IV. EXPERIMENTAL RESULTS

1. Combining ability for characters studied in sorghum:

i. Hybrid analysis:

The analysis of variance for parents, hybrids and different comparisons for the years 1977 and 1978 are given in tables 3 and 4.

There are considerable differences among crosses and among parents for the characters studied. In all cases, male parents were more variable as compared to female parents.

Crosses performed in 1977 (Table 3) were significantly different for plant height, grain yield per plant, number of seeds per head, ear length and ear width; but not significant for 50% flowering, 1000 kernel weight and head size.

Parents were significantly different for plant height, 50% flowering grain yield per plant, number of seeds per head, 1000 kernel weight, ear width and head size and not significant for ear length.

Males were significantly different for plant height, grain yield per plant, ear length and head size and not significant for 50% flowering, number of seeds per head, 1000 kernel weight and ear width.

Table (3): Analysis of variance for parents and hybrids in 1977 season.

Sources	d.f.	Mean Sum of Square							
		Plant height	50% flowering	Yield/ plant	Seeds/ head	1000 kernel weight	Ear-length	Ear-width	Head size
Replications	2	798.87**	79.41**	52.773*	11996	5.0	21.13**	3.92**	0.002
Crosses, checks, parents	21	14147.06**	8.28**	1478.274**	518333**	105.23**	10.09**	3.60**	0.018**
Crosses	11	954.73**	4.80	377.939**	297094**	10.15	6.40*	1.32*	0.002
Parents	6	35432.54**	8.19*	3956.539**	1083250**	304.39**	6.26	7.94**	0.035**
Males	3	852.08**	7.11	307.333**	172637	6.30	8.54*	0.16	0.003*
Females	2	8.34	13.78*	18.111	22411	0.78	5.16	0.50	0.001
Males vs females	1	210022.3**	0.25	22781.015**	5936766**	1805.89**	1.70	46.20**	0.201**
Checks	2	7808.3**	3.00	54.333*	4053	21.07	18.13**	0.05	0.015**
Crosses vs parents	1	57379.0**	17.69*	500.482**	375366**	92.09**	40.65**	2.24*	0.002
Crosses + parents vs checks	1	995.274**	48.24**	2538.038**	733,996**	137.65**	27.07**	11.01**	0.115**
Parents vs checks	1	17601.43**	19.56*	1268.629**	254647	227.53**	3.64	13.32**	0.081**

Table (3): Cont'd.

Sources	d.f.	Mean Sum of Square							
		Plant height	50% flowering	Yield/ plant	Seeds/ head	1000 kernel weight	Ear-length	Ear-width	Head size
Crosses vs checks	1	1201.25**	61.25**	2976.800**	981836**	8242**	45.40**	7.77**	0.115**
Error	42	79.42	3.27	13.861	41983	9.02	2.99	0.51	0.001
Total	65	4646.49	7.228	75.138	194958	39.980	5.843	1.612	0.006
Means:									
Female parents	-	101.67	64.44	27.111	1173	23.34	16.73	3.47	0.206
Male parents	-	303.75	64.67	93.667	2247	42.08	16.16	6.47	0.403
Parents	-	217.14	64.57	65.143	1787	34.05	16.40	5.18	0.318
Hybrids	-	282.92	63.42	59.00	1619	36.58	18.16	5.59	0.306
Checks	-	270.00	66.33	79.333	1988	39.97	15.64	6.63	0.432

* Significant at 5%.

** Significant at 1%.

Females were significantly different for 50% flowering and not significant for the remaining characters.

Males vs. females comparison was significant for plant height, grain yield per plant, number of seeds per head, 1000 kernel weight, ear width and head size. It was insignificant for 50% flowering and ear length. Therefore female parents were similar to male parents for 50% flowering and ear length.

Checks were significant for plant height, grain yield per plant, ear length and head size and not significant for 50% flowering, number of seeds per head, 1000 kernel weight and ear width.

Crosses vs. parents comparison was significant for all characters except head size, indicating heterosis for all these characters except head size.

Crosses + parents vs. checks comparison was significant for all characters studied.

Parents vs. checks comparison was significant for all characters except number of seeds per head and ear length.

Crosses vs. checks comparison was significant for all characters.

During 1978 season, (Table 4), the crosses were also significantly different for all characters studied except 50% flowering, 1000 kernel weight and head size.

Parents were significantly different for all characters studied.

Males were significantly different for all characters studied except plant height and 50% flowering.

Females were significantly different for 50% flowering and ear length only.

Males vs. females comparison was significant for all characters except ear length.

Checks were significant for all characters studied except 50% flowering.

Crosses vs. parents comparison was significant for all characters studied indicating heterosis for all these characters.

Crosses + parents vs. checks comparison was significant for all characters studied except plant height and 50% flowering.

Parents vs. checks comparison was significant for all characters studied.

Table (4): Analysis of variance for parents and hybrids in 1978 season.

Sources	d.f.	Mean Sum of Square							
		Plant height	50% flowering	Yield/ plant	Seeds/ head	1000 kernel weight	Ear-length	Ear-width	Head-size
Replications	2	103.409	13.878**	11.227	258885*	51.60*	1.869	3.383**	0.004*
Cross, checks, parents	21	14330.465**	18.347**	3178.237**	886236**	227.64**	31.656**	4.901**	0.025**
Crosses	11	699.179**	3.361	1351.846**	842393**	17.77	6.659**	0.318*	0.001
Parents	6	35885.317**	19.603**	6867.826**	859534**	696.53**	11.571**	12.573**	0.035**
Males	3	385.417	1.556	632.750**	284466*	100.01**	14.970**	1.412**	0.015**
Females	2	36.111	49.333**	4.333	32762	11.79	11.324*	0.081	0.001
Males vs females	1	214083.433**	14.286*	39300.04**	4238285**	3855.58**	1.868	71.041**	0.159**
Checks	2	6552.775**	0.111	752.778**	396152**	47.52*	37.054**	3.875**	0.051**
Crosses vs parents	1	64364.666**	228.075**	3917.619**	2318360**	102.63**	249.052**	5.178**	0.010**
Crosses + parents vs checks	1	466.673	2.398	5242.552**	1076771**	208.14**	198.936**	11.056**	0.183**
Parents vs checks	1	16869.206**	26.825**	8543.492**	2550360**	302.70**	33.974**	15.873**	0.117**

Table (4): (Cont'd).

Sources	d.f.	Mean Sum of Square							
		Plant height	50% flowering	Yield/ plant	Seeds/ head	1000 kernel weight	Ear-length	Ear-width	Head-size
Crosses vs checks	1	2311.250**	31.249**	2776.939**	342696*	124.00**	318.934**	6.670**	0.193**
Error	42	155.790	2.466	33.973	73357	12.065	2.233	0.131	0.001
Total	65	4733.689	7.948	1049.113	341688	82.930	11.728	1.772	0.008
Means									
Female parents	-	102.222	69.333	35.333	1599	22.24	20.489	4.00	0.196
Male parents	-	306.25	71.00	122.750	2507	49.62	21.092	7.716	0.372
Parents	-	218.809	70.286	85.286	2118	37.89	20.833	6.124	0.297
Hybrids	-	288.472	66.139	102.472	2536	40.67	25.167	6.749	0.269
Checks	-	270.556	68.222	122.111	2754	44.82	18.511	7.749	0.433

* Significant at 5%.

** Significant at 1%.

Crosses vs. checks comparison was significant for all characters studied.

Differences in significance between the two seasons 1977 and 1978 might be due to seasonal fluctuations on some of the characters studied.

Mean values for different characters for the years 1977 and 1978 are given in tables (5-20).

1. Plant height:

Data obtained in 1977, (Table 5), show that hybrids varied from 256.67 cm to 320 cm . .The tallest hybrid was (MS 605 x G 54): 320 cm, while the shortest hybrid was (MS 605 x L 29162): 256.67 cm. According to plant height the crosses can be classified into the following categories: Taller crosses (MS 605 x G 54): 320 cm; (CK60A x G 15): 295 cm; (CK60A x G 54): 293.33 cm; (Martin A x G 15): 293.33 cm; (Martin A x G 114): 291.67 cm and (CK60A x L 29162): 288.33 cm. Middle crosses: (Martin A x L 29/62): 283.33 cm and (MS 605 x G 15): 276.67 cm. Shorter crosses: (MS 605 x G 114): 268.33 cm; (CK60A x G 114): 266.67 cm; (Martin A x G 54): 261.67 cm and (MS 605 x L 29162): 256.67 cm. Female parents varied from 100 cm to 103.33 cm. The shorter female was CK60A and the taller female was MS 605. Male parent varied from 281.67 cm to 321.67 cm. The shorter male was L 29162 and the taller male was G 15.

Table (5): Mean values for plant height (1977).

