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.

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 growth, yield and its components is presented in Table (6). The error variance for the two seasons were homogenous for all the studied traits, consequently the combined analysis would be veiled. Season mean squares were significant for all the studied traits, except number of spikelets/spike, including an overall differences between the two seasons. Also, the mean values in the second season were higher than those in the first one for flowering date, plant height, seed index, grain yield/plant and harvest index, whereas the highest mean values were obtained in the first season for the other studied traits (Table 7). It could be concluded that, the grain yield increased in the second season may be due to the significant increasing in the seed index and high harvest index.

Significant genotypes mean squares were detected for all the studied traits in separate season as well as the combined analysis except, number of spikelets/spike in the first season, indicating the wide diversity was detected between the parental materials that used in the present study. Significant genotypes x season interaction mean squares were obtained for all the studied traits, except, flowering date, number of spikelets/spike, spike length and seed index. Such results indicated that the tested genotypes were varied from each other and ranked differently from season to another. For four exceptional traits, significant genotypes mean squares along with insignificant genotypes x season interaction mean squares were detected. These findings, therefore, might revealed the high repeatability of the tested genotypes under different seasons. Also, it may reflect the minor role of the non-additive type of gene action on the expression of these traits.

The results, also, showed that, mean squares due to parents were significant for all the studied traits except number of spikelets/spike in both seasons and spike length in the first season. Also, significant mean squares due to interaction between parental varieties and seasons were detected for number of spikes/plant, number of grains/spike, straw, grain and biological yield and harvest index. These findings indicated that, parental varieties and/or lines were differed in their performance in all studied traits except number of spikelets/spike. Also, it revealed that parental lines varied in their response to seasonal in the previous traits.

Data presented in Table (6) showed that, crosses mean squares were significant for all studied traits except number of spikelets/spike in the first season, revealing an overall difference

Table (6): Observed mean squares from analysis of variance for all studied traits in each season as well as the combined analysis in F_1-generation.

Source of variation	d.f.		Flowering date (days)			Plant height (cm)			No. of spikelets/spike			Spike length (cm)			No. of spikes/plant			Seed index (g)		
	S	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
Season	-	1			261.45**			1810.69**			3.99			19.42**			300.59**			84.15**
Rep. x S	2	4	5.24	26.00**	15.62*	22.08	6.18	14.13	0.47	4.39	2.43	0.60	0.39	0.49	0.85	0.00	0.42	15.91**	3.41	9.66
Genotype	27	27	60.65**	52.58**	110.19**	234.22**	227.14**	425.13**	2.64	3.39*	4.88**	2.91**	3.40**	4.81**	13.60**	27.14**	26.74**	125.52**	109.29**	231.14**
Parents	6	6	78.19**	74.84**	152.08**	347.22**	365.32**	700.49**	3.71	1.94	4.73*	2.69	5.66**	6.52**	8.98**	19.98**	13.78**	60.09**	78.67**	135.05**
F_1	20	20	57.99**	46.99**	102.96**	176.91**	182.55**	316.48**	1.99	3.84*	4.58**	2.40*	2.72**	3.73**	14.69**	30.05**	31.94**	118.90**	113.94**	232.22**
P. vs F_1	1	1	8.58	30.98**	3.47	700.17**	289.82**	945.96**	9.33*	3.20	11.73*	14.48**	3.58	16.23**	19.38**	12.02**	0.44	650.48**	200.13**	786.10**
Genotype x season	-	27			3.04			36.24**			1.15			1.50			14.01**			3.67
Parent x season	-	6			0.95			12.35			0.92			1.83			15.18			3.70
F_1 x season	-	20			2.02			42.98**			1.24			1.39			12.80			0.62
P. vs F_1x S	-	1			36.09**			44.63*			0.80			1.83			30.96**			64.50**
Error	54	108	3.27	3.72	3.50	8.21	8.57	8.39	1.75	2.02	1.89	1.28	1.31	1.29	2.27	1.76	2.01	6.88	5.67	6.28

Table (6): Cont.

Source of variation	d.f.		No. of grain/spike			Straw yield/plant (g)			Grain yield/plant (g)			Biological yield/plant (g)			Harvest index (%)		
	S	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
Season	-	1			67.22**			425347**			835.45**			1671.77**			1677.39**
Rep. x S	2	4	10.74	1.97	6.35	2.17	52.82	27.49	1.62	26.63	14.12	20..17	9.15	14.66	2.81	14.24	8.53
Genotype	27	27	188.43**	187.72**	301.24**	425.76**	555.62**	782.96**	108.85**	197.92**	255.68**	562.25**	1041.81**	1346.23**	75.55**	65.67**	107.68**
Parents	6	6	383.86**	142.77**	375.05**	581.50**	909.76**	1192.79**	129.23**	240.02**	325.72**	900.90**	1625.67**	2161.73**	86.32**	87.67**	138.47**
F_1	20	20	131.79**	184.47**	263.44**	362.53**	461.39**	647.97**	106.54**	177.71**	232.55**	441.88**	856.04**	1059.88**	75.48**	61.72**	103.83**
P. vs F_1	1	1	148.70**	522.40**	614.27**	755.84**	315.35**	1023.81**	32.83**	349.35**	298.18**	937.56**	1254.20**	2180.26**	12.36	13.35	0.01
Genotype x season	-	27			74.91**			198.41**			51.08**			257.83**			33.56**
Parent x season	-	6			151.58**			298.47**			43.53*			364.85**			35.52**
F_1 x season	-	20			52.82**			175.95**			51.70**			238.04**			33.37**
P. vs F_1x S	-	1			56.84**			47.38			84.00*			11.50			25.70*
Error	54	108	8.25	5.48	6.86	34.93	25.28	30.10	11.94	18.12	15.03	57.46	35.72	46.59	5.01	6.78	5.89

* and ** denote significant differences from zero at 0.05 and 0.01 levels of probability, respectively.
S_1, S_2 and C: first, second and the combined analysis, respectively.

Table (7): The genotype mean performance of season parents and their 5 crosses studied in F_1 generation in separate season as well as the combined analysis for all traits.

Genotypes	Flowering date (days)			Plant height (cm)			No. of spikelets/spike			Spike length (cm)			No. of spikes/plant			Seed index (g)		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
P_1	99.74	102.72	101.23	113.37	121.28	117.28	23.94	23.15	23.55	13.08	13.28	13.18	15.86	17.79	16.83	59.15	63.85	61.50
P_2	95.58	100.45	98.02	98.87	113.04	105.96	22.76	23.11	22.94	11.61	11.72	11.67	16.65	11.87	14.26	53.38	57.33	55.36
P_3	100.56	103.82	102.19	93.88	98.73	96.31	23.50	23.31	23.41	11.94	13.54	12.74	16.61	18.61	17.61	49.71	49.82	49.77
P_4	109.02	113.03	111.03	114.24	122.05	118.15	21.92	22.90	22.41	13.04	12.44	12.74	14.35	13.64	14.00	50.05	54.52	52.29
P_5	107.57	111.61	109.59	105.87	112.58	109.23	23.04	23.52	23.28	10.33	9.92	10.11	15.17	16.84	16.01	45.90	49.36	47.64
P_6	96.73	101.07	98.90	91.83	100.35	96.09	24.23	22.92	23.58	12.18	10.75	11.47	19.84	14.85	17.35	50.36	54.40	52.38
P_7	100.34	105.53	102.94	119.32	127.82	123.57	21.11	21.10	21.11	12.47	10.78	11.63	16.33	18.70	17.52	46.57	50.75	48.66
P. mean	101.36	105.46	103.41	105.34	113.69	109.51	22.93	22.86	22.90	12.08	11.78	11.93	16.40	16.04	16.22	50.73	54.29	52.51
1 x 2	101.81	103.03	102.42	121.85	124.51	123.18	23.09	23.39	23.24	11.94	11.33	11.64	20.50	12.04	16.27	64.64	65.91	65.28
1 x 3	103.34	104.00	103.67	116.17	120.26	118.22	23.89	24.23	24.06	13.04	13.46	13.25	15.37	13.27	14.32	57.20	58.52	57.86
1 x 4	103.64	104.57	104.11	116.62	126.14	121.38	24.33	24.05	24.19	13.73	12.72	13.23	14.53	10.53	12.53	68.87	68.73	68.80
1 x 5	102.07	104.00	103.04	120.92	121.87	121.40	23.19	23.69	23.44	11.98	11.51	11.75	18.76	10.60	14.68	58.69	59.70	59.20
1 x 6	103.04	103.18	103.11	109.40	113.98	111.69	23.31	23.04	23.18	13.33	13.44	13.39	19.41	22.67	21.04	68.14	68.43	68.29
1 x 7	103.57	107.00	105.29	118.94	127.73	123.34	22.19	22.69	22.44	13.69	11.66	12.68	16.71	11.68	14.20	55.90	57.43	56.67
2 x 3	101.70	102.88	102.29	117.97	113.90	115.94	24.76	22.32	23.54	12.79	10.16	11.48	16.73	13.58	15.16	51.21	52.12	51.67
2 x 4	104.60	104.43	104.52	123.76	128.80	126.28	24.57	23.12	23.85	13.91	12.96	13.44	17.23	17.51	17.37	65.21	65.57	65.39
2 x 5	98.17	100.03	99.10	110.73	119.50	115.12	24.30	23.63	23.97	10.33	10.89	10.61	14.61	12.11	13.36	60.85	61.64	61.25
2 x 6	86.57	90.52	88.55	104.48	114.95	109.72	22.27	20.28	21.28	14.19	13.44	13.82	17.51	17.85	17.68	60.04	60.20	60.12
2 x 7	107.11	107.89	107.50	120.59	129.25	124.92	22.77	20.55	21.66	12.93	11.43	12.18	16.68	14.19	15.44	58.25	59.37	58.81
3 x 4	101.13	103.73	102.43	109.32	117.14	113.23	25.22	25.13	25.18	13.36	12.94	13.15	16.42	14.43	15.43	51.69	52.77	52.23
3 x 5	103.54	105.86	104.70	96.74	111.43	104.09	23.92	24.01	23.97	13.21	12.28	12.75	14.07	12.76	13.42	49.98	52.08	51.03
3 x 6	101.36	104.00	102.68	99.92	98.83	99.38	23.04	23.39	23.22	13.82	11.71	12.77	19.68	14.48	17.08	45.76	46.10	45.93
3 x 7	106.68	109.48	108.08	105.92	118.85	112.39	23.02	23.00	23.01	13.17	12.11	12.64	21.42	13.31	17.37	51.67	51.83	51.75
4 x 5	108.13	110.00	109.07	108.25	119.53	113.89	24.53	23.73	24.13	13.08	11.27	12.18	17.32	12.97	15.15	56.41	57.47	56.94
4 x 6	99.14	103.22	101.18	103.95	115.24	109.60	23.19	23.82	23.51	14.30	12.75	13.53	18.22	13.45	15.84	60.27	59.68	59.98
4 x 7	105.88	107.93	106.91	116.42	124.32	120.37	24.00	23.68	23.84	13.43	12.20	12.82	16.06	12.87	14.47	58.44	59.03	58.74
5 x 6	102.27	103.76	103.02	106.91	105.41	106.16	23.90	24.10	24.00	12.38	13.44	12.91	22.35	21.54	21.95	50.22	51.22	50.72
5 x 7	99.84	102.76	101.30	116.16	117.19	116.68	24.00	23.84	23.92	12.53	12.32	12.43	17.58	14.13	15.86	56.77	57.29	57.03
6 x 7	100.52	103.00	101.76	104.32	108.79	106.56	24.15	23.82	23.99	12.95	13.26	13.11	16.56	15.17	15.87	50.11	49.92	50.02
Cross mean	102.10	104.06	103.08	111.87	117.98	114.93	23.70	23.31	23.51	13.05	12.25	12.66	17.51	14.34	15.93	57.16	57.86	57.51
Mean (X)	101.92^b	104.41^a	103.17	110.34^b	116.91^a	113.63	23.51^a	23.20^a	23.36	12.81^a	12.13^b	12.47	17.23^a	14.56^b	15.90	55.55^b	56.97^a	56.26
L.S.D. 5%	2.95	3.15	2.16	4.68	4.78	3.34	N.S.	2.32	1.59	1.85	1.87	1.31	2.46	2.16	1.64	4.29	3.89	2.89
L.S.D. 1%	3.93	4.19	2.87	6.22	6.36	4.45	N.S.	3.09	2.11	2.46	2.48	1.74	3.27	2.88	2.18	5.70	5.17	3.85

Table (7): Cont.

