4. RESULTS AND DISCUSSION

4.1. Mean performance and ranking of inbred lines :

Mean values and ranking of inbreds in their crosses for tasseling and silking dates, plant and ear heights, ear length and diameter, number of rows/ ear, number of kernels/ row, 100- kernel weight and grain yield/ plant combined over two years are presented in Tables (3 - 12).

Results in Table (3) showed that the mean performance of tasseling date was significantly lower than the check variety S.C. 10 by the inbreds M18, M30 and M 35 in their top crosses over the three studied testers. Moreover, five inbreds M1, M18, M 30, M 35 and M 36 tassled significantly earlier than the check variety Giza- 2. It is clear that the top crosses between each of M 7 and M 15 and the tester Giza- 2 were the best among the studied crosses since they were the earliest ones recording 54.67 and 54.33 days, respectively. On the other hand, the top crosses M 2 x S.C. 10 was the latest cross among all crosses followed by the top crosses M 11 x S.C. 10 and M 12 x S.C. 10.

Ranks of tasseling date for inbred in their crosses with each tester and averaged over the three testers are presented in Table (4). It is obvious that inbred line M 18 ranked the first among all lines, being the first ranking with the tester M 13 and third ranking with each of Giza- 2 and S.C.10. The inbred line M 35 ranked the second in crosses

Table (3): Mean performance of 114 top crosses between 38 inbred lines and each of three testes for tasseling and silking dates in maize combined over two seasons.

Trait	Tasseling date (day)				Silking date (day)			
Tester / Lines	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	56.00	58.00	56.33	56.78	58.33	59.33	62.17	59.94
M. 2	58.00	62.50	59.17	59.89	62.00	66.17	66.50	64.56
M. 3	59.50	59.83	58.50	59.28	62.50	64.50	63.50	63.50
M. 4	58.17	58.83	58.33	58.44	60.83	62.50	62.83	62.06
M. 5	59.00	59.17	59.17	59.11	62.33	63.07	63.33	63.11
M. 6	58.00	60.00	60.67	59.56	61.83	64.17	64.00	63.33
M. 7	54.67	56.50	60.50	57.22	60.17	62.50	63.50	62.00
M. 8	60.17	58.83	58.67	59.67	63.33	63.00	64.17	63.50
M. 9	57.83	59.33	58.50	58.50	63.17	64.17	63.33	63.56
M. 10	57.33	59.83	58.83	58.67	62.33	63.83	63.33	63.17
M. 11	56.17	62.33	57.33	58.61	61.00	67.17	62.00	63.39
M. 12	59.17	62.33	59.00	60.17	60.00	66.50	63.33	63.28
M. 13	56.00	60.07	59.00	58.56	60.33	66.00	64.00	63.44
M. 14	56.33	61.17	59.00	58.83	61.17	65.17	64.17	63.50
M. 15	54.33	60.67	59.00	58.00	60.33	66.67	64.00	63.67
M. 16	55.33	58.83	58.33	57.50	60.67	63.50	63.50	62.56
M. 17	55.67	60.67	57.33	57.89	60.67	64.33	62.33	62.44
M. 18	55.00	56.33	55.17	55.50	59.17	61.33	61.50	60.67
M. 19	56.67	61.17	58.00	58.61	60.67	66.33	61.83	62.94
M. 20	56.00	59.17	57.67	57.94	61.50	66.50	62.17	63.39
M. 21	56.17	58.83	58.17	57.72	60.67	65.83	62.00	62.83
M. 22	56.67	60.50	58.50	58.56	61.50	66.67	62.17	63.11
M. 23	56.00	60.17	57.67	57.94	61.33	66.67	61.83	63.28
M. 24	56.17	61.17	59.83	59.06	61.33	60.00	63.50	63.61
M. 25	58.17	58.00	58.50	58.22	62.33	65.67	63.33	63.78
M. 26	57.00	59.17	57.17	57.78	62.67	66.33	63.17	64.06
M. 27	57.83	59.00	58.83	58.56	60.00	64.00	62.50	62.17
M. 28	57.83	62.33	57.83	59.33	64.00	66.50	63.50	64.67
M. 29	57.83	61.50	57.00	58.78	62.50	67.50	62.83	64.11
M. 30	55.17	56.00	55.83	55.67	60.33	66.50	61.87	62.83
M. 31	59.33	61.83	56.50	59.22	64.83	66.17	61.00	64.00
M. 32	56.67	57.83	56.83	57.11	62.83	65.33	61.83	63.33
M. 33	56.00	60.83	59.33	58.72	61.33	67.00	63.17	64.00
M. 34	60.17	60.83	59.00	60.00	63.00	65.50	63.83	64.11
M. 35	56.00	56.00	56.83	55.61	59.17	61.33	60.33	60.28
M. 36	56.67	57.50	56.67	56.94	60.00	61.50	61.83	61.11
M. 37	58.83	58.83	58.17	58.61	62.83	65.00	63.33	63.72
M. 38	59.33	60.83	56.83	59.00	64.00	65.00	61.50	63.50
L.S.D 0.05	2.02				2.42			
L.S.D 0.01	2.72				3.14			
Giza- 2	59.17				63.00			
S.C. 10	57.70				64.50			

Table (4): Ranks of 38 maize inbred lines when evaluated by three testers for tasseling and silking dates in maize combined over two seasons.

Trait	Tasseling date				Silking date			
Tester / Lines	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	11	8	4	**4**	1	1	14	**1**
M. 2	28	38	34	**36**	24	27	38	**37**
M. 3	36	20	24	**33**	29	15	31	**26**
M. 4	30	13	20	**16**	15	6	18	**5**
M. 5	32	17	33	**30**	27	9	26	**14**
M. 6	28	21	38	**35**	22	13	35	**19**
M. 7	2	4	37	**7**	7	6	31	**6**
M. 8	38	10	25	**32**	35	7	37	**26**
M. 9	25	18	24	**19**	34	13	26	**27**
M. 10	25	19	27	**24**	27	10	26	**15**
M. 11	14	37	12	**22**	16	38	11	**21**
M. 12	33	37	32	**38**	6	33	26	**17**
M. 13	11	26	32	**20**	9	25	35	**22**
M. 14	15	32	32	**27**	17	18	37	**26**
M. 15	1	26	32	**14**	10	35	35	**29**
M. 16	5	13	20	**8**	13	8	31	**9**
M. 17	6	26	12	**10**	13	14	15	**8**
M. 18	3	3	1	**1**	3	2	4	**3**
M. 19	19	32	16	**23**	13	29	7	**12**
M. 20	21	17	14	**13**	21	33	13	**21**
M. 21	14	13	18	**9**	14	23	11	**11**
M. 22	19	23	24	**19**	21	22	13	**14**
M. 23	11	22	14	**13**	19	35	9	**17**
M. 24	12	32	36	**29**	19	25	31	**28**
M. 25	30	8	24	**15**	25	22	26	**31**
M. 26	20	17	10	**10**	30	28	19	**34**
M. 27	25	14	27	**19**	6	11	16	**7**
M. 28	25	37	15	**34**	37	33	31	**38**
M. 29	25	33	9	**26**	29	37	18	**36**
M. 30	4	2	3	**3**	9	33	5	**11**
M. 31	35	34	5	**31**	38	27	2	**33**
M. 32	19	6	8	**6**	32	19	9	**19**
M. 33	11	29	36	**25**	23	37	20	**33**
M. 34	38	29	32	**37**	33	20	32	**36**
M. 35	11	1	2	**2**	3	3	1	**2**
M. 36	19	5	6	**5**	6	4	7	**4**
M. 37	31	13	18	**22**	32	17	26	**30**
M. 38	35	29	8	**28**	37	17	4	**26**

over tester, being the first ranking with the tester S.C. 10 and second with tester M 13. Inbred line M 30 occupied the third place in crosses over all testers, being 2 nd with tester S.C. 10 , 3 rd with tester M 13 and 4 th with tester Giza- 2.

Concerning silking date, results in Table (3) indicated that six out of 38 top crosses over all testers were significantly earlier than the check variety S.C. 10. Moreover, the earliest inbred line was M 1 followed by inbred M 35 then M 36 . Among all top crosses, M 1 x Giza- 2, M 35 x Giza-2 and M 1 x S.C. 10 seemed to be the best top crosses since they had the lowest days to 50 % silking being 58.33 and 59.17 and 59.33, respectively.

Ranks of silking date for all inbreds with each tester and over three testers are presented in Table (4). The inbred M 1 ranked the first among all lines, being the first ranking with two testes (Giza-2 and S.C. 10). The inbred line M 35 ranked the second among all lines, being the 1 st ranking with tester M 13 and 3 rd with the testers Giza- 2 and S.C. 10. The inbred M 18 ranked the third among all lines, being the 3 rd, 2 nd and 4 th ranking for the testers Giza- 2, S.C. 10 and M 13, respectively.

From the previous results it could be concluded that the inbred lines M 1, M 18, M35 and M 36 and their top crosses could be utilized for developing early flowering hybrids since they were the earliest among all top crosses.

Regarding plant height, most top crosses were significantly shorter than the check varieties Giza- 2 and S.C. 10 (Table 5). The best inbreds were M 1, M 2, M 3 and M 30 since they expressed the lowest values of plant height in their top crosses over all testers. Such results indicated that these materials are prospecting in maize breeding programs towards development short stature hybrids.

Inbred line M 1 ranked the first among all lines for short plant height, being the first ranking with two testers (Giza- 2 and M 13) as shown in Table (6). Also, inbred line M 2 occupied the second rank over all testers, being 2 nd with Giza- 2. The third rank was occupied by the inbred line M 30 where it had the 4 th ranking with the tester M 13.

The same trend was obtained for ear height (Table 5), where inbred lines M 1, M 2, M 27 and M 30 had the lowest ear height over all testers with significant values from the check variety S.C. 10. Moreover, the best top crosses for ear height were M 30 x M 13, M 2 x Giza-2, M 30 x Giza- 2 and M 29 x M 13 since they expressed the shortest ear height being 96.67, 102.83, 103.83 and 105.33 cm, respectively.

Ranks of inbred lines concerning ear height revealed that inbred line M 30 occupied the first rank over all testers, being the 1 st ranking with the tester M 13, 2 nd with the tester Giza- 2 and the 4 th with S.C. 10 (Table 6). Inbred line M 27 ranked 2 nd among all testers, being

Table (5): Mean performance of 114 top crosses between 38 inbred lines and each of three testes for plant and ear heights of maize combined over two seasons.

