0.01	2.75*	5.10*	0.35**	0.30*	3.38**	3.47*
E	0.02**	0.64	0.54*	0.02	0.01	0.10	0.11
$(H_1/ D)^{½}$	5.44	2.92	1.90	1.84	1.51	1.65	1.59
$(H_2/ 4 H_1)$	0.22	0.21	0.21	0.22	0.21	0.19	0.21
K_D/ K_R	0.60	1.71	1.84	2.02	1.75	2.51	2.01
h^2/ H_2	0.99	3.76	4.50	4.49	4.14	2.81	3.44
h (ns)	0.21	0.17	0.19	0.10	0.33	0.20	0.25
r	-0.27	-0.92**	-0.96**	-0.95**	-0.68	-0.94**	-0.92**
t^2	2.64	10.24**	13.79**	7.94**	9.98**	3.05*	4.04*

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
r = correlation coefficient between mean performance (Yr) and order of dominance (Wr + Vr).

Table (35): Cont.

Characters / Components	No. of kernels/ row		100- kerenl weight (gm)		Grain yield/ plant (gm)		Shelling %	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
D	36.28**	42.36*	9.67*	9.14**	488.86*	639.59*	89.64**	78.61**
H_1	268.11**	294.53**	88.85**	32.99**	10196.78**	11077.10**	183.43**	101.36**
H_2	229.91**	252.79**	84.59**	27.30**	9742.44**	10386.44**	141.64**	67.58**
h^2	937.98**	1066.23**	340.69**	41.26**	44440.35**	42747.86**	532.66**	234.44**
F	67.37**	82.03*	8.88	8.27*	795.24	981.11	120.24**	102.94**
E	1.29	0.71	1.38	2.25**	79.12	129.46	2.40	6.33*
$(H_1/D)^{1/2}$	2.72	2.64	3.03	1.90	4.56	4.16	1.43	1.14
$(H_2/4H_1)$	0.21	0.22	0.24	0.21	0.24	0.23	0.19	0.17
K_D/K_R	2.04	2.16	1.36	1.63	1.43	1.45	2.77	3.72
h^2/H_2	4.08	4.22	4.03	1.51	4.56	4.12	3.76	3.47
h (ns)	0.06	0.02	0.10	0.27	0.03	0.06	0.13	0.17
r	-0.96**	-0.95**	-0.95**	-0.35	-0.93**	-0.90**	-0.95**	-0.91**
t^2	4.88*	12.57**	3.31*	4.17*	6.62*	25.48**	8.02**	5.20**

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
r = correlation coefficient between mean performance (Yr) and order of dominance (Wr + Vr).

magnitude of dominance to additive component (Hayman, 1954-a; Hayman and Mather, 1955 and Mather and Jinks 1971). Therefore, the contradiction in magnitude detected herein ($\hat{D}$) and GCA estimate for ear length in the first season could be attributed to the great role of both allelic and non- allelic gene interactions on the expression of this trait.

The presence of the dominance effects was substantiated by the significant values of ($\hat{H}_1$) for all traits. Moreover, values of ($\hat{H}_1$) were higher in magnitude than the respective ($\hat{D}$) ones for all traits. This result revealed that non- additive type of gene action was the most prevalent genetic component for these traits. The contradiction in magnitude obtained between ($\hat{D}$) and GCA estimate for ear diameter and shelling percentage in the second season could be attributed to the great role of both allelic and non- allelic genic types of the expression of both traits.

The quantity $(\hat{H}_1/\hat{D})^{1/2}$ is a weighed estimate of the average degree of dominance at each locus. The values of $(\hat{H}_1/\hat{D})^{1/2}$ were greater than unity for all characters, indicating that full to overdominance may be important in these characters (Table 35). The similar results were reported by Sotcenko (1970), El- Rouby and Galal (1972), Salem *et al.* (1986) and El- Hosary *et al.* (1990a).

The overall dominance effects of heterozygous loci symbolized as ($\hat{h}^2$) were estimated for all the studied traits (Table 35). Significant ($\hat{h}^2$) values were detected for all traits, indicating that dominance was unidirectional . This finding confirms the results shown above by parent vs. crosses illustrated in Table (21).

The average frequency of negative vs. positive alleles in parental population was detected by the ratio ($\hat{H}_2/ 4\hat{H}_1$) . Values that largely deviate from one quarter were obtained for all traits except for number of ears per plant in the second season, 100- kernel weight in the first season, and grain yield per plant in both seasons, revealing that negative and positive alleles were unequally distributed among the parent. The same conclusion could also be drawn from estimating either the ($\hat{F}$) component or the corresponding proportion K_D/ K_R .

The correlation coefficient values between parental mean (Yr) and (Wr + Vr) for each array were significant negative values for ear length, number of rows per ear, number of kernels per row, shelling percentage and grain yield per plant in both seasons, ear diameter and 100- kernels weight in the first season. This indicates that the increasers genes were dominant over decreasers.

Heritability :

Low heritability values in narrow sense were detected for all traits, indicating that most of the genetic variance may be due to non-additive genetic effects. This finding supported the previous results of genetic components where the H_1 estimates were found to have a great role in yield and yield components (Table 35). Therefore, the bulk method programs for these traits might be quite promising.

F2 - generation :

The computed parameters of the F_2 - generation for all traits are presented in Table (36). The additive components $(\hat{D})$ reached the significance level of probability for all traits except number of ears per plant. This finding is in harmony with the reached above in Table (35). Significant values for the dominance component $(\hat{H}_1)$ were obtained for all traits. Moreover, values of $(\hat{H}_1)$ were significantly larger in magnitude than the respective $(\hat{D})$ values in all traits, revealing that dominance gene effects were the most prevalent genetic type in yield and yield components.

The relative sizes of $(\hat{D})$ and $(\hat{H}_1)$ were estimated as a weight measure of the average degree of dominance at each locus. The results revealed the presence of over-dominance for yield and its components.

The overall dominance effects of heterozygous loci symbolized as $(\hat{h}^2)$ values were computed for all traits. Significant $(\hat{h}^2)$ values were showed in all traits except 100- kernel weight, indicating that dominance was unidirectional.

The average frequency of negative vs. positive alleles in the parental population, could be detected by estimating the ratio $(\hat{H}_2/ 4\hat{H}_1)$. Values that are largely deviating from one quarter were obtained for all traits except number of ears per plant and grain yield per plant, indicating that negative and positive alleles were unequally distributed among the parents. Moreover, $(\hat{F})$ values were detected in the same traits, indicating asymmetry with dominance alleles being more

Table (36): Estimates of genetic components of variation in a diallel maize crosses for yield and yield components in F_2 generation .

Characters / components	No. of ears/ plant	Ear length (cm)	Ear diameter (cm)	No. of rows/ ear	No. of kernels/ row	100- kernel weight (gm)	Gain yield/ plant (gm)	Shelling %
D	0.01	4.66**	0.36**	3.22**	41.26**	10.14**	666.75*	76.90**
H_1	0.31*	68.28**	3.10**	24.65**	75091**	109.74**	29072.94**	289.86**
H_2	0.29*	50.63**	2.47**	18.27**	601.07**	70.79**	26418.09**	175.31*
h^2	0.42**	55.44**	3.68**	38.95**	1520.84**	-4.07	57375.91**	316.24**
F	-0.01	15.03**	0.88*	8.40**	154.92*	36.98**	2336.45	186.77**
E	0.01	0.40	0.01	1.16	1.81	1.40	102.30+	8.09*
$(H_1/D)^{1/2}$	3.57	1.91	1.46	1.38	2.13	1.65	3.30	0.97
$(H_2/4H_1)$	0.23	0.19	0.20	0.19	0.20	0.16	0.23	0.15
K_D/K_R	0.82	2.46	2.43	2.79	2.57	3.49	1.72	4.34
h^2/H_2	1.49	1.10	1.48	2.13	2.53	-0.06	2.17	1.80
h (ns)	0.82	0.90	0.82	0.79	0.91	0.81	0.83	0.22
r	-0.53	-0.09	-0.58	-0.94**	-0.89**	-0.83*	-0.78*	-0.87*
t^2	2.07	0.00	3.47*	0.39*	0.01	0.001	0.47	0.94

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

r = correlation coefficient between parental mean performance (Yr) and order of dominance (Wr + Vr).

frequent. The same conclusion could also be drawn form estimating the corresponding proportion (K_D/ K_R) .