	No. of grains/spike			Straw yield/plant (g)			Grains yield/plant (g)			Biological yield/plant (g)			Harvest index (%)		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
P_1	50.30	59.45	54.88	94.32	95.79	95.01	39.36	49.16	44.26	139.68	144.94	142.31	28.18	33.90	31.04
P_2	68.93	5189	60.41	70.77	69.59	70.18	38.59	36.11	37.35	109.36	105.70	107.53	35.35	34.16	34.76
P_3	69.30	57.43	63.37	53.51	53.66	53.59	36.63	47.68	42.16	90.14	101.35	95.75	40.59	47.05	43.82
P_4	64.76	65.60	65.18	81.10	89.60	85.35	48.00	47.89	47.95	129.10	137.50	133.30	37.19	34.84	36.02
P_5	79.28	68.97	74.13	82.36	68.95	75.66	47.17	54.46	50.82	129.53	123.41	126.47	36.41	44.16	40.29
P_6	50.90	49.56	50.23	75.35	47.78	61.57	30.14	30.88	30.51	105.49	78.66	92.08	28.57	39.30	33.94
P_7	51.98	59.59	55.79	92.53	67.00	79.77	33.87	34.60	34.24	126.40	100.58	113.49	26.82	34.44	30.61
P. mean	62.21	58.93	69.50	78.56	70.34	74.45	39.11	42.97	41.04	118.53	113.16	115.85	33.30	38.26	57.78
1 x 2	57.04	54.26	55.65	100.47	62.60	81.54	38.84	42.06	40.45	139.30	105.00	122.15	27.91	40.10	34.01
1 x 3	70.25	71.02	70.64	90.61	73.29	81.95	40.19	49.23	44.71	130.80	123.38	127.09	30.72	39.94	35.33
1 x 4	52.04	48.01	50..03	88.21	67.05	77.63	29.67	37.79	33.73	118.13	104.84	111.49	25.32	36.08	30.70
1 x 5	59.25	59.47	59.36	77.62	61.49	69.56	34.47	3458	34.53	112.09	94.85	102.47	30.77	36.48	33.63
1 x 6	70.82	57.28	64.05	100.44	92.80	96.62	47.46	62.49	54.98	148.24	155.29	151.77	32.26	40.34	36.30
1 x 7	64.09	64.05	64.07	84.60	79.68	82.14	38.00	41.04	39.52	122.59	120.24	121.42	31.01	34.14	32.58
2 x 3	68.91	69.45	69.18	76.75	66.00	71.38	38.12	42.03	40.08	114.87	104.70	109.79	33.16	40.15	36.66
2 x 4	67.70	67.11	67.45	101.49	105.01	103.25	43.12	56.37	49.75	144.61	161.37	152.99	29.80	35.00	30.90
2 x 5	79.35	76.34	77.85	80.68	77.14	78.91	36.20	45.21	40.71	116.88	122.35	119.62	31.05	36.92	33.99
2 x 6	55.49	54.64	55.07	73.50	81.33	77.42	39.71	49.48	44.60	113.21	129.14	121.18	35.23	38.32	36.78
2 x 7	62.44	60.70	61.57	84.86	78.73	81.80	38.40	42.38	40.39	123.26	121.11	122.19	31.27	34.99	33.13
3 x 4	73.91	72.82	73.37	89.96	97.05	93.48	38.61	46.76	4269	128.57	143.82	136.20	30.04	32.52	31.28
3 x 5	71.04	76.10	73.57	78.42	64.39	71.41	42.81	49.88	46.35	121.23	114.27	117.75	35.45	43.65	39.55
3 x 6	56.08	71.60	63.84	63.88	59.48	61.68	36.15	50.04	43.10	100.04	106.19	103.12	36.13	47.13	41.63
3 x 7	69.22	61.28	65.25	87.10	70.18	78.64	40.44	38.14	39.29	127.20	108.32	117.76	31.75	35.24	33.50
4 x 5	64.63	60.77	62.70	101.49	85.88	93.69	41.48	46.75	44.12	143.96	132.96	138.46	28.92	35.15	32.04
4 x 6	66.77	72.36	69.57	88.50	77.44	82.97	41.86	56.04	48.95	13035	133.48	131.92	32.04	41.96	37.00
4 x 7	62.97	61.77	62.37	93.73	75.72	84.73	38.63	45.49	42.06	132.36	121.20	126.78	29.20	37.54	33.37
5 x 6	67.67	62.41	62.04	81.24	69.21	75.23	53.52	64.15	58.84	137.76	130.03	133.90	38.85	49.57	44.21
5 x 7	65.56	74.27	69.92	88.06	63.81	75.94	37.59	52.43	45.01	125.65	116.25	120.95	29.92	45.18	37.55
6 x 7	65.67	62.74	64.21	63.68	62.79	63.24	56.34	48.90	52.62	120.02	115.02	117.52	30.47	42.50	46.22
Crosses mean	65.28	64.69	64.85	85.49	74.81	81.58	40.55	47.68	44.12	126.24	122.09	124.12	32.41	39.19	35.73
Mean (X)	64.51[a]	63.25[b]	63.88	83.76[a]	73.69[b]	78.73	40.19[b]	46.50[a]	43.35	124.32[a]	119.86[b]	122.09	32.64[b]	38.96[a]	35.80
L.S.D. 5%	4.69	3.82	3.02	9.65	8.21	6.34	5.64	6.95	4.48	12.38	9.76	7.88	3.66	4.25	2.80
L.S.D. 1%	624	5.08	4.02	12.84	10.92	8.42	7.51	9.24	5.95	16.46	12.98	10.48	4.86	5.65	3.73

between these hybrids. Significant mean squares due to interaction between crosses and seasons were obtained for all traits except for, flowering date, number of spikelets/spike, spike length, number of spike/plant and seed index. Such results indicated that these hybrids varied in their response to environmental fluctuations.

The mean performances of the tested parents and their hybrids for all studied traits in each season as well as their combined analysis over both seasons are presented in Table (7).

Concerning parents mean performance, results indicated that, parent P_1 (Gemmeiza 3) recorded the best values for seed index, straw yield and biological. Also, it ranked the third for plant height, grain yield/plant and the second for number of spikelets/spike.

Parent P_1 (Gemmeiza 3) and P_3 (Line 8) recorded the best values for, flowering date, and harvest index, respectively. Meanwhile, the parent P_3 (Line 8) ranked the third one over the tested parents for; straw, and grain yield/plant. The parent P_5 (line 59) had the highest number of grains/spike and grain yield/plant and it ranked the third over the parents for biological yield and fourth for straw yield/plant and the second for harvest index, while, P_6 (Sakha 93) and P_7 (Giza 168) had the best values for number of spikelets/spike and number of spikes/plant, respectively.

Regarding crosses mean performance, it is clear that, the cross P_2xP_6 (Line 5 x Sakha 93) was the earliest among the studied crosses, since it expressed the lowest mean value for flowering date being 86.57, 90.52 and 88.55 in the first, second season as well as the combined analysis, respectively.

For Plant height, the cross P_3xP_6 (Line 8 x Sakha 93) in both seasons as well as the combined analysis had the shorter plant height among the studied crosses. However, the cross P_2xP_4 (Line 5 x Gemmeiza 9) (Line 5 x Gemmeiza 9) had the highest mean values 123.76, 128.80 and 126.28 at the first, second season as well as the combined analysis, respectively, followed by crosses P_2xP_7 (Line 5 x Giza 168), P_1xP_2 (Gemmeiza 9 x Line 5) and P_1xP_7 (Gemmeiza 3 x Giza 168).

For number of spiklets/spike, the cross P_3xP_4 (Line 8 x Gemmeiza 9) gave the highest mean values in the combined analyses (25.18), follwed by crosses P_1xP_3 (Gemmeiza 3 x Line 8), P_1xP_4 (Gemmeiza 3 x Gemmeiza 9), P_2xP_4 (Line 5 x Gemmeiza 9), P_2xP_5 (Line 5 x Line 59), P_3xP_5 (Line 8 x Line 59), P_4xP_5 (Gemmeiza 9 x Line 59), P_4xP_7 (Gemmeiza 9 x Giza 168), P_5xP_6 (Line 59 x Sakha 93), P_5xP_7 (Line 59 x Giza 168) and P_6xP_7 (Sakha 93 x Giza 168) with no significant differences between each of them.

In the combined analysis, the spike length was ranged from 10.61 by cross P_2xP_5 (Line 5 x Line 59) to 13.82 by cross P_2xP_6 (Line 5 x Sakha 93). The highest mean values were obtained by crosses P_2xP_6 (Line 5 x Sakha 93), P_1xP_3 (Gemmeiza 3 x Line 8), P_1xP_4 (Gemmeiza 3 x Gemmeiza 9), P_1xP_6 (Gemmeiza 3 x Sakha 93), P_1xP_7 (Gemmeiza 3 x Giza 168), P_2xP_4 (Line 5 x Gemmeiza 9), P_2xP_5 (Line 5 x Line 59), P_3xP_5 (Line 8 x Line 59), P_4xP_5 (Gemmeiza 9 x Line 59), P_4xP_7 (Gemmeiza 9 x Giza 168), P_5xP_6 (Line 59 x Sakha 93), P_5xP_7

(Line 59 x Giza 168) and P_6xP_7 (Sakha 93 x Giza 168) with no significant between them at 5% of significant.

For number of spikes/plant, the two crosses P_5xP_6 (Line 59 x Sakha 93) followed by cross P_1xP_6 (Gemmeiza 3 x Sakha 93) in the combined analysis, had the highest mean values. However, the cross P_1xP_4 (Gemmeiza 3 x Gemmeiza 9) had the lowest one.

For seed index, the two crosses P_1xP_4 (Gemmeiza 3 x Gemmeiza 9) and P_1xP_6 (Gemmeiza 3 x Sakha 93) in the combined analysis exhibited the heavier seeds (68.80 and 68.29, respectively). However, the cross $P_{3x}P_6$ (Line 8 x Sakha 93) gave the lowest one for this trait.

In the combined analysis, number of grains/spike ranged from 77.85 by cross P_2xP_5 (Line 5 x Line 59) to 50.03 by cross P_1xP_4 (Gemmeiza 3 x Gemmeiza 9). The highest mean value was recorded by cross P_2xP_5 (Line 5 x Line 59) followed by cross P_3xP_5 (Line 8 x Line 59) and P_3xP_4 (Line 8 x Gemmeiza 9).

The cross P_6xP_7 (Sakha 93 x Giza 168) followed by cross P_5xP_6 (Line 59 x Sakha 93) had the highest values of harvest index in the combined analysis. However, the crosses P_1xP_4 (Gemmeiza 3 x Gemmeiza 9), P_1xP_7 (Gemmeiza 3 x Giza 168), P_2xP_4 (Line 5 x Gemmeiza 9), P_2xP_7, P_3xP_4 (Line 8 x Gemmeiza 9), P_3xP_7, P_4xP_5 (Gemmeiza 9 x Line 59) and P_4xP_7 (Gemmeiza 9 x Giza 168) exhibited low harvest index over two seasons.

The four crosses P_2xP_4 (Line 5 x Gemmeiza 9), P_1xP_6 (Gemmeiza 3 x Sakha 93), P_4xP_5 (Gemmeiza 9 x Line 59) and

P_3xP_4 (Line 8 x Gemmeiza 9) had the highest straw and biological yields/plant in the combined analysis. The mean values for the previous crosses were: 103.25, 161.37 and 96.62, 151.77, and 93.69, 138.46 and 93.48, 136.20, respectively.

The two crosses P_5xP_6 (Line 59 x Sakha 93) (58.84 g) and P_1xP_6 (Gemmeiza 3 x Sakha 93) (54.98 g) had the highest grain yield/plant in the combined analysis with no significance between them, followed by cross P_6xP_7 (Sakha 93 x Giza 168). The high grain per plant in cross P_5xP_6 (Line 59 x Sakha 93) may be attributed to high number of spikes/plant and harvest index while, the high grain yield/plant of the cross P_1xP_6 (Gemmeiza 3 x Sakha 93) may be attributed to high number of spikes/plant, seed index, straw and biological yield. Also, the high grain yield/plant of the cross P_6xP_7 (Sakha 93 x Giza 168) may be attributed to high harvest index. It could be concluded that, these crosses would be efficient and prospective in wheat breeding programs for improving grain yield/plant.

Heterosis:

Mean squares for parent vs. crosses as an indication to average heterosis overall crosses was appreciable magnitude in both seasons as well as in their combined analysis for all the studied traits, except; harvest index in both seasons as well as the combined analysis, number of spikeltes/spike and spike length in the second season, flowering date in the first season and in the combined analysis and number of spikes/plant in the combined analysis (Table 6). F_1 mean were significantly higher than parental means for all the studied traits.

Significant interaction between parents vs crosses and seasons was detected for all traits, except for, number of spikelets/spike, spike length, straw and biological yields, indicating that, the heterotic effects were affected by seasonal changes. For the exceptional traits, insignificant interaction between parent vs crosses and seasons was detected. This result 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-parent and better parent average values for all the studied traits at both seasons and average over the two seasons, are presented in Table (8).

For heading date five, seven and seven crosses expressed significant negative heterotic effects relatives to mid-parent values at first, second seasons as well as the combined analysis, respectively. While, the cross P_2xP_6 (Line 5 x Sakha 93) gave significant negative heterotic effects relative to either better parent and mid-parent in both seasons as well as the combined analysis. Significant negative heterotic effects for earliness was previously reported by **Fonseca and Patterson (1968), El-Shamarka (1980), Karrar (1980), Hendawy (1990), Darwish (1992) and Hendawy (1994)**. However, little or no heterotic effects for earliness were previously found by **Mani and Rao (1975) and Mekhamer (1995)**, while, the highest heterotic effect were found by **Tamam and Abdel-Gawad (1999), Abdel-Wahed (2001), Ghanem (2001), Abdel-Hameed (2002) and Darwish and Ashoush (2003)**.

Table (8): Percentage of heterosis over both mid-parent and better parent for the studied traits.

Cross	Flowering date days						Plant height (cm)					
	H.M.P.			H.B.P.			H.M.P.			H.B.P.		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
1x2	4.25**	1.42	2.80**	6.51**	2.57	4.49**	14.82**	6.27**	10.34**	23.24**	10.15**	16.26**
1x3	3.19*	0.70	1.93*	3.61*	1.24	2.41*	12.10**	9.33**	10.67**	23.74**	21.81**	22.75**
1x4	-0.71	-3.07*	-1.91*	3.91*	1.79	2.84**	2.48**	3.68*	3.10*	2.87**	4.01*	3.46*
1x5	-1.53	-2.95*	-2.25*	2.34	1.24	1.78	10.31**	4.23*	7.17**	14.22**	8.26**	11.15**
1x6	4.89**	1.26	3.04**	6.52**	2.09	4.26**	6.62**	2.85	4.67**	19.13**	13.58**	16.23**
1x7	3.53**	2.76	3.14**	3.84*	4.16**	4.00**	2.23**	2.56	2.40*	4.92**	5.32**	5.13**
2x3	3.70**	0.72	2.18*	6.40**	2.42	4.36**	22.40**	7.57**	14.64**	25.65**	15.37**	20.38**
2x4	2.25	-2.16	0.00	9.44**	3.97*	6.63**	16.15**	9.58**	12.70**	25.18**	13.95**	19.19**
2x5	-3.35*	-5.65**	-4.53**	2.71	-0.41	1.11	8.17**	5.93**	7.00**	12.00**	6.15**	8.65**
2x6	-9.97**	-10.17**	-10.07**	-9.43**	-9.89**	-9.66**	9.58**	7.74**	8.61**	13.77**	14.55**	14.18**
2x7	9.34**	4.76**	6.99**	12.06**	7.41**	9.68**	10.53**	7.32**	8.85**	21.97**	14.34**	17.90**
3x4	-3.50**	-4.33**	-3.92**	0.56	-0.09	0.23	5.05**	6.11**	5.60**	16.44**	18.65**	17.57**
3x5	-0.51	-1.72	-1.12	2.96*	1.96	2.45*	-3.314**	5.47**	1.29	3.04*	12.87**	8.08**
3x6	2.76*	1.52	2.12*	4.79**	2.90	3.82**	7.60**	-0.71	3.30*	8.81**	0.11	3.42
3x7	6.20**	4.59**	5.38**	6.32**	5.45**	5.76**	-0.64	4.92*	2.22	12.82**	20.39**	16.70**
4x5	-0.15	-2.07	-1.12	0.53	-1.44	-0.47	-1.64	1.89	0.18	2.25*	6.17**	4.27**
4x6	-3.63**	-3.58**	-3.61**	2.49	2.12	2.31*	0.89	3.63	2.31	13.20**	14.83**	14.05**
4x7	1.14	-1.24	-0.07	5.52**	2.27	3.86**	-0.31	-0.49	-0.41	1.91*	1.86	1.88
5x6	0.12	-2.43	-1.18	5.73**	2.66	4.16**	11.18**	-0.99	4.87**	19.68**	5.04*	12.03**
5x7	-3.96**	-5.35**	-4.67**	-0.50	-2.63	-1.59	3.16**	-2.51	0.24	9.72**	4.09	6.82**
6x7	2.02	-0.29	0.83	3.92*	1.91	2.89**	-1.28	-4.64*	-3.03*	13.50**	8.41**	10.84**

* and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.
S_1, S_2 and C: First, second and combined analysis, respectively. MP and BP mid better, respectively.