Trait	Plant height (cm)				Ear height (cm)			
Tester / Lines	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	209.00	226.87	217.50	217.78	107.00	111.00	109.00	109.00
M. 2	211.17	229.83	226.17	222.39	102.83	114.67	109.67	109.06
M. 3	215.67	237.50	224.67	225.94	108.50	118.50	109.67	112.22
M. 4	224.33	247.50	230.17	234.00	111.50	121.60	111.50	114.83
M. 5	235.33	267.17	258.17	253.56	128.00	133.17	123.17	128.11
M. 6	226.50	253.83	241.50	240.61	109.83	130.50	112.33	117.56
M. 7	218.33	241.67	227.33	229.11	111.67	118.67	110.33	113.56
M. 8	227.50	241.83	230.00	233.11	112.33	131.33	117.83	120.50
M. 9	234.00	258.50	249.67	247.39	121.67	124.17	124.33	123.39
M. 10	232.50	242.50	234.00	236.33	116.17	118.83	120.17	118.39
M. 11	219.83	222.50	240.00	227.44	110.67	115.00	115.00	113.56
M. 12	227.67	231.67	245.17	234.83	118.33	113.67	125.00	119.00
M. 13	227.33	242.00	236.83	235.39	116.00	118.33	115.67	116.67
M. 14	225.00	237.83	236.17	232.67	113.50	114.00	113.83	113.78
M. 15	236.50	231.67	239.50	235.56	119.50	108.50	113.67	113.89
M. 16	235.17	241.33	233.50	236.67	117.50	112.83	110.33	113.56
M. 17	236.00	235.50	219.00	230.17	111.50	120.17	111.83	114.50
M. 18	227.83	216.67	242.50	229.00	116.33	106.50	114.33	112.39
M. 19	242.83	267.50	264.33	258.22	126.50	127.83	125.67	126.67
M. 20	233.83	235.33	243.17	237.44	109.33	114.00	119.67	114.33
M. 21	231.17	247.50	246.50	241.72	114.50	113.33	120.17	116.00
M. 22	225.83	232.50	227.00	228.44	111.83	115.17	116.50	114.50
M. 23	231.50	229.00	241.83	234.11	134.00	117.00	115.83	122.28
M. 24	234.83	233.50	241.00	236.44	116.17	116.33	124.17	118.89
M. 25	225.50	238.67	233.00	232.39	113.33	118.83	113.17	115.11
M. 26	227.67	247.00	230.33	235.00	114.67	125.50	113.17	117.78
M. 27	225.50	237.50	221.50	228.17	104.50	110.00	106.17	106.89
M. 28	226.33	248.17	233.00	235.17	107.83	127.33	111.00	115.39
M. 29	231.50	243.33	233.50	236.11	108.00	117.50	105.00	110.17
M. 30	224.00	229.33	223.50	225.61	103.83	110.33	96.67	103.61
M. 31	240.17	238.33	235.67	238.06	119.83	119.33	105.33	114.83
M. 32	222.50	226.67	30.17	226.44	109.83	113.67	106.83	110.11
M. 33	231.00	227.33	239.83	232.72	111.50	120.33	110.33	114.06
M. 34	224.67	228.17	238.67	230.50	105.83	114.83	119.50	113.39
M. 35	242.00	248.17	239.33	243.17	121.17	123.67	114.00	119.61
M. 36	239.67	222.00	242.83	234.83	116.33	111.17	121.17	116.22
M. 37	250.33	230.83	239.67	240.28	141.50	137.50	127.00	135.33
M. 38	238.17	240.83	240.80	239.94	119.00	128.00	124.67	123.89
L.S.D 0.05	22.17				14.60			
L.S.D 0.01	29.07				19.14			
Giza- 2	283.00				138.10			
S.C. 10	272.00				140.20			

Table (6): Ranks of 38 maize inbred lines when evaluated by three testers for plant and ear heights of maize combined over two seasons.

Trait	Plant height (cm)				Ear height (cm)			
Tester / Lines	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	1	5	1	**1**	5	5	6	**3**
M. 2	2	10	6	**2**	1	13	8	**4**
M. 3	3	19	5	**4**	8	21	8	**7**
M. 4	8	32	11	**17**	15	28	13	**20**
M. 5	30	37	37	**37**	36	37	32	**37**
M. 6	15	35	29	**33**	11	35	15	**26**
M. 7	4	25	8	**10**	16	22	11	**11**
M. 8	17	26	9	**16**	18	36	26	**32**
M. 9	27	36	36	**36**	34	30	34	**34**
M. 10	25	28	17	**26**	24	23	30	**28**
M. 11	5	3	26	**6**	12	15	22	**11**
M. 12	19	13	34	**20**	29	10	36	**30**
M. 13	16	27	20	**22**	23	20	23	**25**
M. 14	10	20	18	**14**	20	12	19	**13**
M. 15	31	13	23	**23**	31	2	18	**14**
M. 16	29	24	16	**28**	28	7	9	**12**
M. 17	32	17	2	**11**	15	26	14	**18**
M. 18	20	1	31	**9**	27	1	21	**8**
M. 19	37	38	38	**38**	35	33	37	**36**
M. 20	26	16	33	**29**	9	12	28	**23**
M. 21	22	32	35	**34**	21	8	29	**23**
M. 22	13	14	7	**8**	17	16	25	**18**
M. 23	24	8	30	**18**	37	18	24	**33**
M. 24	28	15	28	**27**	25	17	33	**29**
M. 25	12	22	14	**13**	19	24	17	**21**
M. 26	19	30	12	**21**	22	31	16	**27**
M. 27	12	19	3	**7**	3	3	4	**2**
M. 28	14	34	14	**24**	6	32	12	**22**
M. 29	24	29	16	**25**	7	19	2	**6**
M. 30	7	9	4	**3**	2	4	1	**1**
M. 31	35	21	19	**30**	32	25	3	**20**
M. 32	6	4	11	**5**	11	10	5	**5**
M. 33	21	6	25	**15**	15	27	11	**15**
M. 34	9	7	21	**12**	4	14	27	**9**
M. 35	36	34	22	**35**	33	29	20	**31**
M. 36	34	2	32	**20**	26	6	31	**24**
M. 37	38	11	24	**32**	38	38	38	**38**
M. 38	33	23	27	**31**	30	34	35	**35**

the 3 rd ranking with the testers Giza- 2 and S.C. 10 and 4 th ranking for the tester M 13.

From such results it is clear that the inbred lines M 1, M 27 and M 30 may be of great useful for the development of new hybrids with short ear position.

Results in Table (7) showed that most of the top crosses were significantly higher than the check varieties Giza- 2 and S.C. 10 for ear length. The best crosses among all 114 top crosses were M 5 x Gixa –2 (20.10 cm), followed by the top cross M 4 x S.C. 10 (20.02 cm) then the top cross M 8 x S.C. 10 (19.25 cm). However, the inbred lines M 5, M 6 and M 38 gave the highest ear length over all testers being 18.48, 18.34 and 18.27 cm, respectively.

Ranks of inbred lines over all testers for ear length revealed that M 5 inbred line occupied the first ranking, being the 1 st with the tester Giza-2 and 5 th with the tester S.C. 10 (Table 8). The inbred M 6 occupied the second rank overall testers being the 2 nd ranking with the tester M 13, the 3 rd ranking with the tester S.C. 10. The inbred line M 38 ranked the third over all testers, being the 2 nd ranking with Giza-2 and 3 rd ranking with tester M 13 and 6 th with tester S.C. 10.

Regarding ear diameter, most top crosses were significantly higher than the check varieties (S.C. 10 and Giza- 2). However, the most desirable top crosses were M 38 x M 13 (46.07 mm) followed by M 8 x S.C. 10 (45.12 mm) and then M 5 x Giza- 2 (44.48 mm). Based

Table (7): Mean performance of 114 top crosses between 38 inbred lines and each of three testes for ear length and diameter of maize combined over two seasons.

Trait	Ear length (cm)				Ear diameter (mm)			
Tester / Lines	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	18.47	17.97	16.33	17.59	41.15	43.67	42.23	42.35
M. 2	15.90	18.12	15.23	16.42	41.30	42.67	41.33	41.77
M. 3	16.57	18.28	16.78	17.21	38.92	40.82	41.75	40.49
M. 4	17.32	20.02	16.42	17.92	41.98	43.87	40.13	41.99
M. 5	20.10	18.43	16.92	18.48	44.48	42.67	41.17	42.77
M. 6	18.10	18.90	18.02	18.34	41.92	40.73	41.25	41.30
M. 7	15.25	17.72	15.35	16.11	42.07	41.67	40.82	41.52
M. 8	16.87	19.25	15.90	17.34	40.68	45.12	40.53	42.11
M. 9	17.75	17.63	17.30	17.56	40.63	41.75	40.60	40.99
M. 10	16.57	17.25	16.06	16.63	43.30	41.80	40.05	41.73
M. 11	16.23	16.30	16.42	16.32	39.82	39.82	39.68	39.77
M. 12	15.90	16.95	16.72	16.52	43.22	41.60	41.40	42.07
M. 13	17.05	18.82	15.83	17.23	42.32	44.53	40.23	42.36
M. 14	16.88	17.78	15.33	16.67	43.42	43.38	41.80	42.87
M. 15	16.85	15.82	16.58	16.42	41.47	39.13	40.60	40.47
M. 16	15.32	16.80	15.20	15.77	41.58	42.20	42.00	41.93
M. 17	17.37	18.33	17.42	17.71	40.03	45.25	44.58	43.29
M. 18	17.27	16.33	16.83	16.81	39.90	40.50	39.92	40.11
M. 19	17.23	15.82	15.87	16.31	40.82	39.47	42.37	40.88
M. 20	18.68	16.25	16.67	17.20	40.40	38.67	41.60	40.22
M. 21	16.72	14.62	15.85	15.73	42.23	40.32	40.98	41.18
M. 22	16.42	16.73	15.90	16.35	41.57	38.90	39.67	40.04
M. 23	16.93	15.92	15.92	16.26	40.23	35.88	38.27	37.46
M. 24	17.55	16.10	15.93	16.53	38.83	38.18	38.77	38.59
M. 25	15.28	16.68	15.83	15.93	41.03	40.55	41.43	41.01
M. 26	15.60	15.87	15.38	15.62	39.08	41.47	40.98	40.51
M. 27	17.92	17.93	16.48	17.44	42.37	44.23	42.97	43.19
M. 28	15.72	17.42	17.05	16.73	42.45	41.83	42.93	42.41
M. 29	16.13	16.45	17.05	16.54	41.82	41.67	43.47	42.32
M. 30	16.78	17.10	18.32	17.40	40.73	42.10	44.82	42.55
M. 31	17.78	17.73	17.72	17.74	43.72	41.82	43.75	43.09
M. 32	17.23	16.05	17.47	16.92	41.27	42.43	41.82	41.84
M. 33	16.67	17.70	17.17	17.18	43.20	43.08	41.28	42.52
M. 34	16.58	16.85	16.62	16.68	38.07	39.72	42.17	39.98
M. 35	18.17	17.37	16.67	17.40	41.85	43.32	43.02	42.73
M. 36	18.53	15.23	17.63	17.13	41.92	41.47	43.87	42.35
M. 37	17.48	16.73	16.55	16.92	41.13	42.47	42.12	41.91
M. 38	18.68	18.42	17.72	18.27	41.53	43.68	46.07	43.76
L.S.D 0.05	1.86				2.62			
L.S.D 0.01	2.44				3.44			
Giza- 2	15.20				35.00			
S.C. 10	15.60				37.50			

Table (8): Ranks of 38 maize inbred lines when evaluated by three testers for ear length and diameter of maize combined over two seasons.