Line	Tester				Mean	% Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	293.33	291.67	261.67	283.33	282.50	101.67
CK60A	295.00	266.67	293.33	288.33	285.83	100.00
MS 605	276.67	268.33	320.00	256.67	280.42	103.33
Mean	288.33	275.56	291.67	276.11		
♂ parental mean	321.67	301.67	310.00	281.67	Hybrid mean =	282.92

S.E.M. for plant height = 5.14

In 1978, (Table 6), hybrids varied in plant height from 255 cm in (Martin A x G 54) to 311.66 cm in (MS 605 x G 15). Taller crosses were (MS 605 x G 15): 311.66 cm; (CK60A x G 15): 305 cm; (CK60A x G 114): 300 cm; (MS 605 x G 114): 300 cm; (Martin A x G 114): 291.66 cm; (Martin A x G 15): 290 cm and (MS 605 x G 54): 288.33 cm. Middle crosses were (MS 605 x L 29/62): 286.66 cm; (CK60A x G 54): 280 cm; (CK60A x L 29/62): 276.66 cm and (Martin A x L 29/62): 276.66 cm. Shorter crosses were: (Martin A x G 54): 255 cm. Female parents ranged from 98.33 cm in Martin A to 105 cm in MS 605. Male parents varied from 295 cm in L 29/62 to 321.66 cm in G 15.

2. 50% flowering:

In 1977, (Table 7), hybrids varied in 50% flowering from 61.66 days in (CK60A x L 29/62) to 65.33 days in (MS 605 x L 29/62). The following crosses were earlier: (CK60A x L 29/62): 61.66 days; (Martin A x G 15): 62 days; (MS 605 x G 54): 62 days; (Martin A x G 114); 63 days; (CK60A x G 114): 63 days; (CK60A x G 54): 63 days; (Martin A x G 54): 63.33 days; (Martin A x L 29/62): 63.66 days and (MS 605 x G 15): 63.66 days. Meanwhile, the flowering hybrids showed lateness in flowering date: (CK60A x G 15): 65 days; (MS 605 x G 114): 65.33 days and (MS 605 x L 29/62): 65.33 days.

Table (6): Mean values for plant height (1978).

Line	Tester				Mean	♀ parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	290.00	291.66	255.00	276.66	278.330	98.330
CK60A	305.00	300.00	280.00	276.66	290.415	103.330
MS 605	311.66	300.00	288.33	286.66	296.662	105.00
Mean	302.22	297.22	274.443	279.993		
♂ Parental mean	321.66	306.66	301.66	295.00	Hybrid mean =	288.472

S.E.M. for plant height = 7.206.

Table (7): Mean values for 50% flowering (1977).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	62.00	63.00	63.33	63.66	63.00	62.00
CK60A	65.00	63.00	63.00	61.66	63.17	65.33
MS 605	63.66	65.33	62.00	65.33	64.08	66.00
Mean	63.55	63.78	62.78	63.55		
♂ Parental mean	66.00	63.33	63.33	66.00	Hybrid mean = 63.42	

S.E.M. for 50% flowering = 1.04.

Female parents varied from 62 days in Martin A to 66 days in MS 605. Male parents varied from 63.33 days in G 114 and G 54 to 66 days in G 15 and L 29/62.

In 1978, (Table 8), hybrids varied in 50% flowering from 64.33 days in (Martin A x G 114) to 67.66 days in (CK60A x G 15). Earlier crosses were: (Martin A x G 114): 64.33 days; (Martin A x G 15): 64.66 days; (Martin A x G 54): 65 days; (Martin A x L 29/62): 65.33 days; (MS 605 x G 54): 66.33 days; (CK60A x G 114): 66.33 days, (MS 605 x G 15): 66.66 days; (MS 605 x G 114): 66.66 days; (MS 605 x L 29/62): 66.66 days and (CK60A x G 54): 66.66 days. Lateness crosses were: (CK60A x L 29/62): 67.33 days and (CK60A x G 15): 67.66 days.

Female parents varied from 64.66 days in Martin A to 72 days in CK60A. Male parents varied from 70 days in the variety G 54 to 71.66 days in G 114.

3. Grain yield per plant:

In 1977, (Table 9) yield performance of hybrids ranged from 40 gm in (Martin A x G 114) to 75.33 gm in (CK60A x G 114). The highest hybrids were: (CK60A x G 114): 75.33 gm; (MS 605 x G 54): 73.33 gm and (Martin A x G 15): 72.33 gm. The following hybrids showed to be lower in grain yield per plant: (Martin A x L 29/62): 64 gm, (MS 605 x G 15): 63.33 gm; (CK60A x L 29/62): 60.66 gm,

Table (8): Mean values for 50% flowering (1978).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	64.66	64.33	65.00	65.33	259.32	64.66
CK60A	67.66	66.33	66.66	67.33	267.98	72.00
MS 605	66.66	66.66	66.33	66.66	266.31	71.33
Mean	198.98	197.32	197.99	199.32		
♂ Parental mean	71.33	71.66	70.00	71.00	Hybrid mean = 66.139	

S.E.M. for 50% flowering = 0.907.

Table (9): Mean values for grain yield/gm: plant (1977).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	72.33	40.00	49.33	64.00	56.42	29.00
CK60A	58.33	75.33	47.33	60.66	60.41	28.00
MS 605	63.33	52.33	73.33	51.66	60.16	24.30
Mean	64.66	55.89	56.66	58.77		
♂ Parental mean	104.60	99.00	89.00	82.00	Hybrid mean = 59	

S.E.M. for grain yield/plant = 2.149.

(CK60A x G 15): 58.33 gm; (MS 605 x G 114): 52.33 gm; (MS 605 x L 29/62): 51.66 gm; (Martin A x G 54): 49.33 gm; (CK60A x G 54): 47.33 gm and (Martin A x G 114): 40 gm. Female parents varied from 24.3 gm in MS 605 to 29.00 gm in Martin A. Male parents ranged from 82 gm in L 29/62 to 104.6 gm in G 15.

In 1978, (Table 10), grain yield per plant of hybrids ranged from 65 gm in (Martin A x G 114) to 128.66 gm in (CK60A x G 114). The following five hybrids showed more promising yield: (CK60A x G 114): 128.66 gm; (MS 605 x G 54): 127.66 gm, (Martin A x G 15): 126.33 gm; (Martin A x L 29/62): 118.33 gm and (MS 605 x G 15): 115.66 gm. The following hybrids were lower in grain yield per plant: (CK60A x L 29/62): 103 gm; (CK60A x G 15): 100.66 gm; (MS 605 x G 114): 95.33 gm; (MS 605 x L 29/62): 86.66 gm; (Martin A x G 54): 84.66 gm; (CK60A x G 54): 77.66 gm and (Martin A x G 114): 65 gm. Female parents varied from 34 gm in MS 605 to 36.33 gm in Martin A. Male parents ranged from 110 gm in L 29/62 to 143 gm in G 15.

4. Number of seeds per head:

Hybrids obtained in 1977, (Table 11) ranged in number of seeds per head from 1066 seeds in (Martin A x G 114) to 2168 seeds in (CK60A x G 114). The best four hybrids were (CK60A x G 114): 2168 seeds; (MS 605 x G 54): 2074 seeds;

Table (10): Mean values for grain yield/gm plant (1978).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	126.33	65.00	84.66	118.33	98.580	36.33
CK60A	100.66	128.66	77.66	103.00	102.495	35.66
MS 605	115.66	95.33	127.66	86.66	106.327	34.00
Mean	114.217	96.33	96.66	102.663		
♂ Parental mean	143.00	123.00	115.00	110.00	Hybrid mean = 102.472	

S.E.M. for grain yield/plant = 3.365.

Table (11): Mean values for number of seeds/head (1977).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	1858	1066	1477	1805	1551	1235
CK60A	1606	2168	1301	1555	1657	1209
MS 605	1606	1495	2074	1414	1647	1074
Mean	1690	1576	1617	1591		
♂ Parental mean	2434	2413	2226	1916	Hybrid mean = 1619	

S.E.M. for number of seeds/head = 118.298.

(Martin A x G 15): 1858 seeds and (Martin A x L 29/62): 1805 seeds. The following hybrids were less in number of seeds per head: (MS 605 x G 15): 1606 seeds; (CK60A x G 15): 1606 seeds; (CK60A x L 29/62): 1555 seeds; (MS 605 x G 114): 1495 seeds; (Martin A x G 54): 1477 seeds; (MS 605 x L 29/62): 1414 seeds; (CK60A x G 54): 1301 seeds and (Martin A x G 114): 1066 seeds. Female parents varied from 1074 seeds in MS 605 to 1235 seeds in Martin A. Male parents ranged from 1916 seeds in L 29/62 to 2434 seeds in G 15.

In 1978, (Table 12) hybrids ranged in number of seeds per head from 1657 seeds in (Martin A x G 114) to 3337 seeds in (MS 605 x G 54). The best five hybrids were: (MS 605 x G 54): 3337 seeds; (Martin A x G 15); 3307 seeds; (CK60A x G 114): 2997 seeds; (Martin A x L 29/62): 2909 seeds and (MS 605 x G 15): 2756 seeds per head. The following hybrids were lower in number of seeds per head: (CK60A x G 15): 2464 seeds; (MS 605 x G 114): 2380 seeds; (CK60A x L 29/62): 2304 seeds; (Martin A x G 54): 2275 seeds; (CK60A x G 54): 2057 seeds; (MS 605 x L 29/62): 1989 seeds and (Martin A x G 114): 1657 seeds per head. Female parents varied from 1486 seeds in Martin A to 1693 seeds in CK60A. Male parents varied from 2137 seeds in L 29/62 to 2854 seeds in G 54.

