RESULTS & DISCUSSION

4. RESULTS AND DISCUSSION

The present study was carried out to investigate the heterosis and types of gene action for some growth and yield characteristics of some parental wheat lines and/or varieties by means of diallel cross system. To achieve this target, half diallel of F_1 and F_2 crosses was studied.

4.1. Analysis of variances, means and heterosis:

4.1.1. F_1-generation:

The analysis of variance in the first fillial generation (F_1 data) for growth, yield and its components is presented in Table (4). Significant genotypes mean squares were detected for all the traits studied, indicating the wide diversity between the parental materials used in the present study. Results also, showed that the mean squares due to parents were significant for all the traits studied. These findings indicate that parental varieties and/or lines differed in their mean performance in all traits under test.

The mean performance of the eight parental lines and or varieties of wheat is presented in Table (5). The parental variety Gemmeiza 7 (No. 1) was the highest mean values for no. of spikelets/spike. The parental variety Gemmeiza 9 (No. 2) behaved as the latest one for earliness (heading and maturity dates). The parental line 1 (No. 4) gave the lowest mean values for plant height and plant height up to flag leaf. It was the top of the tested parental lines in harvest index, and 1000-grain weight.

Table (4): Observed mean squares from analysis of variance for all traits studied of F_1 data.

S.O.V.	d.f.	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
Rep.	2	2.67	1.16	6.11**	5.61**	5.58**	3.66*	0.63	0.49	0.92	3.65*	2.44	22.32**	1703.31**	1808.11**	52.43**
Genotypes	35	38.94**	17.75**	155.94**	108.51**	30.91**	35.80**	8.46**	4.74**	33.59**	38.42**	141.87**	427.21**	2497.36**	4576.48**	45.42**
Parents	7	103.16**	25.90**	264.77**	209.33**	38.06**	75.42**	30.03**	2.94**	79.82**	115.52**	288.75**	379.25**	4012.92**	5818.45**	114.25**
Crosses	27	22.91**	14.34**	130.41**	74.52**	24.54**	24.62**	3.16**	4.71**	20.57**	19.86**	104.19**	361.74**	1172.19**	2454.53**	37.87**
P.vs.F_1	1	22.04**	52.97**	83.52**	320.37**	152.70**	60.50**	0.66	8.38**	61.68**	0.02	131.22**	2530.54**	27667.81**	53175.26**	82.48**
Error	70	1.06	0.16	4.02	4	3.14	1.7	0.41	0.78	1.8	4.16	9.9	21.89	411.35	570.04	11.09

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

Table (5): The genotypes mean performance for all traits studied in the F_1 generation.

Genotype	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
Gemmeiza 7 (1)	107.83	148.67	115.22	78.33	22.45	17.80	15.28	25.66	17.22	49.20	74.11	56.55	143.45	200.00	28.27
Gemmeiza 9 (2)	112.89	151.00	119.33	85.33	19.92	18.17	14.08	25.00	18.17	47.91	74.17	53.50	146.50	200.00	26.75
Sakha 94 (3)	111.15	147.00	118.67	85.16	21.58	21.25	12.58	24.33	20.67	46.60	74.67	65.00	135.00	200.00	32.50
Line 1 (4)	100.41	143.67	92.50	61.00	17.33	21.00	13.00	22.33	19.83	64.99	66.83	54.83	78.50	133.33	41.12
Line 2 (5)	107.49	148.00	110.50	77.66	24.00	22.00	9.67	24.33	22.83	46.21	66.50	63.67	186.33	250.00	25.47
Line 3 (6)	99.08	144.33	117.83	78.00	26.12	17.00	16.08	25.00	17.00	48.70	74.33	54.50	95.50	150.00	36.33
Line 4 (7)	99.14	142.00	102.67	66.00	15.08	6.50	20.42	24.67	6.00	48.51	97.00	28.33	88.33	116.67	24.78
Line 5 (8)	110.50	146.00	114.83	81.00	22.25	20.67	12.75	25.00	20.67	46.82	67.83	56.00	144.00	200.00	28.00
1x2	108.22	151.00	120.00	82.80	19.17	19.67	14.83	28.00	18.33	51.17	8033	66.25	133.75	200.00	33.12
1x3	109.08	147.67	116.50	82.90	20.25	21.17	14.58	26.00	20.17	54.73	74.33	72.83	177.17	250.00	29.13
1x4	106.25	146.83	104.33	74.09	12.83	25.00	14.83	25.00	25.00	46.19	79.33	71.17	195.50	266.67	26.68
1x5	109.75	151.00	114.17	80.29	19.08	20.50	13.67	27.00	23.50	43.76	83.83	67.50	207.50	275.00	24.54
1x6	104.75	147.83	117.33	81.73	18.42	20.33	15.08	25.00	20.33	53.43	84.67	90.25	201.42	291.67	31.03
1x7	110.58	151.33	113.44	78.27	15.45	16.17	16.05	27.55	16.17	50.37	88.50	63.55	178.11	241.67	26.05
1x8	109.50	150.83	118.83	88.71	17.28	18.33	14.89	27.67	18.33	50.37	75.00	57.00	168.00	225.00	25.33
2x3	110.11	152.50	118.00	85.89	15.74	17.00	14.50	27.00	17.00	49.49	84.16	63.16	186.84	250.00	25.26
2x4	102.42	145.67	107.75	69.90	16.45	16.25	14.64	25.67	16.17	53.64	75.50	60.83	172.50	233.33	26.07
2x5	107.82	149.00	116.00	78.90	18.00	17.83	12.50	26.00	17.83	50.56	70.50	54.67	145.33	200.00	27.33
2x6	105.93	150.00	114.33	81.89	19.25	16.67	15.17	27.00	17.50	50.82	70.17	46.50	161.83	208.33	22.33
2x7	105.77	148.00	120.61	78.75	18.83	17.17	14.33	25.33	17.17	53.87	69.01	50.83	149.17	200.00	25.42
2x8	109.65	151.00	114.33	81.90	16.58	19.17	14.08	27.00	19.17	50.73	79.67	73.83	159.50	233.33	31.69
3x4	106.67	146.33	99.67	69.76	15.50	27.17	13.50	24.33	25.67	48.13	72.83	77.17	139.50	216.67	35.61
3x5	109.83	147.83	119.50	77.95	20.17	19.75	12.17	24.33	18.83	49.31	74.07	60.83	139.17	200.00	30.42
3x6	106.42	145.67	119.17	81.49	25.25	22.50	14.25	24.33	21.83	48.69	68.67	67.33	199.33	266.67	25.28
3x7	107.42	146.83	114.00	82.47	16.92	17.67	14.25	25.67	17.33	50.15	83.83	65.72	153.72	219.44	29.94
3x8	111.83	149.33	119.17	84.18	17.42	20.83	13.17	25.33	20.67	49.07	85.47	78.17	155.17	233.33	33.50
4x5	105.80	147.67	103.50	68.37	16.42	23.00	12.75	24.67	23.00	51.38	79.00	91.83	183.17	275.00	33.20
4x6	101.08	145.50	106.94	67.95	16.33	21.17	15.17	23.89	21.17	47.76	83.17	72.44	219.23	291.67	24.83
4x7	102.17	143.33	100.67	63.24	14.58	20.50	14.58	25.33	20.50	50.36	79.50	71.50	178.50	250.00	28.60
4x8	107.42	146.50	100.83	70.95	14.92	23.83	13.42	23.00	23.33	51.14	70.50	71.33	153.67	225.00	31.70
5x6	107.23	148.00	119.00	78.28	23.92	22.67	11.75	25.33	21.83	44.24	69.33	57.33	184.33	241.67	23.70
5x7	106.18	147.33	111.33	76.56	17.25	17.00	14.08	24.67	17.00	47.44	79.00	57.28	151.00	208.33	27.49
5x8	110.32	146.67	117.67	78.85	19.83	17.17	12.33	24.33	17.17	49.31	73.67	50.83	149.17	200.00	25.40
6x7	105.32	148.00	115.00	79.85	22.25	21.00	14.25	26.00	20.00	49.05	73.50	63.83	177.83	241.67	26.41
6x8	102.48	147.33	12133	79.90	21.25	16.00	14.42	24.67	16.00	49.91	81.00	51.37	148.67	200.00	25.67
7x8	106.62	145.50	116.25	80.71	21.25	20.25	14.00	24.83	20.25	52.07	69.75	64.00	161.00	225.00	28.44
Mean of parent	106.06	146.33	111.44	76.56	21.09	18.05	14.23	24.54	17.80	49.87	74.43	54.05	127.20	181.25	30.58
Mean of crosses	107.02	148.02	542.55	78.09	18.24	19.85	14.04	25.53	19.69	49.90	361.11	65.69	165.70	234.62	28.48
Mean	106.76	147.58	446.64	77.70	18.83	19.46	14.06	25.28	19.28	49.91	297.41	63.03	156.69	222.24	29.01
L.S.D. at 5%	1.67	0.64	3.26	3.25	2.88	2.12	1.03	1.43	2.18	331.00	5.11	7.60	32.94	38.77	5.41
at 1%	2.22	0.85	4.32	4.31	3.82	2.81	1.37	1.10	2.89	4.39	6.78	10.08	43.69	51.43	7.17
C.V.	0.96	0.27	1.77	2.49	9.40	6.71	4.52	3.49	6.99	4.09	4.11	7.41	12.91	10.72	11.51

Sakha 94 variety (No. 3) was the top of the tested parental lines in grain yield/plant. Line 2 (No. 5) was the top of the tested parental lines in number of spikes/plant and straw yield/plant. The parental line 3 (No. 6) gave the highest mean value for length of flag region. The parental line 4 (No. 7) was the top of the tested parental lines in spike length and number of grains/spike. It gave the lowest mean values for number of tillers/plant, number of spike/plant, grain yield/plant, straw yield/plant, total weight of plant and harvest index. Meanwhile it behaved as the earliest one for heading date and maturity date. The parental line 5 (No. 8) was intermediate in most the traits. It is interesting to note that the superiority of the parental Sakha 94 (3) and line 2 (5) in grain yield resulted from a higher number of tillers/plant, number of spikelets/spike, number of spikes/plant, 1000-grain weight and number of grains/spike.

Data presented in Table (4) showed that crosses mean squares were significant for all the traits studied revealing an overall difference between these hybrids. The mean performances of F_1 hybrids are presented in Table (5). For heading date, maturity date, plant height, plant height up to flag leaf, length of flag region and number of kernels per spike, the hybrids were within the range of parental lines.

For number of tillers/plant, the two crosses (3x4) and (1x4) had the highest mean values. However, the cross (6x8) had the lowest one. The crosses (1x7), (1x6), (2x6) and (4x6), exhibited the highest mean values for spike length.

For number of spikelets per spike, three crosses (1x2), (1x8) and (1x7) had the highest mean values. However, the cross (4x8) had the lowest mean value for number of spikelets/spike.

The cross (3x4) had the highest values for number of spikes per plant followed by the cross (1x4), but the cross (6x8) had the lowest one in the same trait.

For 1000-kernel weight, the two crosses (1x3) and (2x7) exhibited the highest values. However, the crosses (1x5) and (5x6) had the lowest in this trait.

The cross (3x7) followed by cross (2x8) had the highest values, however the cross (2x6) showed that the lowest values for harvest index.

The crosses (4x5), (4x6), (3x7), (3x4) and (4x8) had the highest grain yield per plant. The high grain yield per plant in cross (4x5) could be attributed to its high 1000-kernel weight, while, the high grain yield per plant of the cross (1x6) could be attributed to its high seed index and harvest index. On the other hand, the high grain yield per plant of the other previous crosses could be attributed to one or more of number of kernels/spike, number of spikes/plant and number of spikelets/spike. It could be concluded that these crosses would be efficient and prospective in wheat breeding programs for improving grain yield/plant.

The crosses (1x6), (4x6), (4x5) and (1x5) had the highest values of total plant weight/plant. While, the two crosses (1x5) and (3x6) had the highest straw yield/plant. It could be concluded that the previous crosses would be efficient and prospective in wheat breeding programs for improving straw yield/plant.

4.1.1.1. Heterosis:

Mean squares for parents vs crosses as indication to average heterosis overall crosses was appreciable magnitude for all investigated traits except for spike length and 1000-kernel weight (Table 4). F_1 mean values were significantly higher than parental means for all the traits studied.

Heterosis expressed as the percentage deviation of F_1 performance from its mid-parents and/or better parent average value for all traits are presented in (Table 6). For heading date, six crosses (1x2, 2x3, 2x4, 2x5, 2x8 and 6x8) manifested significant negative heterosis from the mid-parent. While, no crosses of the previous hybrids had significant negative heterotic effects relative to better parent for this trait. Significant negative heterotic effects for earliness was previously detected by **Fonseca and Patteerson (1968), El-Shamarka (1980), Darwish (1992), Hendawy (1994), Ashoush (1996) Ashoush *et al.* (2001), Darwish (2003) and Darwish (2006).**

However little or no heterotic effects for earliness were previously found by **Gandhi *et al.* (1961), Mani and Rao (1975), Mitkees (1981), Zaied (1995) and Mekhaner (1995).**

Earliness if found in wheat is favourable for escaping destructive injuries by stress conditions (rust, high temp. ..etc). The cross (2x4) as previously mentioned, expressed significant negative heterosis relative to mid-parent for maturity date. Hence it could be concluded that this cross is valuable in breeding for earliness and yield potentiality, whereas, this cross gave significant positive heterotic effect for number of grains per spike, grain yield per plant and straw yield per plant.