Table (8): Cont.

Cross	No. of spikelets/spike						Spike length (cm)					
	H.M.P.			H.B.P.			H.M.P.			H.B.P.		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
1x2	-1.11	1.12	0.00	-3.55**	1.04	-1.30	-3.28	-9.39	-6.35	-8.72	-4.73	-11.75*
1x3	0.72	4.29	2.48	-0.21	3.93	2.18	4.20	0.40	2.23	-0.33	-0.54	0.52
1x4	6.12**	4.44	5.28	1.64	3.89	2.75	5.12	-1.10	2.03	4.94	-4.24	0.32
1x5	-1.27	1.54	0.13	-3.13*	0.74	-0.44	2.35	-0.80	0.78	-8.41	-13.38	-10.91*
1x6	-3.21**	0.01	-1.63	-3.80**	-0.49	-1.70	5.55	11.83	8.62	1.94	1.15	1.54
1x7	-1.49	2.54	0.51	-7.31**	-2.00	-4.70	7.18	-3.09	2.20	4.66	-12.22	-3.84
2x3	-7.04**	-3.84	1.59	5.35**	-4.25	0.57	8.60	-19.56**	-5.97	7.09	-24.97**	-9.94
2x4	9.98**	0.49	5.16	7.95**	0.03	3.96	12.85	7.27	10.09*	6.67	4.15	5.44
2x5	6.14**	1.34	3.72	5.50**	0.47	2.96	-5.83	0.71	-2.59	-11.02	-7.03	-9.02
2x6	-5.21**	-11.90**	-8.52	-8.10**	-12.27*	-9.76**	19.28**	19.69**	19.48**	16.47*	14.74	18.46**
2x7	3.83**	-7.04	-1.63	0.07	-11.09*	-5.55	7.43	1.64	4.64	3.74	-2.42	4.46
3x4	11.04**	8.76	9.89**	7.30**	7.81	7.56*	6.97	-0.40	3.21	2.48	-4.43	3.21
3x5	2.81*	2.54	2.68	1.80	2.08	2.40	18.59*	4.72	11.47*	10.58	-9.28	0.03
3x6	-3.45**	1.21	-1.16	-4.91**	0.36	-1.51	14.53*	-3.56	5.46	13.41	-13.49	0.18
3x7	3.22**	3.57	3.39	-2.03	-1.34	-1.69	7.88	-0.42	3.74	5.61	-10.56	-0.81
4x5	9.11**	2.22	5.61	6.47**	0.88	3.64	11.95	0.79	6.50	0.33	-9.43	-4.44
4x6	0.51	3.97	2.23	-4.29**	3.94	-0.29	13.40*	9.95	11.75*	9.69	2.47	6.16
4x7	11.55**	7.63	9.57**	9.49**	3.39	6.37	5.35	5.11	5.23	3.04	-1.90	0.63
5x6	1.11	3.81	2.45	-1.39	2.48	1.80	9.98	30.12**	19.62**	1.61	25.09**	12.62*
5x7	8.73**	6.87	7.80*	4.18**	1.37	2.76	9.93	19.05*	14.27**	0.51	14.29	6.90
6x7	6.52**	8.25	7.37*	-0.34	3.96	1.75	5.10	23.23**	13.55**	3.90	23.04*	12.78*

* and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.

S_1, S_2 and C: First, second and combined analysis, respectively. MP and BP mid better, respectively.

Table (8): Cont.

Cross	No. of spikes/plant						Seed index (g)					
	H.M.P.			H.B.P.			H.M.P.			H.B.P.		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
1x2	26.10**	-18.83**	4.67	23.12**	-32.33**	-3.31	14.89**	8.78**	11.72**	9.29*	3.23	6.14**
1x3	-5.33	-27.11**	-16.84**	-7.45	-28.72**	-18.69**	5.09	2.96	4.00	-3.30	-8.35**	-5.92*
1x4	-3.81	-32.97**	-18.67**	-8.38	-40.78**	-25.51**	26.14**	16.14**	20.94**	16.44**	7.65*	11.88**
1x5	20.94**	-38.76**	-10.54*	18.28*	-40.39**	-12.73**	11.74**	5.45	8.48**	-0.77	-6.50*	-3.75
1x6	8.74	38.92**	23.15**	-2.17	27.46**	21.30**	24.45**	15.74**	19.93**	15.20**	7.18*	11.04**
1x7	3.82	-23.85**	-9.68*	2.33	-34.31**	-15.61**	5.75	0.23	2.88	-5.50	-10.05**	-7.86**
2x3	0.63	-10.90	-4.88	0.50	-27.04**	-13.93**	-0.65	-2.72	-1..71	-4.07	-9.10*	-6.67*
2x4	11.15	37.25**	22.93**	3.48	28.35**	21.80**	26.10**	17.24**	21.50**	22.18**	14.36**	18.13**
2x5	-8.16	-15.64*	-11.71*	-12.25	-28.09**	-16.52**	22.58**	15.52**	18.92**	14.00**	7.51*	10.64**
2x6	-4.02	33.63**	11.90**	-11.74	20.22**	1.94	15.75**	7.76*	11.60**	12.48**	5.00	8.61**
2x7	1.12	14.60	6.90	0.16	10.03	5.60	16.56**	9.85**	13.08**	9.12*	3.55	6.24*
3x4	6.09	-10.52	-2.38	-1.10	-22.47**	-12.40**	3.63	1.15	2.36	3.27	-3.21	-0.11
3x5	-11.44	-28.00**	-20.17**	-15.27	-31.43**	-23.81**	4.56	5.01	4.79	0.56	4.55	2.56
3x6	7.97	-13.48*	-2.30	-0.84	-22.22**	-3.03	-8.54*	-11.53**	-10.07**	-9.13*	-15.26**	-12.31**
3x7	30.03**	-15.51*	7.77	28.96**	-28.47**	-1.39	7.34	3.08	5.16*	3.95	2.13	4.00
4x5	17.37*	-14.90*	0.98	14.22	-22.98**	-5.35	17.57**	10.62**	13.96**	12.69**	5.41	8.90**
4x6	6.58	-5.56	1.06	-8.16	-9.41	-8.70	20.04**	9.59**	14.60**	19.67**	9.48*	14.50**
4x7	4.65	-3.04	1.08	-1.69	-5.67	-1.06	20.96**	12.16**	16.37**	16.67**	8.28*	12.34**
5x6	27.68**	35.96**	31.61**	12.63	27.93**	26.52**	4.33	-1.30	1..41	-0..28	-5.85	3.18
5x7	11.64	-4.98	3.57	7.65	-16.09*	-0.92	22.78**	14.43**	18.44**	21.90**	12.89**	17.20**
6x7	-8.43	9.33	-0.72	-16.53*	2.15	-8.53	3.39	-5.06	-1.00	-0.50	-8.24*	-4.52

* and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.
S_1, S_2 and C: First, second and combined analysis, respectively. MP and BP mid better, respectively.

Table (8): Cont.

Cross	No. of grains/spike						Straw yield/plant (g)					
	H.M.P.			H.B.P.			H.M.P.			H.B.P.		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
1x2	-4.32	-2.54	-3.46	-17.25**	-8.73**	-7.88**	21.71**	-24.29**	-1.31	6.52	-34.64**	-14.22**
1x3	17.47*	21.53**	19.47**	1.37	19.47**	11.47**	22.59**	-1.92	1027**	-3.93	-23.49**	-13.79**
1x4	-9.54*	-23.21**	-16.66**	-19.64**	-26.81**	-23.25**	0.57	-27.67**	-13.94**	-6.48	-30.00**	-18.33**
1x5	-8.55*	-7.38**	-7.97**	-25.26**	-13.77**	-19.92**	-12.14*	-25.35**	-18.51**	-17.71**	-35.81**	-26.83**
1x6	39.95*	5.09	21.87**	39.14**	-3.65	16.71**	18.40**	29.28**	23.39**	6.49	-3.11	1.65
1x7	25.32*	7.60**	15.79**	23.30**	7.47*	14.84**	-9.45*	-2.11	-6.03	-10.31	16.82**	13.59**
2x3	-0.30	27.04**	11.77**	-0.57	20.92**	9.17**	23.51**	7.10	15.34**	8.45	-5.16	1.70
2x4	1.28	14.23**	7.34**	-1.78	2.29	3.41	33.66**	31.92**	32.77**	25.15**	17.19**	20.97**
2x5	7.08*	26.33**	15.72**	0.09	10.69**	5.02*	5.38	11.36*	8.22*	-2.04	10.85	4.30
2x6	-7.38*	7.71*	-0.46	-19.50**	5.29	-8.85**	0.60	38.58**	17.52**	-2.45	16.87**	10.31*
2x7	3.28	8.89**	5.97**	-9.41**	1.85	1.91	3.93	15.28**	9.10*	-8.30	13.14*	2.54
3x4	10.26*	18.38**	14.14**	6.65	11.01**	12.55**	33.67**	35.49**	34.61**	10.93	8..31	9.56*
3x5	-4.38	20.41**	7.02**	-10.40**	10.34**	-0.75	15.43*	5.04	10.50*	-4.78	-6.61	-5.62
3x6	-6.68	33.83**	12.40**	-19.07**	24.66**	0.75	-0.85	17.28*	7.14	-15..21*	10.85	0.19
3x7	14.15*	4.73	9.52**	-0.12	2.83	2.97	19.28**	16.33**	17.95**	-5.87	4.75	-1.41
4x5	10.26*	-9.68**	-9.98**	-18.47**	-11.88**	-15.41**	24.18**	8.33	16.37**	23.23**	-4.16	9.76**
4x6	15.46*	25.66**	20.55**	3.10	10.29**	6.72**	13.14*	12.73*	12.95**	9.12	-13.58**	-2.79
4x7	7.87*	-1.32	3.12	-2.77	-5.84	-4.32	7.97	-3.30	2.62	1.30	-15.50**	-0.73
5x6	3.97	5.31	4.61*	-14.64**	-9.51**	-12.25**	3.03	18.59**	9.65*	-1.35	0.38	-0.56
5x7	-0.11	15.54**	7.63**	-17.31**	7.69**	-5.68**	0.70	-6.12	-2.28	-4.83	-7.45	-4.80
6x7	27.66*	14.96**	21.12**	26.32**	5.28	15.08**	-24.14**	9.41	-10.52**	-31.18**	-6.29	-20.73**

* and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.
S_1, S_2 and C: First, second and combined analysis, respectively. MP and BP mid better, respectively.

Table (8): Cont.

Cross	Grain yield/plant (g)						Biological yield/plant (g)					
	H.M.P.			H.B.P.			H.M.P.			H.B.P.		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
1x2	-0.34	-1.34	-0.86	-1.30	-14.43	-8.59	11.87**	-16.21**	-2.22	-0.27	-27.56**	-14.17**
1x3	5.77	1.68	3.48	2.11	0.15	1.02	13.83**	0.19	6.77*	-6.36	-14.88**	-10.70**
1x4	-32.08**	-22.12**	-26.84**	-38.19**	-23.12**	-29.65**	-12.10**	-25.76**	-19.10**	-15.42**	-27.67**	-21.66**
1x5	-20.32**	-33.26**	-27.37**	-26.92**	-36.51**	-32.06**	-16.73**	-29.31**	-23.01**	-19.75**	-34.56**	-27.29**
1x6	36.59**	56.15**	47.06**	20.60**	27.12**	24.22**	20.93**	38.90**	29.50**	6.13	7.14*	6.64*
1x7	3.78	-1.99	0.70	-3.46	-16.51*	-10.70*	-7.85	-2.06	-5.07	-12.23**	-17.05**	-14.68**
2x3	1.35	0.33	0.81	-1.23	-11.84	-4.93	15.15**	1.14	8.01*	5.03	-0.95	2.09
2x4	-0.42	34.20**	16.63**	-10.17	17.69*	3.74	21.28**	32.71**	27.05**	12.01*	17.37**	14.77**
2x5	15.58**	-0.17	-7.66	-23.25**	-16.99*	-19.90**	-2.15	6.80	2.24	9.76	-0.86	-5.42
2x6	15.55*	47.72**	31.43**	2.89	37.03**	19.39**	5.39	40.10**	21.42**	3.52	22.18**	12.69**
2x7	6.00	19.86*	12.84*	-0.49	17.35	8.13	4.56	17.42**	10.56**	-2.48	14.58**	7.66*
3x4	-8.77	-2.14	-5.25	-19.57**	-2.36	-10.97*	17.29**	20.43**	18.92**	-0.41	4.60	2.17
3x5	2.16	-2.34	-0.31	-9.25	-8.42	-8.81*	10.37*	1.68	5.98	-6.41	-7.41	-6.90*
3x6	8.29	27.40**	18.62**	-1.31	4.96	2.23	2.27	17.98**	9.80**	-5.17	4.78	7.69
3x7	14.71*	-7.29	2.86	10.38	-20.00**	-6.80	17.49**	7.29	12.57**	0.64	6.88	3.77
4x5	-12.84*	-8.66	-10.67**	-13.59*	-14.17*	-13.20**	11.33**	1.92	6.60*	11.14*	-3.30	3.87
4x6	7.15	42.29**	24.79**	-12.78*	17.02*	2.10	11.13*	23.50**	17.06**	0.97	-2.92	-1.04
4x7	-5.64	10.28	2.35	-19.53**	-5.03	-1228**	3.61	1.82	2.75	2.53	-11.85**	-4.89
5x6	38.45**	50.34**	44.69**	13.45*	17.79**	15.78**	17.24**	28.70**	22.54**	6.36	5.36	5.87
5x7	-7.23	17.74*	5.85	-20.32**	-3.73	-11.43*	-1.81	3.79	0.81	-3.00	-5.81	-4.37
6x7	76.04**	49.36**	62.55**	66.36**	41.33**	53.71**	3.52	28.35**	14.34**	-5.05	14.36**	3.55

* and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.
S_1, S_2 and C: First, second and combined analysis, respectively. MP and BP mid better, respectively.

Table (8): Cont.