Table (12): Mean values for number of seeds/head (1978).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	3307	1657	2275	2909	2537	1486
CK60A	2464	2997	2057	2304	2455	1693
MS 605	2756	2380	3337	1989	2615	1618
Mean	2842	2345	2556	2401		
♂ Parental mean	2635	2401	2854	2137	Hybrid mean = 2536	

S.E.M. for number of seeds/head = 156.372.

5. 1000 kernel-weight:

In 1977, (Table 13), hybrids for 1000 kernel weight ranged from 33.70 gm in (Martin A x G 54) to 39.40 gm in (MS 605 x G 15). The superior crosses were: (MS 605 x G 15): 39.40 gm; (CK60A x L 29/62): 39.13 gm, (Martin A x G 15): 38.39 gm and (Martin A x G 114): 37.57 gm. The lower weight crosses were (MS 605 x L 29/62): 36.67 gm; (CK60A x G 54): 36.43 gm; (CK60A x G 15): 36.30 gm; (MS 605 x G 54): 35.57 gm, (Martin A x L 29/62): 35.50 gm, (MS 605 x G 114): 34.97 gm, (CK60A x G 114): 34.83 gm and (Martin A x G 54): 33.70 gm.

Female parents varied from 22.90 gm in MS 605 to 23.90 gm in Martin A. Male parents ranged from 40.06 gm in G 54 to 43.33 gm in G 15.

Hybrids obtained in 1978, (Table 14), ranged from 37.7 gm in (Martin A x G 54) to 44.9 gm in (CK60A x L 29/62). The superior crosses were; (CK60A x L 29/62): 44.9 gm; (MS 605 x L 29/62): 43.8 gm; (CK60A x G 114): 42.9 gm (MS 605 x G 15): 42.1 gm; (Martin A x L 29/62): 41.4 gm and (CK60A x G 15): 41.2 gm. The lighter weight crosses were; (MS 605 x G 114): 40.1 gm; (Martin A x G 114): 39.3 gm; (Martin A x G 15): 38.4 gm; (MS 605 x G 54): 38.3 gm; (CK60A x G 54): 37.9 gm and (Martin A x G 54): 37.3 gm.

Table (13): Mean values for 1000 kernel weight (1977).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	38.93	37.57	33.70	35.50	36.43	23.90
CK60A	36.30	34.83	36.43	39.13	36.67	23.23
MS 605	39.40	34.97	35.57	36.67	36.65	22.90
Mean	38.21	35.79	35.23	37.10		
♂ Parental mean	43.23	42.00	40.06	43.03	Hybrid mean = 36.58	

S.E.M. for 1000 kernel weight = 1.735

Table (14): Mean values for 1000 kernel weight (1978).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L 29/62		
Martin A	38.40	39.30	37.70	41.40	39.20	24.50
CK60A	41.20	42.90	37.90	44.90	41.72	21.10
MS 605	42.10	40.10	38.30	43.80	41.07	21.10
Mean	40.57	40.77	37.97	43.37		
♂ Parental mean	54.30	51.20	41.20	51.80	Hybrid mean = 40.67	

S.E.M. for 1000 kernel weight = 2.005.

Female parents varied from 21.2 gm in MS 605 and CK60A to 24.5 gm in Martin A. Male parents varied from 41.2 gm in G 54 to 54.3 gm in G 15.

6. Ear-length:

In 1977 (Table 15), hybrids for ear-length ranged from 15.65 cm in (CK60A x G 15) to 19.88 cm in (Martin A x G 15). The taller ear length crosses were: (Martin A x G 15): 19.88 cm; (Martin A x G 114): 19.73 cm; (CK60A x L 29/62): 19.25 cm and (CK60A x G 54): 19.23 cm. The medium ear-length crosses were (CK60A x G 114): 18.88 cm; (MS 605 x G 15): 18.78 cm; (MS 605 x G 54): 18.58 cm; (Martin A x L 29/62): 17.80 cm; (MS 605 x G 114): 17.43 cm and (Martin A x G 54): 16.96 cm. The shorter ear-length crosses were: (MS 605 x L 29/62): 15.66 cm and (CK60A x G 54): 15.65 cm. Female parents ranged from 15.37 cm in CK60A to 17.96 cm in Martin A. Male parent ranged from 14.38 cm in L 29/62 to 17.60 cm in G 15 and G 114.

Hybrids obtained in 1978, (Table 16), ranged from 22.93 cm in (CK60A x L 29/62) to 27.60 cm in (Martin A x G 15). The taller ear-length crosses were: (Martin A x G 15): 27.60 cm; (Martin A x G 114): 27.10 cm: (MS 605 x G 15): 26.63 cm; (CK60A x G 15): 26.46 cm and (CK60A x G 114): 25.46 cm. The medium ear-length crosses were: (MS 605 x G 114): 25 cm; (MS 605 x G 54): 24.63 cm;

Table (15): Mean values for ear-length cm (1977).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L29/62		
Martin A	19.88	19.73	16.96	17.80	18.59	17.96
CK60A	15.65	18.88	19.23	19.25	18.25	15.37
MS 605	18.78	17.43	18.58	15.66	17.61	16.86
Mean	18.10	18.68	18.26	17.57		
♂ Parental mean	17.60	17.60	15.05	14.38	Hybrid mean = 18.16	

S.E.M. for ear-length = 0.998.

Table (16): Mean values for ear-length cm (1978).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L29/62		
Martin A	27.60	27.10	24.30	23.53	25.63	22.53
CK60A	26.46	25.46	24.40	22.93	24.81	20.26
MS 605	26.63	25.00	24.63	23.93	25.05	18.66
Mean	26.90	25.85	24.44	23.46		
♂ Parental mean	22.70	21.46	22.36	17.83	Hybrid mean = 25.167	

S.E.M. for ear-length = 0.863.

(CK60A x G 54): 24.40 cm and (Martin A x G 54): 24.30 cm. The shorter ear-length crosses were: (MS 605 x L 29/62): 23.93 cm; (Martin A x L 29/62): 23.53 cm and (CK60A x L 29/62): 22.93 cm.

Female parents varied from 18.66 cm in MS 605 to 22.53 cm in Martin A. Male parents varied from 17.83 cm in L 29/62 to 22.70 cm in G 15.

7. Ear-width:

In 1977, (Table 17), hybrids for ear-width ranged from 4.40 cm in (CK60A x G 15) to 6.76 cm in (CK60A x L 29/62). The wider hybrids for ear width were: (CK60A x L 29/62): 6.76 cm; (CK60A x G 54): 6.13 cm; (MS 605 x G 54): 6.13 cm; (MS 605 x G 15): 6.05 cm and (Martin A x L 29/62): 6.03 cm. The medium hybrids for ear-width were (Martin A x G 114): 5.70 cm; (Martin A x G 15): 5.45 cm; (Martin A x G 54): 5.36 cm; (MS 605 x G 114): 5.15 cm and (CK60A x G 114): 5.01 cm. The narrower hybrids in width were: (MS 605 x L 29/62): 4.93 cm and (CK60A x G 15): 4.40 cm. Female parents ranged from 3.11 cm in CK60A to 3.91 cm in Martin A. Male parents ranged from 6.28 cm in L 29/62 to 6.76 cm in G 114.

In 1978, (Table 18), hybrids for ear-width ranged from 6.36 cm in (Martin A x G 15) and (MS 605 x G 114) to 7.38 cm

Table (17): Mean values for ear-width cm (1977).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L29/62		
Martin A	5.45	5.70	5.36	6.03	5.64	3.91
CK60A	4.40	5.01	6.13	6.76	5.58	3.11
MS 605	6.05	5.15	6.13	4.93	5.57	3.38
Mean	5.30	5.29	5.87	5.91		
♂ Parental mean	6.52	6.76	6.30	6.28	Hybrid mean = 5.59	

S.E.M. for ear-width = 0.412.

Table (18): Mean values for ear-width cm (1978).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L29/62		
Martin A	6.36	6.38	6.76	6.96	6.62	3.95
CK60A	6.81	7.38	6.85	6.56	6.90	4.18
MS 605	7.10	6.36	6.46	6.95	6.72	3.86
Mean	6.76	6.71	6.69	6.82		
♂ Parental mean	8.02	7.03	7.28	8.53	Hybrid mean = 6.749	

S.E.M. for ear-width = 0.209.

in (CK60A x G 114). The wider hybrids for ear width were: (CK60A x G 114): 7.38 cm; (MS 605 x G 15): 7.10 cm; (Martin A x L 29/62): 6.96 cm; (MS 605 x G 15): 7.10 cm; (Martin A x L 29/62): 6.96 cm; (MS 605 x L 29/62): 6.95 cm; (CK60A x G 54): 6.85 cm; (CK60A x G 15): 6.81 cm and (Martin A x G 54): 6.76 cm, while medium hybrids in ear width were: (CK60A x L 29/62): 6.56 cm and (MS 605 x G 54): 6.46 cm. The narrower hybrids for ear width were: (Martin A x G 114): 6.38 cm; (Martin A x G 15): 6.36 cm and (MS 605 x G 114): 6.36 cm.