Table (6): Percentage of heterosis from either mid-parent or better parent for all traits for the F_1 data.

Cross	Heading date (days)		Maturity date (days)		Plant height (cm)		Plant height up to flag leaf (cm)		Length of flag region (cm)		No. of tillers/plant		Spike length (cm)		No. of spikelets/spike	
	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP
1x2	-0.15	-1.94**	1.56**	0.78**	0.56	2.32	-2.01	5.63**	-14.61*	-9.51	8.25	9.36	-2.94	1.04	9.11**	10.53**
1x3	-1.15	-0.37	0.45*	-0.11	-1.82	-0.38	-1.18	3.09	-9.79	-8.02	-0.37	8.41	-4.58	4.69	1.32	4.01
1x4	-5.81**	2.04**	2.19**	0.46*	-9.45**	0.46	-1.07	9.66**	-42.85**	-35.48**	19.04**	28.87**	-2.94	4.92	-2.57	4.17
1x5	2.10**	1.94**	2.02**	1.80**	-0.91	1.16	5.16*	5.62**	-20.50**	-17.83**	-6.81	3.02	-10.53**	9.58*	5.22	8.01**
1x6	5.72**	1.25	2.42**	0.91**	0.42	0.69	6.11*	7.14**	-29.47**	-24.16**	14.21*	16.86**	-6.21	-3.81	-2.57	-1.31
1x7	12.67**	7.38**	6.57**	4.13**	-1.54	4.13**	3.72	13.29**	-31.18**	-17.68**	-9.15	33.06**	-21.40**	-10.05**	7.36*	9.49**
1x8	1.54*	0.31	3-30**	2.38**	3.13*	3.31**	11.83**	7.44**	-23.02**	-22.68**	-11.32*	-4.68	-2.55	6.23	7.83**	9.22**
2x3	-0.93	-1.71*	3.74**	2.35**	-1.11	-0.84	2.38	3.36*	-27.06**	-24.16**	-20.00**	-13.74**	2.98	8.73*	8.00**	9.45**
2x4	2.00**	-3.97**	1.39**	-1.13**	-9.70**	1.73	-12.64**	3.84*	-17.41 *	-11.70	-22.61**	-17.02**	3.97	8.09*	2.68	8.45**
2x5	0.30	-2.15**	0.67**	-0.33	-2.79*	0.94	-2.58	5.54**	3.12	-18.03**	-18.95**	11.20*	-11.22**	5.26	4.00	5.41*
2x6	6.91**	-0.05	3.92**	1.58**	-4.19**	-3.58*	-6.94**	-0.61	-26.30**	-16.38**	-8.25	-5.21	-5.65	0.55	8.00**	8.00**
2x7	7.77**	0.24	4.22**	1.02**	1.07	8.66**	-0.30	14.75**	-5.47	7.62	-5.50	39.19**	-29.82**	-16.91**	1.32	2.01
2x8	-0.76	-1.83**	3.42**	1.68**	-4.19**	-2.35	-4.67*	-1.08	-25.48**	-21.39**	7.25	-1.29	0.00	4.92	8.00**	8.00**
3x4	6.23**	0.84	1.85**	0.69**	-16.01**	-5.60**	-16.36**	-3.75	-28.17**	-20.34**	27.85**	28.60**	3.84	5.54	0.00	4.29
3x5	2.17**	0.47	0.56*	0.23	0.69	4.29**	3.15	8.06**	-15.95**	-11.52**	-10.22*	-8.67*	-3.25	9.36*	0.00	0.00
3x6	7.40**	1.24	0.92*	0.00	1.13	0.78	-5.71**	-2.55	-3.33	5.86	5.88	17.65**	-11.38**	-0.58	-2.68	-1.35
3x7	9.45**	2.65**	3.40**	1.61**	-3.93**	3.01*	-1.97	9.23**	-21.59**	-7.73	-16.84**	27.33**	-30.21**	-13.64**	4.05	4.76
3x8	1.20	0.91	2.28**	1.93**	0.42	2.07	1.57	1.98	-21.70**	-26.53**	-1.97	-0.60	3.29	3.95	1.32	2.70
4x5	5.36**	1.78*	2.78**	1.26**	-6.33**	1.97	-3.25	6.83**	-31.58**	-20.56**	4.54	6.98	-1.92	12.50**	1.39	5.71*
4x6	2.01*	1.34	1.27**	1.04**	-9.24**	1.69	-4.50*	6.76**	-37.48**	-24.83**	0.80	11.40*	-5.65	4.30	-4.44	0.93
4x7	4.10**	2.91**	0.93**	0.35	-1.94	3.16	6.44**	10.42**	-15.86	-10.03	-2.38	49.09**	-28.59**	-12.72**	2.67	7.80**
4x8	6.98**	1.86**	1.96**	1.15**	-12.19	-2.73*	-13.54**	-0.80	-32.94**	-24.63**	13.47**	14.40**	3.23	4.21	-8.00**	-2.82
5x6	8.22**	3.82**	2.54**	1.25*	0.93	4.23**	5.48**	6.95**	-8.42	-4.57	3.04	16.24*	-29.92**	-8.74*	1.32	2.70
5x7	8.19**	3.28**	3.7S**	1.61**	0.7S	4.46**	4.12	11.11**	-28.12**	-11.73	-22.72**	19.30**	-31.04**	-6.37*	0.00	0.68
5x8	2.63**	1.22	0.45*	0.23	2.47	4.44**	2.00	6.43**	-17.37**	-14.23*	-21.95**	-19.53**	-3.29	10.04*	-2.68	-1.35
6x7	7.31**	6.80**	4.22**	3.38**	-2.40	4.31**	0.63	7.41**	-14.81**	7.99	23.52**	78.72**	-30.21**	-21.92**	4.00	4.70
6x8	3.43**	-2.20**	2.07**	1.49**	2.97*	4.30**	1.78	1.13	18.64**	-12.14*	-22.59**	-15.04**	-10.32**	0.00	-1.32	-1.33
7x8	8.64**	2.20**	2.46**	1.04**	1.23	6.90**	-3.07	7.62**	-4.85	13.39*	-2.03	49.08**	-31.43**	-15.58**	-0.68	0.00

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

Table (6): Cont..

Cross	No. of spikes/plant		1000-grain weight (g)		No. of grains/spike		Grain yield plant (g)		Straw yield/plant		Total weight of plant (g)		Harvest index	
	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP
1x2	6.38	9.27	4.00**	5.40	8.38*	8.36**	17.15*	20.40**	-8.70	-7.74	0.00	0.00	17.15	20.40*
1x3	-2.41	6.46	11.23**	14.27**	-0.45	-0.07	12.04*	19.84**	23.43*	27.18*	25.00*	25.00**	-10.00	-3.74
1x4	26.07**	34.94**	-28.77**	-18.93**	7.04*	12.57**	25.85**	27.78**	27.91*	65.36**	33.33**	60.00**	-25.50**	-10.54
1x5	-10.20*	2.36	-11.05**	-8.28**	13.11**	19.24**	6.01	12.29*	11.36	25.84**	10.00	22.22**	-12.87	-8.34
1x6	18.06**	18.84**	8.59*	9.16**	13.91**	14.07**	59.59**	62.53**	19.49	43.48**	45.83**	66.67**	-14.50	-3.95
1x7	-6.09	39.25**	2.37	3.11	-8.76**	3.44	12.37	49.74**	24.16*	53.69**	20.83*	52.63**	-6.79	-0.65
1x8	-11.32*	-3.22	2.37	4.91	1.20	5.68	0.79	1.29	16.66	16.89	12.50	12.50	-10.39	-9.98
2x3	-17.75**	-12.45*	3.29	4.74	12.70**	13.10**	-2.83	6.60	27.53*	32.74**	25.00*	25.00*	-22.20**	-14.72
2x4	-18.45**	-14.91**	-17.46**	-4.98*	1.79	7.09*	10.94	12.31*	17.74	53.33**	16.66	40.00*	-37.50**	-23.28**
2x5	-21.90**	-13.01**	5.53	7.43*	-4.94	0.24	14.13*	-6.69	-22.00	-12.67	-20.00*	-11.11	6.16	8.79
2x6	-3.68	-0.47	4.35	5.21	-5.50	5.50	-14.67*	-13.89*	10.46	33.75**	4.16	19.05	-38.50**	-29.19**
2x7	-5.50	42.07**	11.04**	11.75**	-28.85**	-19.37**	-4.99	24.24**	1.82	27.04*	0.00	26.32*	4.90	-1.35
2x8	7.25	-1.29	5.88	7.11*	7.44*	12.21**	31.83**	34.86**	6.60*	7.52	16.66	16.67	13.17	15-75
3x4	24.18**	26.75**	-22.94**	-13.74**	-2.46	2.94	18.72**	28.79**	3.33	30.68*	8.33	30.00**	16.30*	-5.11
3x5	-17-52**	-10.41**	5.81	6.25*	-0.80	4.94	-6.41	-5.44	-25.30**	-13.38	-20.00*	-11.11	-6.40	4.95
3x6	5.61	15.93**	-0.02	2.19	-8.03*	-7.83*	3.58	12.69*	47.65**	72.96**	33.33*	52.38**	-30.41**	-26.53*
3x7	-16.15**	30.00**	3.38	5.45	-13.57**	-2.33	1.10	40.83**	-4.65	15.27	9.72	38.60**	4.12	18.15*
3x8	0.00	0.00	4.80	5.05	14.46**	19.95**	20.26**	29.20**	7.75	11.23	16.66	16.67	4.09	11.85
4x5	0.74	7.81	-20.94**	-7.59**	18.21**	18.50**	44.22**	54.99**	-1.69	38.33**	10.00	43.48**	-21.15*	-135.00
4x6	6.75	14.93**	-26.51**	-15.97**	11.89**	17.83**	32.11**	32.52**	91.16**	109.84**	94.44*	105.88**	-40.6**	-35.96**
4x7	0.37	58.71**	-22.51**	-11.26**	-18.04**	-2.95	30.40**	71.94**	102.08**	113.99**	87.50**	100.00**	32.70**	-15.05*
4x8	12.86*	15.23**	-21.31**	-8.52**	3.93	4.70	27.37**	28.72**	12.50	45.62**	12.50	35.00**	-27.4**	-12.45
5x6	-4.38	9.62*	-9.15**	-6.77*	-6.72	-1.54	-9.95	-2.96	-1.07	30.81**	-3.33	20.83*	-34.7**	-23.29*
5x7	-25.53**	17.92**	-2.20	0.17	-18.55**	-3.36	-10.03	24.53**	-18.96*	9.95	-16.66*	13.64	8.91	10.44
5x8	-24.75**	-21.07**	5.31	6.00	8.60*	9.68**	-20.16**	-15.04**	-15.47	-4.64	-20.00*	-11.11	-5.00	-0.54
6x7	17.64**	-3.91**	0.70	0.92	-24.22**	-14.20**	17.11*	54.12**	86.20**	93.47**	61.11**	81.25**	-25.90**	-11.88
6x8	-12-59	-15.04**	2.48	4.50	8.97*	13.95**	-8.26	-7.03	3.24	24.15*	0.00	14.29	-29.30**	-20.20**
7x8	2.03	51.88**	7.33*	9.26**	-28.09**	-15.37**	14.28*	51.78**	11.80	38.59**	12.50	42.11**	1.54	7.77

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

For plant height, eleven hybrids exhibited significant positive effects relative to mid-parents. Also, the crosses (1x8), (4x5) and (6x8) showed significant positive heterotic effects relative to better parent. However, the crosses (2x6), (3x4), (4x8) and (7x8) manifested significant negative heterotic effects relative to mid-parents in the same order. While nine hybrids showed significant negative heterotic effects relative to better parent. Negative heterosis for plant height was reached by **Anwar and Chowdhry (1969), El-Shamarka (1980), Mahdy (1988), Darwish (1992), Ashoush (1996), Tawfelis (1997), Ashoush *et al.* (2001), Safan (2001), Ashoush (2006) and Darwish *et al.* (2006)**.

For length of flag region the cross (7x8) showed significant positive heterotic effects relative to mid-parent value. While, the cross (6x8) expressed significant positive heterotic effects relative to better parent value. On the contrary seventeen crosses exhibited significant negative heterotic effects respective to mid-parents value. Also, twenty crosses had significant negative heterotic effects relative to better parent value.

Regarding to number of tillers per plant, fourteen parental combination significantly exceeded the mid-parent value, While, five crosses of the previous combination had significant positive heterotic effect relative to better parent value. The cross (6x7) had the most desirable heterotic effects. Heterotic effects for number of tillers per plant were also found by **Mani and Rao (1975), Darwish (1992), Mekhamer (1995), Ashoush (1996) and Safan (2001)**.

For number of spikes per plant, thirteen parental combination exhibited significant positive heterotic effect relative to mid-parent value. Also, five crosses from the previous hybrids had significant positive heterotic effect relative to better parent value. These results confirm that reached above for number of tillers per plant. Whereas, the crosses (1x4), (1x6), (3x4), (4x8) and (6x7) had most desirable heterotic effect. In this respect, positive heterotic effect for number of spikes per plant was reached by **Mani and Rao (1975), Darwish (1992), Ashoush (1996), Ashoush *et al.* (2001), Safan (2001), Ashoush (2006) and Darwish (2006)**.