The correlation coefficient values between parental mean (Yr) and (Wr + Vr) for each array were significant negative values for number of rows per ear, number of kernels per row, 100- kernels weight, shelling percentage and grain yield per plant, revealing that the increasers genes were dominant over decreasers. This finding is in general agreement with the results obtained from F_1- generation (Table 35).

Heritability :

High heritability values were detected for all traits except shelling percentage where a low value was obtained . This finding revealed that response to selection would be achieved in the early generations of crosses among the parental inbred lines under study.

From the previous results, it could be concluded that genetic analysis carried out by different methods of diallel cross analysis gave the similar results. Results obtained from F_2 and F_1 generation diallel crosses were relatively similar in this breeding material of corn.

Graphical analysis :

F_1 generation :

The Vr, Wr (variance- covariance) graphs have been presented in Figs. 24- 39. The slopes of the regression line of the Vr, Wr graphs were different from unity for the studied traits, indicating that complementary type of epistasis was involved.

The distribution of the parental arrays along the regression line for all the characters indicated wide distribution of dominant and recessive alleles among the parents.

The regression lines were found to intersect the (Wr) axis below the origin for the yield and yield components, indicating over-dominance in the inheritance of these traits. This finding agrees with the results presented in Table (35).

The parental inbred lines (P_1) for shelling percentage in both seasons, and 100- kernels weight in the second season, (P_2) for number of ears per plant in both seasons, (P_5) for ear diameter, ear length in both seasons, (P_6) for number of rows per ear in both seasons and 100- kernels weight in the first season, (P_7) for number of kernels and grain yield per plant in both seasons, seemed to carry most of the dominant genes responsible for these traits. However, (P_1) for number of ears per plant in both seasons, (P_2) for ear length and 100- kernel weight in both seasons and ear diameter in the second season, (P_3) for grain yield per plant in both seasons and ear diameter in the first season, (P_4) for number of rows per ear, number of kernels per row and shelling percentage in both seasons possessed more recessive genes for the previous traits.