Trait	Ear length (cm)				Ear diameter (mm)			
Tester / Lines	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	5	10	24	**7**	23	7	11	**12**
M. 2	32	9	37	**28**	21	11	21	**21**
M. 3	27	8	14	**14**	36	26	17	**30**
M. 4	14	1	22	**4**	12	5	32	**17**
M. 5	1	5	12	**1**	1	11	24	**6**
M. 6	7	3	2	**2**	14	27	23	**24**
M. 7	38	14	35	**34**	11	21	27	**23**
M. 8	21	2	28	**12**	28	2	30	**15**
M. 9	10	16	8	**8**	29	20	29	**27**
M. 10	28	19	25	**24**	4	17	33	**22**
M. 11	30	29	22	**31**	34	31	35	**36**
M. 12	32	21	15	**27**	5	23	20	**16**
M. 13	18	4	32	**13**	9	3	31	**11**
M. 14	20	12	36	**23**	3	8	16	**5**
M. 15	22	35	19	**28**	20	34	28	**31**
M. 16	36	23	38	**36**	17	15	14	**18**
M. 17	13	7	7	**6**	32	1	3	**2**
M. 18	15	28	13	**20**	33	29	34	**33**
M. 19	16	35	30	**32**	26	33	10	**28**
M. 20	2	30	16	**15**	30	36	18	**32**
M. 21	24	38	31	**37**	10	30	25	**25**
M. 22	29	24	28	**30**	18	35	36	**34**
M. 23	19	33	27	**33**	31	38	38	**38**
M. 24	11	31	26	**26**	37	37	37	**37**
M. 25	37	26	32	**35**	25	28	19	**26**
M. 26	35	34	34	**38**	35	24	25	**29**
M. 27	8	11	21	**9**	8	4	8	**3**
M. 28	34	17	10	**21**	7	18	9	**10**
M. 29	31	27	10	**25**	16	22	6	**14**
M. 30	23	20	1	**10**	27	16	2	**8**
M. 31	9	13	3	**5**	2	19	4	**4**
M. 32	16	32	6	**19**	22	14	15	**20**
M. 33	25	15	9	**16**	6	10	22	**9**
M. 34	26	22	18	**22**	38	32	12	**35**
M. 35	6	18	16	**10**	15	9	7	**7**
M. 36	4	37	5	**17**	13	24	5	**12**
M. 37	12	24	20	**18**	24	13	13	**19**
M. 38	2	6	3	**3**	19	6	1	**1**

on average of all testers, five inbreds namely, M 1, M 5, M 14, M 17 and M 38 produced the highest significant ear diameter compared with the check variety S.C. 10. The respective values of the ear diameter for these inbred lines over all testers were 42.35, 42.77, 42.87, 43.29 and 43.76 mm (Table 7).

Table (8) showed ranks of inbred lines for each tester and over all testers for ear diameter. It is clear that inbred line M 38 ranked the first over all testers, being the 1 st ranking with the tester M 13 and 6 th with tester S.C. 10. Inbred line M 17 occupied the 2 nd ranking followed by inbred line M 27 which occupied the third ranking over all testers.

It could be concluded that the single crosses M 38 x M 13 should have immediate breeding implication for the improvement of ear diameter since it ranked the first among all testers.

For number of rows/ ear, five inbreds namely, M 1, M 27, M 35, M 36 and M 38 were significantly higher in their top crosses than the check variety S.C. 10 over all testers (Table 9). Also, it is clear that the best top crosses were obtained from the crossing between the tester S.C. 10 and each of the inbreds M 1, M 8, M 27, M 35 and M 36 being 14.67, 14.53, 15.02, 14.53 and 14.67, respectively. On the other hand, the top crosses M 11 x S.C. 10 recorded the lowest number of rows/ ear (11.63) followed by the cross M 32 x M 13 (12.08).

Ranking of inbreds for number of rows/ ear indicated the inbred line M 38 occupied the first rank over all testers, being the 1 st ranking with the tester M 13 and 4 th ranking with the tester S.C.10 (Table 10).

Table (9): Mean performance of 114 top crosses between 38 inbred lines and each of three testers for number of rows/ ear and number of kernels/ row of maize combined over two seasons.

Trait / Tester / Lines	No. of rows/ ear				No. of kernels/ row			
	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	13.93	14.67	13.92	14.17	39.03	37.93	37.30	38.09
M. 2	13.70	14.08	13.70	13.83	31.88	36.98	31.47	33.44
M. 3	12.60	12.98	12.88	12.82	31.12	38.08	31.03	33.41
M. 4	12.43	13.17	12.48	12.69	34.05	38.78	32.05	34.96
M. 5	13.15	13.88	12.93	13.32	33.10	36.85	34.23	34.73
M. 6	13.45	13.33	12.37	13.05	33.13	34.83	33.55	33.84
M. 7	13.80	14.10	13.07	13.42	34.08	39.60	31.13	34.94
M. 8	12.97	14.53	14.03	13.84	34.23	37.60	35.63	35.84
M. 9	13.42	13.15	12.80	13.12	37.52	35.90	31.62	35.01
M. 10	13.68	13.67	13.27	13.51	30.47	34.12	29.70	31.59
M. 11	12.20	11.63	12.63	12.16	31.40	30.05	31.73	31.06
M. 12	12.60	12.65	12.73	12.73	31.43	32.85	32.25	32.18
M. 13	13.30	13.50	12.95	13.25	34.08	36.17	31.20	33.62
M. 14	14.23	13.88	13.85	13.99	32.98	35.65	29.58	32.74
M. 15	13.42	13.30	12.80	13.17	31.35	31.77	30.22	31.11
M. 16	14.13	14.15	13.90	14.06	31.33	35.37	29.28	31.99
M. 17	13.10	12.98	14.12	13.40	33.45	33.27	34.87	33.86
M. 18	13.18	13.00	12.83	13.01	32.98	31.57	33.65	32.73
M. 19	13.53	12.57	14.25	13.45	33.52	33.32	34.87	33.90
M. 20	13.02	12.15	13.42	12.86	39.35	33.75	34.82	35.97
M. 21	13.67	13.83	13.25	13.58	34.65	31.96	32.32	32.98
M. 22	13.77	13.52	13.17	13.48	33.15	33.28	32.83	33.09
M. 23	13.67	13.72	12.43	13.27	36.63	31.68	32.87	33.73
M. 24	12.88	13.13	12.08	12.70	39.50	36.47	31.18	35.38
M. 25	12.98	13.60	13.42	13.33	32.82	33.98	35.08	33.96
M. 26	12.57	13.75	12.60	12.97	34.80	32.18	30.57	32.52
M. 27	13.78	15.02	13.58	14.13	32.61	37.85	36.28	35.58
M. 28	13.50	13.52	14.10	13.71	31.57	36.03	33.85	33.82
M. 29	14.12	13.45	14.00	13.86	32.92	36.71	32.08	33.90
M. 30	13.53	13.18	12.65	13.12	34.57	34.52	38.38	35.82
M. 31	13.12	13.57	13.18	13.29	36.27	32.37	37.15	35.26
M. 32	13.82	14.02	12.08	13.31	35.38	31.63	37.00	34.67
M. 33	13.25	12.87	13.47	13.19	32.95	34.43	33.22	33.53
M. 34	12.37	13.48	13.27	13.04	31.90	33.88	33.80	33.19
M. 35	14.17	14.53	13.97	14.22	38.22	38.87	37.07	38.05
M. 36	13.85	14.67	14.13	14.22	38.08	39.17	39.98	39.08
M. 37	13.07	12.78	13.17	13.01	35.20	31.92	32.05	33.06
M. 38	13.90	14.60	14.27	14.26	37.40	38.67	36.13	37.40
L.S.D 0.05	1.11				4.27			
L.S.D 0.01	1.45				5.60			
Giza- 2	12.90				32.00			
S.C. 10	13.00				32.10			

Table (10): Ranks of 38 maize inbred lines when evaluated by three testers for number of rows/ ear and number of kernels/ row of maize combined over two seasons.

Trait	**No. of rows/ ear**				**No. of kernels/ row**			
Tester / Lines	**Giza 2**	**S.C. 10**	**M. 13**	**Average**	**Giza 2**	**S.C. 10**	**M. 13**	**Average**
M. 1	5	2	9	**4**	3	7	3	**2**
M. 2	11	9	12	**10**	31	10	29	**25**
M. 3	34	31	26	**34**	37	6	33	**26**
M. 4	36	27	34	**37**	18	21	25	**12**
M. 5	24	11	25	**19**	23	11	14	**14**
M. 6	18	24	36	**28**	22	19	18	**20**
M. 7	27	8	23	**16**	16	1	32	**13**
M. 8	31	6	6	**9**	15	9	9	**6**
M. 9	19	28	28	**26**	6	15	28	**11**
M. 10	12	17	17	**13**	38	22	36	**36**
M. 11	38	38	32	**38**	34	38	27	**38**
M. 12	33	35	30	**35**	33	29	23	**34**
M. 13	21	21	24	**23**	16	13	30	**21**
M. 14	1	11	11	**7**	24	16	37	**31**
M. 15	20	25	28	**25**	35	34	35	**37**
M. 16	3	7	10	**6**	36	18	38	**35**
M. 17	26	31	4	**17**	20	28	12	**14**
M. 18	23	30	27	**30**	24	37	17	**32**
M. 19	16	36	2	**15**	19	26	11	**18**
M. 20	29	37	15	**33**	2	25	13	**5**
M. 21	13	13	19	**12**	13	32	22	**30**
M. 22	10	19	22	**14**	21	27	21	**28**
M. 23	13	15	35	**22**	8	35	20	**23**
M. 24	32	29	37	**36**	1	17	31	**9**
M. 25	30	16	15	**18**	28	23	10	**16**
M. 26	35	14	33	**32**	12	31	34	**33**
M. 27	9	1	13	**5**	29	8	7	**8**
M. 28	17	19	5	**11**	32	14	15	**21**
M. 29	4	23	7	**8**	27	12	24	**17**
M. 30	15	26	31	**26**	14	20	2	**7**
M. 31	25	18	20	**21**	9	30	4	**10**
M. 32	8	10	37	**20**	10	36	6	**15**
M. 33	22	33	14	**24**	26	21	19	**24**
M. 34	37	22	17	**29**	30	24	16	**27**
M. 35	**2**	**5**	**8**	**2**	4	**3**	**5**	**3**
M. 36	7	2	3	**2**	5	2	1	**1**
M. 37	28	34	21	**30**	11	33	25	**29**
M. 38	6	4	1	**1**	7	5	**8**	**4**

Whereas, inbred lines M 35 and M 36 ranked the second and third over all the three testers, respectively. Concerning number of kernels/ row, most of studied top crosses were significantly higher than the check varieties S.C. 10 and Giza- 2 (Table 9). However, the most desirable values for number of kernels/ row were detected for the top crosses M 36 x M 13 (39.98), M 7 x S.C. 10 (39.60), M 24 x Giza- 2 (39.50), M 20 x Giza-2 (39.35) and M 36 x S.C. 10 (39.17). Based on the average of all testers, four inbreds M 1, M 35, M 36 and M 38 were significantly higher than the check variety S.C. 10, being 38.09, 38.05, 39.08 and 37.40, respectively.