For number of spikelets per spike, eleven crosses significantly exceeded the mid-parent value, while, six cross from the previous hybrids showed significant positive heterotic effects relative to better parent value. The crosses (1x2), (2x3), (2x6) and (2x8) had the most desirable heterotic effect for this traits. Significant positive heterotic effects for number of spikelets/spike was also reached before by **Hendawy (1990), Darwish (1992), Mekhamer (1995) and Ashoush (1996)** reported significant positive heterotic effect. While, **Fonseca and Patterson (1968), Mitkees (1981), Deshpande and Nayeem (1999) and Abdel-Wahed (2001)** found significant negative heterosis for this trait.

Concerning spike length, six crosses had significant positive heterotic effects in this trait relative to mid-parent value. While, no crosses had significant positive heterotic effect relative to better parent. Spike length in fact, may lead to erratic judgenent as the long spike cambelax or dense and therefore, number of spikelets and kernels per spike can resulted in better criterion for spike density than spike length. These results are in agreement with the findings really by **Mitkess (1981), Mosaad *et al.* (1990), Ashoush (1996), Ashoush (2001), Safan (2001), Darwish (2003), Ashoush (2006) and Darwish *et al.* (2006)**.

For number of kernels per spike, twelve crosses significantly exceeded the mid-parents value. Also, eleven crosses from the previous hybrids showed significant positive heterotic effects relative to better parent value for this trait. The cross (3x8) and (4x5) had the most desirable heterotic effects for this trait. Significant positive heterotic effects for number of kernels per spike was reached before by **Bitzer (1972), Darwish (1992), Ashoush (1996), Ashoush (2001), Safan (2001), Ashoush (2006) and Darwish *et al.* (2006)**.

However, no heterotic effects for number of grains per spike are found by **Fonseca and Patterson (1968), Hamdy (1978), El-Shamarka (1980), Mitkees (1981), Hendawy (1990), Abdel-Wahed (2001) and Darwish and Ashoush (2003)**.

For thousand kernel weight, seven crosses showed significant positive heterosis over the mid parents value. Also, four crosses from the previous hybrids showed significant positive heterotic effectsrelative to better parent value in this trait. The cross (1x3) gave the highest value of heterotic effect for this trait followed by cross (2x7). Significant positive heterotic effects were reached before by **El-Shamarka (1980), Younis *et al.* (1988), Mekhamer (1995), Ashoush (1996), Ashoush (2001) and Ashoush *et al.* (2006)**.

For harvest index, the crosses (1x2) and (3x7) showed significant positive heterotic effects over the mid-parent. While, two hybrids showed significant positive of heterotic effects relative to better parent value. Significant positive heterotic effect was reached before by **Hamdy (1978), Ashoush (1996), Ashoush *et al.* (2001), Safan (2001), Darwish (2003) and Darwish *et al.* (2006)**.

Concerning grain yield per plant, twenty crosses out of twenty eight hybrids significantly exceeded out of respective mid parent value. Also thirteen hybrids showed significant positive heterotic effect relative to better parent in this trait. The crosses (1x6), (2x8), (4x5) and (4x6) had the highest values of heterotic effect for this trait. These hybrids exhibited heterosis for one or more of traits contributing yield. This finding agrees with the general trend where the expression of heterosis for a complex trait could be explained on the basis of component interaction, as the numerical 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 wheat breeding programs for improving grain yield per plant.

Significant positive heterotic effects relative to higher yielding parent were also reached before by **Knott (1965), Bitzer (1972), Hamdy (1978), El-Shamarka (1980), Bhatti *et al.* (1982), Darwish (1992), Mekhamer (1995), Ashoush (1996), Ashoush (2001), safan (2001), Darwish (2003a), Ashoush (2006) and Darwish *et al.* (2006)**.

For total plant weight, eighteen crosses showed significant positive heterosis over the mid-parent value. While, nine parental combinations from the previous crosses had significant positive heterotic effect relative to better parent value. The crosses (1x6), (4x6), (4x7) and (6x7) had the highest values of heterotic effect for this trait. Significant positive heterotic effect was reached before by **El-Khatib (1990), Ashoush (1996), Hewezi (1996) Hendawy (1998), Safan (2001) and Ashoush (2006)**.

With respect to straw yield per plant, nineteen crosses exceeded the respective mid-parent value. While, nine hybrids showed significant positive heterotic effect relative to better parent in this trait. The crosses (4x5), (4x6) and (6x7) gave the highest values of heterotic effect for this trait. Significant positive heterotic effect was reached before by **Darwish (1992), Ashoush (1996), Ashoush (2001), Darwish (2003a) and Darwish *et al.* (2006)**.

4.1.2. F_2-generation:

Results in Table (7) showed the analysis of variance for the traits studied. Mean squares for genotypes, parents and F_2 crosses were highly significant for all the traits studied. The mean squares for. parents vs F_2 were significant for all the traits studied except heading date, maturity date and straw yield per plant.

Results in Table (8) showed mean performance of F_2. With the exception of plant height, height of flag leaf region, 1000-grain weight, number of grains per spike and straw yield per plant none of the parents surpassed me high hybrids for all traits. For the exceplantal traits, the parents 1, 6, 7, 7 and 5

Table (7): Observed mean squares from analysis of variance for all traits studied for F_2 data.

S.O.V.	d.f.	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
Rep.	2	1.01	1.08	0.08	0.40	6.15**	1.61	0.17	0.36	1.75	3.48*	18.17**	4.56*	1026.76**	1287.58**	20.71**
Genotypes	35	26.66**	19.66**	207.29**	130.49**	28.24**	30.21**	8.77**	4.71**	29.39**	45.96**	108.66**	245.73**	2038.59**	3260.26**	58.83**
Parents	7	58.95**	24.74**	188.741**	230.20**	42.69**	90.31**	26.27**	2.14*	89.83**	120.02**	249.65**	575.31**	4280.01**	6666.67**	91.12**
Crosses	27	19.28**	18.95**	163.38**	108.03**	12.61**	14.03**	3.30**	4.93**	13.41**	24.98**	67.08**	164.82**	1532.91**	2497.17**	50.15**
P.vs.F_2	1	0.01	3.43	152.26**	39.11**	348.91**	46.30**	33.74**	16.82**	37.60**	94.00**	244.65**	123.18**	2.02	18.88**	67.34**
Error	70	1.83	1.43	16.09	7.31	3.25	2.06	0.36	1.59	1.94	9.32	15.06	42.34	249.57	264.83	10.89

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

Table (8): The genotypes mean performance for all traits studied in the F_2 generation.

Genotype	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
Gemmeiza 7 (1)	110.67	147.33	126.48	78.33	21.06	17.17	16.92	25.00	17.33	47.91	74.50	56.00	160.67	216.67	25.84
Gemmeiza 9 (2)	112.33	149.33	122.17	85.33	19.17	18.33	14.74	24.33	17.67	48.87	74.00	52.83	147.17	200.01	26.42
Sakha 94 (3)	108.33	145.67	119.33	85.17	20.58	19.33	12.38	24.67	19.33	50.35	74.67	67.17	132.83	200.01	33.58
Line 1 (4)	103.17	141.67	114.67	61.00	17.58	19.00	14.02	23.33	19.00	51.47	67.50	54.00	96.00	150.01	36.00
Line 2 (5)	108.67	144.67	112.50	77.67	23.42	22.67	11.63	25.67	22.67	49.53	67.67	63.33	186.67	250.00	25.33
Line 3 (6)	102.67	144.33	122.83	78.00	24.83	16.83	14.08	26.00	16.83	49.01	75.17	53.67	96.33	150.00	35.77
Line 4 (7)	99.33	140.33	101.50	66.00	13.17	4.33	13.47	25.33	4.83	67.29	94.50	21.17	78.83	100.00	21.17
Line 5 (8)	108.67	144.67	121.67	81.67	23.33	19.67	13.80	25.33	19.67	50.66	65.17	56.33	143.67	200.00	28.17
1x2	109.35	148.33	119.38	82.81	14.50	18.19	14.33	29.38	17.85	50.28	80.23	54.83	152.31	207.14	26.43
1x3	108.55	143.33	115.23	82.90	14.99	20.19	13.72	24.71	20.02	55.89	63.66	62.98	137.35	200.33	31.42
1x4	103.65	144.33	107.85	74.09	12.41	24.24	12.69	26.14	23.38	46.82	69.19	71.74	122.54	194.28	36.94
1x5	109.44	149.33	111.31	80.30	19.38	20.63	18.02	25.20	20.63	45.52	74.24	62.33	173.47	235.80	26.43
1x6	106.60	144.67	113.02	81.74	17.20	20.34	13.36	25.37	20.15	50.01	74.41	65.58	203.43	269.01	24.37
1x7	108.24	148.67	106.75	78.27	15.01	16.33	14.00	28.00	16.00	50.09	74.50	58.46	137.37	195.83	29.84
1x8	108.30	148.33	118.14	88.71	16.62	16.76	12.50	28.90	16.62	54.09	74.33	51.69	133.26	184.95	27.93
2x3	110.23	150.00	113.07	85.89	13.60	18.57	12.25	26.18	18.47	49.14	75.31	54.79	101.25	156.04	35.11
2x4	101.72	141.00	97.88	69.91	15.27	16.61	12.41	26.39	16.08	49.87	73.75	55.22	126.37	181.58	30.41
2x5	107.16	147.67	113.57	78.90	15.98	17.57	11.51	24.99	17.38	50.43	69.13	49.63	118.46	168.09	29.59
2x6	105.54	147.33	111.45	81.89	16.17	16.82	13.31	26.66	16.57	50.09	61.70	42.23	164.32	206.55	20.46
2x7	107.11	144.67	108.49	78.75	15.74	16.78	13.71	26.65	16.77	46.40	66.11	49.47	128.54	178.01	27.79
2x8	111.45	147.33	109.95	81.90	13.88	19.18	11.45	26.04	18.95	49.39	73.90	55.85	103.67	159.52	35.01
3x4	104.66	144.00	97.76	69.76	13.92	22.13	12.42	24.77	22.09	50.88	63.96	64.58	89.52	154.10	41.90
3x5	110.00	146.00	108.01	77.95	18.54	16.53	11.23	26.02	16.44	48.27	72.38	45.85	117.11	162.96	28.13
3x6	108.14	142.67	115.14	81.49	20.34	19.43	12.71	25.14	18.75	50.67	64.20	46.08	105.98	152.06	30.33
3x7	109.17	145.67	110.38	82.47	14.19	17.66	14.55	25.66	17.62	48.31	78.90	63.20	110.61	173.81	36.36
3x8	107.13	147.33	114.90	84.19	16.60	18.42	13.01	25.19	18.38	48.64	68.85	56.61	114.34	170.95	33.11
4x5	105.92	145.00	94.53	68.37	14.93	18.34	10.08	25.25	18.07	58.06	72.70	63.83	151.70	215.53	29.61
4x6	102.67	143.33	54.57	67.95	13.90	20.38	12.26	23.85	20.05	48.56	71.52	62.26	137.26	199.52	31.20
4x7	101.13	140.67	93.02	63.25	15.22	20.32	12.33	26.67	20.32	50.70	67.88	53.33	105.71	159.04	33.53
4x8	106.37	144.67	102.88	70.96	14.92	23.31	10.75	23.77	23.07	48.79	62.14	64.52	148.41	212.93	30.30
5x6	106.40	142.67	110.09	78.28	19.22	19.04	15.33	26.71	18.81	49.92	67.14	50.49	109.03	159.52	31.65
5x7	106.11	142.67	103.79	76.57	14.89	16.16	13.09	25.92	15.91	50.84	72.17	48.00	91.96	139.96	34.29
5x8	106.67	145.33	110.17	78.85	19.21	16.73	12.64	24.96	16.55	43.62	70.22	46.77	131.92	178.69	26.17
6x7	105.92	143.33	111.09	79.85	18.15	19.57	19.33	25.09	19.38	46.65	71.33	56.69	155.21	111.90	26.75
6x8	104.80	143.00	119.09	79.90	17.89	15.85	11.64	25.95	15.85	48.96	70.47	48.61	112.33	160.95	30.20
7x8	107.73	143.67	109.62	80.71	17.27	18.69	12.67	25.85	18.52	49.05	70.09	52.04	120.33	172.38	31.18
Mean of parent	106.73	144.75	117.64	76.65	20.39	17.17	13.88	24.96	17.17	51.89	74.15	53.06	129.52	183.34	28.99
Mean of crosses	106.79	145.18	107.18	78.09	16.07	18.74	13.12	25.91	18.52	49.64	70.51	55.63	130.02	180.77	30.89
Mean	106.67	145.01	109.26	77.72	17.01	18.39	13.20	25.70	18.22	50.25	71.31	54.98	129.04	180.41	30.55
L.S.D. at 5%	2.20	1.94	6.52	4.39	2.93	2.33	0.98	2.05	2.26	4.96	6.30	10.57	25.66	26.43	5.36
at 1%	2.92	2.57	8.64	5.82	3.88	3.09	1.30	2.72	3.00	6.57	8.36	14.02	34.03	35.05	7.11
C.V.	1.27	0.82	3.63	3.48	10.59	7.81	4.60	4.91	7.65	6.09	5.44	11.82	12.17	8.84	10.83

surpassed me crosses for plant height, height of flag leaf region, 1000-grain weight, number of grains per spike and straw yield per plant, respectively.