Female parents ranged from 3.86 cm in MS 605 to 4.18 cm in CK60A. Male parents ranged from 7.03 cm in G 114 to 8.53 cm in L 29/62.

8. Head size:

In 1977, (Table 19), hybrids for head size estimated as percentage ranged from 0.27% in (Martin A x G 15) and (CK60A x G 114) to 0.35% in (CK60A x L 29/62). The hybrids could be arranged according to their head size to (CK60A x L 29/62: 0.35%, (Martin A x L 29/62): 0.33%; (MS 605 x G 54): 0.33%; (CK60A x G 54): 0.32%; (Martin A x G 54): 0.32%; (MS 605 x G 15): 0.32%, (MS 605 x L 29/62): 0.31%; (MS 605 x G 114): 0.29%; (Martin A x G 114): 0.29%; (CK60A x G 15): 0.28%; (Martin A x G 15): 0.27% and (CK60A x G 114): 0.27%.

Table (19): Mean values for head size (1977).

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L29/62		
Martin A	0.27	0.29	0.32	0.33	0.302	0.22
CK60A	0.28	0.27	0.32	0.35	0.305	0.20
MS 605	0.32	0.29	0.33	0.31	0.312	0.20
Mean	0.29	0.28	0.32	0.33		
♂ Parental mean	0.37	0.38	0.42	0.44	Hybrid mean = 0.306	

S.E.M. for head size = 0.018.

Female parents ranged from 0.20% in CK60A and MS 605 to 0.22% in Martin A. Male parents ranged from 0.37% in G 15 to 0.44% in L 29/62.

Hybrids obtained in 1978, (Table 20), ranged from 0.23% in (Martin A x G 15) to 0.30% in (Martin A x L 29/62). The arrangement of hybrids would be as follow: (Martin A x L 29/62): 30%, (CK60A x G 114): 0.29%, (MS 605 x L 29/62): 0.29%; (CK60A x L 29/62): 0.29%; (Martin A x G 54): 0.28%; (CK60A x G 54): 0.28%; (MS 605 x G 15): 0.27%; (MS 605 x G 54): 0.26%; (CK60A x G 15) 0.26%; (MS 605 x G 114): 0.25%; (Martin A x G 114): 0.24% and (Martin A x G 15): 0.23%.

Female parents ranged from 0.17% in Martin A to 0.21% in MS 605. Male parents ranged from 0.33% in G 114 to 0.48% in L 29/62.

ii. Combining ability analysis:

The combining ability analysis for plant height; 50% flowering; grain yield per plant; number of seeds per head, 1000 kernel-weight, ear length, ear width and head size are given for the years 1977, (Table 21) and for 1978, (Table 22).

In 1977, (Table 21), showed significant male effects for plant height, grain yield per plant, 1000 kernel-weight and head size, non significant male effects for 50% flowering, number of seeds per head, ear length and ear width.

Table (20): Mean values for head size (1978)..

Line	Tester				Mean	♀ Parental mean
	G 15	G 114	G 54	L29/62		
Martin A	0.231	0.237	0.283	0.296	0.262	0.175
CK60A	0.257	0.290	0.280	0.287	0.278	0.206
MS 605	0.267	0.255	0.262	0.290	0.268	0.208
Mean	0.252	0.261	0.275	0.291		
♂ Parental mean	0.353	0.327	0.331	0.478	Hybrid mean = 0.269	

S.E.M. for head size = 0.018.

Table (21): Combining ability analysis in 1977 season.

Sources	d.f.	Mean Sum of Squares							
		Plant height	50% flowering	Yield/ plant	Seeds/ head	1000 kernel weight	Ear length	Ear width	Head size
Blocks	2	808.34**	52.00**	72.250*	14693	10.225**	31.33**	4.350**	0.0005
Hybrids	11	954.73**	4.80	377.939**	297094**	10.150**	6.40	1.320*	0.0020*
Male effects	3	619.21**	1.73	141.852**	22916	16.110*	1.90	1.080	0.0050**
Female effects	2	89.59	4.08	60.250	41171	0.230	2.97	0.020	0.0005
Females x Males interaction	6	1410.88**	6.57	601.880**	519490**	10.485*	9.80*	1.870*	.0010
Error	22	90.91	4.00	26.462	30158	4.589	3.38	0.54	0.0008
σ^2gca (females)	-	-110.11	-0.21	-47.698	-39860	-0.855	-0.57	-0.154	-0.00004
σ^2gca (males)	-	-87.96	-0.54	-51.114	-55175	0.625	-0.88	-0.088	0.0004
σ^2gca	-	-100.62	-0.35	-45.136	-46424	-0.221	-0.70	-0.965	0.00015
σ^2sca	-	439.99	0.86	191.806	10053	1.965	2.14	0.443	0.00007
σ^2gca/σ^2sca	-	-0.23	-0.41	-0.235	-4.618	-0.112	-0.33	-2.178	2.14300

* Significant at 5%.
** Significant at 1%.

Insignificant female effects were obtained for all characters studied.

Significant females x males interaction for plant height, grain yield per plant, number of seeds per head, 1000 kernel-weight, ear length and ear width were noticed, while there were insignificant females x males interaction for 50% flowering and head size.

The estimations of g.c.a. and s.c.a. variances showed that:

1. Plant height: The specific combining ability variance σ^2sca (439.99) was more than four times as the general combining ability variance σ^2 gca (-100.62), while σ^2 gca for females (-110.11) was more than σ^2 gca for males (-87.96). The ratio between σ^2 gca/σ^2 sca was -0.23.

2. 50% flowering: The σ^2 sca (0.86) was more than twice as σ^2 gca (-0.35), while σ^2 gca for males (-0.54) was more than σ^2 gca for females (-0.21) and the ratio of σ^2 gca/σ^2 sca was -0.41.

3. Grain yield per plant: The σ^2 sca: (191.81) was more than four times as σ^2 gca (-45.14), while σ^2 gca for males (-51.11) was slightly more than σ^2 gca for females (-47.70) and σ^2 gca/σ^2 sca was -0.23.

4. Number of seeds per head: The σ^2 gca (-46424) was nearly five times lower than σ^2 sca (10053); while σ^2gca for males (-55175) was more than σ^2 gca females: (-39860) and the ratio of σ^2 gca/σ^2 sca was -4.6.

5. 1000 kernel-weight: The σ^2 sca (1.97) was more than eight times σ^2 gca (-0.22); while σ^2 gca for females (-0.86) was larger than σ^2 gca for males (0.63) and σ^2 gca/σ^2 sca was -0.11.

6. Ear length: The σ^2 sca (2.14) was more than thrice as the σ^2 gca (-0.70); while σ^2 gca for females (-0.57) was lower than σ^2 gca for males (0.88) and the ratio σ^2gca/ σ^2 sca was -0.33.

7. Ear-wdith: The σ^2 gca (-0.96) was more than twice larger than σ^2 sca (0.44), while σ^2 gca for females (-0.15) was more than σ^2 gca for males (-0.09) and σ^2gca/ σ^2 sca was -2.2.

8. Head size : The σ^2 gca (0.00015) was more than twice the σ^2 sca (0.00007); while the σ^2 gca for males (0.0004) was more than σ^2 gca for females (-0.00004) and σ^2 gca/σ^2 sca was 2.1.

In 1978, (Table 22), showed significant male effects for all characters studied except 50% flowering, and ear

Table (22): Combining ability analysis in 1978 season.

Sources	d.f.	Mean Sum of Squares							
		Plant height	50% flowering	Yield/ plant	Seeds/ head	1000 kernel weight	Ear length	Ear width	Head size
Blocks	2	92.361	6.028	18.776	74956	11.16	3.261	2.742**	0.0060**
Hybrids	11	699.179**	3.361	1351.846**	842393**	17.77	6.659**	0.318	0.0013**
Male effects	3	1602.546**	0.843	628.472**	447401**	43.99*	20.672**	0.032	0.0026**
Female effects	2	1042.361*	15.861**	180.195*	76726	20.58	2.123	0.248	0.001
Females x Males interaction	6	133.102	0.454	2104.083**	1295112**	3.73	1.165	0.485*	0.0008*
Error	22	205.240	2.694	49.323	89523	10.71	1.801	0.151	0.0003
σ^2gca(females)	--	75.772	1.284	-160.324	-101532	1.41	0.080	-0.020	0.00002
σ^2gca (males)	--	163.271	0.043	-163.957	- 94190	4.47	2.167	-0.050	0.0002
σ^2gca	-	113.272	0.752	-161.881	- 98385	3.16	0.974	-0.033	0.0000971
σ^2sca	-	-24.046	-0.747	684.920	401863	-2.33	-0.212	0.111	0.00017
σ^2gca/σ^2sca	-	- 4.711	-1.007	-0.236	-0.245	-1.356	-4.594	-0.297	0.571

* Significant at 5%.