Inbred line M 36 occupied the first ranking over all testers for number of kernels/ row, being the 1 st with the tester M 13 and 2 nd with tester S.C. 10 and 5 th with tester Giza- 2 (Table 10). Inbred line M1 ranked the second over all testers, being the third ranking with each of the two testers, Giza- 2 and M 13. Inbred line M 35 ranekd the third, being the third , fourth, fifth ranking with S.C. 10, Giza- 2 and M 13, respectively.

Mean values of 100- kernel weight of most top crosses were significantly higher than the check varieties Giza- 2 and S.C. 10 (Table 11). The top cross M 37 x Giza- 2 had the heaviest 100- kernel (38.00 g) followed by the top crosses M 38 x Giza- 2 (37.67 g) and M 38 x S.C. 10 (37.67 g). However, two inbreds namely, M 36 and M 38 were significantly higher than the check variety S.C. 10 over all testers in their top crosses being 35.39 and 36.72 g, respectively.

Table (11): Mean performance of 114 top crosses between 38 inbred lines and each of three testers for 100- kernel weight and grain yield/ plant of maize combined over two seasons.

Trait	100- kernel weight (g)				Grain yield g/ plant			
Tester / Lines	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	35.67	36.67	29.17	33.83	189.17	202.50	185.00	192.22
M. 2	26.75	31.33	27.83	28.64	111.33	128.17	103.33	114.28
M. 3	27.67	32.33	30.33	30.11	104.83	123.00	120.17	116.00
M. 4	29.83	32.33	27.33	29.83	122.00	198.17	109.17	143.11
M. 5	37.50	31.83	30.33	33.22	178.83	163.00	180.00	173.94
M. 6	30.50	28.00	31.17	29.89	124.33	136.56	121.33	127.39
M. 7	30.33	30.17	26.50	29.00	151.00	149.67	92.00	130.89
M. 8	30.00	31.00	28.00	29.67	149.83	171.83	168.17	163.28
M. 9	31.83	32.83	29.67	31.44	130.33	150.50	118.00	132.94
M. 10	30.17	29.83	27.83	29.28	127.50	135.83	117.17	126.83
M. 11	30.83	35.83	28.83	31.83	114.67	127.50	109.17	117.11
M. 12	29.67	29.33	28.67	29.22	113.33	108.50	123.17	115.00
M. 13	32.00	32.50	28.83	31.11	170.50	204.67	116.50	163.89
M. 14	31.83	27.67	27.50	29.00	136.33	186.00	112.83	145.06
M. 15	31.83	28.00	26.67	28.83	121.17	90.67	111.33	107.72
M. 16	29.67	29.67	26.67	28.67	124.17	126.17	118.17	122.83
M. 17	32.67	35.33	28.00	32.00	129.33	148.67	124.83	134.28
M. 18	28.33	30.83	26.83	28.67	120.33	106.83	117.67	115.00
M. 19	32.17	26.33	27.17	28.56	124.00	133.33	149.67	135.67
M. 20	31.00	24.83	26.67	27.50	167.83	161.83	124.50	151.39
M. 21	29.00	29.17	28.33	28.83	116.17	123.33	107.67	115.72
M. 22	28.83	27.67	27.33	27.94	176.67	127.67	111.83	138.72
M. 23	28.00	25.33	24.83	26.06	111.67	119.33	90.50	107.17
M. 24	29.67	29.17	25.00	27.94	153.33	139.50	120.50	137.78
M. 25	29.17	30.17	27.50	28.94	133.83	186.67	185.50	168.67
M. 26	27.67	28.17	26.00	27.28	108.67	109.83	130.83	116.22
M. 27	33.17	36.17	33.33	34.22	198.67	217.50	175.17	197.11
M. 28	29.67	31.00	31.83	30.83	126.50	166.67	167.33	153.50
M. 29	28.00	30.50	30.50	29.67	127.83	129.50	130.00	129.11
M. 30	28.83	31.00	30.07	30.17	151.83	178.17	129.33	153.11
M. 31	32.17	32.33	29.50	31.33	163.67	161.17	142.33	155.72
M. 32	31.67	29.83	32.50	31.33	129.00	217.67	169.00	171.89
M. 33	30.67	32.33	28.50	30.50	130.17	140.50	136.17	135.61
M. 34	26.67	32.00	26.67	28.44	115.67	109.00	120.67	115.11
M. 35	36.33	36.00	32.00	34.78	175.33	172.17	172.00	173.17
M. 36	28.33	37.50	30.00	35.39	218.00	219.50	216.67	218.06
M. 37	38.00	32.33	30.00	30.11	160.50	112.83	120.50	131.28
M. 38	37.67	37.67	34.83	36.72	131.17	191.83	155.50	159.50
L.S.D 0.05	4.37				16.57			
L.S.D 0.01	5.20				21.73			
Giza- 2	28.50				155.80			
S.C. 10	30.20				174.30			

The inbred ranking for 100- kernel weight are presented in Table (12). Inbred line M 38 ranked the first over all testers, being first ranking with each of the testers S.C. 10 and M 13, and second with the tester Giza- 2. Inbred line M 36 which occupied the second ranking over all testers was the first ranking with tester Giza- 2, second ranking with the tester S.C. 10 and 9 th ranking with the tester M 1. Inbred line M 35 ranked the third over all testers, being the 4 th ranking with each of Giza- 2 and M 13 and 5 th ranking with S.C. 10.

For grain yield/ plant, ten and twenty out of 114 top crosses were significantly higher than the check varieties S.C. 10 and Giza-2, respectively (Table 11). However, the best top crosses were M 36 x S.C. 10 (219.50 g), M 36 x Giza- 2 (218.0 g), M 32 x S.C. 10 (217.67 g), M 27 x S.C. 10 (217.50 g), M 36 x M 13 (216.67 g), M13 x S.C. 10 (204.67) and M 1 x S.C. 10 (202.50 g). Based on the average of all testers, three inbred lines namely, M 1, M 27, and M 36 had significantly higher grain yield in their top crosses than the check variety S.C. 10, being 192.22, 197.11 and 218.06 g, respectively.

From such results, it could be concluded that the inbred lines M 1, M 27, and M 36 and their top crosses with S.C. 10 could be immediately utilized as 3- way crosses by corn breeders to develop new hybrids with high yield potentiality.

Ranks of grain yield/ plant for all inbred lines in their top crosses are presented in Table (12). Inbred line M 36 ranked the first over all testers, being the first ranking with each of the studied three testers.

Table (12): Ranks of 38 maize inbred lines when evaluated by three testers for 100- kernel weight and grain yield/ plant of maize combined over two seasons.

Trait	100- kernel weight (g)				Grain yield g/ plant			
Tester / Lines	Giza 2	S.C. 10	M.13	Average	Giza 2	S.C. 10	M.13	Average
M. 1	5	3	15	**5**	3	5	3	**3**
M. 2	37	17	23	**31**	36	26	36	**36**
M. 3	36	12	9	**17**	38	31	24	**31**
M. 4	22	12	28	**19**	28	6	33	**16**
M. 5	3	16	9	**6**	4	14	4	**4**
M. 6	18	32	6	**18**	25	22	20	**26**
M. 7	19	23	35	**24**	13	18	37	**24**
M. 8	21	18	21	**20**	14	12	8	**9**
M. 9	11	8	13	**9**	18	17	26	**22**
M. 10	20	25	23	**22**	23	23	28	**27**
M. 11	16	6	16	**8**	33	28	33	**29**
M. 12	26	28	18	**23**	34	36	19	**34**
M. 13	10	9	17	**12**	7	4	29	**8**
M. 14	11	34	25	**24**	15	9	30	**15**
M. 15	11	32	31	**27**	29	38	32	**37**
M. 16	23	27	33	**29**	26	29	25	**28**
M. 17	7	7	21	**7**	20	14	17	**21**
M. 18	31	21	30	**29**	30	37	27	**34**
M. 19	9	36	29	**32**	27	24	11	**19**
M. 20	15	38	33	**36**	8	15	18	**14**
M. 21	28	29	20	**27**	31	30	35	**32**
M. 22	29	34	27	**34**	5	27	31	**17**
M. 23	32	37	38	**38**	35	32	38	**38**
M. 24	23	29	37	**35**	11	21	22	**18**
M. 25	27	23	25	**26**	16	8	2	**7**
M. 26	35	31	38	**37**	37	34	14	**30**
M. 27	6	4	2	**4**	2	3	5	**2**
M. 28	23	18	5	**13**	24	13	9	**12**
M. 29	32	22	8	**20**	22	25	15	**25**
M. 30	29	18	7	**15**	12	10	16	**13**
M. 31	8	12	14	**10**	9	16	12	**11**
M. 32	14	25	3	**10**	21	2	7	**6**
M. 33	17	10	19	**14**	19	20	13	**20**
M. 34	38	15	31	**33**	32	35	21	**33**
M. 35	4	**5**	4	**3**	6	11	6	**5**
M. 36	1	2	9	**2**	1	1	1	**1**
M. 37	32	10	12	**16**	10	33	22	**23**
M. 38	2	1	1	**1**	17	7	10	**10**

Inbred line M 27 ranked the second over all testers, being the second ranking with Giza- 2, third ranking with S.C. 10 and fifth ranking with tester M 13. Inbred line M 1 ranked third over all testers, being 3 rd ranking with each of Giza- 2 and M 13 and 5 th ranking with S.C. 10. Inbred M 5 ranked fourth, being 4 th ranking with each of the tessters Giza- 2 and M 13 and 1 th ranking with S.C. 10. From the previous results, it is clear that ranking of inbred lines for most of the studied traits differed from trait to another. Increasing number of testers for the evaluation of inbred lines may be more efficient. In this respect, Abel and Pollak (1991) reported the importance of using at least two (and perhaps more) divergent testers that contain an inherently high level of favorable alleles.

4.2. Correlation studies :

Simple correlation coefficients between testers in top crosses and mean performance over all testers for all traits combined over two years are presented in Table (13). Results indicated that correlation coefficients values between each of the three testers and mean over all testers (multiple tester) were significant for all traits studied. However, the highest correlation values were detected for the tester S.C. 10 and mean of all testers for tasseling date (0.8256), silking date (0.8352), ear diameter (0.8718), number of rows/ ear (0.8339), 100- kernel weight (0.8766) and grain yield/ plant (0.8904).