Cross	Harvest index					
	H.M.P.			H.B.P.		
	S_1	S_2	C	S_1	S_2	C
1x2	-12.14*	17.84**	3.37	-21.05**	17.38**	-2.16
1x3	-10.64*	-1.32	-5.60	-24.31**	-15.12**	-19.37**
1x4	-22.54**	4.99	-8.43*	-31.92**	3.57	-14.75**
1x5	-4.73	-6.52	-5.71	-15.50**	-17.39**	-16.54**
1x6	13.68*	10.21	11.73**	12.89	2.64	6.95
1x7	12.75*	-0.10	5.63	10.04	-0.89	4.95
2x3	-12.67**	-1.12	-6.70*	-18.31**	-14.66**	-16.35**
2x4	-17.84**	1.45	-8.43*	-19.87**	0.47	-10.03*
2x5	-13.45**	-5.72	-9.41**	-14.71**	-16.39**	-15.63**
2x6	10.23	4.33	7.08*	-0.33	-2.49	5.82
2x7	0.61	2.01	1.34	-11.52*	1.60	-4.67
3x4	-22.74**	-20.59**	-21.64**	-25.98**	-30.89**	-28.62**
3x5	-7.92	-4.30	-5.96*	-12.66**	-7.24	-9.75**
3x6	4.48	9.15*	7.07*	-10.99*	0.16	-5.01
3x7	-5.80	-13.51**	-10.02**	-21.78**	-25.10**	-23.56**
4x5	-21.41**	-11.02*	-16.03**	-22.23**	-20.41**	-20.48**
4x6	-2.56	13.20*	5.79	-13.85**	6.78	2.74
4x7	-8.76	8.36	0.14	-21.48**	7.74	-7.34
5x6	19.56**	18.78**	19.12**	6.69	12.24*	9.73**
5x7	-5.38	14.95**	5.89	-17.83**	2.30	-6.80
6x7	80.29**	15.27**	43.16**	74.77**	8.15	36.19**

*** and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.**
S_1, S_2 and C: First, second and combined analysis, respectively. MP and BP mid better, respectively.

Earliness if found in wheat is a favorable for escaping destructive injuries by stress conditions. Hence, it could be concluded that the previous cross is valuable in breeding for earliness.

For plant height, fifteen, twelve and fourteen crosses exhibited significant positive heterotic effects relative to mid-parent values at the first, second seasons and the combined analysis, respectively. The cross P_1xP_3 (Gemmeiza 3 x Line 8) (22.75%) and P_2xP_3 (Line 5 x Line 8) (20.38%) manifested high desirable heterosis relative to better parent in the combined analysis. Several investigators reported significant positive heterotic effects for plant height. Among those are **Moshref (1996), Ghanem (2001), Abdel-Wahed (2001), Abdel-Hameed (2002), Darwish and Ashoush (2003) and Ashoush (2006a)**.

For number of spikelets/spike, eleven, zero and four hybrids relative to mid-parent value and seven, zero and one relative to better parent exhibited significant positive heterotic effects at the first, second seasons and the combined analysis, respectively. The cross P_3xP_4 (Line 8 x Gemmeiza 9) had significant positive heterotic effects relative either mid-parent value and better parent value in the first season and the combined analysis. Significant positive heterotic effects for number of spikelets/spike were found by **Hendawy (1990), Darwish (1992), and Abdel-Wahed (2001)**. However, significant negative heterotic effects relative to mid- and/or better parent was reported by **Fonseca and Patterson (1968), Mitkees (1981), Deshpand and Nayeem (1999) and Abdel-Wahed (2001)**.

For spike length, four, four and seven crosses gave significant positive heterotic effects relative to mid-parent values in the first, second seasons and their combined analysis, respectively. Also, one, two and three from previous parent values had the same order. These three crosses i.e., P_2xP_6 (Line 5 x Sakha 93), P_5xP_6 (Line 59 x Sakha 93) and P_6xP_7 (Sakha 93 x Giza 168) expressed significant heterotic effects relative to either mid- and better parent values in the combined analysis. Significant positive heterotic effects were previously reported by **Karrar (1980), Mitkess (1981), Mosaad *et al.* (1990), Ghanem (2001) and Darwish and Ashoush (2003)**.

For number of spikes/plant, five, four and four crosses gave significant positive heterotic effects relative to mid-parent values at the first, second seasons as well as the combined analysis, respectively. Meanwhile, three, four and three crosses expressed significant positive heterotic effects relative to better parent. The three crosses P_1xP_6 (Gemmeiza 3 x Sakha 93), P_2xP_4 (Line 5 x Gemmeiza 9) and P_5xP_6 (Line 59 x Sakha 93) gave the highest values of heterotic effects for this trait in the combined analysis. Positive heterotic effects for number of spikes/plant was reached by **Mani and Rao (1975), Hendawy (1990), Darwish (1992), Tamam and Abdel-Gawad (1999), Abdel-Wahed (2001), Darwish and Ashoush (2003) and Ashoush (2006a)**.

For seed index, twelve, eleven and thirteen crosses had a significant positive heterotic effects relative to mid-parent and eleven, seven and eleven of these crosses exhibited significant positive heterotic effects relative to the better parent in the first, more of trait contributing yield. The heterotic magnitude, however, differed from season to another. This finding agreed with the general trend where the expression of heterosis for a complex trait could be explained on the basis of component interaction, as 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/plant. In most traits, the value of heterotic effects were affected from season to another. This finding coincided with that reached above for significant genotypes by season mean squares, Table (6). Significant positive heterotic effects to higher yielding parent or mid-parent values were also reached before by **Knott (1965), Brown *et al.* (1966), Bitzer (1972), Eisea (1976), Hamdy (1978), Sharma *et al.* (1986), Hendawy (1989), Hendawy (1990), Darwish (1992), Mekhamer (1995), Deshpand and Nayeem (1999), Tamam and Abdel-Gawad (1999), Abdel-Wahed (2001), Ghanem (2001), Abdel-Hameed (2002), Darwish and Ashoush (2003) and Ashoush (2006a)**.

For harvest index; four, sex and five crosses expressed significantly heterotic effects relative to mid-parent values in the first, second seasons as well as the combined analysis, respectively. On the other hand, the cross P_6xP_7 (Sakha 93 x Giza 168) in the first season, two crosses P_1xP_2 (Gemmeiza 3 x Line 5) and P_5xP_6 (Line 59 x Sakha 93) in the second season and two P_5xP_6 (Line 59 x Sakha 93) and P_6xP_7 (Sakha 93 x Giza 168) in the combined analysis exhibited significant positive heterotic effects relative to the better parent values. Significant positive heterotic effects for this trait were also noted before by **Hamdy (1978), Sharma *et al.* (1986), Hendawy (1990), Abdel-Wahed (2001) and Abdel-Hameed (2002).**

b- F_2-generation:

The results in Table (9) showed the analysis of variance for all the studied traits. Mean squares for; genetypes, F_2 crosses, parents and parent vs. F_2 crosses were significant for all the studied traits except P. vs. F_2 for;plant height, spike length, harvest index and grain yield/plant. The results in Table (10) showed that, the mean performance of F_2 with exception of; flowering date, number of spikelets/spike and number of grains/spike, non of the hybrids surpassed the high parents for all traits. For the exceptional traits, the cross P_1xP_4 (Gemmeiza 3 x Gemmeiza 9), for flowering date and cross P_4xP_5 (Gemmeiza 9 x Line 59) for number of spikletes/spike and number of grains/spike surpassed the better parent.

Remain heterosis:

The results in Table (11) showed the remain heterosis values relative to mid and better parent values for all the studied traits in the F_2-generation.

Two and two, eight and two, seven and two, two and one, seven and five, one and one, four and one, four and two, four and three, and three and two crosses exhibited significant desirable remain heterotic effects relative to either mid-parent values or better-parent values for heading date, spike length, number of

Table (9): Observed mean squares from analysis of variance for all traits studied for F_2-generation.

Source of variation	d.f.	Flowering date (days)	Plant height (cm)	No. of spikelets/ spike	Spike length (cm)	No. of spikes/plant	Seed index (g)	No. of grains/ spike	Straw yield/plant (g)	Grain yield/plant (g)	Biological yield/plant (g)	Harvest index (%)
Rep.	2	0.35	0.59	0.40	0.06	1.20	7.71	19.26	5.57	4.28	30.48	5.33
Genotype	27	47.53**	208.51**	1.88**	1.69**	20.28**	39.78**	161.36**	360.51**	127.77**	712.15**	42.29**
Parent	6	80.47**	365.52**	1.99**	5.25**	20.00**	112.34**	143.31**	909.54**	249.04**	1621.63**	62.75**
F_2 crosses	20	37.26**	171.82**	1.85**	0.68**	19.80**	18.61*	168.80**	195.15**	97.74**	462.45**	36.84**
P. v. F_2	1	55.23**	0.21	1.76*	0.40	31.43**	87.77**	120.97**	373.30**	0.76	249.15**	28.63
Error	54	4.21	10.15	0.30	0.12	0.80	10.94	10.94	35.27	7.12	82.76	10.81

* and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.

Table (10): Mean performance for all parents and crosses studied for F_2-generation.

	Flowering date (days)	Plant height (cm)	No. of spikelets/ spike	Spike length (cm)	No. of spikes/ plant	Seed index (g)	No. of grains/ spike	Straw yield/plant (g)	Grain yield/plant (g)	Biological yield/plant (g)	Harvest index (%)
P_1	102.72	121.28	23.15	13.28	17.79	63.85	57.12	95.79	49.16	144.94	3.90
P_2	100.45	131.10	23.05	11.72	11.77	63.33	51.84	69.59	36.11	105.70	34.16
P_3	103.16	98.71	23.31	13.29	18.51	49.82	57.43	53.67	47.68	101.35	43.63
P_4	113.03	122.05	22.90	12.44	13.64	54.52	65.60	89.60	47.89	137.33	36.36
P_5	112.27	112.58	23.52	9.92	16.84	49.38	68.97	68.95	54.46	123.41	44.16
P_6	101.07	100.35	23.25	10.75	14.85	54.40	49.56	47.78	30.88	78.66	39.30
P_7	105.53	127.82	21.10	10.78	12.90	50.75	58.26	67.00	33.58	100.58	33.53
1 x 2	111.32	115.69	22.54	11.26	15.53	53.15	47.50	76.76	43.37	117.91	36.82
1 x 3	108.28	110.46	23.51	12.11	11.13	50.95	52.68	63.81	33.52	97.33	34.46
1 x 4	96.81	102.85	21.98	11.77	13.50	53.62	54.81	54.33	42.10	96.43	43.74
1 x 5	110.25	122.91	22.28	11.87	13.42	54.82	57.90	65.03	38.58	103.62	37.38
1 x 6	106.81	117.48	23.23	11.93	12.39	57.62	66.70	59.71	39.69	99.40	40.13
1 x 7	103.92	122.07	23.06	12.55	13.58	55.40	58.54	68.39	41.12	109.50	37.55
2 x 3	108.92	117.65	23.40	11.61	13.78	53.62	65.40	63.78	38.57	102.35	36.70
2 x 4	110.76	118.36	23.22	11.61	14.14	54.78	58.20	73.47	132.30	132.30	33.03
2 x 5	106.47	119.92	24.01	11.62	13.83	51.78	63.93	62.98	108.68	108.68	42.23
2 x 6	105.61	101.71	22.75	12.26	24.22	51.25	63.15	87.27	145.19	145.19	40.03
2 x 7	105.84	125.57	23.21	11.60	12.93	56.63	61.82	62.75	98.97	98.97	37.36
3 x 4	113.33	117.42	22.87	12.09	11.22	54.83	52.91	65.36	106.78	106.78	36.09
3 x 5	107.46	111.34	22.92	11.82	12.96	52.55	63.97	69.04	112.50	112.50	38.67
3 x 6	105.70	111.57	22.37	11.66	13.63	50.50	58.93	66.37	105.10	105.10	33.77
3 x 7	108.65	100.16	22.98	11.77	13.32	51.80	66.71	71.52	48.41	120.78	40.15
4 x 5	106.50	107.69	25.46	12.70	13.32	51.73	84.64	64.00	53.06	115.17	46.08
4 x 6	108.36	108.01	23.96	13.01	13.02	55.98	61.43	47.22	41.92	95.90	44.46
4 x 7	111.91	125.24	23.52	12.46	12.69	51.37	61.80	61.82	42.91	104.73	40.97
5 x 6	103.35	109.28	22.68	11.37	13.84	53.08	64.65	62.62	43.17	105.78	40.79
5 x 7	107.59	113.63	23.41	11.54	13.65	60.47	64.91	59.89	41.10	97.65	42.12
6 x 7	106.20	106.27	23.64	11.23	13.13	54.33	54.11	68.79	47.51	116.30	40.93
Mean (X)	106.87	113.61	23.15	11.86	14.13	54.15	60.48	66.69	42.66	110.16	38.88
L.S.D. 5%	3.35	5.20	0.90	0.57	1.46	4.87	5.40	9.70	4.36	14.86	5.37
L.S.D. 1%	4.46	6.92	1.20	0.75	1.94	6.47	7.19	12.90	5.80	19.76	7.14

* and ** significant at 0.05 and 001 levels of probability, respectively.

Table (11): Percentage of remain heterosis from either mid-parent or better parent for F_2 crosses.

Cross	Flowering date (days)		Plant height (cm)		No. of spikelets/spike		Spike length (cm)		No. of spikes/plant		Seed index (g)	
	HMP	HBP	HMP	HBP	HMP	HBP	HMP	HBP	HMP	HBP	HMP	HBP
1x2	9.58**	10.82**	9.58**	10.82**	-2.43	-2.65	-9.95**	-15.26**	5.10	-12.69**	-16.42**	-16.76**
1x3	5.18**	5.41**	5.18**	5.41**	1.22	0.87	-8.87**	-8.88**	-38.68**	-39.88**	-10.35**	-20.20**
1x4	-10.26**	-5.75**	-10.26**	-5.75**	-4.55*	-5.05*	-8.49**	-11.39**	-14.06**	-24.08**	-9.41*	-16.03**
1x5	2.56	7.33**	2.56	7.33**	-4.52**	-5.27**	2.30	-10.66**	-22.49**	-24.55**	-3.18	-14.15**
1x6	4.82**	5.68**	4.82**	5.68**	0.14	-0.07	-0.74	-10.21**	-24.09**	-30.36**	-2.55	-9.76*
1x7	-0.20	1.17	-0.20	1.17	4.20*	-0.40	4.34*	-5.50**	-11.47**	-23.63**	-3.32	-13.23**
2x3	6.99**	8.43**	6.99**	8.43**	0.96	0.39	-7.11**	-12.59**	-8.96*	-25.55**	-5.23	-15.34**
2x4	3.77**	10.27**	3.77*	10.26**	1.05	0.74	-3.88	-6.67**	11.28*	3.64	-7.03	-13.50**
2x5	0.10	6.00**	0.10	5.99**	3.11	2.07	7.40**	-0.85	-3.33	-17.89**	-8.12*	-18.24**
2x6	4.81**	5.14**	4.81*	5.14**	-1.72	-2.15	9.19**	4.67	81.99**	63.10**	-12.94**	-19.08**
2x7	2.76	5.36**	2.76	5.37*	5.16**	0.72	3.13	-1.00	4.84	0.23	-0.72	-10.58**
3x4	4.85**	9.87**	4.85**	9.86**	-1.02	-1.89	-6.01**	-9.01**	-30.23**	-39.41**	5.11	0.58
3x5	-0.24	4.17*	-0.24	-4.17*	-2.10	-2.54	1.88	-11.04**	-26.70**	-30.01**	5.95	5.49
3x6	3.51*	4.58**	-1.87	4.58**	-3.92*	-4.05	-3.00	-12.27**	-18.27**	-26.36**	-3.09	-7.17
3x7	4.12**	5.32**	4.12*	5.32*	3.50	-1.40	-2.22	-11.44**	-15.17**	-28.03**	3.02	2.07
4x5	-5.46	-5.14**	-5.46**	-2.19	9.70**	8.26**	13.64**	2.12	-12.62**	-20.92**	-0.42	-5.11
4x6	1.23	7.22**	1.23	3.26	3.83*	3.05	12.22**	4.58	-8.60	-12.32*	2.80	2.69
4x7	2.40	6.04**	2.40	5.10	10.82**	6.46**	7.35**	0.19	-4.40	-6.99	-2.41	-5.78
5x6	-3.12*	2.25	-3.12	8.20**	-3.01	-3.57	10.05**	5.80*	-12.67**	-17.83**	2.30	-2.42
5x7	-1.20	1.95	-1.20	1.20	4.91**	-0.48	11.55**	7.08**	-8.18	-18.92**	20.77**	19.15**
6x7	2.81	5.08**	2.01	3.090	6.61**	1.69	4.37	4.21	-5.35	-11.56*	3.34	-0.12

* and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.
S_1, S_2 and C: First, second and combined analysis, respectively. MP and BP mid better, respectively.