** Significant at 1%.

width. Moreover, significant female effects were noticed only for plant height, 50% flowering and grain yield per plant which disagree with the results in 1977 season probably due to seasonal effects.

Significant females x males interactions were found in grain yield per plant, number of seeds per head, ear width and head size. However, insignificant females x males interactions for plant height, 50% flowering, 1000 kernel weight and ear length.

The estimates of g.c.a. and s.c.a. variances were as follows:

1. Plant height: The σ^2 gca (113.27) was more than five times the σ^2 sca (-24.05); while the σ^2 gca for males (163.27) was more than the σ^2 gca for females (75.77). The ratio between σ^2 gca/σ^2 sca was 4.7.

2. 50% flowering: The σ^2 gca (0.75) nearly equals in value to σ^2 sca but was positive while the latter was negative (-0.75) which makes the σ^2 gca to be more effective for lateness. Meanwhile, the σ^2 gca for females (1.28) was more than σ^2 gca for males (0,043) and the ratio σ^2 gca/ σ^2 sca was -1, which means no effect of both of them.

3. Grain yield per plant: The σ^2 sca (684.92) was more than four times σ^2 gca (-161.88), while the σ^2 gca for males (-163.96) was a little more than the σ^2 gca for females (-160.32). The ratio of σ^2 gca/σ^2 sca was -0.24.

4. Number of seeds per head: The σ^2 sca (401863) was more than four times the σ^2 gca (-98385); while the σ^2 gca for females (-101532) was more than the σ^2 gca for male (-94190) and σ^2 gca/σ^2 sca was -0.25.

5. 1000 kernel-weight: The σ^2 gca (3.16) was higher than the σ^2 sca (-2.33); while the σ^2 gca for males (4.47) was more than the σ^2 gca for females (1.41). The ratio of σ^2 gca/σ^2 sca was 1.4.

6. Ear-length: The σ^2 gca (0.97) was about five times the σ^2 sca (-0.21); while the σ^2 gca for males (2.17) was more than the σ^2 gca for females (0.08). The ratio of σ^2 gca/σ^2 sca was 4.6.

7. Ear-width: The σ^2 sca (0.11) was more than four times the σ^2 gca (-0.03); while the σ^2 gca for males (-0.05) was more than the σ^2 gca for females (-0.02) and the ratio of σ^2 gca/σ^2 sca was -2.9.

8. Head size: The σ^2 sca (0.0002) was about twice the σ^2 gca (0.00001), while the σ^2 gca for males (0.0002) was more than the σ^2 gca for females (0.00002) and σ^2 gca/σ^2 sca was 0.60.

iii. General and specific combining ability: General combining ability was studied in the years 1977 (Table 23) and in 1978 (Table 24).

In 1977, (Table 23), general combining ability effects of females did not show any significant differences in all characters studied, but exhibited non-significant negative and positive effects. However, the general combining ability effects of males, Giza 15 gave positively a high significant value for grain yield per plant (+ 5.67) and a positive significant effects for 1000 kernel weight (+1.63). Giza 114 showed negative significant effects for both plant height (-7.36) and head size (-0.02). Giza 54 showed positive significant effects for plant height (+8.75) and the local 29/62 had a negative significant effect for plant height (-6.81) but lower than G 114 effect and showed positive significant effect for head size (+0.02): The remaining characters in four male parents did not exhibit any significant effects for g.c.a.

In 1978, (Table 24), the general combining ability effects of females did not show any significant effect in all females except Martin A which had negatively significant effects for plant height (-10.14) and for 50% flowering (-1.31). Meanwhile, the general combining ability effects of males showed that Giza 15 had highly positive significant

Table (23): General combining ability effects of female and male parents in 1977 season.

Parents	Plant height cm	50% flowering	Yield/ plant	Seeds/ head	1000 kernel weight	Ear length	Ear width	Head size
Females:								
Martin A	-0.42	-0.42	-2.583	-67.667	-0.15	+0.44	+0.047	-0.004
CK60A	+2.91	-0.25	+1.417	+38.417	+0.10	+0.09	-0.011	-0.003
MS 605	-2.50	+0.66	+1.167	+28.417	+0.07	-0.54	-0.023	+0.007
S.E. (gj)	2.75	0.58	1.484	50.132	0.618	0.53	0.212	0.008
Males:								
Giza 15	+5.41	+0.14	+5.667**	+71.00	+1.63*	-0.06	-0.290	-0.018
Giza 114	-7.36*	+0.36	-3.111	-42.778	-0.79	+0.70	-0.301	-0.024*
Giza 54	+8.75*	-0.64	-2.333	- 1.667	-1.35	+0.10	+0.288	+0.015
Local 29/62	-6.81*	+0.14	-0.222	-27.667	+0.52	-0.59	+0.321	+0.025*
S.E. ($\hat{g}i$)	3.178	0.67	1.714	57.887	0.714	0.61	0.245	0.0094

* Significant at 5%
** Significant at 1%

Table (24): General combining ability effects of female and male parents in 1978.

Parent	Plant height cms	50% flowering	Yield/ plant	Seeds/ head	1000 kernel weight	Ear length	Ear width	Head size
Females:								
Martin A	-10.139*	-1.306*	- 3.889	0.750	1.462	0.466	-0.128	-0.0075
CK60A	1.945	0.861	0.028	- 80.417	1.063	-0.350	0.155	0.0094
MS605	8.195	0.444	3.861	79.50	0.405	-0.117	-0.028	-0.0005
S.E. (gj)	4.136	0.474	2.027	86.373	0.94	0.387	0.112	0.005
Males:								
Giza 15	13.750**	0.194	11.750**	306.333**	-0.092	1.733**	0.012	-0.0175**
Giza 114	8.750	-0.361	- 6.139*	-191.333	0.119	0.688	-0.038	-0.0084
Giza 54	-14.027**	-0.139	- 5.805*	20.00	-2.714*	-0.723	-0.055	0.006
Local 29/62	- 8.472	0.305	0.195	-135.222	2.697*	1.700**	0.079	0.0218**
S.E. ($\hat{g}i$)	4.775	0.547	2.341	99.735	1.09	0.447	0.129	0.0058

* Significant at 5%.
** Significant at 1%.

effects for the characters: plant height (+13.75), grain yield per plant (+11.75), number of seeds/head (+306.33), ear length (+1.733) and had a negative highly significant value for head size (-0.017). Giza 114, exhibited negative significant effects only for grain yield per plant (-6.14). Giza 54 showed negative significant effects for plant height (-14.03), grain yield per plant (-5.8) and 1000 kernel weight (-2.7). The local 29/62 exhibited positive significant effects for 1000 kernel weight (+2.70), highly positive effects for ear length (+1.70) and head size (+0.02). The other characters in the four male parents did not show any significant effect for g.c.a.

iv. Specific combining ability: The results of years 1977 and 1978 are shown in tables (25 and 26) respectively.

In 1977, (Table 25), the specific combining ability effects (sca) for the eight characters studied were as follows:

1. Plant height: The s.c.a. effects revealed that the two hybrids Martin A x G 114 (+ 16.50) and MS 605 x G 54 (+30.83) showed positive effects for plant height and were the best for all. Meanwhile, the following three hybrids showed significant negative effects ranging from -11.80 to -29.58. CK60A x G 114 was (-11.80), MS 605 x L 29/62

Table (25): Specific combining ability effects (1977).

Character	Line	Tester			
		G 15	G 114	G 54	L 29/62
Plant height (cm)	Martin A	5.420	16.500**	-29.580**	7.640
	CK60A	3.760	-11.800	-1.250	9.310
	MS 605	-9.160	-4.730	30.830**	-16.940**
50% flowering	Martin A	-1.140	-0.360	0.970	0.520
	CK60A	1.690	-0.530	0.470	-1.650
	MS 605	-0.560	0.890	-1.440	1.110
Grain yield/ plant	Martin A	10.246**	-13.306**	-4.754	7.805*
	CK60A	-7.754*	18.024**	-10.754**	0.465
	MS 605	-2.504	-4.726	15.496**	-8.285*
Number of seeds/ head	Martin A	235.667*	-442.555**	-72.666	281.334*
	CK60A	-122.417	553.361**	-354.750**	-74.750
	MS 605	-112.417	-109.639	428.250**	-205.750
1000 kernel weight	Martin A	0.870	1.930	-1.380	-1.450
	CK60A	-2.010	-1.060	1.100	1.930
	MS 605	1.120	-0.890	0.270	-0.500
Ear length	Martin A	1.340	0.430	-1.740	-0.210
	CK60A	-2.540*	-0.070	0.880	1.590
	MS 605	1.220	-0.890	0.860	-1.370

Table (25): (Cont'd).