4.1.2.1. Remain heterosis:

Mean squares for parents vs F_2 hybrids as an indication of average remain heterosis of overall crosses was significant for all the traits studied except heading date, maturity date and straw yield per plant (Table 7).

The most desirable remain heterotic effects for mid parent value were presented by six crosses for heading date, four crosses for maturity date, seven crosses for plant height up to flag leaf, twelve crosses for number of tillers per plant, seven crosses for number of tillers per plant, seven crosses for number of spikelets per spike, eleven crosses for number of spikes per plant, three crosses for 1000-grain weight, two cross for number of grains per spike, nine crosses for grain yield per plant, six crosses for straw yield per plant, nine crosses for total weight per plant and nine crosses for harvest index (Table 9). For the other traits, significant negative heterotic effects relative to mid parents values were detected.

The most desirable remain heterotic effects relative to better parent value were presented by the cross (1x3) for maturity date, cross (lx2) for plant height, cross (1x8) for plant height to flag leaf, five crosses (1x4) (1x6) (3x4) (4x8) and 6x7) for number of tillers plant, three crosses (1x2, 1x7 and 1x8) for number of spikelets per spike, four crosses (1x4, 1x6, 3x4 and 4x8) for number of spikes per plant, two crosses (1x3 and 4x5)

Table (9): Percentage of remain heterosis from either mid-parent or better parent for all traits for the F_2 cross.

Cross	Heading date (days)		Maturity date (days)		Plant height (cm)		Plant height up to flag leaf (cm)		Length of flag region (cm)		No. of tillers/plant		Spike length (cm)		No. of spikelets/spike	
	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP
1x2	-1.19	-1.93*	0.66	0.00	5.61*	-3.98	-2.95	1.19	-31.14**	-27.91**	-0.76	2.46	-12.88**	-5.69*	17.52**	19.09**
1x3	-0.20	-0.86	-1.60*	-2.16**	-8.89**	-6.24**	-2.66	1.41	-28.82**	-28.02**	4.44	10.61	-24.17**	-15.13**	-1.16	-0.50
1x4	-0.01	-3.28**	1.87**	-0.12	-14.72**	-10.55**	-5.41	6.35*	-41.07**	-35.79**	27.57**	34.03**	-17.13**	-4.41	4.56	8.15*
1x5	-1.16	0.25	3.22**	2.28**	-11.99**	-6.85**	2.51	2.94	-17.25**	-12.85**	-8.99	3.56	-31.26**	-13.85**	-1.83	-0.53
1x6	3.82**	-0.06	0.22	-0.80	-10.64**	-9.33**	4.35	4.57	-30.72**	-25.03**	18.40**	19.65**	-16.78**	-12.68**	-2.42	-0.52
1x7	8.97**	3.09**	5.94**	3.36**	-15.59**	-6.35*	-0.07	8.46**	-28.72**	-12.29	-4.39	51.91	-30.31**	-25.66**	10.54*	11.25**
1x8	-0.34	-1.24	2.52**	1.60**	-6.59*	-4.78*	8.62**	10.89**	-0.28**	-25.11**	-14.79*	-9.00	-18.43**	-6.68*	14.09**	14.83**
2x3	1.75	-0.09	2.97**	1.69**	-7.44**	-6.36**	0.65	0.75	-33.91**	-31.59**	-3.93	-1.42	-4.25	3.20	6.12	6.86
2x4	-1.88	-5.82**	-0.47	-3.09**	-19.88**	-17.34**	-18.07**	-4.46	-20.34**	-16.88*	-12.57*	-11.04*	-11.44**	-5.12	8.40	10.73**
2x5	-1.38	-3.02**	2.07**	0.45	-7.03*	-3.21	-7.53**	-3.19	-31.76**	-24.93**	-22.49**	-14.31**	-16.12**	-1.54	-2.64	-0.03
2x6	2.82*	-1.79*	2.07**	0.34	-9.26**	-9.02**	-4.03	0.28	-34.87**	-26.50**	-3.23	-4.34	-12.65**	-9.75**	2.53	5.95
2x7	7.83**	1.21	3.09**	-0.12	-11.19**	-2.99	-7.71**	4.07	-17.89*	-2.66	-8.45	48.09**	-27.57**	-16.81**	5.21	7.30*
2x8	2.55*	0.86	1.83**	0.23	-10.00**	-9.82**	-1.01	-1.92	-40.50**	-34.67**	-2.49	0.96	-12.77**	-7.43*	2.80	4.87
3x4	0.95	-1.27	1.64*	0.23	-11.32**	-16.44**	-18.09**	-4.54	-32.36**	-27.06**	14.48*	15.48**	-0.08	0.65	0.40	3.21
3x5	1.54	1.38	0.91	0.57	-9.48**	-6.32**	-8.47**	-4.25	-20.83**	-15.71**	-27.08**	21.27**	-6.04	3.07	1.36	3.40
3x6	5.32**	2.50**	-1.15	-1.61**	-6.26*	-4.91*	-4.32	-0.11	-18.08**	-10.41	0.51	7.45	-13.17**	-3.49	-3.30	-0.76
3x7	9.90**	5.14**	3.80*	1.86**	-7.50**	-0.04	3.17	9.12*	-31.04**	-15.89*	-8.63	49.27**	-29.07**	-13.18**	1.30	2.64
3x8	-1.10	-1.26	1.83**	1.49*	-5.56*	-4.65	-1.15	0.92	-28.84**	-24.42**	-6.35	-5.52	-9.62*	-8.09	-0.55	0.75
4x5	2.17*	-0.24	2.35**	1.28*	-17.56**	-16.78**	-11.97**	-1.39	-36.25**	-27.17**	-19.10**	-11.95*	-9.58*	-0.21	1.63	3.05
4x6	0.00	-0.48	1.17	0.23	-23.00**	-20.36**	-12.88**	-2.23	-44.01**	-34.48**	7.26	13.73*	-17.09**	-8.40**	-8.26*	-3.30
4x7	1.81	-0.36	2.37	-0.24	-18.88**	-13.94**	-4.16	-0.40	-13.42	-1.01	6.94	74.1 **	-24.72**	-8.33	5.29	9.62**
4x8	2.60*	0.19	2.11**	1.05	-15.44**	-12.93**	-13.11**	-0.53	-36.04**	-27.09**	18.50**	20.55**	2.68	3.73	-6.15	-2.30
5x6	3.63**	0.69	-1.15	-1.27*	-10.37**	-6.14**	0.35	0.58	-22.59**	-20.33**	-16.01**	-3.59	-20.02**	-3.55	2.73	3.39
5x7	6.82**	2.03*	1.66*	0.12	-7.74**	-3.00	-1.41	6.59*	-36.42**	-18.58**	-28.71**	19.73*	-36.21**	-16.19**	0.97	1.65
5x8	-1.84	-1.84*	0.45	0.46	-9.45**	-5.90*	-3.45	-1.03	-17.97**	-17.80**	-14.94*	-20.98**	-15.15**	-5.52	-2.76	-2.12
6x7	6.63**	4.87**	2.13*	0.70	-9.55**	-0.96	2.37	10.90**	-26.90**	-4.47	16.28*	84.88**	-32.28**	-24.48**	-3.50	-2.23
6x8	2.07	-0.82	-0.92	-1.04	-3.04	2.58	-2.16	0.08	-27.95**	-25.73**	-19.42**	-13.13*	-17.54**	-9.74**	-0.19	1.09
7x8	8.45**	3.58**	2.38**	0.82	-9.90**	1.76	-1.17	9.31**	-25.97**	-5.37	-4.98	55.78**	-39.78**	-27.27**	2.05	2.04

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

Table (9): Cont..

Cross	No. of spikes/plant		1000-grain weight (g)		No. of grains/spike		Grain yield plant (g)		Straw yield/plant		Total weight of plant (g)		Harvest index	
	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP
1x2	1.01	2.02	2.88	3.91	7.69	8.06*	-2.08	0.77	-5.20	-1.05	-4.39	-0.57	0.03	0.69
1x3	3.56	9.20	11.00*	13.73**	-14.74**	-14.65**	-6.23	2.26	-14.43	-6.32	-7.54	-3.84	-6.68	5.17
1x4	23.05**	28.68**	-9.03	-5.77	-7.12	-2.55	28.10**	30.44**	-23.73**	-4.51	-10.33	5.97	2.61	19.01**
1x5	-8.99	3.13	-0.09	-6.57	-0.34	4.44	-1.57	4.46	-7.07	-0.12	-5.68	1.06	2.56	5.43
1x6	16.27*	14.97**	2.04	3.20	-1.01	-0.57	17.10	19.60*	9.59	40.31**	24.15**	46.73**	-16.30*	-3.28
1x7	-7.67	47.69**	-25.56**	-13.05**	-21.11**	-11.84**	4.39	51.52**	-14.50	14.72	-9.61	23.68**	14.41	26.31**
1x8	-15.50**	-10.18	6.77	9.76*	-0.22	6.44	-8.23	-7.96	-16.73*	-12.03	-14.63*	-11.22*	-0.85	2.97
2x3	-4.44	-0.14	-2.40	-0.95	0.72	1.17	-18.43*	-8.68	-16.25	-11.96	-21.98	-21.98**	-8.37	2.69
2x4	-15.36**	-12.29*	-3.10	-0.59	-0.33	4.24	2.25	3.37	-14.13	3.93	-9.21	3.76	-14.33	-1.19
2x5	-23.33**	-13.83**	1.81	2.51	-6.44	-2.26	-21.63*	-14.55	-36.54**	-29.03**	-32.76**	-25.29**	11.99	15.85
2x6	-6.32	-3.94	2.20	2.35	-17.91**	-17.27**	-21.31	-20.70*	11.65	38.37**	3.27	18.03**	-93.00**	-34.21**
2x7	-5.09	52.48**	-31.04**	-20.10**	-30.04**	-21.53**	-6.36	33.70**	-12.61	13.81	-10.96	18.72*	6.62	18.39
2x8	-5.66	15.00	-2.50	-0.74	-0.13	6.20	-0.85	2.33	-27.29**	-26.42**	-20.24**	-20.24**	25.16*	29.18**
3x4	14.17*	15.23**	-1.14	-0.06	-14.34**	10.02*	-3.85	6.60	-32.60**	-21.76*	-22.95**	-11.94	17.00*	20.91**
3x5	-27.48**	-21.7**	-4.13	-3.34	-3.06	1.70	-31.74**	-29.74**	-37.26**	-26.69**	-34.81**	-27.57**	-15.85	2.88
3x6	-3.00	3.67	0.63	2.00	-14.59**	-14.30**	-31.39	-23.72**	-20.21*	-5.02	-23.97**	-13.11*	-15.00*	-12.64
3x7	-8.84	48.87**	-28.20**	-17.86**	-16.50**	-6.72*	-5.91	43.10**	8.36	36.01**	-13.09	15.87*	9.59	34.52**
3x8	-6.55	-5.76	-3.98	-3.68	-7.79	-1.52	-15.72	-8.33	-20.41*	-17.29*	-14.52*	-14.53*	6.14	15.60*
4x5	-20.29**	-13.26**	12.80**	14.98**	7.43	7.58	0.78	8.81	-18.73**	7.33	-13.78*	7.77	-18.25*	-2.96
4x6	5.52	11.89*	-5.65	-3.33	-4.85	0.26	15.29	15.65	42.97**	47.33**	33.01**	33.01**	-12.77	-12.50
4x7	6.94	74.17**	-24.65**	-14.62**	-28.16**	-16.20**	-1.24	41.90**	10.11	20.93	6.02	27.23**	-6.36	17.94*
4x8	17.28**	19.33**	-3.69	-4.46	-7.94	-6.32	14.53	16.96*	3.29	23.85**	6.46	21.68**	-14.58	-4.16
5x6	-0.17**	-4.78	0.78	1.32	-10.68*	-5.99	-20.27*	-13.69	-41.59**	-21.28*	-36.19**	-20.24**	-11.51	4.73
5x7	29.81**	17.85	-24.44**	-12.96**	-23.02**	-10.62**	-24.20**	13.60	-50.73**	-30.72**	-41.01**	-20.02**	30.64**	40.60**
5x8	-26.99**	-21.81**	-13.89**	-12.92**	3.76	5.72	-26.14**	-21.83**	-29.32**	-20.13**	-28.52**	-20.58**	-1.91	4.61
6x7	15.15*	83.09**	-30.67**	-19.77**	-24.51**	-15.92**	5.62	51.51**	71.82**	83.50**	41.26**	69.52**	-23.53**	-3.93
6x8	-19.42**	-13.15*	-27.24**	-1.76	-6.25	0.43	-13.70	-11.61	-21.81*	-3.99	-19.52**	-8.03	-10.62	0.01
7x8	-5.84	54.33**	-17.10**	-16.83**	-25.83**	-12.20*	-7.61	34.31**	-16.24	8.16	-13.81*	14.92	10.18	25.82**

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

for 1000-grain weight, one cross (1x4) for grain yield per plant, two crosses (4x6 and 6x7) for straw yield per plant, three crosses (1x6, 4x6 and 6x7) for total weight of plant and three crosses (2x8, 3x4 and 5x7) for harvest index (Table 9). For the other traits, significant negative heterotic effects relative to better parent value were detected. The cross (1x4) exhibited significant positive remain heterotic effects (28.1) in the F_2 generation for grain yield per plant. From the F_1 data, this cross was found the same expression respective to better parent value. These results revealed the possibility of hybrids wheat production on commercial scale by using both generations. **Lee and Smith (1969), Krrar (1980), Younis *et al.* (1988), Hendawy (1990 and 1994) and Ashoush (1996)** suggested the possibility of using hybrids F_1 and F_2) in commercial production.