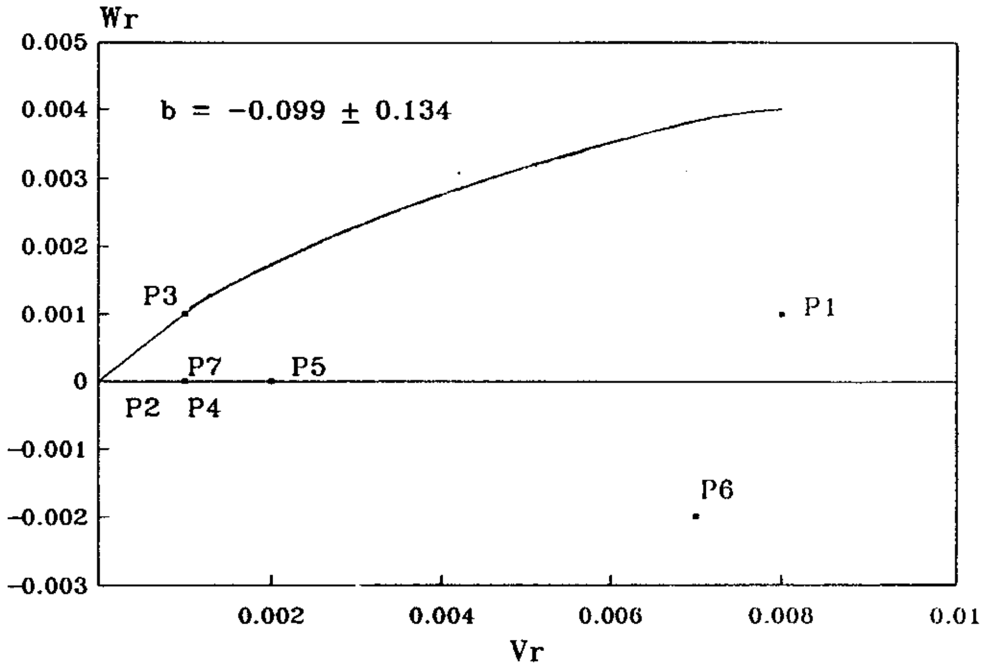

Fig. 24: Vr and Wr graph for number of ears/ plant of F_1 S_1

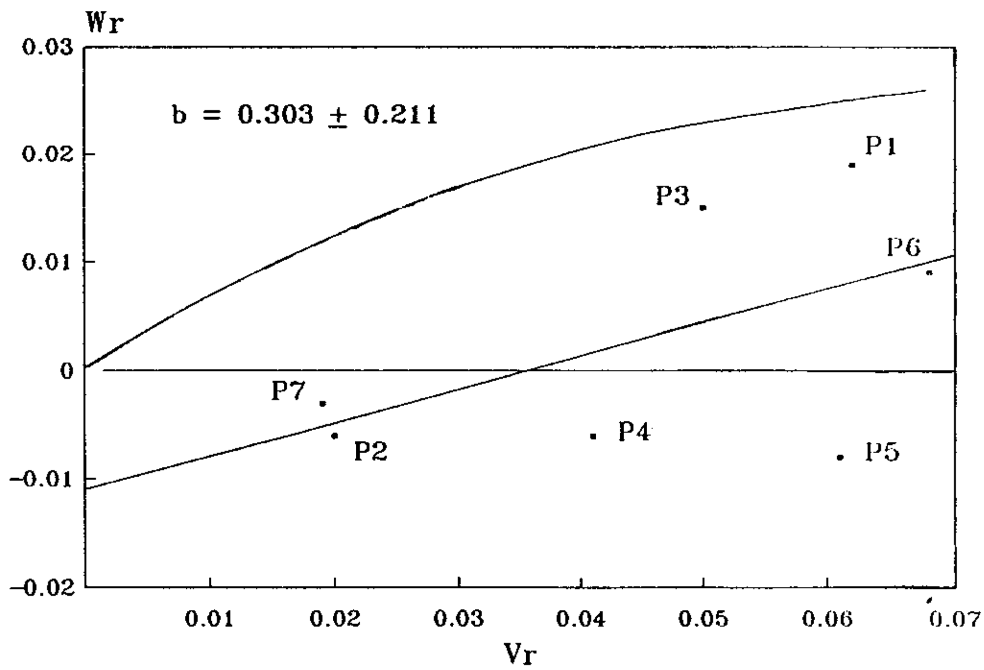

Fig. 25: Vr and Wr graph for number of ears/ plant of F_1 S_2

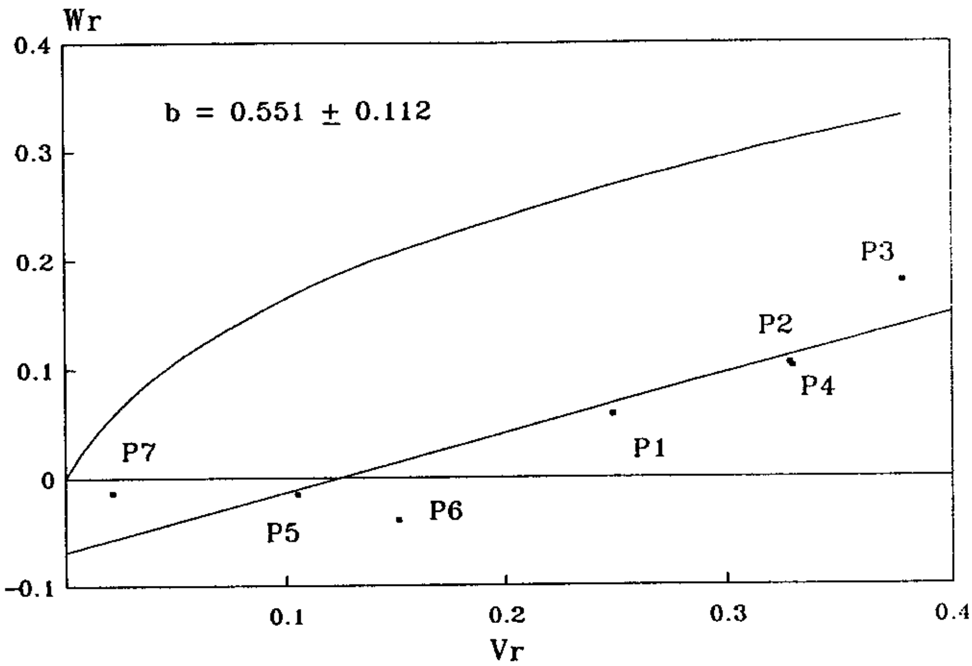

Fig. 26: Vr and Wr graph for ear diameter (cm) of F_1 S_1

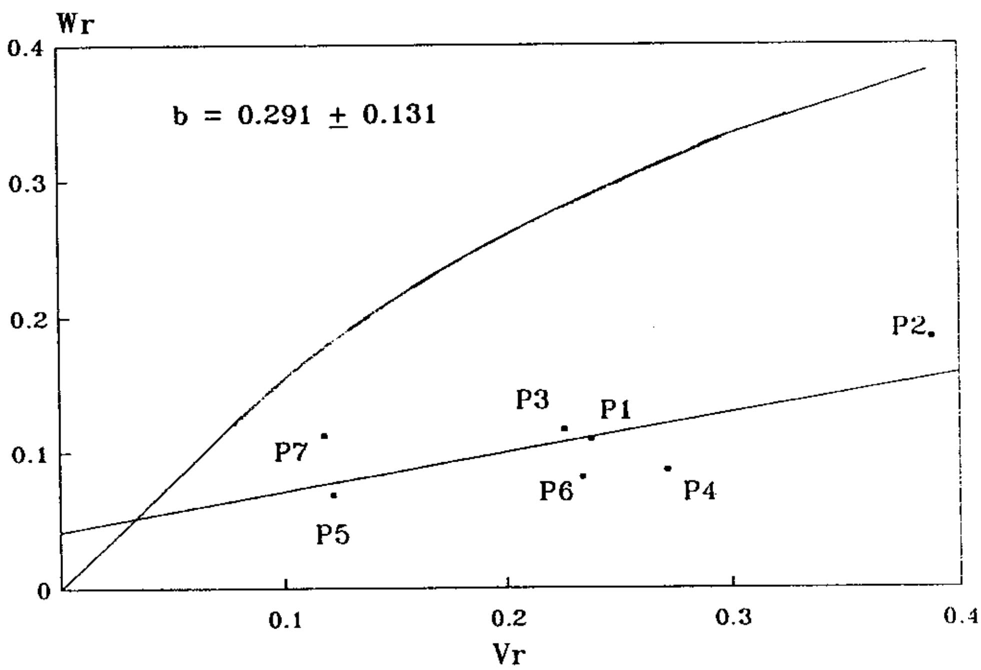

Fig. 27: Vr and Wr graph for ear diameter (cm) of F_1 S_2

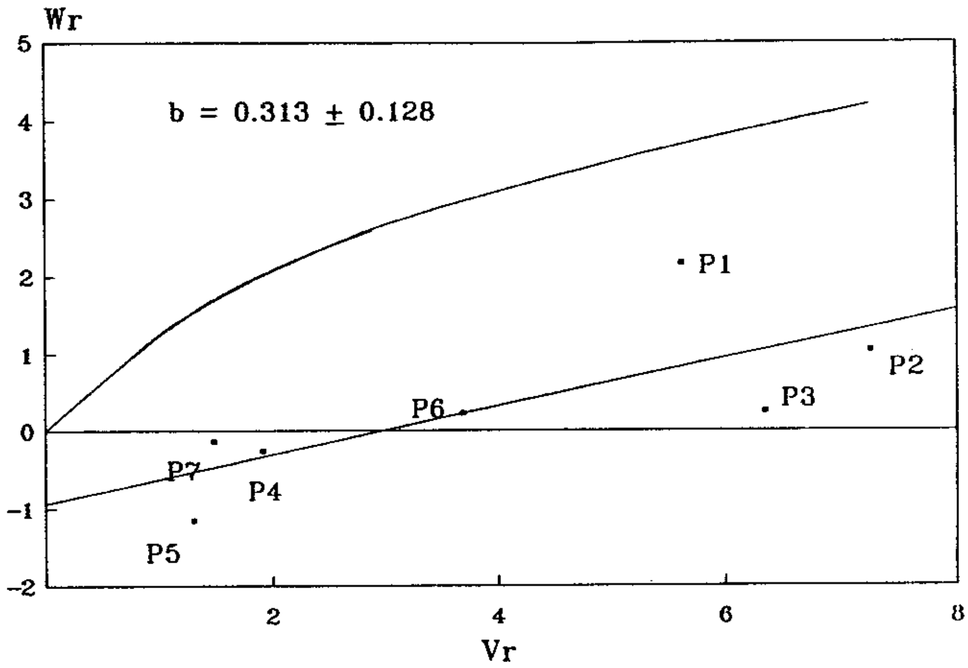

Fig. 28: Vr and Wr graph for ear length (cm) of F_1 S_1

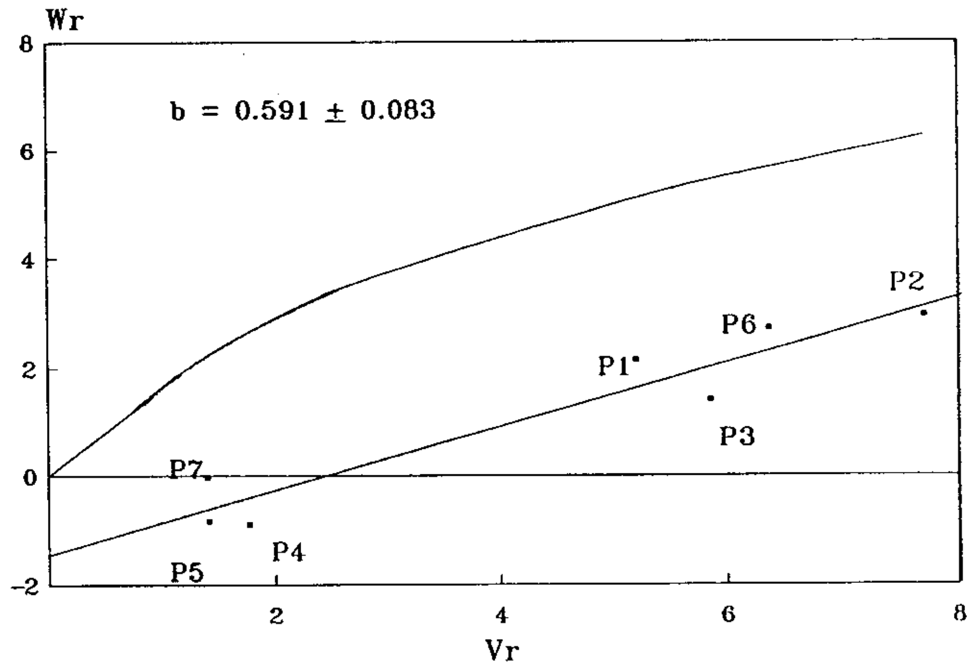

Fig. 29: Vr and Wr graph for ear length (cm) of F_1 S_2

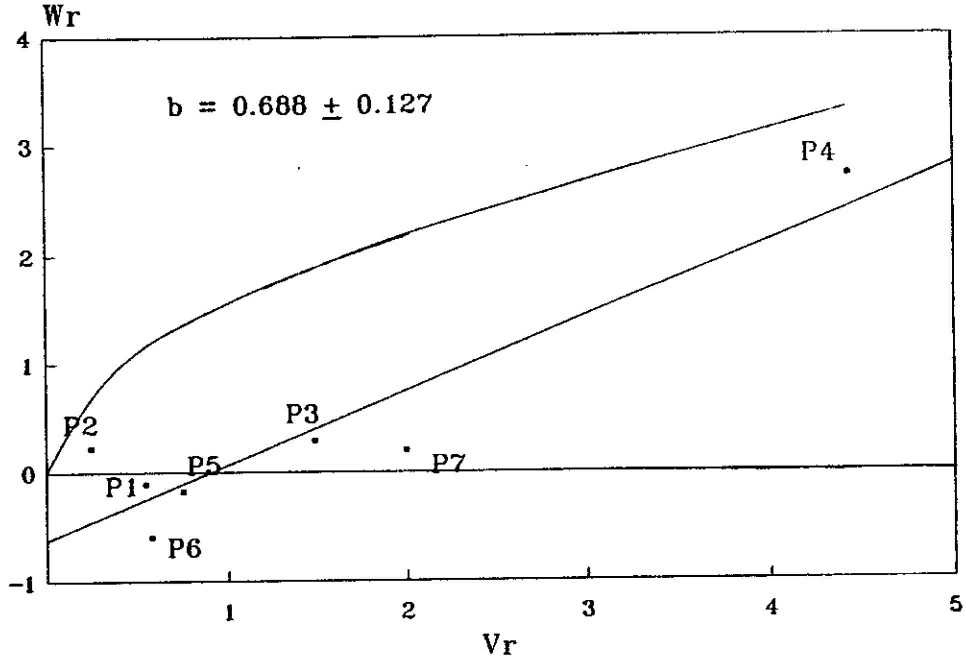

Fig. 30: Vr and Wr graph for No. of rows/ ear of F_1 S_1