Table (13): Correlation coefficient (r) between mean performance of three testers and means over testers for ten traits in maize combined over two seasons.

Correlation	Tasseling date	Silking date	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows/ ear	No. of kernels/ row	100-kernel weight (g)	Grain yield/ plant (g)
- Between testers and mean over testers:										
Giza 2 vs. Mean	0.6917**	0.7688**	0.7431**	0.8649**	0.7773**	0.6198**	0.8170**	0.7614	0.8295**	0.8329**
S.C. 10 vs. Mean	0.8256**	0.8352**	0.7705**	0.7620**	0.6717**	0.8718**	0.8339**	0.6475**	0.8766**	0.8904**
M. 13 vs. Mean	0.6434	0.5232**	0.8375**	0.8082**	0.6781**	0.7652**	0.7571**	0.7703**	0.7985**	0.8547**
- Between testers in Crosses :										
Giza 2 vs. S.C 10	0.3256*	0.4350**	0.2809	0.4682**	0.1911	0.3812*	0.5747**	0.2068	0.5559**	0.6091**
Giza 2 vs. M. 13	0.1670	0.2095	0.5715**	0.6060**	0.4886**	0.1623	0.4638**	0.4726**	0.4983**	0.5828**
S. C. 10 vs. M. 13	0.3641*	0.1803	0.4265**	0.3927*	0.1214	0.5219**	0.3711*	0.1955	0.5950**	0.6372**

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

Also, the correlation values between the tester M 13 and over all testers (multiple tester) was highest for plant height (0.8375) and number of kernels/ row (0.7703). Highest correlation values between the tester Giza- 2 and multiple tester were detected only for ear height (0.8649) and ear length (0.7733).

These results indicated that the tester S.C. 10 seemed to be the best combiner followed by the inbred line M 13 as compared with the testers Giza- 2. In this respect, Abel and Pollak (1991) reported that inbred lines and single crosses were more desirable than populations in test crosses.

The correlation coefficients values between each of the two testers are presented in Table (13). It is clear that, the highest correlation values were detected between Giza- 2 and S.C. 10 for silking date (0.4350) and number of rows/ ear (0.5747). Highest correlation values between Giza- 2 and M 13 were obtained for plant height (0.5715), ear height (0.6060), ear length (0.4886) and number of kernels/ row (0.4726). Whereas, correlation coefficients between S.C. 10 and M 13 reached maximum values for number of days to 50 % tasseling (0.3641), ear diameter (0.5219), 100-kernel weight (0.5959) and grain yield/ plant (0.6372). Such results confirm the superiority of the two testers S.C. 10 and M 13 .

The correlation coefficients between ranks of top crosses for each tester and average of all testers (multiple tester) for all traits are presented in Table (14). Correlation coefficients between ranks of each tester in top crosses and multiple tester were highly significant for all traits. However, the correlation values between the ranks of the tester Giza- 2 and multiple tester were the highest for tasseling date (0.7263), silking date (0.7575), plant height (0.7277), ear length (0.7434) and number of rows/ ear (0.8094). Consequently, this tester (Giza- 2) was the best for these traits as compared with the other two testers (S.C. 10 and M 13). Whereas, rank correlation indicated that the tester S.C. 10 was the best for evaluating ear diameter (0.8349) and grain yield/ plant (0.9044). The tester M 13 was the best for the evaluation of ear height (0.7872), number of kernels/ row (0.7029) and 100- kernel weight (0.8347).

The correlation coefficients between ranks of top crosses for each two testers for all traits are presented in Table (14). Significant correlation values were detected between each testers for at least five traits. However, significant correlation values were obtained between all pairs of testers for both 100 kernel weight and grain yield/ plant. Such result showed that the maximum consistency between the three testers was detected for 100- kernel weight and grain yield/ plant. This suggested that individual tester can be used for measuring the combining ability for inbreds for both traits. Meanwhile, the highest correlation coefficient values were detected between ranks of Giza- 2 and S.C. 10 for ear diameter (0.4019), number of rows/ ear (0.5819) and grain yield/ plant (0.6810). Also, highest correlation values were obtained between Giza- 2 and M 13 for plant height (0.6328), ear height (0.6244), ear length (0.4821) and number of kernels/ row (0.4387). For silking date and 100 kernel weight the highest correlation values were detected between the tester S.C. 10 and M 13 being 0.3619 and 0.5950, respectively.

From the previous correlation values, it could be concluded that there were some differences among testers in ranking the inbred lines. This confirms the importance of increasing the number of testers used in the evaluation of new inbred lines of maize.

4.3. Analysis of variance:

Test of homogeneity revealed the validity of the combined analysis for the data of the two growing seasons. Therefore, the combined analysis of variance for the studied traits over two seasons was accomplished and the results are presented in Table (15). Years mean squares were highly significant for all studied traits except for number of rows/ ear. Such result indicated that there was an overall differences between the two years. Mean performance of all traits were higher in the first year than those of the second one due to delaying planting date in the second season (data not included).

Significant mean squares due to top crosses along with lines and testers were detected for all studied traits except that of testers mean squares for ear diameter. Such results indicated a wide range of variability among both parental inbred lines and testers. It is clear that the means squares due to testers were much higher than those of inbred lines for all traits except plant height and ear diameter. Such result revealed that testers contributed much more to the total variation as compared to inbreds. Therefore, the total GCA variance was due to the tester GCA variance.

Table (15): Analysis of variance of top crosses for ten traits of maize combined over two seasons.

S.O.V	d.f	Tasseling date (day)	Silking date (day)	Plant height (cm)	Ear height (cm)	Ear length (cm)
Years	1	2032.22	240.99	118184.33	256545.37	44.44
Rep./ year	4	15.11	26.44	949.61	1179.84	9.23
Crosses	113	20.90**	24.82**	674.72**	342.73**	6.74**
Lines	37	23.26**	21.21**	1087.69**	647.54**	9.49**
Testers	2	357.93**	644.01**	498.89**	1184.28**	27.57**
Line x testers	74	10.61**	9.89**	351.72	167.57	4.81
Crosses x year	113	13.61**	9.17**	512.08*	196.13	3.10
Line x year	37	21.19**	7.76	712.13*	220.53	3.95
Testers x year	2	119.46**	116.86**	1149.25	158.99	2.36
Line x testers x year	74	6.96**	6.96*	394.83	184.93	2.70
Pooled error	452	3.42	4.56	390.13	168.90	2.59

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

Table (16): Estimates of variance components and their interaction with years for ten traits of maize.

Variance component	Tasseling date	Silking date	Plant height (cm)	Ear height (cm)	Ear length (cm)
δ^2 f	-0.09	0.58	23.26	24.69	0.19
δ^2 m	1.03	2.30	17.02	4.57	0.10
δ^2 fm	0.61	-0.48	-7.19	-2.89	0.35
δ^2 f x year	1.58**	0.09	35.26	3.96	0.14
δ^2 m x year	0.99	0.96	6.62	-0.23	0.00
δ^2 fm x year	1.18	0.80	1.57	5.34	0.04
δ^2 gca	0.95	2.17	17.47	6.04	0.11
δ^2 sca	0.61	0.49	-7.19	-2.89	0.35
δ^2 gca x year	1.03	0.90	8.71	0.08	0.01
δ^2 sca x year	1.18	0.80	1.57	5.34	0.04

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

Table (16): Cont.

Variance component	Ear diameter (cm)	No. of rows/ ear	No. of kernels/ row	100- kernel weight (g)	Grain yield/ plant (g)
δ^2 f	0.98	0.16	1.93	3.71	459.78
δ^2 m	-0.47	-0.07	0.52	1.50	76.61
δ^2 fm	0.95	0.05	1.21	1.45	84.72
δ^2 f x year	0.30	0.04	-0.02	1.26	239.51
δ^2 m x year	0.87	0.17	-0.15	0.25	-11.93
δ^2 fm x year	0.25	0.01	2.16	1.50	524.97
δ^2 gca	-0.36	-0.05	0.62	1.66	104.64
δ^2 sca	0.95	0.05	1.21	1.45	84.72
δ^2 gca x year	0.83	0.16	-0.14	0.32	6.46
δ^2 sca x year	0.25	0.01	2.16	-1.50	524.97

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

Height, 100- kernel weight and grain yield/ plant. Consequently, the additive types of gene action were important in controlling the behavior of these traits. The importance of additive gene action in controlling yield and other traits were reported by Eberhart *et al.* (1966), Russell *et al.* (1973), El- Zeir *et al.* (1993), Salama *et al.* (1995) and Mahmoud (1996).

On the other hand, δ^2SCA played the major role in the inheritance of ear length, ear diameter, number of rows/ ear and number of kernels/ row, revealing that the largest part of the total genetic variability associated with these traits was a result of non additive gene action. Similar results were reported by Nawar and El- Hosary (1984), Galal *et al.* (1987) and Sedhom (1992 and 1994).

The magnitude of the interaction between specific combining ability and years was much higher than that of general combining ability for date of tasseling, ear height, ear length, number of kernels/ row and grain yield/ plant. These results led to the conclusion that non- additive gene action was more biased by the interaction with environment than the additive effects.

In this respect, Rojas and Sprague (1952) found that specific combining ability x environment interaction was significant and larger than general combining ability x environment. In other words, the non-additive component of genetic variation interacted more with the environment than the additive component. The same conclusion was reached by Shehata and Dahawan (1975), El- Hosary (1985), Sedhom (1992 and 1994), Mahmoud (1996) and Al- Naggar *et al.* (1997).

4.3.1. Estimation of general combining ability effects :

The general combining ability effects g_i of testers and inbred lines for all traits combined over two years are presented in Table (17). High negative values observed for tasseling date, silking date, plant height and ear height from one side and high positive values observed for yield and its components from other side would be useful from breeders point of view. Data revealed that the best general combiners were M 1, M 7, M 18, M30, M 32, M 35 and M 36 for number of days to 50 % tasseling, and M 1, M 4, M 7, M 18, M 35 and M 36 for number of days to 50% silking. These parental lines had significantly negative g_i effects for both traits. Moreover, inbred lines M 1, M 7, M 18, M 35 and M 36 were the best combiners for both traits together. Consequently, they could be utilized in developing new hybrids characterized by earliness in flowering.

The best inbreds in general combining ability were M 1, M 2, and M 30 for plant height and M 1, M 2, M 27, M 30, and M 32 for ear height. These lines expressed significant negative g_i effects for both traits. From these lines, three inbreds (M 1, M 2, and M 30) were common for both traits. Therefore, they could be of great value in breeding programs for developing new hybrids with short plant stature.

Table (17): Estimates of general combining effects for ten traits of maize combined over two seasons.