Table (11): Cont.

Cross	No. of grain/spike		Straw yield/plant (g)		Grain yield/plant (g)		Biological yield/plant(g)		Harvest index	
	HMP	HBP	HMP	HBP	HMP	HBP	HMP	HBP	HMP	HBP
1x2	-12.86**	-16.84**	-7.17	-19.86**	1.74	-11.77*	-5.91	-18.65**	8.21	7.80
1x3	-8.02	-8.28	-14.62*	-33.39**	-30.76**	-31.80**	-20.96**	-32.85**	-11.11	-21.03**
1x4	-10.67**	-16.45**	-41.39**	-43.28**	-1323**	-14.35**	-31.67**	-33.47**	24.50**	20.28**
1x5	-8.16*	-16.05**	-21.05**	-32.11**	-25.53**	-29.16**	-22.78**	-28.51**	-4.22	-15.35*
1x6	25.04**	16.77**	-16.82**	-37.67**	-0.81	-19.25**	-11.09	-31.42**	9.66	2.12
1x7	1.48	0.48	-15.98**	-28.61**	-0.60	-16.36**	-10.80	-24.45**	11.38	10.79
2x3	19.65**	13.88**	3.49	-8.35	-7.92	-19.09**	-1.13	-3.17	-5.64	-15.88*
2x4	-0.93	-11.28**	-7.69	-18.00**	1.17	-11.28*	8.88	-3.66	-6.33	-9.17
2x5	5.79	-7.31	-9.08	-9.49	0.91	-16.09**	-5.13	-11.94	7.83	-4.39
2x6	24.50**	21.70**	48.72**	25.42**	72.91**	60.39**	57.51**	37.36**	8.99	1.87
2x7	12.25**	6.12	-8.11	-9.82	3.95	0.30	-4.04	-6.36	10.38	9.37
3x4	-13.99**	-19.34**	-8.77	-27.06**	-19.58**	-19.77**	-10.52	-22.24**	-9.76	-17.28**
3x5	1.21	-7.25	12.61	0.14	-14.91**	-20.22**	0.10	-8.85	-11.91*	-12.44
3x6	10.16*	2.61	30.85**	23.67*	-9.88	-25.76**	16.78*	3.71	-18.56**	-22.61
3x7	15.33**	14.51**	18.53*	6.74	19.15**	1.53	19.62*	19.77*	4.05	-7.99
4x5	25.79**	22.73**	-19.27**	-28.57**	3.68	-2.58	-11.66*	-16.14**	14.45*	4.34
4x6	6.68	-6.36	-31.25**	-47.30**	6.42	-12.48**	-11.20	-30.17**	17.52**	13.13
4x7	-0.21	-5.79	-21.05**	-31.01**	5.33	-10.41*	-11.96*	-23.74**	17.22**	12.66
5x6	9.09*	-6.25	7.28	-9.19	1.16	-20.74**	4.70	-14.29*	-2.25	-7.63
5x7	2.03	-5.89	-11.90	-13.14	-6.63	-24.54**	-12.81*	-20.87**	8.41	-4.63
6x7	0.37	-7.12	19.85**	2.66	47.43**	41.51**	29.77**	15.63*	12.38	4.14

* and ** denote significant differences from zero at 0.05 and 001 levels of probability, respectively.
S_1, S_2 and C: First, second and combined analysis, respectively. MP and BP mid better, respectively.

spikelets/spike, number of spikes/plant, number of grains/spike, seed index, harvest index, straw, biological and grain yields/plant, respectively. The cross P_2xP_6 (Line 5 x Sakha 93) gave the most desirable remain heterotic effects for grain, straw and biological yields, number of grains/spike, spike length and number of spikes/plant. In the second season of F_1 data which are presented in Table (8). This cross was found to express an average increasing of 37.03% relative to the better parent value for grain yield/plant. These results revealed the possibility of hybrid wheat production on commercial scale by using both generations. **Mitkess (1981), Younis *et al.* (1988), Henawy (1990 and 1994)** possibility of using hybrids (F_1 and F_2)suggested the in commercial production. It is worth noting that, heterotic effects was generally more pronounced in the F_1 generation than F_2 in all studied traits, which are logically expected.

Combining ability:

a- F_1-generation:

Analysis of variance for combining ability as outlined by **Griffing's (1956)** model-1 method-2 in each season and their combined data for all the studied traits is shown in Table (12). The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were significant for all the studied traits, except SCA for; number of spikelets per spike in the first and second seasons and spike length in the first season and GCA for number of spikelets/spike in the first

Table (12): Observed mean squares for general and specific combining abilities from diallel cross analysis for all the studied traits for F_1 generation.

Source of variation	d.f.		Flowering date (days)			Plant height (cm)			No. of spikelets/spike			Spike length (cm)			No. of spikes/plant			Seed index (g)		
	S	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
G.C.A.	6	6	43.47**	43.19**	85.98**	213.20**	286.84**	494.13**	0.87	2.21**	2.65**	2.23**	1.51**	3.40**	6.32**	9.60**	14.60**	98.28**	111.89**	209.71**
S.C.A.	21	21	13.57**	10.20**	22.66**	39.47**	15.39**	41.02**	0.88	0.82	1.33**	0.61	1.03**	1.09**	4.02**	8.89**	7.29**	25.71**	14.87**	39.14**
G x S		27			1.01			12.08**			0.38			0.50			4.67**			1.22
G.C.A. x S		6			0.67			5.90			0.42			0.35			1.32			0.46
S.C.A. x S		21			1.11			13.84**			0.37			0.54			5.62**			1.44
Error	54	108	1.09	1.24	1.17	2.74	2.86	2.80	0.58	0..67	0.63	0.43	0.44	0.43	0.76	0.59	0.67	2.29	1.89	2.09
G.C.A./S.C.A.			3.20	4.23	3.79	77.81	18.64	12.05	0.99	2.70	1.99	3.66	1.47	3.12	1.57	1.08	2.00	3.82	7.52	5.36
G.C.A. xS/ G.C.A.					0.01			0.01			0.16			0.10			0.09			0.002
S.C.A x S/ S.C.A.					0.05			0.34			0.28			0.50			0.77			0.04

Table (12): Cont.

Source of variation	d.f.		No. of grain/spike			Straw yield/plant (g)			Grain yield/plant (g)			Biological yield/plant (g)			Harvest index (%)		
	S	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
G.C.A.	6	6	128.61**	90.57**	203.49**	283.26**	338.33**	560.61**	19.83**	59.67**	66.17**	325.98**	395.96**	632.72**	30.27**	56.57**	78.32**
S.C.A.	21	21	44.01**	54.57**	70.96**	101.54**	141.46**	175.38**	40.98**	67.77**	90.67**	147..83**	333.36**	396.18**	23.73**	11.99**	23.77**
G x S		27			24.97**			66.14**			17.03**			85.94**			11.19**
G.C.A. x S		6			15.69**			60.99**			13.33**			89.22**			8.52**
S.C.A. x S		21			27.62**			67.61**			18.08**			85.01**			11.95**
Error	54	108	2.75	1.83	2.29	11.64	8.43	10.03	3.98	6.04	5.01	19.15	1191	15.53	1.67	2.26	1.96
G.C.A./S.C.A.			2.92	1.66	2.87	2.79	2.39	3.20	0.48	0.88	0.73	2.21	1.19	1.60	1.28	4.72	3.29
G.C.A. xS/ G.C.A.					0.08			0.11			0.20			0.14			0.11
S.C.A x S/ S.C.A.					0.39			0.39			0.20			0.21			0.50

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

S_1, S_2 and C: first, second and the combined analysis, respectively.

season. It is evident that, both additive and non-additive gene effects were involved in determining the performance of single cross progeny. To reveal the nature of genetic variance which had greater role, GCA/SCA ratio was computed. The values largely exceeding the unity were detected for; flowering date, plant height, seed index, number of grains/spike, straw yield/plant and harvest index in both seasons as well as their combined analysis, number of spikes/plant and biological yield/plant in the first season and the combined analysis and number of spikelets/spike in the second season and the combined analysis. Thus, the largest part of total genetic variability was due to additive and additive by additive gene effects, while, the magnitude of additive and non-additive types of gene action were similar for number of spikes/plant and biological yield/plant in the second season.

For grain yield/plant in both seasons as well as their combined analysis, low values of GCA/SCA ratio less than unity were obtained, indicating the largest role of the non-additive gene action in the expression of the two cases.

The mean square associated with GCA was highly significant, meanwhile, SCA mean square did not significantly differ from error variance for; spike length and number of spikelets/spike in the first and second seasons, respectively. For such case one would accept the hypothesis that the performance of a single-cross progeny can be adequately predicted on the basis of additive and additive by additive types of gene action.

The mean squares of interaction between seasons and both types combining ability were significant for; number of grains/spike, harvest index, straw yield/plant, biological and grain yield/plant indicating that the magnitute of types of gene action varied from season to another. Meanwhile, the mean squares of interaction between seasons and both types of combining ability were insignificant for; flowering date, number of spikelets, spike length and seed index revealing that, the all types of gene actions did not appreciability fluctuated in magnitude from season to another. These findings confirm those obtained above from ordinary analysis of variance.

For plant height and number of spikes/plant, significant interaction between SCA and seasons was detected, indicating that, the magnitude of non-additive type of gene action varied from season to another. However, insignificant interaction between GCA x season mean square for the previous to traits was detected, revealing that, additive and additive by additive types of gene action did not differ from environment to another.

General combining ability effects:

Estimates of GCA effects ($\hat{g}_1$) for individual parental varieties and/or lines in each trait in both seasons as well as their combined analysis are presented in Table (13). General combining ability effects computed herein were found to be differ significantly from zero in all cases. High positive values would be interest under all traits in question, except for; flowering date where high negative effects would be useful from the breeder point of view. Parents P_6 (Sakha 93) and P_2 (Line 5) expressed significant negative $\hat{g}_1$ effects for flowering date in both seasons as well as their combined analysis indicating that, both parental varieties could be considered as a good combiners for developing early genotypes.

For plant height, significant negative $\hat{g}_1$ effects were detected for P_6 (Sakha 93), P_3 (Line 8) and P_5 (Line 59) in both seasons as well as the combined analysis, revealing the possibility of utilizing these parents to release short varieties. On the other hand, considerable positive values were obtained for other parents from which breeding for tallness is more likely. Also, the three parents P_1 (Gemmeiza 3), P_2 (Line 5) and P_7 (Giza 168) may 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 *et al.*, 1966)**. Yet releasing short cultivars may be of special interest in such purpose the parental lines.

For number of spikelets/spike, parental lines P_3 (Line 8), P_4 (Gemmeiza 9) and P_5 (Line 59) gave significant positive $\hat{g}_1$ effects in the combined data.

The parent P_4 (Gemmeiza 9) seemed to be a good combiner for spike length in the first season as well as combined analysis, followed P_6 (Sakha 93) and then by P_1 (Gemmeiza 3).

The parent P_6 (Sakha 93) seemed to be a good general combiner for high number of spikes/plant in all cases. However, the other parents gave significant negative or insignificant $\hat{g}_1$ effects for this trait in both seasons as well as their combined analysis (Table 13).

Table (13): Estimates of general combining ability effects for parents studied.

Parent	Flowering date (days)			Plant height (cm)			No. of spikelets/spike			Spike length (cm)			No. of spikes/plant			Seed index (g)		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
P_1	0.18	-0.45	-0.14	5.32**	4.64**	4.98**	-0.02	0.20	0.09	0.15	0.40	0.28**	-0.09	-0.01	-0.05	5.26**	5.63**	5.45**
P_2	-2.69**	-2.85**	-2.77**	1.60**	2.41**	2.00**	-0.09	-0.67**	-0.38**	-0.35	-0.38	-0.37**	-0.15	-0.61*	-0.38**	2.50**	2.64**	2.57**
P_3	0.39	0.26	0.32*	-5..44**	-6.38**	-5.91**	0.31	0.35	0.33**	0.09	0.30	0.19*	-0.11	0.29	0.09	-4.16**	-4.74**	-4.45**
P_4	2.80**	2.74**	2.77**	2.67**	4.44**	3.56**	0.18	0.42	0.30**	0.60**	0.29	0.45**	-1.04**	-0.83**	-0.93**	1.84**	1.84**	1.84**
P_5	1.54**	1.59**	1.56**	-0.92	-1.69**	-1.31**	0.21	0.50	0.35**	-0.93**	-0.61**	-0.77**	-0.32	0.15	-0.08	-2.19**	-1.95**	-2.07**
P_6	-3.22**	-2.83**	-3.02**	-7.47**	-8.60**	-8.03**	0.03	-0.14	-0.06	0.32	0.28	0.30**	1.73**	2.04**	1.89**	-1.02*	-1.26*	-1.14**
P_7	0.99**	1.54**	1.27**	4.24**	5.17**	4.70**	-0.63	-0.64*	-0.64**	013	-0.28	-0.08	-0.02	-1.04*	-0.53**	-2.24**	-2.15**	-2.19**
L.S.D.$_{0.05}$ gi	0.64	0.69	0.28	1.02	1.04	0.44	N.S.	0.51	0.22	0.40	0.41	0.18	0.54	0.47	0.22	0.94	0.85	0.36
L.S.D.$_{0.01}$ gi	0.86	0.91	0.37	136	1.39	0.09	N.S.	0.67	0.29	0.54	0.54	0.24	071	0.63	0.29	1.24	1.13	0.51
L.S.D.$_{0.05}$ (gi-gj)	0.98	1.05	1.00	1.56	1.59	0.78	N.S.	0.77	0.38	0.62	0.62	0.30	0.82	0.72	0.38	1.43	1.30	0.68
L.S.D.$_{0.01}$ (gi-gj)	1.31	1.40	0.67	2.07	2.12	1.04	N.S.	1.03	0.51	0.82	0.83	0.40	1.09	0.96	0.51	1.90	1.72	0.90
r	0.89**	0.89**	0.89**	0.88**	0.95**	0.93**	0.58	0.63	0.91**	0.73	0.82	0.97**	0.39	0.72	0.84*	0.93**	0.89**	0.91**

* and ** significant at 0.05 and 001 levels of probability, respectively.