It is worth to note that heterotic effects were generally more pronounced for grain yield per plant than for any of its components and it was more pronounced in the F_1 generation than F_2 for all traits which are logically expected.

4.2. Combining ability:

4.2.1. F_1-generation:

The analysis of variance for combining ability as outlined by Griffing's (1956) method-2 model-1 in F_1 data for all the traits studied in shown in Table (10). The mean squares for general combining ability (GCA) and specific combining ability (SCA) were found to be significant for all traits. The other studied results revealed that both additive and non-additive gene effects were involved in determining the performance of single cross

Table (10): Observed mean squares of general and specific combining ability from diallel cross analysis for all traits studied in the F_1 generation.

S.O.V.	d.f.	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
GCA	7	49.14**	18.86**	224.41**	138.71**	29.27**	29.63**	10.31**	4.36**	26.67**	20.90**	63.82**	207.04**	589.43**	1108.64**	63.48**
SCA	27	3.94**	2.68**	8.87**	10.53**	5.56**	7.51**	0.95**	0.89**	7.33**	10.79**	43.16**	126.24**	893.21**	1629.71**	14.31**
Error	70	0.35	0.05	1.34	1.33	1.05	0.57	0.14	0.26	0.60	1.39	3.30	7.30	137.21	190.01	3.7
GCA/SCA		12.47	7.03	25.29	13.71	5.26	3.94	10.85	4.89	3.63	1.93	1.47	1.64	0.65	0.68	2.33

* and ** significant at 0.05 and 0.01 levels of probability, respectively.
GCA refers to general combining ability.
SCA refers to specific ability.

progeny. To reveal the nature of genetic variance the GCA/SCA ratio was computed. High GCA/SCA ratio which exceeded the unity was detected for all traits except for straw and total plant weight/plant. Such results indicate that additive and additive by additive types of gene action were more important than non additive effect in controlling these traits. For the two exceptional traits, exhibited low GCA/SCA ratio of less than unity indicating the predominance of non-additive gene action in the inheritance of such traits.

For straw yield/plant and total weight of plant, however, non additive type of gene action seem to be more prevalent. The genetic variance was previously reported to be by **(Crumpaker and Urguhart, 1962; Sajnami, 1968; El-Shamarka, 1980; El-Khatib, 1990; Hendawy, 1990; Darwish, 1992; Ashoush, 1996) and Asoush *et al.*, 2001)**, for plant height **(Johnson *et al.*, 1966; Singh *et al.*, 1973; Eisea, 1976; El-Khatib, 1990; Hendawy, 1990; Darwish, 1992; Ashoush, 1996 & 2006 and Darwish, 2006)**; for number of spikes per plant **(Eisea, 1976; El-Shamarka, 1980; Mitkees, 1981; El-Khatib, 1990; Darwish, 1992, Ashoush, 1996; Ashoush *et al.*, 2001 and Darwish, 2003)**; for number of spikelets per spike **(Sognami, 1968; Maya Deleom, 1975; Eisea, 1976; Bashir *et al.*, 1984; Younis *et al.*, 1988; El-Katib, 1990; Henawy, 1990; Darwish, 1992 and Asoush, 1996)**; for grains per spike **(Younis *et al.*, 1988; El-Khatib, 1990; Hendawy, 1990; Darwish, 1992; Ashoush, 1996; Ashoush *et al.*, 2001; Darwish, 2003) and Ashoush, 2006)**; for 1000-kernel weight **(Eisea, 1976; Soomro and Askel, 1976; Darwish, 1992; Ashoush, 1996; Ashoush *et*** *al.*, **2001; Darwish, 2003 and Darwish *et al.*, 2006)**; for straw and total plant weight and **(El-Khatib, 1990; Merkamer, 1995; Ashoush, 1996 and Safan, 2001)** and for grain yield per plant.

However **(Johnson *et al.*, 1966; El-Shamarka, 1980; El-Khatib, 1990; Hendawy, 1990; Abul-Naas *et al.*, 1991; Darwish, 1992 and Ashoush, 1996). However, Larrea (1966), Gyawali *et al.* (1968), Abul-Nass *et al.* (1986) and Narula (1987)**, reported that both additive and non-additive types of gene action were responsible for controlling the inheritance of yield and some of its components.

4.2.1.1. General combining ability effects:

Estimates of GCA effects ($\hat{g}_i$) for individual parental line and/or variety in each trait in F_1 data are presented in Table (11). General combining ability effects computed herein were found to differ significant from zero in all cases. High positive values would be interest under all traits in question except heading date and maturity date where high negative effects would be useful from the breeder point view. Parental line 1 (P_4), line 3 (P_6) and line 4 (P_7), expressed significant negative ($\hat{g}_i$) effects for heading date and maturity date, indicating that these parental lines or varieties could be considered as a good combiners for developing early genotypes.

For plant height, significant negative ($\hat{g}_i$) effects were detected for line 1 (P_4), and line 4 (P_7), revealing the possibility of utilizing these parents to release short varieties. On the other hand, considerable positive value, were obtained for other parents from which breeding for tallness is more likely. Also, the parental Gemmeiza 9 (P_2) and line 3 (P_6), could be considered as an excellent parents in breeding programs towards releasing varieties by higher of plant height. Tall stature wheat's would suffer for lodging when yield are maximized by the use of irrigation and heavy application of fertilizers **(Johnson and Schidt, 1996)**.

Yet releasing short cultivars and parents may be of special interest in such purpose. The parental line 1 (P_4) could be considered as an excellent parent in breeding programs towards releasing varieties characterized by short region of flag leaf. The parental Gemmeiza 7 (P_1), Gemmeiza 9 (P_2), Sakha 94 (P_3), line 2 (P_5), and line 5 (P_8), exhibited significant positive ($\hat{g}_i$) effect for plant height to flag leaf. However, the parental line 1 (P_4),and line 4 (P_7), gave significant negative ($\hat{g}_i$) effect for plant height to flag leaf. The parental line 1 (P_4) Sakha 94 (P_3) and line 2 (P_5) could be considered as an excellent parent in breeding programs towards releasing varieties characterized by higher number of tillers per plant Gemmeiza 7 (P_1), line 3 (P_6) and line 4 (P_7), showed significant positive ($\hat{g}_i$) effects for spike length. Also, the parental line 4 (P_7) was the best combiner for increasing spike length. For number of spikelets per spike, parental varieties Gemmeiza 7 (P_1) and Gemmeiza 9 (P_2) gave the desirable ($\hat{g}_i$) effects. Therefore, both parents were considered as the best combiner for this trait. For number of spikes per plant, the parental Sakha 94 (P_3), line 1 (P_4) and line 2 (P_5), gave the desirable ($\hat{g}_i$) effect. Also, the parental line 1 (P_4),was the best combiner for increasing number of spikes per plant.

Table (11): Estimates of general combining ability effects for parents studied for F_1 generation.

Parent	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
Gemmeiza 7 (1)	1.28**	1.50**	1.72**	1.25**	-0.24	0.17	0.77**	0.97**	0.14	-0.05	2.58**	3.37**	9.19**	14.51**	-0.26
Gemmeiza 9 (2)	1.47**	2.04**	3.19**	3.69**	-0.60*	-1.50**	0.14	0.82**	-1.24**	0.71*	-1.08*	-4.49**	1.57	-7.99	-1.42*
Sakha 94 (3)	2.26**	0.14**	2.55**	2.39**	0.46	1.36**	-0.53**	-0.22	0.99**	-0.63	0.43	4.73**	-1.85	3.12	1.80**
Line 1 (4)	-2.84**	-1.96**	-10.91**	-8.01**	-2.81**	2.39**	-0.19	-1.13**	2.16**	2.96**	-1.49**	5.80**	-5.56	2.01	3.68**
Line 2 (5)	1.09**	0.47**	0.44	0.84	1.29**	0.69**	-1-82**	-0.28	0.89**	-2.06**	-2.60**	-0.03	12.64**	9.51*	-1.45*
Line 3 (6)	-2.97**	-0.78**	3.10**	0.02	3.91**	-0.07	0.55**	-0.16	-0.02	-0.77*	-0.93	-9.99	0.27	3.68	-0.77
Line 4 (7)	-2.07**	-1.45**	-2.12**	-2.47**	-1.32**	-3.23**	1.56**	0.09	-3.25**	0.13	4.87**	-7.45**	-11.33**	-18.54**	-1.37
Line 5 (8)	1.78**	0.04	2.03**	2.29**	0.31	0.19	-0.50**	-0.10	0.33	-0.28	-1.77**	-0.94	-1.78	-6.32	-0.21
LSD at 5% $\hat{g}_i$	0.35	0.13	0.68	0.68	0.60	0.44	0.22	0.30	0.46	0.69	1.07	1.59	6.89	9.11	1.13
LSD at 1% $\hat{g}_i$	0.46	0.18	0.90	0.90	0.80	0.59	0.29	0.40	0.61	0.92	1.43	2.11	9.14	10.76	1.50
LSD at 5% $\hat{g}_i$-$\hat{g}_j$	0.53	0.20	1.03	1.03	0.91	0.67	0.33	0.45	0.69	1.05	1.62	2.40	10.42 **	12.27	1.71
LSD at 1% $\hat{g}_i$-$\hat{g}_j$	0.70	0.27	1.37	1.36	1.21	0.89	0.43	0.60	0.92	1.39	2.14	3.19	13.82	16.27	2.27

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

For 1000-kemel weight, the parental Gemmeiza 9 (P_2) and line 1 (P_4) gave the diserable ($\hat{g}_i$) effect. The parental line 1 (P_4)was considered as the best combiner for 1000-kemel weight. The parental line 4 (P_7) was the best combiner for number of grains per spike. For grain yield per plant, the parental Gemmeiza 7 (P_1), Sakha 94 (P_3) and line 1 (P_4) had significant positive ($\hat{g}_i$) effects and proved to be good combiners in this respect. Also, Gemmeiza 7 (P_1) and line 2 (P_5) had considerably significant positive ($\hat{g}_i$) effects for straw yield per plant and total weight of plant.

For harvest index, significant positive ($\hat{g}_i$) effects were obtained for parental Sakha 94 (P_3) and line 1 (P_4).

Gemmeiza 7 (P_1), Sakha 94 (P_3) and Line 1 (P_4) had considerably significant positive ($\hat{g}_i$) effects for grain yield per plant and proved to be good combiners in this respect line 1 (P_4) exhibited the highest effect for ($\hat{g}_i$) effects. While Gemmeiza 7 (P_1) appeared to be the moderate combiner for ^ grain yield per plant. It is worth note that the parental line and/or variety which possessed high ($\hat{g}_i$) effects for grain yield per plant might show the same for one or more of the traits contributing to grain yield per plant. For example line 1 (P_4) showed the highest positive ($\hat{g}_i$) effects for 1000-grain weight, no. of spikes per plant, harvest index and grain yield per plant.

4.2.1.2. Specific combining ability effects ($\hat{S}_{ij}$):

Specific combining ability effects of the parental combination computed for all traits in the F_1-generation are showin (Table 12). For heading date, four crosses exhibited significantly negative (SCA) effects. The rest of the crosses gave significantly positive or insignificant ($\hat{S}_{ij}$) effects. The crosses (2x4) and (6x8) gave the highest desirable ($\hat{S}_{ij}$) values for this traits.

For maturity date, nine crosses expressed significantly negative ($\hat{S}_{ij}$) effects. Results indicated that the crosses (lx3) (2x4) (2x5) (3x6) and (5x8) had the best desirable ($\hat{S}_{ij}$) effects for this trait. Earliness, if found in wheat is favourable for escaping from destructive injuries by stress condition and intensive production.

The both crosses (1x6) and (7x8) as previously mentioned expressed significant negative ($\hat{S}_{ij}$) effects of maturity date. Also, both crosses involved one or two good combiners for this trait. In addition, both crosses (1x6) and (7x8) gave significant positive ($\hat{S}_{ij}$) effects for grain yield per plant. Hence, it could be concluded that these crosses are valuable in breeding for earliness and yield potentiality.

Regarding plant height seven crosses showed significantly positive ($\hat{S}_{ij}$) effects among twenty eight crosses. Four crosses gave significant negative ($\hat{S}_{ij}$) effects. The cross (2x7) had the highest positive ($\hat{S}_{ij}$) effects. However, the cross (2x6) gave the highest negative ($\hat{S}_{ij}$) effects.

For height up to flag leaf, ten crosses had significantly positive ($\hat{S}_{ij}$) effects. The highest positive ($\hat{S}_{ij}$) effects was obtained by the cross (2x7) followed by cross (3x5).

Ten hybrids had significant positive ($\hat{S}_{ij}$) effects for plant height up to flag leaf. The cross (2x7) had the highest positive ($\hat{S}_{ij}$) effects.

Table (12): Estimates of specific combining ability effects for crosses studied for F_1 generation.