Trait / Parent	Tasseling date (day)	Silking date (day)	Plant height (cm)	Ear height (cm)	Ear length (cm)
Testers:					
Giza- 2	-1.13**	-1.55**	-5.26**	-1.33	0.12
S.C. 10	1.35**	1.78**	3.70**	2.63**	0.27**
M. 13	-0.21	-0.23	1.56	-1.30	-0.39**
S.E. (g_i)	0.12	0.14	1.31	0.86	0.11
S.E. (g_i- g_j)	0.17	0.20	1.85	1.22	0.15
Lines :					
M. 1	-1.52**	-3.12**	-16.89**	-7.13*	0.66
M. 2	1.60**	1.49*	-12.28**	-7.08*	-0.51
M. 3	0.98*	0.43	-8.72	-3.91	0.28
M. 4	0.15	-1.01*	-0.67	-1.30	0.99*
M. 5	0.82	0.04	18.89**	11.98**	1.55**
M. 6	1.26*	0.27	5.94	1.42	1.41**
M. 7	-1.07*	-1.01*	-5.56	-2.58	-0.82*
M. 8	0.93*	0.43	-1.56	4.37	0.41
M. 9	0.26	0.49	12.72*	7.26*	0.63
M. 10	0.37	0.10	1.67	2.26	-0.30
M. 11	0.32	0.32	-7.22	-2.58	-0.61
M. 12	1.87**	0.21	0.17	2.87	-0.41
M. 13	0.26	0.38	0.72	0.54	0.30
M. 14	0.54	0.43	-2.00	-2.35	-0.26
M. 15	-0.29	0.60	0.89	-2.24	-0.51
M. 16	-0.79	-0.51	2.00	-2.58	-1.16**
M. 17	-0.40	-0.62	-4.50	-1.63	0.78*
M. 18	-2.79**	-2.40**	-5.67	-3.74	-0.1
M. 19	0.32	-0.12	23.55**	10.54**	-0.62
M. 20	-0.35	0.32	2.78	1.80	0.27
M. 21	-0.57	0.23	7.05	-0.13	-1.20**
M. 22	0.26	0.04	-6.22	-1.63	-0.58
M. 23	-0.35	0.21	-0.56	6.15*	-0.67
M. 24	0.76	0.54	1.78	2.76	-0.40
M. 25	-0.07	0.71	-2.28	-1.02	-1.00*
M. 26	-0.52	0.99*	0.33	1.65	-1.31**
M. 27	0.26	-0.90	-6.50	-9.24**	0.52
M. 28	1.04*	1.60**	1.17	-0.74	-0.20
M. 29	0.48	1.04*	1.44	-5.96	-0.38
M. 30	-2.63**	-0.23	-9.06*	-12.52**	0.47
M. 31	0.93*	0.93	3.39	-1.30	0.82*
M. 32	-1.18*	0.27	-8.22	-6.02*	-0.01
M. 33	0.43	0.93	-1.95	2.08	0.25
M. 34	1.71**	1.04*	-4.17	2.74	-0.25
M. 35	-2.68**	-2.79**	8.50	3.48	0.47
M. 36	-1.35**	-1.96**	0.17	0.09	0.20
M. 37	0.32	0.65	5.61	19.20**	-0.01
M. 38	0.71	0.43	5.28	7.76*	1.34**
S.E. (g_i)	0.44	0.50	4.66	3.06	0.36
S.E. (g_i- g_j)	0.62	0.71	6.58	4.33	0.54

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

Table (17): Cont.

Trait / Parent	Ear diameter (mm)	No. of rows/ ear	No. of kernels/ row	100- kernel weight (g)	Grain yield g/ plant
Testers:					
Giza- 2	-0.16	-0.03	-0.02	0.60**	-1.76**
S.C. 10	0.11	-0.16*	0.76**	0.90**	9.73**
M. 13	0.05	0.13*	-0.74*	-1.50**	-7.98**
S.E. (g_i)	0.15	0.07	0.25	0.28	0.48
S.E. (g_i- g_j)	0.22	0.09	0.36	0.40	1.38
Lines :					
M. 1	0.81	0.79**	3.87**	3.55**	49.95**
M. 2	0.23	0.45	-0.77	-1.65*	27.99**
M. 3	-1.04	-0.56*	0.81	-0.17	-26.27**
M. 4	0.46	-0.69**	0.74	-0.45	0.84
M. 5	1.23*	-0.06	0.51	2.94*	31.67**
M. 6	-0.24	-0.33	-0.38	-0.40	-14.88**
M. 7	-0.02	0.03	0.72	-1.28	-11.38**
M. 8	0.57	0.46*	1.63*	-0.62	21.01**
M. 9	-0.54	-0.26	0.79	1.16	-9.33*
M. 10	0.20	0.12	-2.62*	-1.01	-15.44**
M. 11	-1.77**	-1.23**	-3.16**	1.55	-25.16**
M. 12	0.53	0.65*	-2.04*	-1.06	-27.27**
M. 13	0.82	-0.13	-0.40	0.83	21.62**
M. 14	1.33*	0.61*	-1.48	-1.28	2.79
M. 15	-1.07*	-0.21	-3.11**	-1.45	-34.55**
M. 16	0.39	0.68*	-2.22*	-1.62	-19.44**
M. 17	1.75**	0.02	-0.36	1.72	-7.99*
M. 18	-1.43*	-0.38	-1.48	-1.62	-27.27**
M. 19	-0.65	0.07	-0.32	-1.73	-6.60
M. 20	-1.32*	-0.52*	1.76	-2.78*	9.12*
M. 21	-0.36	0.20	-1.23	-1.45	-26.55**
M. 22	-1.49*	0.10	-1.13	-2.34*	-3.55
M. 23	-4.08**	-0.11	-0.49	-4.23**	-35.10**
M. 24	-2.94**	-0.68*	1.17	-2.23*	-4.49
M. 25	-0.53	0.05	-0.26	-1.34	26.40**
M. 26	-1.03	0.41	-1.70	-3.01*	-26.05**
M. 27	1.65**	0.75*	1.36	3.94**	54.84**
M. 28	0.87	0.32	-0.40	0.55	11.23**
M. 29	0.78	0.47*	-0.32	-0.62	-13.16**
M. 30	1.01	-0.26	1.61	0.12	10.84**
M. 31	1.56*	-0.09	1.04	1.05	13.45**
M. 32	0.30	-0.08	0.46	1.05	29.62**
M. 33	0.98	-0.19	-0.68	0.22	-6.66
M. 34	-1.55*	-0.34	-1.02	-1.84	-27.16**
M. 35	1.19*	0.84**	3.83**	4.49**	30.90**
M. 36	0.81	0.83**	4.86**	5.10**	75.79**
M. 37	0.37	-0.38	-1.16	-0.14	-10.99**
M. 38	2.22**	0.87**	3.18**	6.44**	17.23**
S.E. (g_i)	0.54	0.23	0.90	1.01	3.48
S.E. (g_i- g_j)	0.77	0.33	1.27	1.43	4.92

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

For ear length, the inbreds No. 4, 5, 6, 17, 31 and 38 were the best combiners since they had significant and positive g_i effects for this trait. The best inbreds in general combining ability were No. 5, 14, 17, 27, 28, 31, 35 and 38 for ear diameter, No. 1, 8, 12, 14, 16, 27, 29, 35, 36, and 38 for number of rows/ ear, No. 1, 35, 36 and 38 for number of kernels/ row, No. 1, 5, 27, 35, 36 and 38 for 100- kernel weight. These inbreds expressed significant and positive g_i effects for the previously mentioned traits and would be utilized in corn breeding programs.

For grain yield/ plant, the best general combiners which had significant and positive g_I effects were M 1, M 2, M 5, M 8, M 13, M 20, M 25, M 27, M 28, M 30, M 31, M 32, M 35, M 36 and M 38. Moreover, the most desirable combiner for gain yield/ plant was inbred M 36 followed by inbred M 27 then inbred M 1 and M 5 since they expressed the highest significant and positive g_i effects. Furthermore, the inbred lines M 1, M 35, and M 38 which had high g_i effect for grain yield was among the best combiners for all yield components. Therefore, these three inbred lines (M 1, M 35 and M 38) could be of great value in breeding programs for improving grain yield and its components.

General combining ability effects for the three testers combined over two growing seasons are presented in Table (17). The tester Giza-2 expressed significant and negative GCA effects for tasseling and silking dates, plant height, and ear height. Parental tester, S.C. 10 was the best general combiner for ear length, number of kernels/ row, 100-kernel weight and grain yield/ plant, since it expressed significant and positive GCA effects for such traits. However, the tester M 13 was the best combiner for number of rows/ ear only.

From such results, it could be concluded that S.C. 10 was the best tester for grain yield and most of its components. The superiority of single crosses as good testers was noticed by several workers (El-Ghawas, 1963; Katta, 1971; Galal *et al.* 1987; and Sedhom, 1992).

4.3.2 Estimation of specific combining ability effects :

Specific combining ability effects of the test crosses for all traits combined over two years are presented in Tables (18 - 22). Significant and negative SCA effects for tasseling date were detected in top crosses: Giza- 2 with each of M 2, M 7, M 11, M 13, M 14, M 15, M 16, M 17, M 19, M 22, M 23, M 24 and M 33; S.C. 10 with each of M 3, M 4, M 5, M 6, M 7, M 8, M 25, M 27, M 30 and M 37 and tester M 13 with each of M 11, M 28, M 31, M 34 and M 38 (Table 18). However, the most desirable SCA effects for this trait were detected for the top cross M 15 x Giza- 2 (-2.54) followed by the crosses M 31 x M 13 (-2.51) and M 7 x S.C. 10 (-2.07). This means that the immediate use of line M 31 as a parent of single cross with tester M 13 and line M 7 in 3- way cross with S.C. 10 could be recommended.

Table (18): Specific combining ability effects for tasseling and silking dates of maize combined over two seasons.