Table (13): Cont.

Parent	No. of grains/spike			Straw yield/plant (g)			Grain yield/plant (g)			Biological yield/plant (g)			Harvest index (%)		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
P_1	-4.67**	-3.67**	-4.17**	6.72**	4.33**	5.52**	-1.58*	-0.72	-1.15**	6.22**	3.85**	5.03**	-2.97**	-1.86**	-2.42**
P_2	1.41*	-2.19**	-0.39	-1.20	2.27*	0.54	-1.11	-2.47**	-1.79**	-2.63	-0.42	-1.52*	-0.22	-1.98**	-1.10**
P_3	3.54**	3.46**	3.50**	-8.48**	-5.76**	-7.12**	1.33*	-0.06	-0.70*	-10.17**	-6.16**	-8.17**	1.93*	2.34**	2.13**
P_4	0.16	0.90	0.53**	6.17**	10.87**	8.52**	0.87	1.44	1.16**	6.85**	12.65**	9.75**	-1.27**	-2.64**	-1.95**
P_5	5.55**	4.59**	5.07**	0.24	-3.30**	-1.53**	2.10**	3.32**	2.71**	2.46	-0.14	1.16*	0.74	2.63**	1.68**
P_6	-3.53**	-2.87**	-3.20**	-5.35**	-5.66**	-5.50**	1.53*	2.32**	1.93**	-3.77**	-3.60**	-3.68**	2.28**	2.97**	2.63**
P_7	-2.47**	-0.22	-1.34**	1.89	-2.74**	-0.42	-0.49	-3.83**	-2.16**	1.04	-6.17**	-2.57**	-0.48	-1.46**	-0.97**
L.S.D.$_{0.05}$ gi	1.02	0.83	0.40	2.11	1.79	0.84	1.23	1.52	0.60	2.70	2.13	1.06	0.80	0.93	0.38
L.S.D.$_{0.01}$ gi	1.36	1.11	0.53	2.80	2.38	1.12	1.64	2.02	0.80	3.59	2.83	1.41	1.06	1.23	0.51
L.S.D.$_{0.05}$ (gi-gj)	1.56	1.27	072	3.22	2.74	1.50	1.88	2.32	1.06	4.13	3.25	1.86	1.22	1.42	0.66
L.S.D.$_{0.01}$ (gi-gj)	2.08	1.69	0.96	4.28	3.64	2.00	2.50	3.08	1.41	5.49	4.33	2.47	1.62	1.88	0.88
r	0.98*	0.66	0.90*	0.83*	0.87**	0.89**	0.96**	0.76*	0.87**	0.29	0.95*	0.37	0.31	0.86*	0.62

* and ** significant at 0.05 and 001 levels of probability, respectively.

The parent P_1 (Gemmeiza 3) seemed to be a good combiner for heavy 1000-kernel weight in both seasons as well as their combined analysis. Also, the parent P_2 (Line 5) and P_4 (Gemmeiza 9) showed significant positive $\hat{g}_1$ effects for this trait in both seasons and their combined analysis. However, the other parents gave significant negative or insignificant $\hat{g}_1$ effects in both seasons and their combined data.

For number of grains/spike, the parent P_5 (Line 59) gave the highest significant positive $\hat{g}_1$ effects followed by plant P_3 (Line 8) in both seasons as well as their combined analysis.

For biological yield/plant, the parent P_4 (Gemmeiza 9) followed by P_1 (Gemmeiza 3) gave significant positive $\hat{g}_1$ effects at both seasons as well as their combined over them. Both parents may be considered as an excellent in breeding programs towards releasing high biological yield. Also, the two parents gave significant positive $\hat{g}_1$ effects for straw yield/plant.

For harvest index; P_3 (Line 8) and P_6 (Sakha 93) gave significant positive $\hat{g}_1$ effects in both seasons as well as the combined analysis. Also, P_5 (Line 59) showed significant positive $\hat{g}_1$ effects in the second season and their combined analysis. The other parents gave significant negative or insignificant $\hat{g}_1$ effects for this trait.

For grain yield/plant, the parent P_5 (Line 59) and P_6 (Sakha 93) showed significant positive $\hat{g}_1$ effects in both seasons and their combined analysis. Therefore, those parents were considered as the best combiners for grain yield/plant. High general combiner for P_6 (Sakha 93) and P_5 (Line 59) for grain yield may be due to high $\hat{g}_1$ effects in harvest index and number of grains/spike, respectively.

Significant correlation coefficient values between the performance and its g_1 effects were obtained for; flowering date, plant height, seed index straw yield/plant and biological yield/plant in both seasons as well as their combined analysis, spike length and number of grains/spike in the first season as well as the combined analysis, number of spikes/plant and harvest index in the first and second season, respectively (Table, 13). These findings indicated that, the parental line gave a good index of intrinsic performance of their g_1 effects. Therefore, selection among the tested parental populations for initiating any proposed breeding program could be practiced either on mean performance or ($\hat{g}_1$) effects basis with similar efficiency. For the other cases, insignificant correlation coefficient values were detected between the two variables. This disagreement revealed that, hybrids characterized with high values could be expected for these cases. This result may be due to high magnitude of non-additive gave effects in some of these cases (Table 9). A rather good agreement between ranking of parental performance was reported by **Singh *et al.* (1986), Darwish (1992), Mekhamer (1995), Ashoush (1996), Hendawy (1998), Mahmoud (1999), Abdel-Wahed (2001) and Ashoush (2006a).**

Specific combining ability effects:

Specific combining ability effects S_{ij} of the parental combinations were computed for all traits in separate seasons as well as their combined analysis in the F_1 generation are presented in Table (14).

For flowering date, the four crosses namely P_2xP_5 (Line 5 x Line 59), P_2xP_6 (Line 5 x Sakha 93), P_3xP_4 (Line 8 x Gemmeiza 9) and P_5xP_7 (Line 59 x Giza 168) exhibited significant negative S_{ij} effects in both seasons as well as their combined analysis. Such results indicated that, the crosses P_2xP_6 (Line 5 x Sakha 93) followed by cross P_2xP_5 (Line 5 x Line 59) may be considered as an excellent crosses for developing line to early flowering date which they involved two and one good combiners for early flowering, respectively.

Seven, five and nine crosses exhibited significant positive S_{ij} effects for; plant height in the first, second season as well as the combined analysis, respectively. However, three crosses expressed significant negative S_{ij} effects in the same order for plant height in all cases.

The cross P_6xP_7 (Sakha 93 x Giza 168) followed by cross P_3xP_4 (Line 8 x Gemmeiza 9) showed significant positive S_{ij} effects for number of spikletes/spike in the combined analysis.

For spike length, the cross P_2xP_6 (Line 5 x Sakha 93) followed by cross P_5xP_6 (Line 59 x Sakha 93) expressed significant positive S_{ij} effects in the second season.

Table (14): Estimates of spesific combining ability effects for crosses studied.

	Flowering date (days)			Plant height (cm)			No. of spikelets/spike			Spike length (cm)			No. of spikes/plant			Seed index (g)		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
1 x 2	2.40*	1.91	2.16**	4.59*	0.54	2.57**	-0.31	0.67	0.18	-0.67	-0.83	-0.75	3.51**	-1.90**	-0.80	1.33	0.67	1.00
1 x 3	0.85	-0.22	0.32	5.94**	5.09**	5.52**	0.09	0.48	0.29	-0.01	0.63	0.31	-1.66*	-1.57*	-1.61**	0.55	0.66	0.61
1 x 4	-1.26	-2.13*	-1.70**	-1.72	0.14	-0.79	0.66	0.23	0.45	0.16	-0.11	0.03	-1.56*	-3.19**	-2.38**	6.22**	4.29**	5.26**
1 x 5	-1.56	-1.55	-1.56**	6.18**	2.01	4.10**	-0.51	-0.20	-0.35	-0.06	-0.42	-0.24	1.94*	-4.09**	-1.08*	0.07	-0.95	-0.44
1 x 6	4.16**	2.05*	3.11***	1.20	1.02	1.11	-0.21	-0.22	-0.21	0.05	0.63	0.34	0.55	6.08**	3.31**	8.35**	7.10**	7.72**
1 x 7	0.48	1.50	0.99	-0.96	1.02	0.03	-0.67	-0.07	-0.37	0.60	-0.60	0.00	-0.40	-1.83**	-1.12*	-2.68	-3.02*	-2.85**
2 x 3	2.08*	1.05	1.57**	11.47**	0.95	6.21**	1.02	-0.55	0.24	0.25	-1.89**	-0.82	-0.25	-0.66	-0.45	-2.68	-2.74*	-2.71**
2 x 4	2.57**	0.13	1.35*	9.15**	5.04**	7.09**	0.97	0.18	0.57	0.85	0.91	0.88	1.18	4.38**	2.78**	5.31**	4.12**	4.72**
2 x 5	-2.59**	-3.12**	-2.86**	-0.29	1.87	0.79	0.68	0.61	0.64	-1.20	-0.25	-0.72	-2.16**	-1.99**	-2.08**	4.98**	3.99*	4.48**
2 x 6	-9.44**	-8.12**	-8.83**	0.01	4.23**	2.12*	-1.18	-2.10	-1.64**	1.42	1.41*	1.42	-1.30	1.86**	0.28	3.00*	1.86	2.43**
2 x 7	6.89**	4.79**	5.84**	4.41*	4.76**	4.58**	-0.01	-1.33	-0.67	0.35	-0.04	0.15	-0.39	1.28	0.44	2.43	1.91	2.17**
3 x 4	-3.99**	-3.67**	-3.83**	1.74	2.16	1.95*	1.22	1.17	1.19**	-0.14	0.21	0.04	0.34	0.41	0.37	-1.54	-1.30	-1.42
3 x 5	-0.31	-0.40	-0.35	-7.24**	2.59	-2.33*	-0.10	-0.03	-0.07	1.23	0.46	0.85	-2.74**	-2.23**	-2.49**	0.78	1.81	1.30
3 x 6	2.27	2.16*	2.22**	2.48	-3.10*	-0.31	-0.81	-0.01	-0.41	0.60	-0.99	-0.20	0.82	-2.41**	-0.80	-4.61**	-4.86**	-4.73**
3 x 7	3.37**	3.28**	3.33**	-3.23*	3.16*	-0.04	-0.16	0.10	-0.03	0.14	-0.04	0.05	4.31**	-0.50	1.91**	2.52	1.76	2.14**
4 x 5	1.88*	1.26	1.57**	-3.84*	-0.14	-1.99*	0.63	-0.38	0.12	0.60	-0.55	0.02	1.45	-0.91	0.27	1.20	0.61	0.91
4 x 6	-2.36	-1.10	-1.73**	-1.60	2.48	0.44	-0.53	0.35	-0.09	0.57	0.04	0.31	0.30	-2.32**	-1.01*	3.89**	2.14	3.02**
4 x 7	0.16	-0.76	-0.30	-0.84	-2.20	-1.52	0.94	0.71	0.83	-0.10	0.06	-0.02	-0.11	0.17	0.03	3.28*	2.38	2.83**
5 x 6	2.04*	0.58	1.31*	7.95**	-1.22	3.37**	0.15	0.55	0.35	0.18	1.65**	0.91	3.70**	4.79**	4.25**	-2.13	-2.53*	-2.33**
5 x 7	-4.61**	-4.78**	-4.69**	2.50	-3.20*	-0.35	0.92	0.79	0.86*	0.52	1.08	0.80	0.69	0.46	0.57	5.64**	4.43**	5.03**
6 x 7	0.83	-0.12	0.36	-2.89	-4.69**	-3.79**	1.24	1.41	1.33**	-0.30	1.13	0.42	-2.38*	-0.40	-1.39**	-2.19	-3.63**	-2.91**
L.S.D. 0.05 S_{ij}	1.87	2.00	1.16	2.97	3.03	1.80	N.S.	N.S.	0.85	N.S.	1.18	N.S.	1.56	1.37	0.88	2.72	2.47	1.55
L.S.D. 0.01 S_{ij}	2.49	2.66	1.54	3.95	4.03	2.38			1.13		1.58		2.08	1.83	1.17	3.62	3.28	2.06
L.S.D. 0.05 (S_{ij}-S_{ik})	2.78	2.97	2.03	4.41	4.51	3.14			1.50		1.76		2.32	2.04	1.54	4.04	3.67	2.72
L.S.D. 0.01 (S_{ij}-S_{ik})	3.70	3.95	2.69	5.87	5.99	4.20			2.00		2.34		3.09	2.71	2.05	5.37	4.88	3.62
L.S.D. 0.01 (S_{ij}-S_{kl})	2.46	2.78	0.72	5.49	5.61	1.12			0.50		2.19		2.89	2.54	0.54	5.03	4.56	0.96
L.S.D. 0.05 (S_{ij}-S_{kl})	3.60	3.70	0.96	4.13	4.22	1.49			0.69		1.65		2.17	1.91	0.72	3.78	3.43	1.28

* and ** significant at 0.05 and 001 levels of probability, respectively.

Table (14): Cont.