Character	Line	Tester			
		G 15	G 114	G 54	L 29/62
Ear width	Martin A	0.103	0.364	-0.565	0.072
	CK60A	-0.889*	-0.268	0.263	0.860
	MS 605	0.773	-0.116	0.275	-0.958*
Head size	Martin A	-0.014	0.012	0.003	0.003
	CK60A	-0.005	-0.009	0.002	0.022
	MS 605	0.025	0.001	0.002	-0.028

* Significant at 5% level.
** Significant at 1% level.

S.E. (sij) plant height = ±5.50

S.E. (sij) 50% flowering = ±1.15

S.E. (sij) grain yield/plant = ±2.970

S.E. (sij) number of seeds/head = ±100.263

S.E. (sij) 1000 kernel weight = ±1.749

S.E. (sij) ear-length = ±1.060

S.E. (sij) ear-width = ±0.424

S.E. (sij) Head-size = ±0.016

(-16.94) and Martin A x G 54 (-29.58); thus these hybrids gave the shortest hybrid plants.

2. 50% flowering: The data did not show s.c.a. with respect to this character. All hybrids had insignificant effects.

3. Grain yield per plant: The four hybrids, Martin A x L 29/62 (+7.805); Martin A x G 15 (+10.246), MS 605 x G 54 (+15.496) and CK60A x G 114 (+18.024) showed positive effects for grain yield per plant which ranging from +7.805 to 18.024. The four hybrids: CK60A x G 15 (-7.754), MS 605 x L 29/62 (-8.285), CK60A x G 54 (-10.754) and Martin A x G 114 (-13.306) showed negative significant effects ranging from -7.75 to -13.31. Thus the productivity of these hybrids were lower with respect to plant grain yield.

4. Number of seeds per head: The four hybrids Martin A x G 15 (+235.667), Martin A x L 29/62 (+281.334), MS 605 x G 54 (+428.25) and CK60A x G 114 (+553.361), showed positive effects for number of seeds per head, which ranged from +235.67 to 553.36. Two hybrids only CK60A x G 54 (-354.75) and Martin A x G 114 (-442.555), showed negatively significant effects ranging from -354.75 to -442.55 and gave lower number of seeds per head.

5. 1000 kernel-weight: Data did not show s.c.a. effects for this character and all hybrids had significant effects for 1000 kernel-weight.

6. Ear-length: Only the hybrid CK60A x G 15 (-2.54), showed negative significant effect for ear length; thus this hybrid gave shorter ear-length.

7. Ear-width: Only the two hybrids: CK60A x G 15 (-0.889) and MS 605 x L 29/62: (-0.958), showed negative significant effects for ear width. Therefore, these hybrids tend to give narrow ear-width.

8. Head size: All hybrids had insignificant effects for the percentage of ear-size.

1. Plant height:

In 1978 data in table (26), With respect to plant height , all hybrids had non significant effects for s.c.a.

2. 50% flowering: The results also obtained for this character did not show any significant s.c.a. effects in all hybrids studied.

3. Grain yield per plant: The four hybrids Martin A x G 15 (+16.00), Martin A x L 29/62 (+19.55) MS 605 x G 54 (+27.13) and CK60A x G 114: (+32.299) showed positive effects for plant grain yield which ranged from +16.00 to

Table (26): Specific combining ability effects (1978).

Character	Line	Tester			
		G 15	G 114	G 54	L 29/62
Plant height (cm)	Martin A	-2.083	4.577	-9.306	6.799
	CK60A	0.833	0.833	3.610	-5.285
	MS 605	1.243	-5.417	5.690	-1.535
50% flowering	Martin A	-0.367	-0.142	0.306	0.192
	CK60A	0.466	-0.309	-0.201	0.025
	MS 605	-0.117	0.438	-0.114	-0.228
Grain yield/ plant	Martin A	16.000**	-27.444**	-8.118	19.552**
	CK60A	-13.590**	32.299**	-19.035**	0.305
	MS 605	-2.423	-4.864	27.132**	-19.868**
Number of seeds per head	Martin A	463.917*	-688.417**	-281.75	507.472**
	CK60A	-297.916	732.750**	-418.583*	-16.361
	MS 605	-165.833	-44.167	701.500**	-491.278**
1000 kernel weight	Martin A	-0.716	-0.027	1.206	-0.505
	CK60A	-0.441	1.048	-1.119	0.470
	MS 605	1.117	-1.094	-0.061	0.028
Ear length	Martin A	0.234	0.779	-0.610	-0.403
	CK60A	-0.090	-0.045	0.306	-0.187
	MS 605	-0.153	-0.738	0.303	0.580

32.30. The four hybrids, CK60A x G 15 (-13.59) CK60 A x G 54 (-19.03), MS 605 x L 29/62 (-19.87) and Martin A x G 114 (-27.44) showed negative significant effects ranging from -13.59 to -27.44.

4. Number of seeds per head: The four hybrids: Martin A x G 15 (+463.92); Martin A x L 29/62: (+507.47); MS 605 x G 54 (+701.50) and CK60A x G 114 (+732.75) showed positive effect ranging from +463.92 to + 732.75. Meanwhile, the three hybrids CK60A x G 54 (-418.58), MS 605 x L 29/62 (-491.28) and Martin A x G 114 (-688.42) showed negative significant effects ranging from -418.58 to 688.42, and gave fewer number of seeds.

5. 1000 kernel-weight: The s.c.a. effects did not exhibit any significant effects in all hybrids for 1000 kernel weight.

6. Ear-length: There was also no s.c.a. effects for this character since all hybrids had no significant effects in all crosses studied.

7. Ear-width: On the hybrid: CK60A x G 114 (+0.51) exhibited positive significant effects for ear-width.

8. Head size: Only the hybrid CK60A x G 114 (+0.02%) showed positive significant effect for head size.

2. Heterosis in characters studied:

Expression of heterosis for each character is presented in table (27) for 1977 and table (28) for 1978 seasons.

1. Plant height:

In 1977, (Table 27), estimations of heterosis over the mid-parents for plant height was highly significant in all the F_1 crosses ranging from (+27.13%) in the cross Martin A x G 54 to (+54.84%) in the cross MS 605 x G 54. Comparing with better parents, all the F_1 crosses showed negative estimates except in the crosses Martin A x L 29/62 (+0.59%), CK60A x L 29/62 (+2.36%) and MS 605 x G 54 (+3.23%), showing positive values. Heterotic effects ranged from -15.59% in the cross Martin A x G 54 to + 3.23% in the cross MS 605 x G 54. Meanwhile, the three crosses: Martin A x G 15 (-8.81%), CK60A x G 15 (-8.29%) and MS 605 x G 114: (-11.05) were significant at level of 5%, and also the three crosses: Martin A x G 54 (-15.59%) CK60A x G 114 (-11.60%) and MS 605 x G 15 (-13.99%) were highly significant, while the other crosses were insignificant.

2. 50% flowering:

Heterosis for 50% flowering over mid-parents ranged from (-6.10%) in the cross CK60A x L 29/62 to (+1.06%) in

Table (27): Expression of heterosis in F_1 over mid and better parents as percentage for each character studied in the twelve hybrids (1977).

Cr. No.	Crosses ♀ x ♂	Plant height		50% flowering		Yield/Plant		No. seeds/head	
		M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
1	Martin A x G 15	38.58**	-8.81*	-3.12	-6.06	8.28	-30.85**	1.28	-23.66
2	Martin A x G 114	44.63**	-3.31	0.53	-0.52	-37.50**	-59.60**	-41.56**	-55.82**
3	Martin A x G 54	27.13**	-15.59**	1.06	0.00	-16.39*	-44.57**	-14.65	-33.65*
4	Martin A xL29/62	47.82**	0.59	-0.53	-3.54	15.31	-21.95**	14.57	-5.79
5	CK60A x G 15	39.92**	-8.29*	-1.01	-1.51	-12.02	-44.23**	-11.83	-34.02**
6	CK60A x G 114	32.78**	-11.60**	-2.07	-3.57	18.63*	-23.91**	19.71	-10.15
7	CK60A x G 54	43.09**	-5.38	-2.07	-3.57	-19.09*	-46.83**	-24.25	-41.55**
8	CK60A x L29/62	51.09**	2.36	-6.10	-6.58	10.29	-26.02**	-0.48	-18.84
9	MS 605 x G 15	30.20**	-13.99**	-3.54	-3.54	-1.74	-39.45**	-8.44	-34.02**
10	MS 605 x G 114	32.51**	-11.05*	1.03	-1.01	-15.12*	-47.14**	-14.25	-38.04**
11	MS 605 x G 54	54.84**	3.23	-4.12	-6.06	29.44**	-17.61**	25.70	-6.83
12	MS 605 x L29/62	33.33**	-8.88	-1.01	-1.01	-2.80	-37.00**	-5.42	-26.20

t 5% = 2.021
t 1% = 2.704

Table (27): (Cont'd).