Cross	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
1x2	-1.30*	-0.19	2.00	0.77	1.14	1.54*	-0.17	0.90	1.23	0.63	2.34	4.26	-31.02*	-29.29*	5.86**
1x3	-1.24*	-1.62**	-0.87	-0.43	1.17	0.19	0.24	-0.07	-0.17	5.52**	-5.16**	1.63	12.58	9.60	-1.24
1x4	1.03	-0.35	0.43	3.14**	-2.98*	2.99**	0.16	-0.16	3.49**	-6.52**	1.76	-1.11	22.72**	27.38*	-0.68
1x5	0.60	1.38**	-1.08	-0.88	-0.83	0.19	0.63	1.00*	0.26	-4.02**	7.37**	1.06	28.53**	28.21*	-2.60
1x6	-0.34	-0.54**	-0.58	2.27*	-3.12**	0.78	-0.32	-1.13*	1.01	4.37**	6.52**	24.76**	4.81	50.71**	3.10
1x7	4.60**	3.63**	0.75	2.87**	-1.86*	-0.23	-0.37	1.18*	0.07	0.40	4.56**	4.53	23.11**	22.93	-0.9
1x8	-0.34	1.65**	1.99	2.84**	-1.66	-1.48**	0-53	1.48**	-1.35	0.81	-2.36	-8.54**	3.44	-5.96	-3.15
2x3	-0.40	2.68**	-0.83	1.41	-2.99**	-2.31*	0.79*	1.08*	1.96**	-0.48	8.32**	0.18	33.12**	32.10*	-4.06*
2x4	-2.99**	-2.05**	2.38*	0.71	0.99	-4.09**	0.60	0.66	-3.96**	0.08	1.58	-3.59	22.49*	16.54	-4.62**
2x5	1.52**	-1.15**	0.71	0.68	1.56	-0.81	0.09	0.15	-1.03	2.02	-2.31	-3.92	-22.88*	-24.29	2.33
2x6	0.65	1.10**	-5.04**	-2.33*	-1.93*	-1.22	0.39	1.03*	-0.45	0.99	-4.32*	-11.13**	5.99	-10.12	-4.40
2x7	-0.41	-0.24	6.45**	6.00**	1.88*	2.44**	-1.46**	-0.89	2.44**	3.15**	-11.27**	-0.33	4.92	3.77	-0.74
2x8	0.38	1.28**	-3.97**	-2.59*	-2.00*	1.03	0.35	0.97*	0.86	0.41	6.02**	16.16**	2.37	24.88**	4.37*
3x4	0.46	0.51*	-5.06**	-3.99**	-1.02	3.98**	0.12	0.36	3.30**	-4.10**	-2.59	3.53	-10.24	-11.24	1.19
3x5	-0.30	-0.42**	3.42**	3.65**	-0.45	-1.74*	0.42	-0.48	-2.26**	2.10	-0.25	-6.97**	-28.71**	-35.40**	1.13
3x6	0.34	-1.34**	0.43	-3.03**	3.01**	1.77*	0.44	-0.60	1.65*	0.20	-7.33**	0.49	43.77**	37.10**	-4.69**
3x7	0.44	0.50*	0.47	2.63*	-1.09	0.09	-0.88**	0.48	0.38	0.75	2.05	5-34*	-15.24	12.10	4.46*
3x8	1.01	1.51**	1.50	0.88	-2.22*	-0.16	0.10	0.33	0.13	0.08	10.32**	11.28**	1.65	13.77	3.30
4x5	0.77	1.51**	0.89	1.22	-0.93	0.48	0.67*	0.76	0.74	0.59	6.60**	22.96**	18.94	40.71**	2.38
4x6	0.11	0.60**	1.67	3.15**	-2.63**	-0.66	0.72*	-0.14	-0.18	-4.32**	9.09**	4.53	30.70**	63.21**	-6.60**
4x7	0.30	-0.90**	0.61	1.70	-0.15	1.89**	-0.88**	1.06*	2.38**	-2.63**	-0.37	10.05	38.24**	43.77**	-2.66
4x8	1.70**	0.78**	-3.37**	-2.06	-1.45	1.81**	0.02	-1.09*	1.63*	-1.14	-2.73	3.37	12.19	6.54	-1.53
5x6	2.32**	0.66**	2.38*	2.18*	0.85	2.60**	-1.06	0.46	1.75*	-2.28**	-3.63**	-4.75	14.29	5.71	-3.02
5x7	0.39	0.66***	-0.08	1.34	-1.58	0.09	0.26	-0.45	0.14	-0.52	0.24	1.67	-7.45	-5.40	1.62
5x8	0.67	-1.49**	2.11*	2.09*	-0.63	-3.16**	0.56	-0.60	-3.27**	1.76	1.55	-11.30**	-10.50	-25.96*	-0.69
6x7	3.57**	2.58**	0.93	0.66	1.79	4.85**	-1.94**	0.76	4.06**	-0.20	-6.93**	9.17**	31.75**	33.77**	0.11
6x8	-3.11**	0.43*	3.12**	-0.26	0.84	-3.57**	0.28	-0.39	-3.52**	1.07	7.21**	-9.80**	-6.96	-20.12	-2.30
7x8	0.13	-0.74**	3.25**	1.15	3.30**	3.85**	-1.15**	-0.47	3.95**	2.33*	-9.84**	9.29**	16.97	27.10*	1.07
LSD at 5% $\hat{S}_{ij}$	1.07	0.41	2.09	2.08	1.85	1.36	0.66	0.92	1.40	2.13	3.28	4.87	21.13	24.87	3.47
at 1% $\hat{S}_{ij}$	1.42	0.54	2.77	2.76	2.45	1.80	0.88	1.22	1.86	2.82	4J5	6.47	28.03	33.00	4.60
LSD at 5% $\hat{S}_{ij}$-$\hat{S}_{jk}$	1.59	0.61	3.09	3.08	2.73	2.01	0.98	1.6	2.07	3.14	-1.85	7.21	31.26	36.80	5.17
at 1% $\hat{S}_{ij}$-$\hat{S}_{jk}$	2.10	0.81	4.10	4.09	3.63	2.67	1.30	1.81	2.75	4.17	6.43	9.S7	41.47	48.82	6.81
LSD at 5% $\hat{S}_{ij}$-$\hat{S}_{kl}$	1.49	0.57	2.91	2.91	2.58	1.90	0.92	1.28	1.95	2.96	4.57	6.80	29.48	34.70	4.84
at 1% $\hat{S}_{ij}$-$\hat{S}_{kl}$	1.98	0.76	3.87	3.86	3.42	2.52	1.23	1.70	2.59	3.93	6.07	9.02	39.10	46.03	6.42

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

Ten and ten crosses showed significant positive ($\hat{S}_{ij}$) effects for number of tillers per plant and number of spikes per plant, respectively. The cross (6x7) had the highest ($\hat{S}_{ij}$) values for both traits.

Three crosses (2x3), (4x5) and (4x6) had significantly positive ($\hat{S}_{ij}$) effects for spike length.

Considering number of spikelets per spike, seven parental combinations had significant positive ($\hat{S}_{ij}$) effects. The cross (1x8) gave the highest ($\hat{S}_{ij}$) effects followed by the cross (1x7).

For 1000-kemel weight, four crosses (1x3), (1x6), (2x7) and (7x8) had significantly positive ($\hat{S}_{ij}$) effects.

Nine crosses exhibited significant ($\hat{S}_{ij}$) effect for number of kernels per spike. The best combinations were (3x8) followed by (4x6) in this trait.

Regarding grain yield per plant, seven parental combinations showed significantly positive ($\hat{S}_{ij}$) effects. In conclusion, the best combinations were (1x6), (2x8), (4x5) and (7x8).

It could be concluded that the previous crosses seemed to be the best combinations, where it had significant ($\hat{S}_{ij}$) effects for grain yield per plant as well as most of yield components.

Three combinations (1x2), (2x8) and (3x7) exhibited significant positive ($\hat{S}_{ij}$) effects for harvest index. The best combination was (1x2).

Concerning total plant weight, eleven crosses showed significant positive ($\hat{S}_{ij}$) effects. While, for straw yield, nine crosses exhibited significant positive ($\hat{S}_{ij}$) estimates in the same order. The crosses (1x4), (1x5), (2x3), (3x6), (4x6). (4x7) and (6x7) had the highest desirable ($\hat{S}_{ij}$) effects for the two traits. The mentioned combinations might be of interest in breeding programs aimed at producing pure line varieties for high straw yield, as most combinations involved at least one good combiner for both traits.

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

4.2.2. F_2-generation:

Analysis of variance for general combining and specific combining ability for all traits studied are shown in Table (13). The mean squares for general and specific combining ability were found to significant for all traits studied.

Both additive and non-additive gene effects were involved in determining the performance of single cross progeny for all traits. Also, when GCA/SCA ratio was used, it was found for all the traits studied except for 1000-grain weight, to exhibit high GCA/SCA ratios which exceeded, the unity, indicating the predominance of additive gene action in me inheritance of such traits.

Table (13): Observed mean squares of general and specific combining ability from diallel cross analysis for all traits studied in the F_2 generation.

S.O.V.	d.f.	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
GCA	7	30.14**	19.82**	196.25**	189.80**	19.86**	20.33**	9.28**	2.07**	19.87**	12.85**	57.62**	165.70**	1110.06**	2010.36**	42.99**
SCA	28	3.57**	3.24**	37.31**	6.92**	6.80**	7.50**	1.33**	1.45**	7.28**	15.94**	30.87**	60.97**	571.90**	855.85**	13.77**
Error	70	0.61	0.48	5.36	2.44	1.08	0.69	0.12	0.53	0.65	3.11	5.02	14.11	83.19	88.28	3.63
GCA/SCA		8.44	6.11	5.25	27.42	2.92	2.71	6.97	1.42	2.72	0.80	1.86	2.71	1.94	2.34	3.12

* and ** significant at 0.05 and 0.01 levels of probability, respectively.
GCA refers to general combining ability.
SCA refers to specific ability.

On the other hand, low GCA/SCA ratio which is less than unity was detected for 1000-grain weight. Such result indicates that non-additive gene action was more important than additive effects in controlling this trait. GCA/SCA ratios were higher magenitude in F_2 than F_1 generation for most traits, revealing that additive and additive x additive gene effects were increased and non-additive gene effect was also reduced in the F_2 generation. Similar conclusion was obtained by **Mekhamer (1995), Mahmoud (1999), Abdel-Wahed (2001), El-Sayed (2004), Ashoush (2006) and El-Marakby *et at* (2007)**.

4.2.2.1. General combining ability effects:

Estimates of GCA effects ($\hat{g}_i$) for individual parent for the traits studied are presented in Table (14). Results indicated that the parental Gemmeiza 7 (P_1) seemed to be the best combiner for plant height, plant height up to flag leaf, spike length, number of spikelets per spike, number of spikes per plant, number of grains per spike, grain yield per plant, straw yield per plant and total weight of plant. The parental Gemmeiza 9 (P_2) expressed significant positive ($\hat{g}_i$) effects for plant height, plant height up to flag leaf and spike length. The parental cultivar Sakha 94 (P_3) seemed to be the best combiner for plant height, plant height up to flag leaf, number of tillers per plant, number of spikes per plant, grain yield per plant and harvest index.

The parental line 1 (P_4) seemed to be good combiner for number of tillers per plant, number of spikes per plant, grain yield per plant and harvest index. Also, it had significant desirable ($\hat{g}_i$) effects for heading date, maturity date and plant

Table (14): Estimates of general combining ability effects for parents studied in the F_2 generation.

Parent	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
Gemmeiza 7 (1)	1.47**	1.59**	4.91**	2.55**	-0.10	0.55	0.99**	0.64**	0.54*	-0.27	1.76**	4.41**	18.64**	26.36**	-1.28*
Gemmeiza 9 (2)	1.60**	1.93**	2.26**	3.08**	-0.98**	-0.51*	0.36**	0.37	-0.65**	-0.79	0.6	-2.79*	4.67	0.00	-1.98**
Sakha 94 (3)	1.33**	0.46**	1.76*	3.50**	0.01	0.61*	-0.51**	-0.43*	0.66**	0.12	-0.55	3.29**	-7.07*	-8.68**	2.88**
Line 1 (4)	-2.78**	-1.94**	-7.77**	-9.37**	-1.75**	1.78**	-0.26*	-0.78**	1.72**	0.54	-2.58**	4.79**	-9.45**	-4.00	3.30**
Line 2 (5)	0.83**	0.23	-1.91**	-0.54	1.57**	0.48*	-1.62**	-0.09	0.52*	-0.55	-0.83	-0.20	9.90**	10.35**	-1.93**
Line 3 (6)	-1.58**	-1.01**	2.46**	0.72	1.93**	-0.04	0.40**	-0.05	-0.07	-0.84	-1.09	-1.63	2.71	0.25	0.04
Line 4 (7)	-1.72**	-1.58**	-4.94**	-2.81**	-1.65**	-3.13**	1.34**	0.35	-3.07**	2.54**	4.83**	-7.20**	12.72	-22.60**	1.27*
Line 5 (8)	0.85**	0.33	3.25**	2.86**	0.98**	0.28	-0.70**	0.01	0.34	-0.74	-2.16**	-0.68	1.25	-1.67	0.24
LSD at 5% $\hat{g}_i$	0.46	0.41	1.36	0.92	0.61	0.49	0.21	0.43	0.47	1.04	1.32	2.21	5.37	5.53	1.12
LSD at 1% $\hat{g}_i$	0.61	0.54	1.81	1.22	0.81	0.65	0.27	0.57	0.63	1.38	1.75	2.93	7.12	7.34	1.49
LSD at 5% $\hat{g}_i$-$\hat{g}_j$	0.70	0.61	2.06	1.39	0.93	0.74	0.31	0.65	0.72	1.57	1.99	3.34	8.12	8.36	1.70
LSD at 1% $\hat{g}_i$-$\hat{g}_j$	0.92	0.81	2.73	1.84	1.23	0.98	0.41	0.86	0.95	2.08	2.65	4.44	10.77	11.09	2.25

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

height. The line 2 (P_5) had significant desirable ($\hat{g}_i$) effect for height of flag region, number of tillers per plant, number of spikes per plant, straw yield per plant and total weight of plant. Also, it had significant negative ($\hat{g}_i$) effect for plant height. The parental line 3 (P_6) expressed significant negative ($\hat{g}_i$) effects for heading and maturity dates and it was found to be significant positive ($\hat{g}_i$) effects for plant height, height of flag region and spike length. The parental line 4 (P_7), gave significant desirable ($\hat{g}_i$) effects for spike length, 1000-grain weight, number of grains per spike. Also, it gave negative significant effect for heading date, maturity date, plant height and plant height to flag leaf.