	No. of grains/spike			Straw yield/plant (g)			Grain yield/plant (g)			Biological yield/plant			Harvest index		
	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C	S_1	S_2	C
1 x 2	-4.21**	-3.13*	-3.67**	11.18**	-17.69**	-3.25	1.33	-1.24	0.05	11.39**	-18.28**	-3.45	-1.54	4.99**	1.73
1 x 3	6.86**	7.98**	7.42**	8.61**	1.03	4.82**	2.90	3.51	3.21**	10.43*	5.84	8.14**	-0.87	0.51	-0.18
1 x 4	-7.96**	-12.47**	-10.21**	-8.44**	-21.84**	-15.14**	-9.82**	-9.43**	-9.62**	-19.25**	-31.51**	-25.38**	-3.08*	1.63	-0.73
1 x 5	-6.15**	-4.70**	-5.42**	-13.10**	-13.23**	-13.17**	-6.24**	-14.52**	-10.38**	-20.90**	-28.71**	-24.81**	0.36	-3.23*	-1.44
1 x 6	14.51**	0.57	7.54**	15.31**	20.44**	17.88**	7.32**	14.39**	10.85**	21.47**	35.18**	28.33**	0.32	0.27	0.29
1 x 7	6.71**	4.69**	5.70**	-7.78*	4.40	-1.69	-0.13	-0.91	-0.52	-8.98*	2.70	-3.14	1.83	-1.49	0.17
2 x 3	-0.56	4.93**	2.18**	2.67	-4.20	-0.77	0.36	-1.93	-0.79	3.35	-8.57**	-2.61	-1.19	0.84	-0.18
2 x 4	1.62	5.15**	3.38**	12.76**	18.18**	15.47**	3.16	10.90**	7.03**	16.07**	29.29**	22.68**	-1.35	0.66	-0.34
2 x 5	7.88**	10.69**	9.28**	-2.12	4.48	1.18	-4.98**	-2.14	-3.56**	-7.26	3.06	-2.10	-2.11	-2.68	-2.39**
2 x 6	-6.90**	-3.55**	-5.22**	-3.71	11.02**	3.65*	-0.91	3.14	1.11	-4.71	13.30**	4.30	0.54	-1.63	-0.55
2 x 7	-1.02	-0.14	-0.58	0.40	5.51*	2.95	-0.19	2.17	0.99	0.53	7.85*	4.19	-0.66	-0.52	-0.59
3 x 4	5.69**	5.22**	5.45**	8.52*	18.25**	13.39**	-1.13	-1.12	-1.12	7.57	17.48**	12.53**	-3.55**	-6.15**	-4.70**
3 x 5	-2.57	4.80**	1.11	2.90	-0.24	1.33	1.85	0.12	0.98	4.62	0.72	2.67	0.14	-0.28	-0.07
3 x 6	-8.44	7.76**	-0.34	-6.05	-2.79	-4.42*	-4.24*	1.29	-1.48	-10.34*	-3.91	-7.12**	-0.71	2.85*	1.07
3 x 7	3.63*	-5.21**	-0.79	4.93	4.99	7.46**	2.06	-4.47*	-1.20	12.02**	0.80	6.41**	-2.33*	-4.59**	-3.46**
4 x 5	-5.59	-7.96**	-6.78**	11.32**	4.62	7.97**	-1.68	-4.52*	-3.10*	10.34*	0.60	5.47*	-3.19**	-3.80**	-3.49**
4 x 6	5.63*	11.08**	8.36**	3.92	-1.46	1.23	-0.73	5.78*	2.53*	2.95	4.57	3.76	-1.61	2.67	0.53
4 x 7	0.76	-2.15	-0.70	1.91	-6.11*	-2.10	-1.94	1.37	-0.29	0.15	-5.13	-2.49	-1.68	2.68	0.50
5 x 6	1.14	-2.56*	-0.71	2.59	4.48	3.54*	9.70**	12.01**	10.85**	14.76**	13.92**	14.34**	3.19**	5.01**	4.10**
5 x 7	-2.04	6.65**	2.31**	2.17	-3.84	-0.84	-4.21*	6.43**	1.11	-2.16	2.71	0.27	-2.98*	5.06**	1.04
6 x 7	7.15**	2.58*	4.87**	-16.62**	-2.51	-9.57**	15.11**	3.91	9.51**	-1.57	4.94	1.68	15.51**	2.04	8.77**
L.S.D. 0.05 S_{ij}	2.98	2.43	1.63	6.12	5.21	3.40	3.58	4.41	2.41	7.86	6.19	4.24	2.32	2.70	1.91
L.S.D. 0.01 S_{ij}	3.96	3.23	7.16	8.15	6.93	4.52	4.76	5.87	3.19	10.45	8.24	5.62	3.09	3.59	2.00
L.S.D. 0.05 (S_{ij}-S_{ik})	4.42	3.60	2.86	9.10	7.74	5.98	5.32	6.55	4.22	11.67	9.20	7.44	3.45	4.01	2.64
L.S.D. 0.01 (S_{ij}-S_{ik})	5.88	4.79	3.80	12.10	10.30	7.95	7.08	8.72	5.61	15.52	12.24	9.90	4.58	5.33	3.51
L.S.D. 0.01 (S_{ij}-S_{kl})	4.14	4.48	1.00	11.32	9.63	2.12	6.62	8.15	1.50	10.92	11.45	2.62	4.29	4.99	0.94
L.S.D. 0.05 (S_{ij}-S_{kl})	5.50	3.37	1.33	8.51	7.24	2.82	4.98	6.13	2.00	14.52	8.61	3.48	3.22	3.75	1.25

* and ** significant at 0.05 and 001 levels of probability, respectively.

For number of spikes/plant, four crosses exhibited significant positive S_{ij} effects in separate seasons as well as their combined analysis. However, the cross P_5xP_6 (Line 59 x Sakha 93) gave the highest desirable $\hat{S}_{ij}$ effects in both seasons as well as their combined analysis, respectively.

Regarding 1000-kernel weight; eight, five and ten parental combinations exhibited significant positive S_{ij} effects in the first, second seasons as well as their combined analysis, respectively. However, the best S_{ij} effects were recorded by crosses P_1xP_6 (Gemmeiza 3 x Sakha 93), P_1xP_4 (Gemmeiza 3 x Gemmeiza 9), P_5xP_7 (Line 59 x Giza 168), P_2xP_4 (Line 5 x Gemmeiza 9) and P_2xP_5 (Line 5 x Line 59) in both seasons and their combined over them.

For number of grains/spike; eight, eleven and ten hybrids exhibited significant positive S_{ij} effects in the first, second seasons as well as their combined analysis, respectively. The highest and significant positive S_{ij} effects in both seasons as well as their combined over them were detected by the crosses; P_1xP_3 (Gemmeiza 3 x Line 8), P_1xP_7 (Gemmeiza 3 x Giza 168), P_2xP_5 (Line 5 x Line 59), P_3xP_4 (Line 8 x Gemmeiza 9), P_4xP_6 and P_6xP_7 (Sakha 93 x Giza 168) for this traits.

For straw yield/plant; six, five and eight parental combinations expressed significant positive S_{ij} effects in the first, second seasons as well as their combined analysis, respectively. The highest significant positive S_{ij} effects for this trait was detected by crosses P_1xP_6 (Gemmeiza 3 x Sakha 93), P_2xP_4 (Line

5 x Gemmeiza 9) and P_3xP_4 (Line 8 x Gemmeiza 9) in both seasons and their combined analysis.

For grain yield/plant; three, five and six crosses expressed significant positive S_{ij} effects in the first, second seasons and their combined analysis, respectively.

For biological yield/plant; seven, six and eight crosses exhibited significant positive S_{ij} effects in the first, second seasons as well as their combined analysis, respectively. Also, the best combinations were P_1xP_6 (Gemmeiza 3 x Sakha 93) and P_5xP_6 (Line 59 x Sakha 93) for biological and grain yield/plant in both seasons as well as their combined analysis, respectively.

For harvest index; two, four and two crosses expressed significant positive S_{ij} effects in the first, second seasons as well as their combined analysis, respectively. The best combinations for S_{ij} effects for this trait were P_5xP_6 (Line 59 x Sakha 93) in both seasons as well as their combined analysis and cross P_6xP_7 (Sakha 93 x Giza 168) in the first season and their combined analysis.

If crosses showing high specific combining ability involve only one good combiner, such combinations would throw out desirable transgressive segregates providing that the additive genetic system are present in the good combiner and complementary and epistatic gene effects are present in these 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.

b- F_2-generation:

The analysis of variance of combining ability in F_2 data is presented in Table (15). General combining ability mean squares were highly 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 greater role, G.C.A./S.C.A. ratio was computed. The values were largely exceeding unity were detected for; flowering date, plant height, spike length, seed index, number of grains/plant and harvest index. Thus, the largest part of the total genetic variability was due to additive and additive by additive gene effects. For the other traits, low values of GCA/SCA ratio less than unity were obtained, indicating the largest role of the non-additive gene action in the expression of those traits. G.C.A./S.C.A. ratios were higher in magnitude in F_2 than F_1 generation for most studied traits revealing that, additive and additive by additive gene effects were increased and non-additive gene effects was also reduced in the F_2 generation. The same trend had been reported by **Ashoush (1996), Hendawy (1998), Mahmoud (1999), Abdel-Wahed (2001), El-Sayed (2004), Ashoush (2006b) and El-Marakby *et al.* (2007)**.

Estimates of G.C.A. effects ($\hat{g}_1$) for individual parents for the studied traits are presented in Table (16). The results indicated that, the parental (P_1) seemed to be the best one for; flowering date, plant height, spike length, seed index, straw yield and biological yield/plant.

Table (15): Observed mean squares from general and specific combining abilities from diallel cross analysis for all the studied traits for F_2-generation.

Source of variation	d.f.	Flowering date (days)	Plant height (cm)	No. of spikelets/ spike	Spike length (cm)	No. of spikes/plant	Seed index (g)	No. of grains/ spike	Straw yield/plant (g)	Grain yield/plant (g)	Biological yield/plant (g)	Harvest index (%)
G.C.A.	6	17.55**	137.56**	0.44**	1.08**	3.37**	20.36**	94.16**	117.11**	35.11**	180.69**	21.94**
S.C.A.	21	15.36**	50.06**	0.68**	0.41**	7.61**	11.23**	42.25**	121.04**	44.73**	253.58**	11.86**
Error	54	1.40	3.38	0.10	0.04	0.27	2.96	3.65	11.76	2.37	27.59	3.60
G.C.A./ S.C.A.		1.14	2.75	0.64	2.63	0.44	1.81	2.23	0.97	0.78	0.71	1.85

** denote significant differences from zero at 001 level of probability.

Table (16): Estimates of general combining ability effects F_2 for parents study.

Crosses	Flowering date (days)	Plant height (cm)	No. of spikelets/ spike	Spike length (cm)	No. of spikes/plant	Seed index (g)	No. of grains/ spike	Straw yield/plant (g)	Grain yield/plant (g)	Biological yield/plant (g)	Harvest index
P_1	-1.34**	2.79**	-0.25*	0.35**	0.24	2.22**	-3.50**	5.12**	-0.51	3.65*	-1.46*
P_2	-0.57	1.80**	0.00	-0.16**	0.55**	1.63**	-2.23**	3.63**	-0.53	3.95*	-1.83**
P_3	0.41	-4.77**	-0.06	0.31**	0.01	-2.15**	-0.93	-2.92**	-0.90	-3.75*	-0.43
P_4	2.09**	1.64**	0.28**	0.41**	-0.87**	-0.21	2.35**	1.32	1.72**	4.97**	0.68
P_5	1.25**	0.11	0.29**	-0.46**	0.19	-1.11*	6.01**	-1.34	3.64**	1.00	2.73**
P_6	-1.86**	-5.99*	-0.01	0.21**	0.77**	-0.19	-1.75**	-5.11**	-1.54**	-6.25**	-0.54
P_7	0.03	4.41**	-0.25*	-0.24**	-0.88**	-0.19	0.06	-0.71	-1.87**	-3.57*	1.17
L.S.D.$_{0.05}$ gi	0.73	1.14	0.20	0.12	0.32	1.06	1.18	2.12	0.95	3.24	1.56
L.S.D.$_{0.01}$ gi	0.97	1.51	0.26	0.16	0.42	1.41	1.57	2.81	1.26	4.31	1.79
L.S.D.$_{0.05}$ (gi-gj)	1.12	1.73	0.30	0.19	0.49	1.62	1.80	3.23	1.45	4.95	2.38
L.S.D.$_{0.01}$ (gi-gj)	1.49	2.31	0.40	0.25	0.65	2.16	2.39	4.30	1.93	6.59	2.87
r	0.88**	0.95**	0.51**	0.94**	0.22	0.94**	0.86*	0.85*	0.77*	0.83*	0.70

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

The parent P_2 (line 5) expressed significant positive $\hat{g}_1$ effects for; plant height, number of spikes/plant, seed index, straw and biological yields/plant.

The parent P_3 (Line 8) exhibited significant positive $\hat{g}_1$ effects for spike length. However, it gave significant negative and insignificant $\hat{g}_1$ effects for the other traits.

Parent P_4 (Gemmeiza 9) expressed significant positive $\hat{g}_1$ effect for; plant height, number of spikelets/spike, spike length, number of grains/spike, biological yield/plant and grain yield/plant. Moreover, it occupied the first best combinr for biological yield and ranked the second one for grain yield/plant.

Parent P_5 (Line 59) seemed to be the best $\hat{g}_1$ effects for; number of grains/spike, grain yield/plant and harvest index. Since it expressed significant positive $\hat{g}_1$ effects for number of spikelets/spike. Therefore, P_5 (Line 59) could be considered as an excellent parent in breeding programs towards releasing new wheat varieties characterized by higher values for grain yield.

Parent P_6 (Sakha 93) expressed to be the best $\hat{g}_1$ for, flowering date and short plant, revealing the possibility of utilizing this parent to release as an early and short wheat varieties. Also, it expressed significant positive $\hat{g}_1$ effects for spike length and number of spikes/plant.

Parent P_7 (Giza 168) expressed significant positive $\hat{g}_1$ effects for, plant height.

Significant correlation coefficient values between the parental performance and its of $\hat{g}_1$ effects were obtained for all the studied traits, except for; number of spikes/plant and harvest index (Table 16). These findings indicated that, the parental lines gave a good index of intrinsic performance of their ($\hat{g}_1$) effects. Therefore, the selection among the tested parental populations for initation any proposed breeding program may be practiced either on mean performance or $\hat{g}_1$ effects basis with similar efficiency.

For the exceptional traits insignificant correlation coefficient values were detected between the two variables. Such results might be add another proof that, both types of genetic variance are important for these traits and conceder with the findings reacted above in Table (15).

Specific combining ability effects of the parental combinations were computed for all the studied traits in the F_2-generation (Table, 17). The most desirable inter- and intra-allelic interactions were represented by four, eight, four, seven, one, one, six, five, four, five and three crosses for flowering date, plant height, number of spikelets/spike, spike length, number of spikes/plant, seed index, number of grains/spike straw, biological and grain yields/plant and harvest index, respectively. The best cross for S_{ij} effects for yield and its components were P_2xP_6 (Line 5 x Sakha 93) followed by cross P_3xP_7 (line 8 x Giza 168) and then by cross P_6xP_7 (Sakha 93 x Giza 168). The mentioned combinations might be of interest in breeding programs amid at producing pure line varieties as most combinations involved at least one good combiner. Also, in these traits one or more of the previous crosses had significant desirable (S_{ij}) effects in the F_1-generation.

Table (17): Estimates of specific combining ability effects for the studied crosses of F_2-generation.