Trait / Tester / Lines	Tasseling date (day)			Silking date (day)		
	Giza 2	S.C. 10	M. 13	Giza 2	S.C. 10	M. 13
M. 1	0.35	-0.12	-0.23	-0.06	-2.39**	2.45**
M. 2	-0.76*	1.26**	-0.51	-1.00*	-0.17	1.17*
M. 3	1.35**	-0.79*	-0.56	0.55	-0.78	0.23
M. 4	0.85*	-0.96*	0.10	0.33	-1.34**	1.01*
M. 5	1.02*	-1.29**	0.27	0.78	-1.23**	0.45
M. 6	-0.42	-0.90*	1.33**	0.05	-0.95*	-0.90*
M. 7	-1.42**	-2.07**	3.49**	-0.33	-1.34**	1.87**
M. 8	2.08**	-1.74**	-0.34	1.39**	-2.28**	0.90*
M. 9	0.41	-0.57	0.16	1.17**	-1.17*	0.01
M. 10	-0.20	-0.18	0.38	0.72	-1.12*	0.40
M. 11	-1.31**	2.38**	-1.06*	-0.83*	1.99**	-1.16*
M. 12	0.13	0.82*	0.95*	-1.72**	1.44**	0.29
M. 13	-1.42**	0.76*	0.66	-1.56**	0.77	0.79
M. 14	-1.37**	0.99*	0.38	-0.78*	-0.12	0.90*
M. 15	-2.54**	1.32**	1.21**	-1.78**	1.22*	0.56
M. 16	-1.04*	-0.01	1.05*	-0.33	-0.84	1.17*
M. 17	-1.09**	1.43**	-0.34	-0.22	0.11	0.12
M. 18	0.63	0.51	-0.12	0.05	-1.12*	1.06*
M. 19	-0.81*	1.21**	-0.40	-0.72	1.61**	-0.88*
M. 20	0.19	0.12	0.06	-0.33	1.33	-0.99*
M. 21	-0.42	-0.24	0.66	-0.61	1.22*	-0.60
M. 22	-0.76*	0.60	0.16	-0.66	0.77	-0.71
M. 23	-0.81*	0.88*	0.06	-0.39	1.61**	-1.21*
M. 24	-1.76**	0.76*	0.99*	-0.72	0.61	0.12
M. 25	1.08**	-1.57**	0.49	0.11	0.11	-0.21
M. 26	0.35	0.04	-0.40	0.17	0.49	-0.66
M. 27	0.41	-0.91*	0.49	-0.61	0.05	0.56
M. 28	-0.37	1.65**	-1.29**	0.89*	0.05	-0.94*
M. 29	0.19	1.38**	1.56**	-0.06	1.11*	-1.05*
M. 30	0.63	-1.01*	0.38	-0.95*	1.88**	-0.94*
M. 31	1.24**	1.26**	-2.51**	2.39**	0.38	-2.77**
M. 32	0.69	-0.62	-0.06	1.05*	0.22	-1.27**
M. 33	-1.59**	0.76*	0.83*	-0.61	1.22*	-0.60
M. 34	1.30**	0.51	-0.79*	0.44	-0.39	-0.05
M. 35	1.52**	1.96**	0.44	0.44	-0.73	0.29
M. 36	0.85*	0.79*	-0.06	0.44	-1.39**	0.95*
M. 37	1.35**	-1.12**	-0.23	0.67	-0.51	-0.16
M. 38	1.46**	0.49	-1.95**	2.05**	-0.28	-1.77**
S.E. (S_{ij}- S_{ij})		0.75			0.87	
S.E. (S_{ij}- S_{kl})		1.07			1.23	

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

Data in Table (18) also showed that the tester Giza- 2 expressed the highest number of significantly negative SCA effects and showed the highest negative SCA effect for tasseling date. However, the tester M 13 exhibited the widest range of SCA effects (-2.51 to 3.49) followed by Giza- 2 (-2.54 to 2.08).

Regarding silking date, seven, ten and eleven significant and negative SCA effects were obtained for the testers Giza- 2, S.C. 10 and M 13, respectively (Table 18). Moreover, the most desirable SCA effects for this trait were obtained for the top crosses M 31 x M 13 (-2.77), M 1 x S.C. 10 (-2.39) and M 15 x Giza- 2 (-1.78). Also, the tester M 13 had the widest range of SCA effect for this trait (–2.77 to + 2.45 days) as compared with the other testers.

It could be concluded that the tester M 13 was the best among all testers for silking date since it exhibited the largest number of significantly negative SCA effects, in addition this tester expressed the best SCA effect over all crosses and had the widest range of SCA effect for this trait. In this respect, Zambezi *et al.* (1986) pointed out that inbred testers are preferred over broad base testers and mentioned two practical reasons for preferring inbred line (narrow base) testers to broad- base testers. First, sampling errors are likely to occur with heterogeneous testers. Second, use of an inbred- line (or single cross) tester may permit quicker utilization of new lines in commercial hybrids, especially if the tester is already in commercial use.

For plant height, the most desirable SCA effects were detected for the top crosses M 36 x S.C. 10 (-16.53 cm) followed by the cross M 18 x S.C. 10 (-16.03 cm) as shown in Table (19). However, the tester S.C. 10 exhibited the greatest number of significant and negative SCA effect (6 cases) as compared with Giza- 2 (4 cases) and M 13 (2 cases). Whereas, the tester Giza- 2 showed the widest range between SCA effects for this trait (-12.97 to 15.3 cm) followed by S.C. 10 (-16.53 to 9.91 cm).

The same trend was reached for ear height where the tester S.C. 10 expressed the highest significant and negative SCA effect (-8.52 cm) when crossed with the inbred line M 18, followed by the tester M 13 when crossed with the line M 31 (-8.20 cm) as shown from Table 19 . Also, the tester S.C. 10 had the largest number of desirable SCA effects (5 cases) compared with the other testers (3 cases each). Furthermore, the tester Giza- 2 exhibited the widest range between SCA effects for this trait (-6.83 to 13.06). Therefore, the immediate use of inbred line M 18 as parent in the 3- way cross with the tester S.C. 10 and line M 31 as parent in single cross with the tester M 13 could be recommended.

Concerning ear length, the best SCA effects were detected for the top crosses : Giza- 2 with each of M 1, M 5, M 19, M 20, M 21, M 24 and M 36; S.C. 10 with each of M 2, M 3, M 4, M 7, M 8, M 13 and M 16; **and tester M 13 with each of M 28, M 29, M 30, M 32 and** M 36. All these top crosses had significant and positive SCA effects for ear length as shown in Table (20). However, the most desirable

Table (19): Specific combining ability effects for plant and ear heights of maize combined over two seasons.

Trait / Tester / Lines	Plant height (cm)			Ear height (cm)		
	Giza 2	S.C. 10	M. 13	Giza 2	S.C. 10	M. 13
M. 1	-3.52	5.36	-1.83	-0.67	0.63	1.30
M. 2	-5.97	3.74	2.22	-4.89	2.98	1.91
M. 3	-5.02	7.86	-2.83	-2.39	3.65	-1.26
M. 4	-4.41	9.80*	-5.39	-2.00	4.04	-2.04
M. 5	-12.97**	9.91*	3.06	1.22	2.42	-3.65
M. 6	-8.86*	9.52*	-0.67	-6.39*	10.31**	-3.92
M. 7	-5.52	8.86*	-3.33	-0.56	2.48	-1.92
M. 8	-0.36	5.02	-4.67	-6.83*	8.20**	-1.37
M. 9	-8.13*	7.41	0.72	-0.39	-1.85	2.24
M. 10	1.42	2.47	-3.89	-0.89	-2.19	3.08
M. 11	-2.36	-8.64*	11.00*	-1.58	-1.19	2.74
M. 12	-1.91	-6.87	8.70*	0.67	-7.96**	7.30*
M. 13	-2.80	2.91	-0.11	0.67	-0.96	0.30
M. 14	-2.41	1.47	0.94	1.06	-2.41	1.35
M. 15	5.20	-7.59	2.39	6.94*	-8.02**	1.08
M. 16	3.76	0.97	-4.72	5.28	-3.35	-1.92
M. 17	11.09*	1.63	-12.72**	-1.67	3.04	-1.37
M. 18	4.09	-16.03**	11.94	5.29	-8.52**	3.24
M. 19	-10.13*	-5.58	4.56	1.17	-1.46	0.30
M. 20	1.64	-5.81	4.17	-3.67	-2.96	6.63*
M. 21	-5.30	2.08	3.22	-0.17	-5.30	5.48*
M. 22	2.64	0.36	-3.00	-1.33	1.96	3.30
M. 23	2.64	-8.81*	6.17	13.06**	-7.91**	-5.15
M. 24	3.64	-6.64	3.00	-1.39	-5.19	6.58*
M. 25	-1.63	2.58	-0.94	-0.44	1.09	-0.65
M. 26	-2.08	8.30*	-6.22	-1.78	5.09	-3.31
M. 27	2.59	5.63	-8.22*	-1.06	0.48	0.58
M. 28	-4.24	8.63*	-4.39	-6.22*	9.31**	-3.09
M. 29	0.64	3.52	-4.17	-0.83	4.70	-3.87
M. 30	3.64	0.02	-3.67	1.58	4.09	-5.65*
M. 31	7.37	-3.42	-3.94	6.33*	1.87	-8.20**
M. 32	1.32	-3.48	2.17	1.06	0.92	-1.98
M. 33	3.53	-9.09*	5.56	-1.22	3.65	-2.42
M. 34	-0.58	-6.03	6.61	-6.22	-1.19	7.41*
M. 35	4.09	1.30	-5.39	2.84	1.42	-4.31
M. 36	10.09*	-16.53**	5.44	1.44	-7.69**	6.24*
M. 37	15.31**	-13.14**	-2.17	7.50**	-0.46	-7.04*
M. 38	3.48	-2.81	-0.87	-3.56	1.48	2.08
S.E. (S_{ij}- S_{kl})		8.06			5.31	
S.E. (S_{ij}- S_{kl})		11.40			7.50	

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

Table (20): Specific combining ability effects for ear length and diameter of maize combined over two seasons.

Trait / Tester / Lines	Ear length (cm)			Ear diameter (mm)		
	Giza 2	S.C. 10	M. 13	Giza 2	S.C. 10	M. 13
M. 1	0.79*	0.11	-0.86*	-1.04*	1.21*	-0.17
M. 2	-0.64	1.43**	-0.79*	-0.31	0.79	-0.49
M. 3	-0.76*	0.80*	-0.04	-1.42**	0.22	1.20*
M. 4	-0.72*	1.83**	-1.11**	0.15	1.77**	-1.91**
M. 5	1.50**	-0.32	-1.17**	1.87**	-0.21	-1.66**
M. 6	-0.36	0.29	0.07	0.77*	-0.67	-0.10
M. 7	-0.97**	1.34**	-0.36	0.71	0.04	-0.75
M. 8	-0.59	164**	-1.05**	-1.27*	2.90**	-1.63**
M. 9	0.07	-0.20	0.13	0.20	0.65	-0.45
M. 10	-0.18	0.35	-0.17	1.72**	0.01	-1.74**
M. 11	-0.20	-0.29	0.49	2.20	-0.06	-0.14
M. 12	-0.74*	0.16	0.59	1.30*	-0.58	-0.72
M. 13	-0.30	1.31**	-1.01**	0.11	2.07**	-2.18**
M. 14	0.10	0.84	-0.94**	0.71	0.41	-1.12*
M. 15	0.31	-0.87*	0.56	1.16*	-1.44**	0.28
M. 16	-0.57	0.76*	-0.18	-0.19	0.17	0.02
M. 17	-0.46	0.35	0.11	-3.10**	1.86**	1.24*
M. 18	0.34	-0.75*	0.41	-0.05	0.29	-0.24
M. 19	0.81*	-0.76*	-0.05	0.09	-1.52**	1.43**
M. 20	1.36**	-1.22**	-0.14	0.34	1.66**	1.33*
M. 21	0.87**	-1.38**	0.51	1.21*	-0.97*	-0.25
M. 22	-0.05	0.11	-0.06	1.68**	-1.25*	-0.43
M. 23	0.56	0.61	0.05	2.93**	-1.68**	-1.25*
M. 24	0.90*	-0.70*	-0.20	0.40	-0.52	0.12
M. 25	-0.77*	0.48	0.29	0.19	-0.56	0.38
M. 26	-0.14	-0.02	0.16	-1.27*	0.85	0.42
M. 27	0.35	0.22	-0.57	-0.66	0.94*	-0.27
M. 28	-1.13**	0.42	0.71*	0.20	-0.68	0.48
M. 29	-0.53	0.37	0.90*	-0.34	-0.76	1.10*
M. 30	-0.74*	-0.57	1.31**	-1.60**	-0.56	2.21**
M. 31	-0.08	-0.28	0.36	0.78	-1.38**	0.60
M. 32	0.20	-1.14**	0.94**	-0.41	0.49	-0.07
M. 33	-0.63	0.25	0.38	0.84	0.46	-1.29*
M. 34	-0.22	-0.11	0.33	-1.76**	-0.37	2.13**
M. 35	0.65	-0.31	-0.34	-0.72	0.48	0.24
M. 36	1.28**	-2.18**	0.89*	-0.28	-0.99*	1.26*
M. 37	0.44	0.46	0.02	-0.61	0.46	0.16
M. 38	0.29	-0.13	-0.16	-2.07**	-0.18	2.25**
S.E. (S_{ij}- S_{ij})		0.66			0.94	
S.E. (S_{ij}- S_{kl})		0.93			1.33	