The parental line 5 (P_8) had desirable ($\hat{g}_i$) effects for plant height, plant height up to flag leaf and height of flag region. Also, it was poor combiner for other traits. It could be concluded the best combiner for the traits studied in the F_2 generation were the same for the corresponding traits in the F_1 generation (Table 11).

4.2.2.2. Specific combining ability effects:

Specific combining ability effects of the parental combinations were computed for all the traits studied in the F_2 generation Table (15). Five, five, seven and eight crosses significant negative ($\hat{S}_{ij}$) effect for heading date, maturity date, plant height and height of flag region, respectively. Five crosses had significant positive ($\hat{S}_{ij}$) effects for plant height to flag leaf. While the most desirable inter and intra-allelic interaction were represented by eight, two, four, nine, three, four, six, seven, seven, five, five and five crosses for number of tillers per plant, Table (15): Estimates of specific combining ability effects for crosses studied in the F_2 generation.

Cross	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spike/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
1x2	-0.53	-0.27	1.60	-0.60	-1.45	-0.24	0.27	2.67**	-0.25	1.21	6.53**	-1.85	-0.77	-3.33	-0.70
1x3	-1.05	-3.80**	-2.05	-0.93	-1.95*	0.64	-1.22**	-1.20	0.61	5.90**	-8.88**	0.22	-3.86	-1.47	-0.60
1x4	-1.84*	-0.40	0.10	3.13*	-2.77**	3.52**	0.18	0.57	2.91**	-3.58*	-1.32	7.48*	-16.43	-12.19	4.46*
1x5	0.84	2.43**	-2.31	0.51	0.88	1.21	-0.36**	-1.05	1.35	-3.79*	-1.97	3.06	15.15	14.97	-0.51
1x6	-0.10	-1.00	-4.96*	0.70	-1.65	1.44	-0.43	-0.92	1.47*	0.98	2.41	7.74*	30.38**	58.27**	0.69
1x7	1.68*	3.57**	-3.83	0.76	-0.27	0.52	-1.97	1.33*	0.32	-2.32	-3.42	6.19	1.68	7.96	1.92
1x8	-0.83	1.33*	-0.64	5.52**	-1.28	-2.45**	0.39	2.56**	-2.47**	4.97**	3.41	-7.10*	-13.38	-23.86**	-1.50
2x3	0.49	2.53**	-1.56	1.54	-2.46*	0.08	0.74*	0.54	0.26	-0.34	3.81	-0.77	-4.12	-19.39*	-0.52
2x4	-3.91**	-4.07**	-7.22**	-1.58	0.98	-3.05**	-0.53	1.10	-3.20**	-0.01	4.39*	1.85	1.37	1.48	0.95
2x5	-2.07**	0.43	2.61	-1.41	-1.64	-0.79	0.16	-0.98	-0.71	1.64	-1.89	-2.45	-25.88**	-26.37**	3.03
2x6	-1.25	1.33*	-3.88	0.33	-1.81	-1.01	-0.50	0.65	-0.93	1.58	-9.16**	-8.42*	32.59**	22.19*	-8.00*
2x7	0.42	-0.77	0.56	0.71	1.33	2.04**	-0.82*	0.26	2.28**	-5.48**	-10.64**	4.40	6.88	16.57	0.91
2x8	2.19**	0.00	-6.18**	-1.81	-3.15**	1.03	-0.29	-0.03	1.05	0.79	4.12*	4.26	-26.19**	-22.92**	6.53**
3x4	-0.70	0.40	-6.84**	-2.15	-1.36	1.35	0.07	0.28	1.51*	0.08	-4.24*	1.44	-23.74**	-17.33*	5.40**
3x5	1.04	0.23	-2.46	-2.78	-0.07	-2.95**	0.52	0.84	-2.94*	-1.44	2.42	12.30**	15.50	-22.83**	-3.09
3x6	1.58*	-1.87**	0.31	-0.50	1.38	0.47	0.29	-0.08	-0.05	1.24	-5.49**	10.64**	-14.02	-23.62**	-3.06
3x7	2.75**	1.70*	2.94	4.00**	-1.20	1.80*	-0.24	0.07	1.82*	-4.49**	3.29	12.06**	33.95**	20.97*	4.81*
3x8	-1.85*	1.47*	-0.73	0.05	-1.42	-0.85	-0.46	-0.08	-0.83	0.88	0.23	-1.06	-7.11	-2.82	2.15
4x5	1.06	1.63*	-6.41**	0.50	-1.92*	2.31**	-0.01	0.41	-2.18**	7.94**	4.78*	4.18	21.47*	25.07**	-2.40
4x6	0.26	1.20	-10.73**	-1.17	-3.31**	0.25	-0.55	-1.02	0.19	-1.27	3.86	4.03	19.64*	19.16*	-2.40
4x7	-1.17	-0.90	-4.88*	-2.35	1.59	3.28**	0.36	1.43*	3.46**	-2.51	-5.70**	0.68	-1.90	1.54	1.21
4x8	1.49*	1.20	-3.21	-0.31	-1.34	2.86**	0.85**	-1.15	2.81**	-1.15	-4.44*	5.35	29.34**	34.49**	-3.26
5x6	0.35	-1.63*	-1.07	0.33	-1.31	0.21	0.35	1.15	0.14	1.17	-2.28	-2.75	-27.94**	-35.19**	3.07
5x7	0.19	-1.07	0.02	2.14	-2.06*	0.42	-0.51	-0.01	0.25	1.28	-2.86	0.34	-34.99**	-31.90*	4.96**
5x8	-1.82*	-0.30	-1.79	-1.24	-0.37	-2.43**	-0.06	-0.65	-2.52**	-5.22**	1.88	-7.41*	-6.50	-14.11	-1.15
6x7	2.41**	0.83	2.96	4.17**	0.84	4.35**	-1.77**	-0.88	4.30**	-5.19**	-3.74	10.46**	40.87**	50.15**	-1.89
6x8	-1.28	-1.40*	2.76	-1.45	-2.05*	-2.77**	-0.19	0.29	-2.63**	0.40	2.39	-4.14	-13.48	-21.75*	1.22
7x8	1.79*	-0.17	0.69	2.89*	0.91	3.16**	-2.12**	-0.18	3.04**	-2.89	-3.91	4.86	4.53	12.53	1.59
LSD at 5% $\hat{S}_{ij}$	1.41	1.24	4.18	2.82	1.88	1.50	0.63	1.52	1.45	3.18	4.04	6.78	16.46	16.95	3.44
at 1% $\hat{S}_{ij}$	1.87	1.65	5.54	3.74	2.49	1.93	0.83	1.75	1.92	4.22	5.36	8.99	21.83	22.49	4.56
LSD at 5% $\hat{S}_{ij}-\hat{S}_{jk}$	2.09	1.84	6.18	4.17	2.78	2.21	0.93	1.92	2.15	4.71	5.98	10.03	24.35	25.08	5.09
at 1% $\hat{S}_{ij}-\hat{S}_{jk}$	2.77	2.44	8.20	5.53	3.69	2.94	1.23	2.58	2.85	6.24	7.94	13.13	32.31	33.28	6.75
LSD at 5% $\hat{S}_{ij}-\hat{S}_{kl}$	1.97	1.74	5.83	3.93	2.62	2.09	0.88	1.84	2.02	4.44	5.64	9.46	22.96	23.65	4.79
at 1% $\hat{S}_{ij}-\hat{S}_{kl}$	2.61	2.30	7.73	5.21	34.80	2.77	1.16	2.43	2.68	5.89	7.48	12.55	30.46	31.38	6.36

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

spike length, number of spikelets per spike, number of spikes per plant, 1000-grains weight, number of grains per spike, grain yield per plant, straw yield per plant, total weight of plant, harvest index, heading date and maturity date, 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 pure line varieties in most combinations involved at best one good combiner.

4.3. Genetic components:

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

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

2- Homozygous parents; the parental lines were assumed to be homozygos,

3- No reciprocal differences in this study,

4- No genotypic by environmental interaction within locations and/or years.

5- No epistasis,

6- No multiple alleles; and

7- Uncorrelated gene distribution.

To test the validity of these assumptions, therefore, two main testers were employed. First of all was t^2 value. This value of t is presented in Table (17). With the exception of total weight of plant, insignificant t value, were detected for all traits. 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 assumption are satisfied **(Jinks and Hayman, 1953)**. Significant regression lines from zero were detected for heading date, maturity date, plant height, plant height to flag leaf, height of flag region, number of tillers/plant, spike length number of spikes/plant, 1000-grain weight and number of grains/spike, and the slope of the regression lines did not deviate significantly from unity. For other traits, regression less than unity were obtained, indicating that the assumption of genetic interaction was not satisfied in the data. However, the estimation of population parameters, could be possible with such partial fulfillment **(Hayman (1954b)**. These estimation, however, would be less reliable than those traits which completely satisfied this assumption.

Data were subjected to the diallel cross analysis proposed by **Hayman (1954b)** for more information about the genetical behaviour of the agronomic traits under study.

4.3.1. F_1-generation:

The computed parameters for all the traits are presented in Table (16). Significant value for both additive ($\hat{D}$) and dominance ($\hat{H}_1$) components were obtained in all traits. Values of ($\hat{D}$) were significantly smaller in magnitude than the respective ($\hat{H}_1$) in all traits except, heading date, plant height, plant height up to flag leaf and spike length. This result revealed that dominance type of gene action was the most prevalent genetic type. The contradiction in magnitude obtained between

Table (16): Estimates of genetic components of variation in a diallel wheat crosses in (F_1) for the traits studied.

Characters components	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spikes/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
$\hat{D}$	34.02**	8.57**	86.90**	68.43**	11.62**	24.55**	9.87**	0.72*	26.02**	37.12**	93.02**	119.12**	1188.56**	1738.01**	34.00**
$\hat{F}$	23.71**	2.25*	3.14*	24.87**	3.08*	25.01**	9.40**	-0.75*	29.55**	55.16**	126.39**	121.99*	2031.56**	3330.39*	42.67**
$\hat{H}_1$	18.66**	10.19**	35.31**	38.52**	18.71**	34.13**	5.09**	2.90**	34.29**	54.00**	193.14**	491.01**	3244.84**	6178.88**	57.73**
$\hat{H}_2$	11.63**	9.01**	27.50**	28.25**	15.18**	22.97**	2.39**	2.36**	21.59**	30.60**	142.03**	398.44**	2259.34**	4126.78**	38.39**
$\hat{h}^2$	3.45*	8.66**	13.11**	51.97**	24.58**	9.67**	0.05	2.90**	9.86**	-0.60	20.12*	411.97**	4474.03*	8635.92**	11.75*
E	0.37	0.06	1.36	1.35	1.07	0.59	0.14	0.26	0.59	1.38	3.23	7.30	149.08	201.48	4.08
$(\hat{H}_1/\hat{D})^{1/2}$	0.74	1.09	0.64	0.75	1.27	1.18	0.72	2.00	1.15	1.21	1.44	2.03	1.65	1.89	1.30
$\hat{H}_2/4\hat{H}_1$	0.16	0.22	0.19	0.18	0.20	0.17	0.12	0.20	0.16	0.14	0.18	0.20	0.17	0.17	0.17
K D/Kr	2.78	1.27	1.06	1.64	1.23	2.52	4.92	0.59	2.96	4.21	2.78	1.67	3.14	3.07	2.86
h(n.s)	0.73	0.62	0.85	0.76	0.55	0.46	0.68	0.54	0.43	0.23	0.19	0.30	0.09	0.16	0.28
r	-0.16	-0.43	-0.14	-0.40	0.47	-0.77*	0.63*	0.02	-0.82*	0.95**	0.83**	-0.81*	-0.75*	-0.78*	0.88**
YD	93.43	140.82	54.99	37.60	8.78	1.62	11.78	23.47	1.69	33.24	8.80	-6.42	-450.02	-373.10	16.72
YR	140.30	153.40	173.11	142.51	37.46	59.46	25.77	25.42	65.15	117.75	256.71	157.34	1905.88	1855.99	69.64
T^2	0.33	1.38	0.40	0.01	0.00	0.25	0.03	10.26	0.58	0.39	1.10	0.45	1.71	14.33	0.00
b =	0.90	0.67	1.01	0.97	0.87	0.96	0.95	0.52	1.03	0.90	0.89	0.32	0.53	0.31	0.52
Error (b)	0.04	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.04	0.98	0.05	0.01	0.01	0.06
Ho : b = 0	23.16	41.46	69.18	136.24	40.91	47.03	157.89	76.26	75.30	20.81	11.56	7.07	58.33	40.15	8.32
Ho : b = 1	2.54	20.87	-0.41	4.75	6.36	1.72	9.13	70.39	-1.93	2.48	1.45	14.87	51.16	90.02	7.79

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

($\hat{D}$) and GCA estimate for most traits could be attributed to the great role of both allelic and non allelic genetic types of expression of most traits. These results are in line with those obtained by **Mosaad *et al.* (1990), Ashoush (1996), Salem *et al.* (2000) and El-Marakby *et al.* (2007)**.