Crosses	Flowering date (days)	Plant height (cm)	No. of spikelets/ spikes	Spike length (cm)	No. of spikes/plant	Seed index (g)	No. of grains/ spike	Straw yield/plant (g)	Grain yield/plant (g)	Biological yield/plant (g)	Harvest index
1x1	6.37**	-2.51	-0.36	-0.79**	0.62	-4.86**	-7.25**	1.32	1.75	0.16	1.24
1x3	2.34*	-1.17	0.68*	-0.41*	-3.24**	-3.28**	-3.37	-5.08	-7.73**	-12.73**	-2.53
1x4	-10.80**	-15.20**	-1.19**	-0.85**	0.01	-2.55	-4.52*	-18.80**	-1.76	-22.34**	5.64**
1x5	3.48*	6.39**	-0.90**	0.11	-1.13*	-0.45	-5.09**	-5.44	-7.21**	-11.19*	-2.77
1x6	3.15**	7.06**	0.34	-0.07	-2.74**	1.42	11.47**	-7.00*	-0.91	-8.15	1.86
1x7	-1.63	1.26	0.42	0.58**	0.10	-0.79	1.50	-2.72	0.84	-0.73	0.68
2x3	2.21*	7.00**	0.30	-0.39*	-0.90	-0.02	8.08**	-3.62	-2.65	-8.01	0.10
2x4	2.37*	1.30	-0.21	-0.49**	0.33	-0.79	-2.40	1.83	-1.35	13.22**	-4.69**
2x5	-1.07	4.40**	0.56	0.38*	-1.04*	-2.88	-0.33	-6.00	-0.07	-6.42	2.45
2x6	1.17	-7.71**	-0.40	0.78**	8.77**	-4.35**	6.65**	22.06**	17.33**	37.33**	2.13
2x7	-0.49	5.74**	0.32	0.14	-0.87	1.04	3.51*	-6.86*	4.04**	-11.56*	0.86
3x4	3.96**	6.94**	-0.50	-0.48**	-2.04**	3.04	-8.99**	0.27	-5.04**	-4.60	-3.03
3x5	-1.07	2.38	-0.46	0.11	-1.36**	1.66	-1.59	6.62*	-1.94	5.09	-2.51
3x6	0.28	8.71**	-0.72*	-0.30	-1.27**	-1.32	1.13	7.71*	-4.81**	4.94	-5.53**
3x7	-3.71**	-13.10**	0.15	-0.16	0.07	-0.01	7.10**	8.46**	8.52**	17.94**	2.25
4x5	-3.71**	-7.68**	1.75**	0.89**	-0.12	-1.10	15.80**	-2.67	5.05**	-0.95	3.80*
4x6	1.27	-1.25	0.54	0.96**	-1.00*	2.22	0.35	-15.68**	-0.91	-12.97**	4.05*
4x7	2.92**	5.58**	1.21**	0.44*	0.31	-2.39	-1.09	-5.49	0.41	-6.82	1.96
5x6	-2.91**	1.54	-0.75*	0.18	-1.25**	0.23	-0.08	2.37	-1.58	0.88	-1.67
5x7	-0.55	-4.50**	0.22	0.38*	0.22	7.62**	-1.64	-4.76	-3.32*	-9.93*	1.05
6x7	1.17	-5..77*	0.76*	-0.17	-0.88	0.56	-4.68**	7.91*	8.27**	15.97**	1.74
L.S.D.$_{0.05}$ sij	2.13	3.30	0.57	0.36	0.93	3.09	3.43	6.15	2.77	9.43	3.41
L.S.D.$_{0.01}$ sij	2.83	4.39	0.76	0.48	1.23	4.11	4.56	8.19	3.68	12.54	4.53
L.S.D.$_{0.05}$ (sij-sik)	3.16	4.90	0.85	0.53	1.38	4.59	5.09	9.14	4.11	14.01	5.06
L.S.D.$_{0.01}$ (sij-sik)	4.20	6.52	1.13	0.71	1.83	6.10	6.77	12.16	5.46	18.63	6.73
L.S.D.$_{0.05}$ (sij-skl)	2.96	4.59	0.79	0.50	1.29	4.29	4.76	8.55	3.84	13.10	4.73
L.S.D.$_{0.01}$ (sij-skl)	3.93	6.10	1.06	0.66	1.71	5.71	6.34	11.37	5.11	17.43	6.30

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

Genetic components and heritability:

The estimation of genetic components for the studied traits depends upon several assumptions such as; homozygous parents, diploid segregation, no reciprocal differences, no genotype environmental interaction, number epistasis, number multi allelis and uncorrelated gene distribution. Moreover, the validity of these assumptions must be tested before estimating the genetic components. Two test more were used in this concern; the first test was t^2 value which is expected to be insignificant if all assumptions are valid. These values of t^2 are presented in Table (18). With the exception of; number of spikes/plant and seed index in both seasons, flowering date, spike length, number of grains/spike and harvest index in the first season and number of spikelets in the second season, insignificant t^2 were detected for all cases. 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 for this assumption.

Data were also subjected to the diallel analysis proposed by **Hayman (1954b)** to get more information about the traits under study in each season. The computed parameters are presented in Table (18).

The results indicated that, the additive component (D) was significant for all the studied traits, except for; number of spikelets/spike at the second season. Such results are in harmony with that previously obtained by means of G.C.A. analysis in Table (12).

Table (18): Estimate of genetic components of variation in a half diallel wheat crosses in F_1 for the studied traits during the first and second seasons.

	Flowering date (days)		Plant height (cm)		No. of spikelets/spike		Spike length (cm)		No. of spikes/plant		Seed index (g)	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
D	24.95**	23.44**	112.94**	118.94**	0.67*	-005	0.48*	1.46**	2.25**	6.10*	17.63**	24.36**
F	14.14*	12.15*	55.36*	4.14**	1.33**	-0.63*	-0.51	2.12*	-0.61	11.04*	-15.52**	-21.43**
H_1	56.09**	40.79**	154.06**	57.09**	2.49	1.87*	1.07*	3.69*	13.70*	39.96**	91.72**	57.17**
H_2	47.80**	32.13**	114.48**	39.15**	1.54*	1.35*	1.09*	2.49*	13.96*	29.09**	69.88**	43.77**
h^2	1.06	5.04*	129.33**	52.69**	1.46*	0.25	2.50**	0.46	3.25*	1.97**	120.19**	136.44**
E	1.11	1.51	2.90	2.83*	0.57	0.70	0.42	0.42	0.74	0.56	2.40	1.86
$(H_1/D)^{1/2}$	1.50	1.32	1.17	0.69	1.93	#NUM	1.49	1.59	2.47	2.56	2.28	1.53
$(H_2/4H_1)$	0.21	0.20	0.19	0.17	0.15	0.18	0.26	0.17	0.25	0.18	0.19	0.19
KD/Kr	1.47	1.49	1.53	1.05	3.14	#NUM	0.48	2.68	0.90	2.09	0.68	0.55
h(n.s)	0.42	0.49	0.61	0.84	0.13	0.35	0.41	0.20	0.24	0.27	0.58	0.70
YD	89.83	93.23	52.44	36.24	22.34	22.59	11.45	11.97	13.68	13.68	27.36	22.50
Yr	118.67	124.35	187.61	198.62	24.60	23.20	12.78	11.26	19.31	19.31	68.49	74.10
r	-0.30	0.15	-0..48	-0.61	-0.78*	-0.58	-0.69*	0.55	-0.34	-0.34	-0.11	0.09
t^2	5.69	0.68	2.11	0.65	0.30	8.16	18.06	0.42	5.64	14.22	9.85	20.65
b	0.37	0.47	0.49	0.91	0.51	0.19	0.47	-0.12	0.41	0.19	0.46	0.64

* and ** significant at 0.05 and 001 levels of probability, respectively.

Table (18): Cont.

	No. of grains/spike		Straw yield/plant (g)		Grain yield/plant (g)		Biological yield/plant (g)		Harvest index (%)	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
D	125.17**	45.80**	182.58**	294.50**	39.22*	73.87*	28159**	530.30*	27.13*	26.88**
F	110.30*	45.14*	149.85**	291.40*	90.74*	144.24*	230.19*	771.49*	55.71*	11.76*
H_1	181.06**	226.57**	411.15**	610.15**	189.86**	305.10**	555.79**	1494.70**	117.52**	48.28**
H_2	153.15**	178.55**	318.17**	478.40**	125.50**	201.18**	495.75**	1094.65**	69.38**	37.27**
h^2	26.38**	96.60**	135.52**	54.55**	4.24**	62.18**	165.77**	228.34**	1.50	1.34
E	2.78	1.78	11.25	8.76	3.86	6.14	18.71	11.59	1.64	2.35
$(H_1/D)^{1/2}$	1.20	2.22	1.50	1.44	2.20	2.03	1.40	1.68	2.08	1.34
$(H_2/4H_1)$	0.21	0.20	0.19	0.20	0.17	0.16	0.22	0.18	0.15	0.19
KD/Kr	2.16	1.57	1.75	2.05	3.22	2.85	1.82	2.53	2.95	1.39
h(n.s)	0.34	0.34	0.41	0.34	0.15	0.23	0.28	0.22	0.34	0.53
YD	30.94	35.45	-167.58	-42.89	34.09	14.37	-229.87	-101.89	41.40	16.27
YR	129.86	96.21	519.51	303.68	54..92	123.70	766.96	657.03	9.65	70.52
r	0.70*	-0.87**	-0.87**	-0.72*	-0.33	-0.65	-0.88**	-0.70*	-0.37	0.89**
t^2	4.99	0.61	3.0	1.39	1.01	0.39	3.08	0.68	24.01	0.36
b	0.32	0.29	1.17	0.40	0.11	0.34	1.17	0.42	-0.27	0.68

* and ** significant at 0.05 and 001 levels of probability, respectively.

For the exceptional trait in the second seasons, insignificant (D) value inspite of appreciable G.C.A. was detected. Dominance may be had a role in G.C.A. estimate as emphasized by **Jinks (1955)**. Moreover, the regression coefficient of the parental offspring covariance (Wr) on the parental arry variance (Vr) was found to be less than unity for this trait. Also, significant t^2 value was detected for this trait, in (Wr) disproportionally more than (Vr) which usually lead to an inflation in the relative magnitude of dominance to additive components **(Hayman, 1954b and Mather and Jinks, 1971)**. Therefore, the contradiction in magnitude detected between (D) and G.C.A. estimate for this trait could be attributed the great role of both allelic and non-allelic genetic types on the expression of this trait.

Significant values for the dominance components (H_1) were obtained for all the studied trait in both seasons, except for, number of spikelets/spike in the first season. Values of H_1 were large in magnitude than the respective (D) for all the studied traits, except for, plant height in the second season, These results revealed that, non-additive type of gene action was the most prevalent genetic component for these cases. The contradiction in magnitude obtained between (D) and G.C.A. estimated for most studied traits may be attributed to the great role of both allelic and non-allelic genetic types of the expression of most studied traits.

These results were in line with those reported by **Mosaad *et al.* (1990), Ashoush (1996), Hassan (1998), Salem *et al.* (2000), Ashoush (2006a) and El-Marakby *et al.* (2007)**.

The component F refers to covariance of additive and no-additive gene effects. It can be used to determine the relative frequencies of dominant and recessive alleles in the parental populations and the variation in the dominance level over loci.

The results indicated that, significant positive F values were detected for; flowering date, plant height, number of grains/spike, straw, grain and biological yields and harvest index in both seasons, number of spikelets/spike in the first season and spike length and number of spikes/plant in the second season, indicated that the excess of dominant alleles. However, significant negative F values were detected for, seed index in both seasons and number of spikelets/spike in the second one, indicating the excess of recessive alleles of loci in the parental populations. Meanwhile, insignificant F values were detected for the other cases, indicating that dominant and recessive alleles of loci were equally distributed among the parents. The same conclusion may be again draw from the corresponding properties $(4\ DH_1)^{1/2} + F/(4\ DH_1)^{1/2} - F$. These results were partial agreement with previously reached by **Singh (1990), Ashoush (1996a), Hassan (1998), Salem *et al.* (2000) and Ashoush (2006b)**.

The overall dominance effects of heterozygous loci (h^2) were computed (Table, 18). Significant h^2 values were detected for all traits, except for; harvest index in both seasons, flowering date in the first seasons, number of spikelets/spike and spike length in the second one, indicating that dominance was unidirectional, appreciable heterotic effects was previously reported by **Tamam (1989)**.

The symmetry vs. a symmetry in gene frequency was also estimated by ratio ($H_2/4\ H_1$) (Table, 18). Values which largely deviate from one quarter were obtained for all studied traits except for; spike length and number of spikes/plant in the first season, revealing that negative and positive alleles were unequally distributed among the parents.

The ratio $(H_1/D)^{1/2}$ that refers to a weighted measure of average degree of dominance at each locus was computed for all traits. The results indicated that, the values of $(H_1/D)^{1/2}$ were high than unity for all traits except for plant height in the second season, indicating the presence of over dominance. For the exceptional case whereas, the ratio of $(H_1/D)^{1/2}$ was less than unity revealing that the presence of partial dominance **(Tamam, 1989; Hassan, 1998; Salem *et al.*, 2000 and Ashoush, 2006a)**.

The correlation coefficient values between parental mean (Yr) and (Wr+Vr) for each array were significant negative values for; straw and biological yields/plant in both seasons, number of spikelets/spike and spike length, in the first season, and number of grains/spike in the second season, revealing that increases genes were dominant over decreases.

Significant positive correlation coefficient values were detected for number of grains/spike and harvest index in the first and second seasons, respectively, revealing that, decreases genes were dominant over increases. For the other cases, low or insignificant 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 relation size of D and H_1 estimated as 4 $(H_1/D)^{1/2}$ can be used as a weighted measure of the average degree of dominance at each locus, showed the presence of partial dominance for all studied traits, except for, number of spikelets/spike and number of spikes/plant. For the two exceptional traits the dominance ratios $[¼(H_1/D)]^{1/2}$ were found to be nearly equal unity, indicating that, both characters were controlled by complete dominance. Over dominance was obtained from F_1 inspite of partial dominance in the F_2 is logic whereas the dominance decreased in the F_2 than F_1 genotypes.

The average frequency of negative vs. positive alleles in parental population was detected by computing the ratio (H_2/4 H_1). Values largely deviating from one quarter were obtained for all studied traits, indicating that negative and positive alleles were unequally distributed among the parents (Table 19). The symmetry vs. asymmetry in gene frequency was also examined by computing the (F) values which were detected for all studied traits, revealing that the asymmetry with dominance alleles being more frequent. The same conclusion could be again be drawn from the corresponding proportion $(¼\ DH_1)^{1/2} + ½F/(¼\ DH_1)^{1/2} - ½F$. This finding in agreement with the obtained results from F_1 data (Table 18).

The over all dominance effects of heterozygous loci (h^2) were computed. Significant (h^2) values were detected for all studied traits, except for; plant height, spike length, grain yield/plant and harvest index, indicating that, the effect of dominance was due to heterozygosity and that dominance was unidirectional. Appreciable heterotic effect was previously reported by **Abul-Naas *et al.* (1986)**.

High positive coefficient values were detected for; flowering date, plant height, number of spikes/plant, seed index, number of grains/spike and straw yield/plant revealing 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. Also, it might reveal that high performance for such traits was controlled by dominant and recessive genes as well.

Hertability:

Low to moderate heritability estimates in narrow sense were detected in all the studied traits. This result supported the previous obtained resulted in the F_1 date (Table 19).

From the previous results, it can be concluded that, genetic analysis carried out by different methods of diallel cross analysis gave a similar results.

Results obtained from F_2 and F_1 generations diallel cross were relatively similar in this breeding material of wheat.