Cr. No.	Crosses ♀ x ♂	1000 kernel weight		Ear length		Ear-width		Head-size	
		M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
1	Martin A x G 15	15.98	-9.95	11.81	10.69	4.51	-16.41	-8.47	-27.03*
2	Martin A x G 114	14.02	-10.55	10.97	9.85	6.84	-15.68	-3.33	-23.68
3	Martin A x G 54	5.38	-15.88	2.76	-5.57	4.99	-14.92	-0.94	-24.52*
4	Martin A x L29/62	6.08	-17.50	10.08	-0.89	18.35	-3.98	0.91	-24.32*
5	CK60A x G 15	9.24	-16.03	-5.06	-11.08	-8.62	-32.52*	-3.16	-25.40*
6	CK60A x G 114	6.79	-17.07	14.53	7.27	1.52	-25.89	-8.28	-30.00*
7	CK60A x G 54	15.12	-9.06	26.43	25.11	30.29	-2.70	2.26	-24.52*
8	CK60A x L29/62	18.11	-9.06	29.41*	25.24	43.98*	7.64	9.37	-20.45
9	MS 605 x G 15	19.16	-8.86	9.00	6.70	22.22	-7.21	11.23	-14.32
10	MS 605 x G 114	7.77	-16.74	1.16	-0.97	1.58	-23.82	1.03	-22.89
11	MS 605 x G 54	12.99	-11.21	16.45	10.20	26.65	-2.70	6.45	-21.43
12	MS 605 x L29/62	11.24	-14.78	0.26	-7.12	2.07	-21.50	-3.12	-29.54**

t 5% = 2.021.

t 1% = 2.704.

the cross Martin A x G 54. All the crosses were insignificant and showed negative estimates except the three crosses: Martin A x G 114 (+0.53), Martin A x G 54 (+1.06) and MS 605 x G 114 (+1.03) which gave positive values. With respect to heterosis over better-parents all the crosses showed negative values without any significant i.e. earlier in flowering except (Martin A x G 54) which did not show any heterosis (zero %). Percentage of heterosis ranged from (-6.58%) in the cross MS 605 x L 29/62 to (-0.52%) in the cross Martin A x G 114.

3. Grain yield per plant:

Heterosis in plant grain yield over the mid-parents ranged from (-37.50%) in the cross Martin A x G 114 to (+29.44%) in MS 605 x G 54. All the crosses showed negative estimates, except the five crosses: Martin A x G 15 (+8.28%), Martin A x L 29/62 (+15.31%), CK60A x G 114: (+18.63%); CK60A x L 29/62 (+10.29%) and MS 605 x G 54 (+ 29.44%) which had positive values. However, the two crosses Martin A x G 114 (-37.50%) and MS 605 x G 54 (+29.44%) showed highly significant effects, and the four crosses Martin A x G 54 (-16.39%); CK60A x G 114 (+18.63%); CK60A x G 54 (-19.09%) and MS 605 x G 114 (-15.12%), were significant at the level 5%. Comparing with better-parents, all the crosses gave negative heterosis and had highly

(+19.16%) in the cross MS 605 x G 15. Heterosis over better-parents in all crosses were negative and had insignificant values ranging from (-17.50%) in Martin A x L 29/62 to (-9.06%) in the two crosses CK60A x G 54 and CK60A x L 29/62.

6. Ear-length:

Heterosis for ear-length over mid-parents had positive values except the cross CK60A x G 15 (-5.06%) which had negative heterosis. All the crosses studied were non significant except the cross CK60A x L 29/62 (+29.41%) which was significant at 5% level. Heterosis values ranged from (-5.06%) in CK60A x G 15 to (+ 29.41%) in the cross CK60A x L 29/62. With respect to better parents, heterosis ranged from (-11.08%) in CK60A x G 15 to (+25.24%) in CK60A x L 29/62. All the crosses had non significant positive heterosis values except the following five crosses, Martin A x G 54 (-5.57%), Martin A x L 29/62 (-0.89%), CK60A x G 15 (-11.08%), MS 605 x G 114 (-0.97%) and MS 605 x L 29/62 (-7.12%), which showed negative heterosis.

7. Ear-width:

Data for heterosis of ear-width over mid-parents showed that all the crosses had positive heterotic effects except the cross CK60A x G 15 (-8.62%) which showed negative heterosis. Moreover, all the crosses studied

showed insignificant heterosis except the cross CK60A x L 29/62 (+43.98%) which was significant at 5% level. Heterosis obtained ranged from (-8.62%) in CK60A x G 15 to (+43.98%) in CK60A x L 29/62. Heterosis over better-parents had negative effects in all crosses except in the cross CK60A x L 29/62 (+7.64%), which had positive heterosis. All the crosses were insignificant except CK60A x G 15 (-32.52%) which was significant at 5% level. Heterosis scored ranged from: (-32.52%) in the cross CK60A x G 15 to (+7.64%) in the cross CK60A x L 29/62.

7. Head size:

Heterosis for head size over mid-parents showed that all the crosses were non significant with negative heterosis except the six crosses; Martin A x L 29/62 (+0.91%), CK60A x G 54 (+2.26%), CK60A x L 29/62 (+9.37%), MS 605 x G 15 (+11.23%), MS 605 x G 114 (+1.03%) and MS 605 x G 54 (+6.45%) which showed positive values. Heterosis obtained ranged from (-8.47%) in Martin A x G 15 to (+11.23%) in MS 605 x G 15. Comparisons with the better-parents showed that all crosses studied represented negative values ranging from (-30%) in the cross CK60A x G 114 to (-14.32%) in MS 605 x G 15. Only the cross Martin A x L 29/62 (-29.54%) was highly significant. Moreover, the six crosses Martin A x G 15 (-27.03%),

Martin A x G 54 (-24.52%), Martin A x L 29/62 (-24.32%), CK60A x G 114 (-30%), CK60A x G 54 (-24.52%), showed to be exhibited significant at 5% level.

1. Plant height:

In 1978, (Table 28), estimations of heterosis over mid-parents for plant height were highly significant in all the F_1s and ranged from (+27.50%) in the cross Martin A x G 54 to (+46.35%) in CK60A x G 114. Comparisons with better parents showed that all the F_1's gave negative estimations without any significance, except in the cross Martin A x G 54 (-15.47%) which showed significant at 5% level. Heterosis ranged from (-15.47%) in Martin A x G 54 to (-2.17%) in the crosses CK60A x G 114 and MS 605 x G 114.

2. 50% flowering:

For 50% flowering heterosis ranged from (-18.14%) in Martin A x G 15 to (-3.46%) in Martin A x G 54, and from (-10.23%) in Martin A x G 114 to (-6.03%) in CK60A x G 15) with respect to differences from mid-parents and better-parents, respectively. Regarding differences from mid-parents mean, the four crosses Martin A x G 114 (-5.62%), Martin A x G 54 (-3.46%), Martin A x L 29/62 (-3.69%) and CK60A x G 15 (-5.59%) did not show significant differences, Meanwhile, the remainder eight crosses showed significant heterosis. With respect to better-parents all the crosses

Table (28): Expression of heterosis in F_1 over mid and better parents as percentage for each character studied in the twelve hybrids (1978).

Cr. No.	Crosses ♀ x ♂	Plant height M.P.	Plant height B.P.	50% flowering M.P.	50% flowering B.P.	Grain yield/ plant M.P.	Grain yield/ plant B.P.	No. seeds/head M.P.	No. seeds/head B.P.
1	Martin A x G 15	38.10**	-9.84	-18.14**	-9.35**	40.89**	-11.66*	60.50**	25.50
2	Martin A x G 114	44.03**	-4.89	-5.62	-10.23**	-18.41*	-47.15**	-14.74	-30.99
3	Martin A x G 54	27.50**	-15.47*	-3.46	-7.14*	11.89	-26.38**	4.84	-20.29
4	Martin A x L29/62	40.34**	-6.44	-3.69	-7.99*	61.73**	7.57	60.58**	36.12
5	CK60A x G 15	43.53**	-5.18	-5.59	-6.03	12.68	-29.61**	13.86	-6.49
6	CK60A x G 114	46.34**	-2.17	-7.66**	-7.87*	62.18**	4.60	46.41**	24.82
7	CK60A x G 54	38.27**	-7.18	-6.11*	-7.42*	3.09	-32.47**	-9.52	-27.93*
8	CK60A x L29/62	38.91**	-6.22	-5.83*	-6.49	41.42**	-6.36	20.31	7.81
9	MS 605 x G 15	46.09**	-3.11	-6.55*	-6.55*	30.69**	-19.12**	29.60	4.59
10	MS 605 x G 114	45.75**	-2.17	-6.76*	-6.98*	21.44*	-22.50**	18.44	-0.87
11	MS 605 x G 54	41.80**	-4.42	-6.13*	-7.01*	71.36**	11.01	49.24**	16.92
12	MS 605 x L29/62	43.33**	-2.83	-6.33*	-6.55*	20.36*	-21.22**	5.94	-6.93

t 5% = 2.021.

t 1% = 2.704.