Theoretically ($\hat{H}_2$) should be equal to or less than ($\hat{H}_1$) **(Hayman, 1954b)**. The smaller ($\hat{H}_2$) than H_1 found in the all traits, indicated that the positive U and negative V alleles frequencies at the loci for the traits in question are not equal in proportion in the parents. This was reflected in the estimates of the covariance of additive and dominance effects ($\hat{F}$) which were significantly positive in all traits except number of spikelets/spike. Positive estimates of ($\hat{F}$) indicate the excess of dominante alleles. Also, the values of $\hat{H}_2/4\ \hat{H}_1$ were below the maximum value of 0.25, which arises when U = V = 0.5 over all loci, indicating that the positive and negative alleles were not equally distributed among the parents for the previous traits. The same conclusion could again drawn from corresponding proportion $(4\ \hat{D}\ \hat{H}_1)^{1/2} + \hat{F}\ (4\ \hat{D}\ \hat{H}_1)^{1/2} - F$. These result was partial agreement with previously reached by **Singh (1990), Ashoush (1996), Salem *et al.* (2000) and Ashoush (2006)**.

The overall dominance effects of heterozygous loci ($\hat{h}^2$) were computed. Significant ($\hat{h}^2$) values were reached here in all traits except spike length and 1000-Kernel weight, indicating that dominance was unidirectional. This finding confirms the results reached above for parent vs. crosses presented in Table (4). Appreciable heterotic effects were previously reported: for heading date **(Mosaad *et al.*, 1990; Singh *et al.*, 1990; Ashoush,**

1996 and Darwish *et al.*, 2006). For plant height **(Ashoush, 1996; Hassan, 1998; Ashoush, 2006 and Darwish *et al.*, 2006)** for number of tillers/plant (Ashoush, 1996) for spike length **(Mosaad *et al.*, 1990; Ashoush, 1996 and Darwish *et al.*, 2006)**. For spikes/plant **(Singh *et al.*, 1990; Ashoush, 1996; Hassan, 1998 and Ashoush, 2006)** for 1000-grains weight **(Ashoush, 1996; Hassan, 1998 and Darwish *et al.*, 2006)**. For number of grains/spike **(Mosaad *et al.*, 1990; Ashoush, 1996; Ashoush, 2006 and Darwish *et al.*, 2006)**. For grain yield/plant **(Mosaad *et al.*, 1990; Ashoush, 1996; Hassan, 1998 and Darwish, 2006)** for straw/plant and total weight of plant **(Singh *et al.*, 1990; Ashoush, 1996; Ashoush, 2006 and Darwish *et al.*, 2006)**.

The relative size of ($\hat{D}$) and ($\hat{H}_1$) estimated as $(\hat{H}_1/\hat{D})^{1/2}$ can be used a weight measure of average of dominance at each locus, showed the presence of over dominance for all traits except heading date, maturity date, plant height, plant height up to flag leaf and spike length, for maturity date, when dominance ratios $(\hat{H}_1/\hat{D})^{1/2}$ were found to be nearly equal unity, indicating that this character was controlled by complete dominance. However, for heading date, plant height, plant height up to flag leaf and spike length, the ratio was found to be less than, unity, revealing the presence of partial dominance similar results were obtained by **Singh (1990), Ashoush (1996), Hassan (1998), Salem *et al.* (2000) and Darwish *et al.* (2006)**. For plant height **(Mossad *et al.*, 1990; Singh *et al.*, 1990 and Ashoush, 2006)** for spike length **(Masaad *et al.*, 1990; Ashoush, 1996; Hassan, 1998 and Darwish, 2006)** for grain yield/plant **(Singh *et al.*,**

1990; Ashoush, 1996; Hassan, 1998 and Ashoush, 2006). For number of spikes/plant **(Ashoush, 1996; Hassan, 1998 and Darwish *et al.*, 2006)**. For number of grains/spike **(Mosaad *et al.*, 1990; Ashoush, 1996; Hassan, 1998 and Ashoush, 2006)**. For straw yield/plant and total weight of plant **(Ashoush, 1996 and Darwish *et al.*, 2006)**.

4.3.1.1. Heritability values:

Heritability estimates in narrow sense h(n-s) for all traits are given in Table (16). Low heritability values in narrow sense were detected for 1000-grain weight, number of grains/spike, grain yield/plant, straw yield/plant, total weight of plant and harvest index. Also, moderate values were detected for height of flag region, number of tillers/plant, number of spikelets/spike and number of spikes/plant, indicating the most of genetic variance may be due to non-additive genetic effects. This finding supported the previous results of genetic components where the $\hat{H}_1$ estimates were found to have a great role in these traits. Therefore the bulk method programme for these traits might be quite promising. High heritability values in narrow sense were detected for flowering date, maturity date, plant height, plant height up to flag leaf and spike length, indicating that the genetic variance associated with those traits was mostly attributed to additive effects of genes. This finding supported those mentioned before in Table (4). Therefore, a pedigree selection programme for these traits might be quite promising **(Hassan, 1998; El-Sayed *et al.*, 2004; Ashoush, 2006 and Darwish, 2006)**.

The correlation values between parental mean (Y) and (Wr + Vr) for each array were significant for number of tillers/plant, number of spikes/plant, grain yield/plant, straw yield and total weight of plant, revealing that increases genes were dominant over decreasers.

High positive correlation coefficient values were detected for spike length, 1000-grain weight, number of grains/spike and harvest index, indicating that decreases genes were dominant over increases. For the other traits, low correlation values which could not be fruitful in getting any idea about the direction of dominance were obtained. Such low values of correlation coefficient might be due to the presence of epistasis and to additively of most genes involving the system in these traits. Also, it might be reveal that high performance for such traits was controlled by dominant and recessive genes as well.

4.3.2. F_2-generation:

The computed parameters for all traits are presented table (17). With the exception of number of spikelets/spike, spike length and 1000-kernel weight, insignificant t^2 value were detected for all traits. With the exception of number of spikelets/spike, the additive component ($\hat{D}$) reached the significant level of probability. This finding is in harmony with that reached a bone in Table (13).

For the exceptional 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 computed t^2 was significant (Table 17). In addition, the

Table (17): Estimates of genetic components of variation in a diallel wheat crosses in (F_2) for the traits studied.

Characters components	Heading date (days)	Maturity date (days)	Plant height (cm)	Plant height up to flag leaf (cm)	Length of flag region (cm)	No. of tillers/plant	Spike length (cm)	No. of spikelets/spike	No. of spike/plant	1000-grain weight (g)	No. of grains/spike	Grain yield plant (g)	Straw yield/plant	Total weight of plant (g)	Harvest index
$\hat{D}$	19.05**	7.77**	57.70**	74.36**	13.12**	29.42**	8.64**	0.19	29.30**	36.96**	78.17**	178.01**	1336.28**	2124.48**	26.66**
$\hat{F}$	6.07**	0.86	10.09	8.20*	9.52**	10.27**	2.96**	0.15	12.98**	32.05**	100.88**	252.40**	1820.44*	2076.62**	24.87**
$\hat{H}_1$	16.75**	12.46**	131.21**	28.40**	19.37**	37.54**	5.67**	4.81**	36.64**	70.68**	129.43**	290.58**	2584.77**	4167.20**	53.92**
$\hat{H}_2$	10.35**	11.36**	88.37**	16.76**	16.05**	20.76**	3.47**	3.86**	20.31**	44.17**	91.67**	155.67*	1742.92**	2552.21**	39.24**
$\hat{h}^2$	-0.26	0.36	247.52**	5.38*	56.76**	7.30**	5.48**	2.53*	5.89*	14.09**	37.93**	14.19*	-39.21	-39.67	9.42*
E	0.60	0.47	5.22	2.37	1.11	0.68	0.12	0.52	0.64	3.05*	5.05	13.76	90.39	97.75	3.72
$[\frac{1}{4}(\hat{H}_1/\hat{D})]^{1/2}$	0.43	0.63	0.75	0.19	0.73	0.63	0.32	12.65	0.62	0.95	0.82	0.81	0.96	0.98	1.01
$\hat{H}_2/4\hat{H}_1$	0.15	0.23	0.17	0.15	0.21	0.14	0.15	0.20	0.14	0.16	0.18	0.13	0.17	0.15	0.18
K D/Kr	2.30	1.09	1.12	1.20	1.85	4.07	3.64	1.17	4.13	4.09	3.01	3.49	2.92	3.00	1.98
h(n.s)	0.84	0.62	0.54	0.85	0.74	0.82	0.95	0.04	0.84	0.73	0.97	0.99	0.93	0.84	0.62
r	-0.13	0.19	0.65	-0.26	0.70	-0.89	0.80	-0.22	-0.87	0.93	0.90	-0.89	0.21	-0.01	0.20
YD	96.76	138.01	132.54	34.66	8.32	3.23	12.03	25.07	3.49	26.31	23.31	-63.85	-476.23	-372.95	19.18
YR	129.86	152.56	99.67	129.38	43.46	72.82	21.77	24.79	72.20	151.77	225.25	448.90	1882.81	1840.57	49.13
T^2	1.20	0.03	2.48	0.22	0.92	0.44	4.03	26.45	0.46	5.83	0.58	1.73	0.03	0.09	0.05
b =	0.87	0.68	-0.17	0.91	0.98	1.01	0.67	-0.07	1.01	1.12	0.92	1.02	0.59	0.35	0.34
Error (b)	0.00	0.05	0.03	0.01	0.04	0.01	0.01	0.01	0.01	0.00	0.05	0.06	0.06	0.06	0.09
Ho : b = 0	182.39	13.03	-6.24	149.96	22.61	67.71	80.66	-12.22	69.26	539.54	20.40	15.85	9.31	6.08	3.88
Ho : b = 1	27.17	6.06	42.54	13.97	0.38	-0.68	39.41	195.66	-0.89	-55.80	1.67	-0.33	6.56	11.18	7.56

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

regression coefficient of parental offspring covariance (Wr) on the parental array variance (Vr) was found to be less than unity for this trait, revealing the presence of complementary type of epistasis, therefore, the contradiction in magnitude detected between ($\hat{D}$) and GCA estimate for this trait could be attributed to the great role of both allelic and non-allelic genetic types expression of this trait.

Significant values for dominance component $\hat{H}_1$ were obtained for all traits. Values of ($\hat{H}_1$) were larger in magnitude than the respective ($\hat{D}$) ones for all traits except plant height up to flag leaf and spike length. This result revealed that non-additive type of gene action was the most prevalent genetic component for both traits. This finding supported the previous results of genetic components in the F_1 (Table, 16).

The overall dominance effects of heterozygous loci ($\hat{h}^2$) were computed. Significant ($\hat{h}^2$) values were detected for all traits except heading date, maturity date, straw and total plant weight, indicating that the effect of dominance was unidirectional. Appriciable remain heterotic effects in the F_2 were previously reported by **Abul-Nas *et al.* (1986), Abdel-Saboor *et al.* (1990) and Ashoush (1996)**.

The relative size of ($\hat{D}$) and ($\hat{H}_1$) estimated a $[1/4 (\hat{H}_1/\hat{D})]^{1/2}$ can be used a weighted measure of the average degree of dominance at each locus, showed presence of partial dominance for all traits except plant height, number of spikelets/spike and harvest index. For the harvest index had a complete dominance. However, for plant height and number of spikelets/spike. The ratio was found to be over dominance **(Ashoush, 1996 & 2006 and Darwish *et al.*, 2006)**.

The average frequency of negative vs positive alleles in parental population was detected by the ratio of $\hat{H}_2/4\hat{H}_1$. Values largely deviating from one quarter were obtained for all traits except plant height and number of spikelets/spike, indicating that negative and positive alleles were unequally distributed among the parents (Table 17). The symmetry vs. asymmetry in gene frequenty was also examined by computing the ($\hat{F}$) component. Significant positive ($\hat{F}$) values were detected for the previous traits (Table 17), revealing asymmetry with dominance alleles being more frequent. The same conclusion could be again by drawn from the corresponding proportion $[1/4\ (4\ \hat{D}\ \hat{H}_1)]^{1/2}$ + F/[1/4(4 $\hat{D}\ \hat{H}_1$)]1/2 – $\hat{F}$. This finding is agreement with the results obtained from F_1 data (Table 16).

4.3.2.1. Heritability:

High to moderate heritability estimates in narrow sense were obtained for all the traits studied except number of spikelets/spike which low value was detected. The heritability values were high in the F_2 compared with in the F_1.