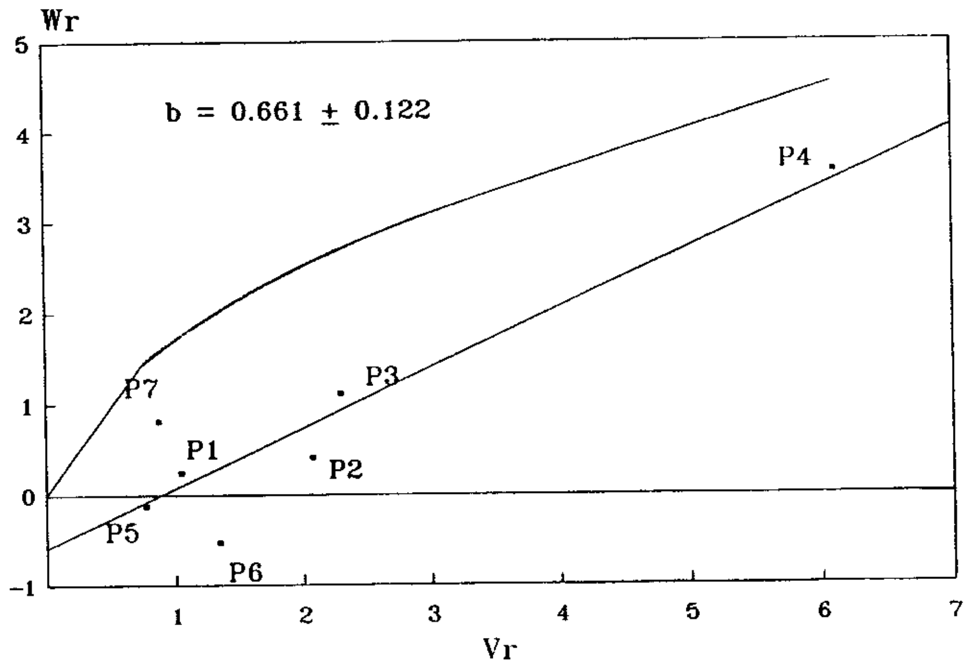

Fig. 31: Vr and Wr graph for No. of rows/ ear of F_1 S_2

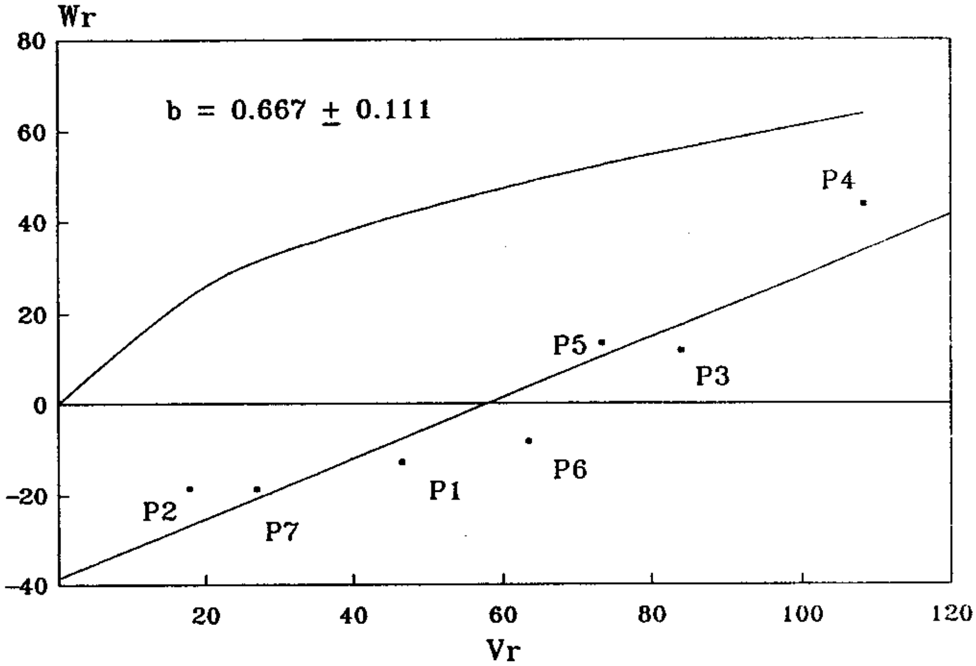

Fig. 32: Vr and Wr graph for No. of kernels/ row of F_1 S_1

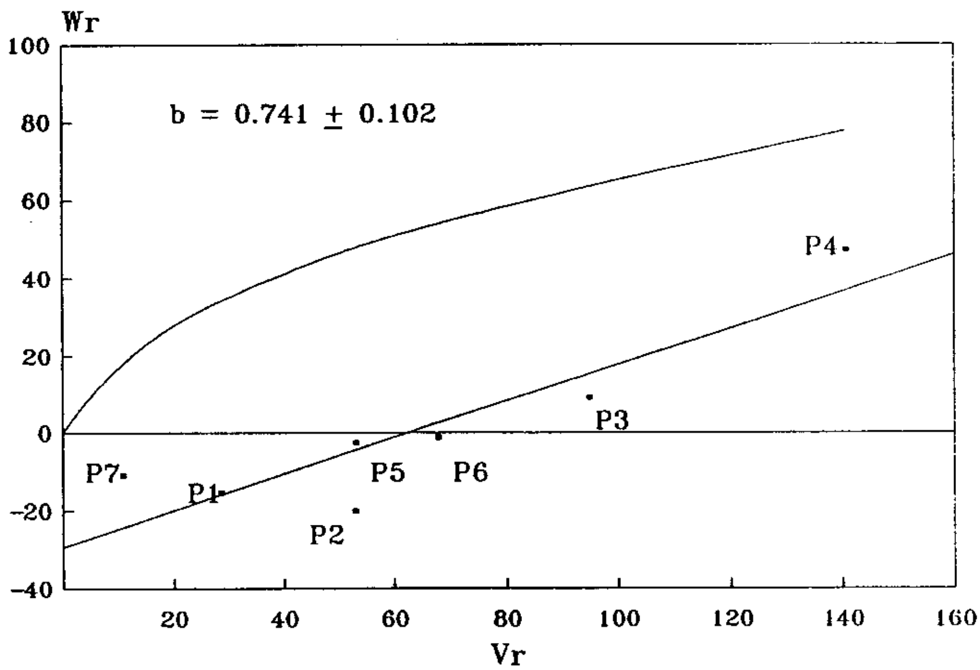

Fig. 33: Vr and Wr graph for No. of kernels/ row of F_1 S_2

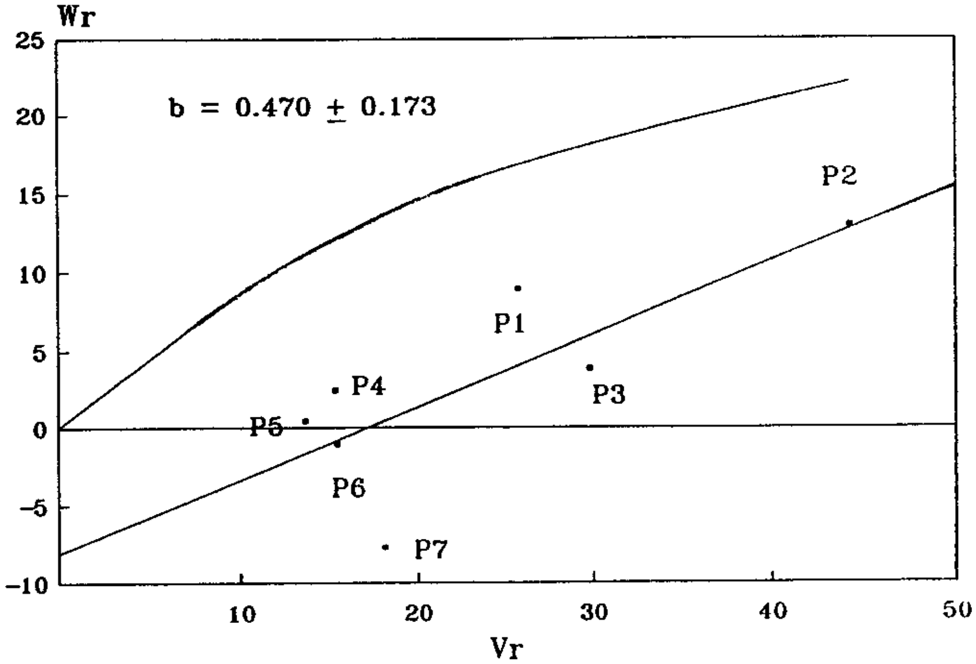

Fig. 34: Vr and Wr graph for 100 kernel weight of F_1 S_1

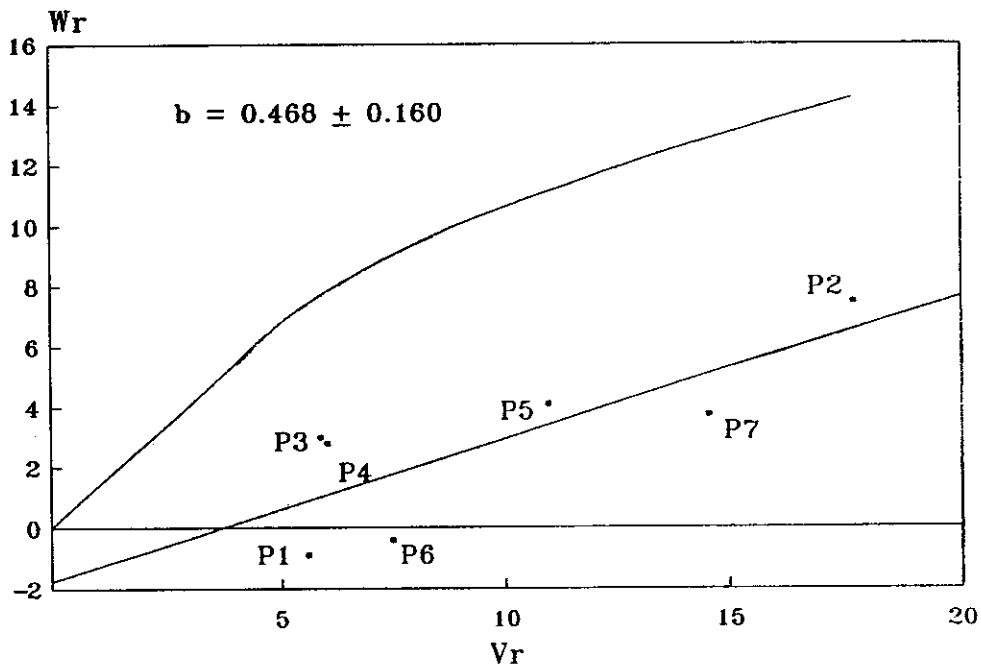

Fig. 35: Vr and Wr graph for 100 kernel weight of F_1 S_2

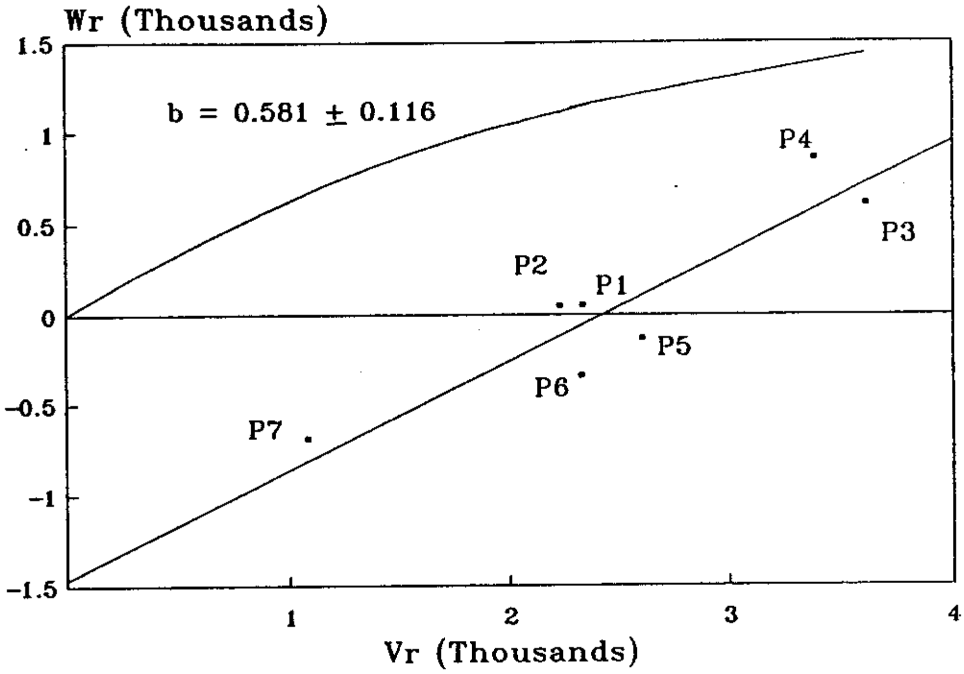

Fig. 36: Vr and Wr graph for grain yield/ plant of F_1 S_1

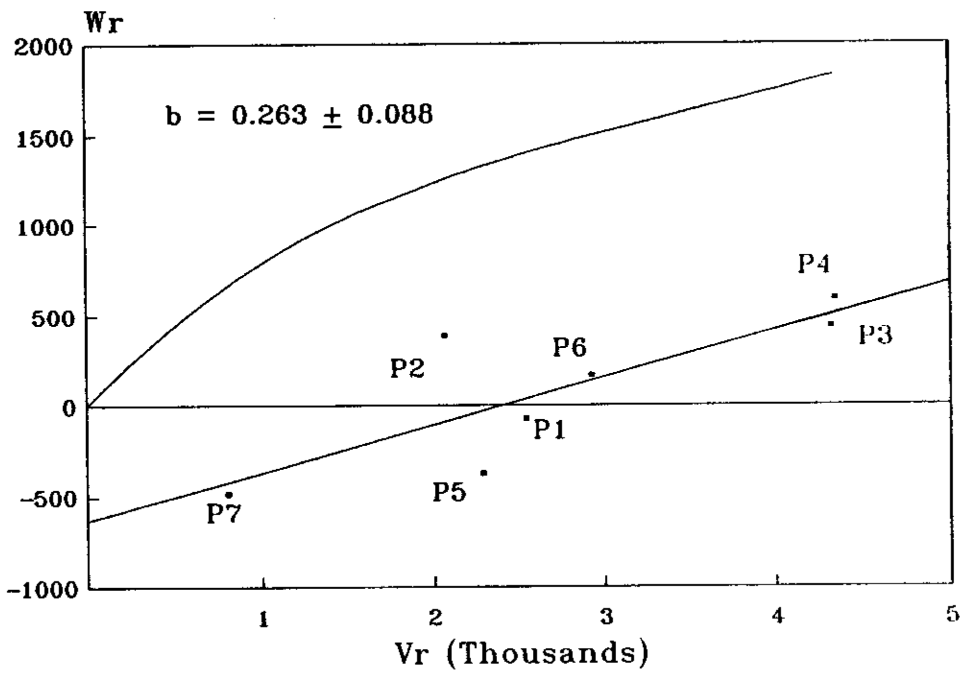