Table (28): (Cont'd)

Cr. No.	Crosses ♀ x ♂	1000-kernel weight M.P.	1000-kernel weight B.P.	Ear-length M.P.	Ear-length B.P.	Ear-width M.P.	Ear-width B.P.	Head-size M.P.	Head-size B.P.
1	Martin A x G 15	-2.54	-29.28**	22.04**	21.59*	6.27	-20.70**	-12.50	-34.56**
2	Martin A x G 114	3.83	-23.24*	23.21**	20.28*	16.21	-9.25	-5.58	-27.52*
3	Martin A x G 54	14.76	-8.49	8.26	7.86	20.39*	-7.14	11.86	-14.50
4	Martin A x L29/62	8.52	-20.08*	16.60	4.44	11.54	-18.41**	-9.20	-38.07**
5	CK60A x G 15	9.28	-24.12*	23.18**	16.56	11.64	-15.09*	-7.88	-27.19*
6	CK60A x G 114	18.67	-16.21	22.05*	18.64	31.67**	4.98	9.02	-11.31
7	CK60A x G 54	21.67	-8.01	14.50	9.12	19.55*	-5.91	4.48	-15.41
8	CK60A x L29/62	23.18	-13.32	20.40*	13.18	3.23	-23.10**	-16.08	-39.96**
9	MS 605 x G 15	11.67	-22.47*	28.77**	17.31	19.53*	-11.47	-4.64	-24.36
10	MS 605 x G 114	10.93	-21.68*	24.63*	16.50	16.80*	-9.53	-4.49	-22.02
11	MS 605 x G 54	22.95	-7.04	20.09*	10.15	15.98	-11.26	-2.60	-20.85
12	MS 605 x L29/62	20.16	-15.44	31.16**	28.24*	12.19	-18.52**	-15.45	-39.33**

t 5% = 2.021.

t 1% = 2.704.

showed significant differences except the two crosses CK60A x G 15 (-6.03%) and CK60A x L 29/62 (-6.49%), which did not show any significance.

3. Grain yield per plant:

Heterosis in grain yield per plant over mid-parents were positively significant in all crosses except the three crosses, Martin A x G 54 (+11.89%), CK60A x G 15 (+12.68) and CK60A x G 54 (+3.09%) which did not show any significant diffferences. Only the cross Martin A x G 114 (-18.41) showed negative heterosis while the other crosses had positive values. Heterosis obtained ranged from (18.41%) in Martin A x G 114 to (+71.36%) in MS 605 x G 54. Comparing with the better parents, all the crosses showed negative significant heterosis except the three crosses, Martin A x L 29/62 (+7.57%)., CK60A x G 114 (+4.60%) and MS 605 x G 54 (+11.01%), which exhibited positive insignificant estimates. Heterosis ranged from (-47.15%) in Martin A x G 114 to (+11.01%) in MS 605 x G 54.

4. Number of seed per head:

For number of seeds per head, heterosis in all the crosses over mid-parents ranged from (-14.74%) in Martin A x G 114 to (+60.58%) in Martin A x L 29/62. Moreover, the following four crosses showed highly

significant differences, Martin A x G 15 (-60.50%), Martin A x L 29/62 (+60.58%), CK60A x G 114 (+46.41%) and MS 605 x G 54 (+49.24%). Meanwhile the two crosses Martin A x G 114 (-14.74%) and CK60A x G 54 (-9.52%) showed insignificant negative differences, while the other crosses had positive values. Comparing with the better parents all the F_1s were not significant, except in the cross CK60A x G 54 (-27.93%), which exhibited a significant negative value. The percentage obtained ranged from (-30.29%) in Martin A x G 114 to (+36.12%) in Martin A x L 29/62. Six crosses showed negative heterosis, Martin A x G 114 (-30.99%), Martin A x G 54 (-20.29%), CK60A x G 15 (-6.49%), CK60A x G 54 (-27.93%), MS 605 x G 114 (-0.87%) and MS 605 x L 29/62 (-6.93%), while the other crosses gave positive values.

5. 1000 kernel weight:

For 1000 kernel weight, heterosis over mid-parents values in all crosses were insignificant and it ranged from (-2.54%) in Martin A x G 15 to (+23.18%) in CK60A x L 29/62. Only the cross Martin A x G 15 (-2.54%) was negative in heterosis. F_1 compared with better-parents in all the crosses showed negative heterosis ranging from (-29.28%) in Martin A x G 15 to (-7.04%) in MS 605 x G 54. Meanwhile, the five crosses Martin A x G 114 (-23.24%), Martin A x L 29/62 (-20.08%), CK60A x G 15 (-24.12%), MS 605 x G 15

(-22.47%) and MS 605 x G 114 (-21.68%) had significant values at 5% level. Moreover, the cross Martin A x G 15 (-29.28%) was highly significant, while the other crosses were insignificant.

6. Ear length:

For ear-length heterosis in all crosses over mid-parents and better parents showed positive differences. It ranged from (+8.26%) in Martin A x G 54 to (+31.16%) in MS 605 x L 29/62. Furthermore, the five crosses Martin A x G 15 (+22.04%), Martin A x G 114 (+23.21%), CK60A x G 15 (+23.18%), MS 605 x G 15 (+28.77%) and MS 605 x L 29/62 (+31.16%) were highly significant, while the four crosses CK60A x G 114 (+22.05%), CK60 A x L 29/62 (+20.40%); MS 605 x G 114 (+24.63%) and MS 605 x G 54 (+20.09%) showed to be significant positive heterosis at 5% level; other crosses were insignificant. Heterosis over better-parents ranged from (+4.44%) in Martin A x L 29/62 to (+28.24%) in MS 605 x L 29/62. However, the crosses did not show any significant effect except the three crosses: Martin A x G 15 (+21.59%), Martin A x G 114 (+20.28%) and MS 605 x L 29/62) (+28.24%) which showed significant effect at 5% level.

7. Ear-width:

Heterosis for ear width over mid-parents showed positive values in all the crosses studied ranging from

(+3.23%) in CK60A x L 29/62 to (+31.67%) in CK60A x G 114. It was found that the four crosses Martin A x G 54 (+20.39%), CK60A x G 54 (+19.55%), MS 605 x G 15 (+19.53%) and MS 605 x G 54 (+16.80%), showed significant positive heterosis at 5% level. The cross CK60A x G 114 (31.67) showed highly significant heterosis, while the other crosses were insignificant. Heterosis over better-parents in all the crosses showed to be negative except in the cross CK60A x G 114 (+4.98%) which showed positive heterosis. The range of heterosis was between (-23.10%) in CK60A x L 29/62 to (+4.98%) in CK60A x G 114. Meanwhile, the following four crosses showed highly significant effects. Martin A x G 15 (-20.70%), Martin A x L 29/62 (-18.41%), CK60A x L 29/62 (-23.10%) and MS 605 x L 29/62 (-18.50%). The cross CK60A x G 15 (-15.09%) was significant at 5% level, meanwhile the other crosses had insignificant differences.

8. Head size:

Heterosis for head-size over mid-parents showed negative value in all crosses studied except the three crosses Martin A x G 54 (+11.86%), CK60A x G 114 (+9.02%) and CK60A x G 54 (+4.48%). Meanwhile, other crosses showed insignificant differences ranging from (-16.08%) in CK60A x L 29/62 to (+11.86%) in Martin A x G 54.

Comparisons of F_1's with better parents in all the crosses showed negative estimates ranging from (-39.96%) in CK60A x L 29/62 to (-11.31%) in CK60A x G 114. Only the four crosses Martin A x G 15 (34.56%), Martin A x L 29/62 (-38.07%), CK60A x L 29/62 (-39.96%) and MS 605 x L 29/62 (-39.33%), were highly significant and the two crosses Martin A x G 114 (-27.52%) and CK60A x G 15 (-27.19%) were significant at 5% level. The other crosses showed insignificant effects.

3. Inheritance of some characters:

The inheritance of the four following characters were studied in twelve crosses: plant height, grain yield per plant, ear length and ear width. Data obtained in 1978 in F_2 are shown in the tables from (29) to (32).

1. Plant height:

All the male-sterile lines with a length of 97-104 cm were considered as a shorter plants, while the Egyptian varieties ranged from 295-321 cm were taller plants.

Martin A x Giza 15:

a. Nature of dominance: the observed F_1 mean (288.66 cm) was higher than the F_1 calculated arithmetic mean (209.17 cm), this indicated the presence of pertial dominance effect in the F_1 which gave a higher mean values than the mid-parents. However the value was depressed in F_2 mean (250.09). These facts suggested the partial dominance of taller parent Giza 15: 321.66 as shown in Table (29).

b. Number of genes involved: The Castle-Wright and Wright's formula resulted in the estimation of (2.34 - 2.93) pairs of genes, respectively, indicating that the minimum number of genes responsible for the parental difference in plant height in this cross was from (2-3) pairs of genes. Out of 213 plants obtained in the F_2,