Fig. 37: Vr and Wr graph for grain yield/ plant of F_1 S_2

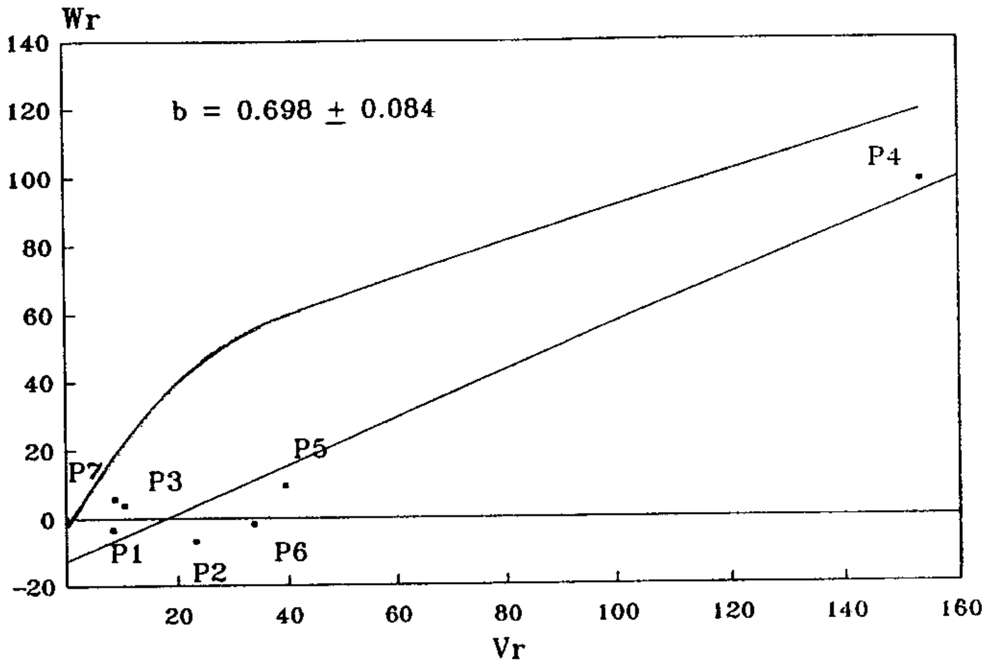

Fig. 38: Vr and Wr graph for shelling % of F_1 S_1

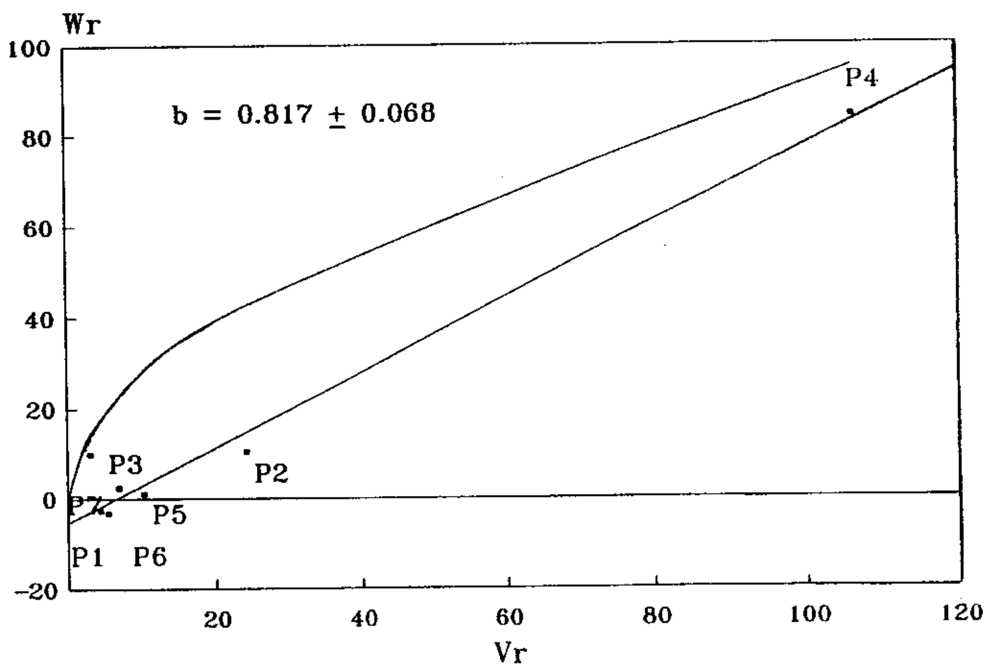

Fig. 39: Vr and Wr graph for shelling % of F_1 S_2

F_2- generation :

The Vr, Wr graphs are presented in Figs. 40 - 47 for the F_2 generation. The slope in the Vr, Wr graph did not differ significantly from unity for all traits except number of ears and grain yield per plant indicating the absence of genetic interaction for all traits studied in the present material.

For all traits except shelling percentage, over- dominance was observed as the regression lines were significantly deviated below the origin. For shelling percentage, the regression line passed through the origin, revealing the complete dominance for that trait. Similar results were obtained by Sotcenko (1970), El- Rouby and Galal (1972) and Odiemah (1973).

The parental inbred lines (P_5), (P_6), (P_4), (P_6), (P_1), (P_4), (P_5) and (P_6) seemed to carry most of dominant genes responsible for number of ears per plant, ear diameter, ear length, number of rows per ear, number of kernels per row, 100- kernels weight, grain yield per plant and shelling percentage, respectively. However, in the same order, (P_3), (P_3), (P_7), (P_4), (P_4), (P_2), (P_3) and (P_4) possessed more recessive genes.

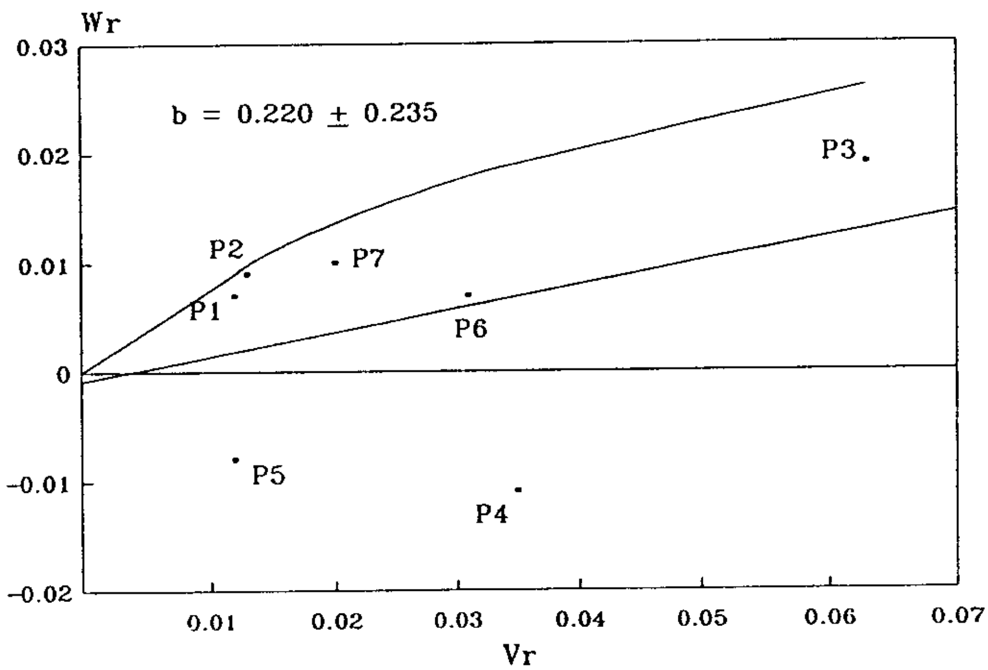

Fig. 40: Vr and Wr graph for No. of ears/ plant of F_2

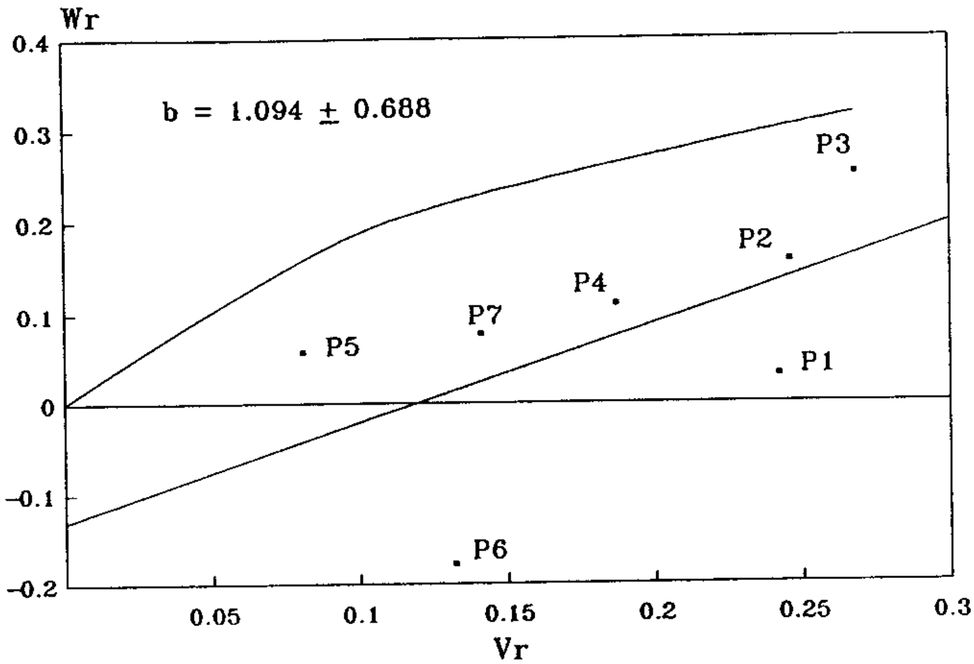

Fig. 41: Vr and Wr graph for ear diameter (cm) of F_2

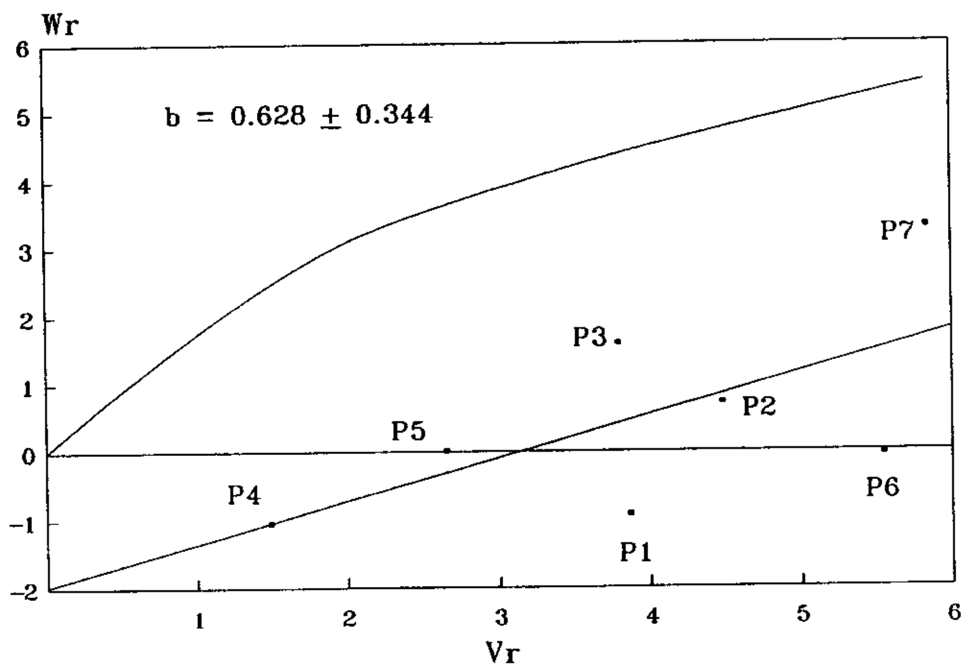

Fig. 42: Vr and Wr graph for ear length (cm) of F_2

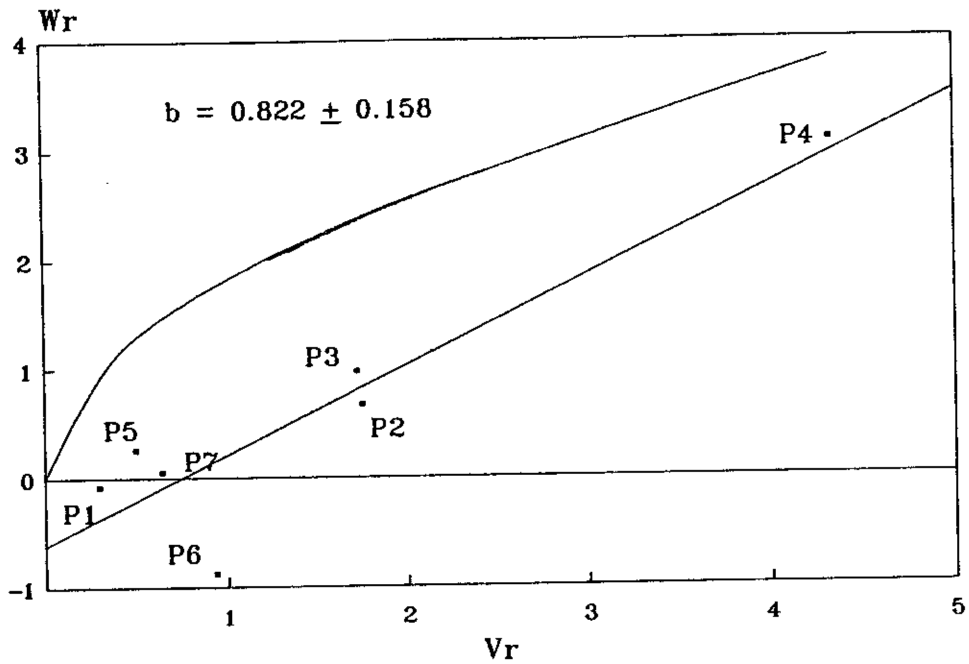

Fig. 43: Vr and Wr graph for No. of rows/ ear of F_2

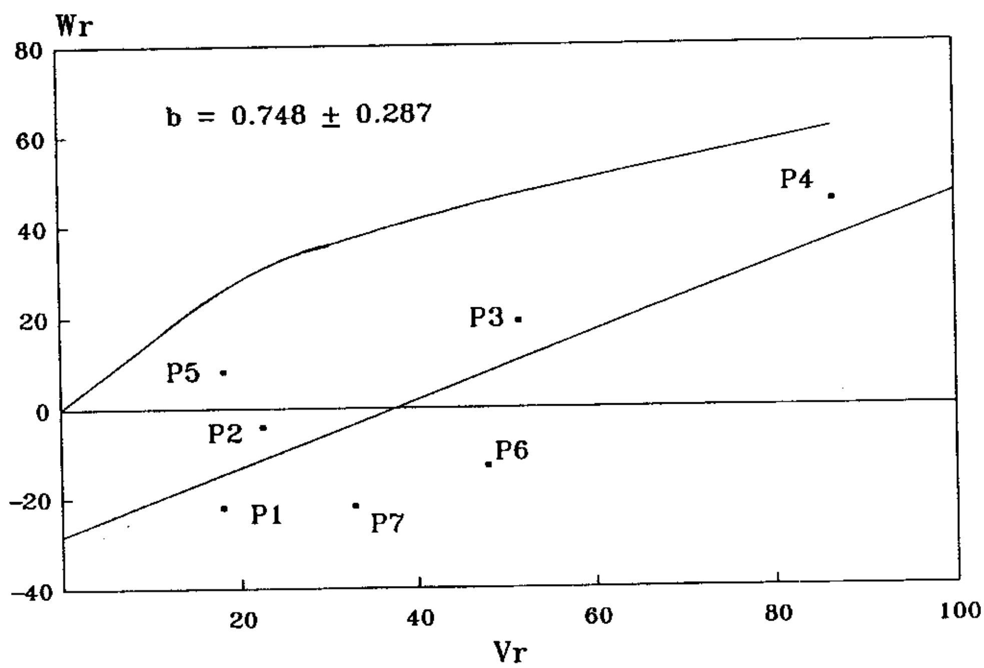

Fig. 44: Vr and Wr graph for No. of kernels/ row of F_2

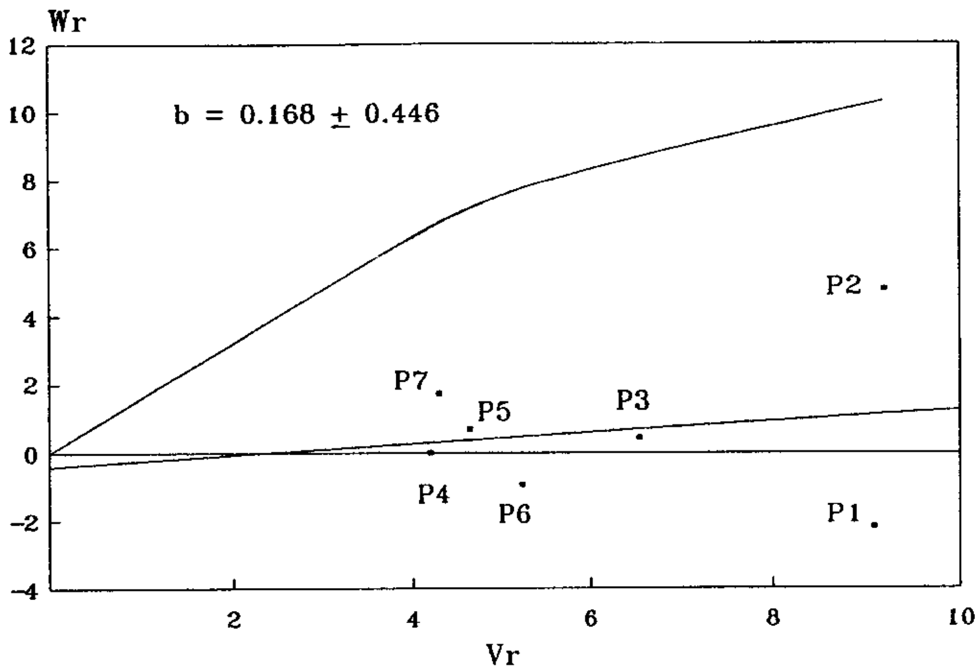

Fig. 45: Vr and Wr graph for 100 kernel weight of F_2

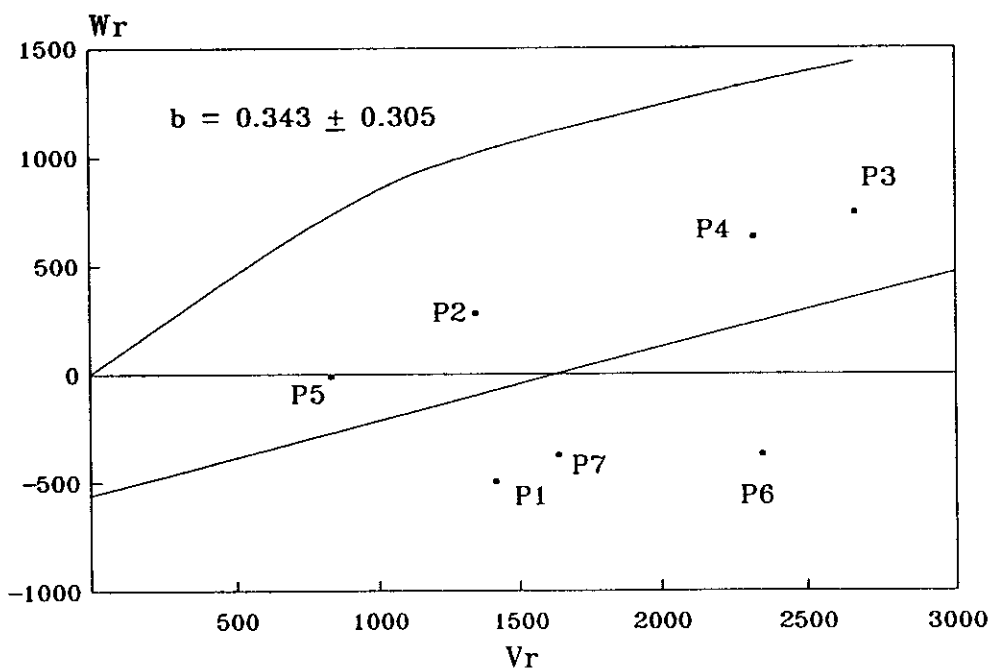

Fig. 46: Vr and Wr graph for grain yield/ plant of F_2

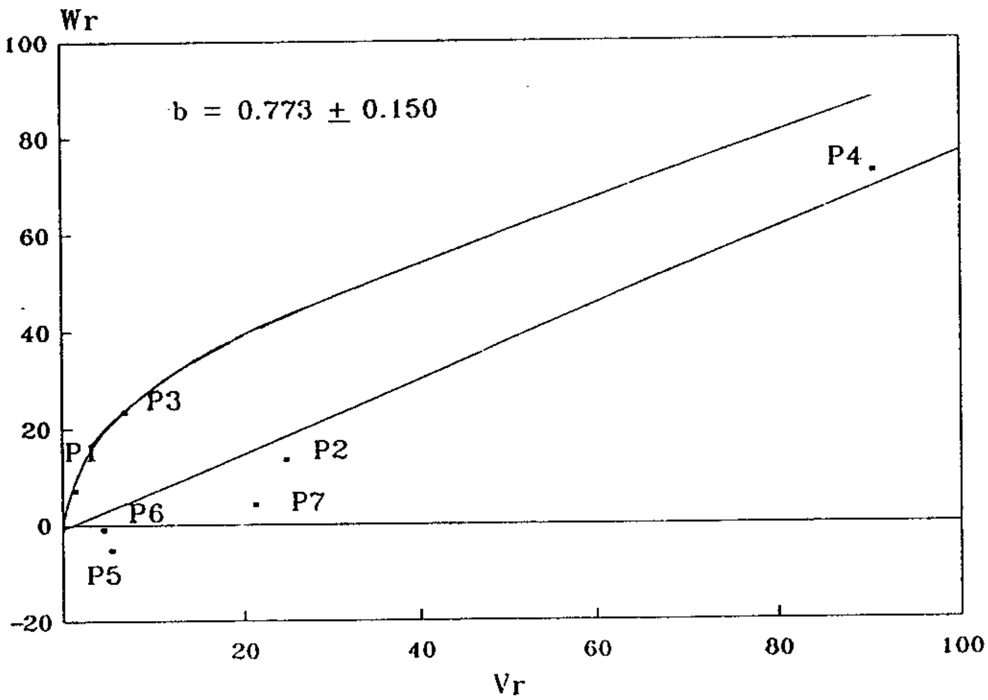

Fig. 47: Vr and Wr graph for shelling % of F_2

SUMMARY