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

SCA effects were detected for the top crosses M 4 x S.C. 10 (1.83 cm), M 8 x S.C. 10 (1.64 cm) and M 5 x Giza- 2 (1.50 cm). The testers S.C. 10 and Giza- 2 exhibited the largest number of desirable SCA effects (7 cases) as compared with the tester M 13 (5 cases). The widest range between SCA effects (-2.18 to 1.83 cm) was recorded for the tester S.C. 10 followed by the tester M 13 (-1.17 to 1.31 cm). This may suggest the immediate use of inbred lines M 4 and M 8 as parents in the development of 3- way crosses with S.C. 10 to improve ear length trait.

For ear diameter, eight, seven and nine significant and positive SCA effects were detected for the testers Giza- 2, S.C. 10 and M 13, respectively (Table 20). However, the most desirable SCA effects were obtained for the top crosses M 23 x Giza- 2 (2.93 mm), M 8 x S.C.10 (2.90 mm) and M 38 x M 13 (2.25 mm). In this trait, Giza- 2 seemed to be the best tester over all studied testes since it had the highest SCA effect and ranked second for number of desirable SCA effects in addition, it expressed the widest range between SCA effects (-3.10 to 2.93 mm) as compared with S.C. 10 (-1.68 to 2.90 mm) and M 13 (-2.18 to 2.25 mm).

Regarding, number of rows/ ear, the most desirable SCA effects were detected for the top crosses M 19 x M 13 (0.93), M 17 x M 13 (0.84) and M 27 x S.C. 10 (0.73). It is clear that, the inbred line M 13 appeared to be the best tester among all testers since it exhibited the largest number of SCA effects (5 cases), expressed the highest SCA effect and had the widest range between SCA effects (-1.10 to 2.94). This is may suggest the immediate use of inbreds M 17 and M 19 as parents for the development of single crosses with the tester M 13 and inbred line M 27 as a parent for the development of 3- way cross with S.C. 10 (Table 21). For number of kernels/ row, seven, nine, and eight top crosses exhibited significant and positive SCA effects for the testers Giza- 2, S.C. 10 and M 13, respectively (Table 21). However, the best SCA effects were recorded for the top crosses M 24 x Giza- 2 (4.13), M 3 x S.C. 10 (3.91) and M 7 x S.C. 10 (3.90). The ranges between SCA effects for this trait were (-2.96 to 4.13), (-2.98 to 3.91) and (-3.48 to 3.30) for the testers Giza- 2, S.C. 10 and M 13, respectively.

Concerning 100- kernel weight, the desirable SCA effects were recorded for the top crosses Giza- 2 with each of M 14, M 15, M 19, M 20 and M 36; the tester S.C. 10 with each of M 1, M 2, M 11, M 17 and M 34; and the tester M 13 with each of M 6, M 28 and M 37. These top crosses had significant and positive SCA effects for this trait as shown in Table (22). However, the best top crosses for this trait were M 11 x S.C. 10 (3.10), M 19 x Giza- 2 (3.01) and M 20 x Giza- 2 (2.90).

It is obvious that S.C. 10 was the best tester among all studied testers because it had the highest SCA effect and the widest range between SCA effects for 100- kernel weight (Table 22). The superiority of single crosses as good testers was noticed by several workers. Among those are El- Ghawas (1963), Katta (1971), Galal *et al.* (1987) and Sedhom (1992).

Table (21): Specific combining ability effects for number of rows/ ear and kernels/ row of maize combined over two seasons.

Trait / Tester / Lines	No. of rows/ ear			No. of kernels/ row		
	Giza 2	S.C. 10	M. 13	Giza 2	S.C. 10	M. 13
M. 1	-0.21	0.34	-0.13	0.96	-0.92	-0.05
M. 2	-0.10	0.10	0.00	-1.54	2.78**	-1.24
M. 3	-0.19	0.00	0.19	-2.28**	3.91**	-1.64*
M. 4	-0.23	0.31	-0.09	-0.89	3.06**	-2.17*
M. 5	-0.14	0.40*	-0.26	-1.61*	1.36	0.25
M. 6	0.43*	0.13	-0.58**	-0.69	0.23	0.45
M. 7	-0.30	0.53*	-0.22	-0.84	3.90**	-3.06**
M. 8	-0.85**	0.53*	0.31	-1.59*	1.06	0.53
M. 9	0.33	-0.13	-0.20	2.52**	0.13	-2.65**
M. 10	0.21	-0.10	-0.11	-0.61	1.76**	-1.15
M. 11	0.08	-0.68**	0.60**	0.36	-1.77*	1.41
M. 12	0.10	-0.24	0.13	-0.73	-0.09	0.81
M. 13	0.08	0.09	-0.17	0.28	1.59*	-1.87*
M. 14	0.28	-0.26	0.01	0.26	2.15*	-2.41**
M. 15	0.28	-0.03	-0.25	0.26	-0.10	-0.15
M. 16	0.10	-0.07	-0.04	0.64	2.61**	-0.97*
M. 17	-0.27	-0.57**	0.84**	-0.39	-1.35	1.75*
M. 18	0.21	-0.16	-0.05	0.27	-1.93*	1.66*
M. 19	0.11	-1.04**	0.93**	-0.37	-1.34	1.71*
M. 20	0.19	-0.87**	0.68**	3.39**	-2.98**	-0.41
M. 21	0.11	0.09	-0.21	1.68*	-1.76*	0.08
M. 22	0.31	-0.12	-0.19	0.08	-0.57	0.49
M. 23	0.43	0.29	-0.71**	2.92**	-2.81**	-0.12
M. 24	0.21	0.28	-0.49*	4.13**	-0.68	-3.48**
M. 25	-0.32	0.11	0.21	-1.13	0.74	1.86*
M. 26	0.37	0.62**	-0.25	2.30**	-1.09	-1.21
M. 27	-0.31	0.73**	-0.42*	-2.96**	1.51	1.45
M. 28	-0.17	-0.36	0.52*	-2.23**	1.46	0.78
M. 29	0.29	-0.56*	0.27	-0.97	2.04*	-1.08
M. 30	0.44*	-0.10	-0.35	-1.24	-2.07*	3.30**
M. 31	-0.14	0.12	0.02	1.02	-3.65**	2.63**
M. 32	0.54*	0.55	-1.10**	0.73	-3.80	3.07**
M. 33	0.09	-0.49	0.40	-0.57	0.14	0.43
M. 34	0.64**	0.29	0.35	-1.28	-0.07	1.35
M. 35	-0.02	0.15	-0.13	0.18	0.06	-0.24
M. 36	-0.34	0.29	0.04	-0.98	-0.67	1.65*
M. 37	0.09	-0.38	0.29	2.16*	-1.90*	-0.26
M. 38	-0.32	0.19	0.14	0.02	0.51	-0.52
S.E. (S_{ij}- S_{kj})		0.40			1.55	
S.E. (S_{ij}- S_{kl})		0.57			2.20	

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

Table (22): Specific combining ability effects for 100- kernel weight and grain yield/ plant of maize combined over two seasons.

Trait / Tester / Lines	100- kernel weight (g)			Grain yield g/ plant		
	Giza 2	S.C. 10	M. 13	Giza 2	S.C. 10	M. 13
M. 1	1.23	1.93*	-3.10**	-1.30	0.54	0.75
M. 2	-2.49**	1.79*	0.70	-1.19	4.15	-2.97
M. 3	-3.05**	1.32	1.73	-9.41**	-2.73	12.14**
M. 4	-0.60	1.60	-1.00	-19.35**	45.32**	-25.97**
M. 5	3.67	-2.29*	-1.39	6.65*	-20.68**	14.03**
M. 6	0.01	-2.49**	2.78**	-1.30	-0.62	1.92
M. 7	0.73	0.27	-1.00	21.87**	9.04*	-30.91**
M. 8	-0.27	0.43	-0.16	-11.69**	-1.18*	12.87**
M. 9	-0.21	0.49	-0.27	-0.85	7.82*	-6.97*
M. 10	0.29	-0.34	0.06	2.42	-0.73	-1.64
M. 11	-1.60	3.10**	-1.50	-0.69	0.65	0.03
M. 12	-0.16	0.79	0.95	0.09	-16.23**	16.14**
M. 13	0.29	0.49	-0.77	8.37*	31.04**	-39.41**
M. 14	2.23*	-2.23*	0.00	-6.96*	31.21**	-24.25**
M. 15	2.40*	-1.73	-0.66	15.20**	-26.49**	11.59**
M. 16	0.40	0.10	0.50	3.09	-6.40*	3.31
M. 17	0.06	2.43*	-2.50**	-3.19	4.65	-1.47
M. 18	0.94	1.27	-0.33	7.09*	-17.90**	10.81**
M. 19	3.01**	-3.12**	0.11	-9.91**	12.07**	21.98**
M. 20	2.90**	-3.57**	0.67	18.20**	0.71	-18.91**
M. 21	0.44	-0.57	1.00	2.20	-2.12	0.08
M. 22	0.29	-1.18	0.89	39.70**	-20.41**	-18.91**
M. 23	1.34	-1.62	0.28	6.26*	2.43	-8.69**
M. 24	1.12	0.32	-1.44	17.31**	-8.01*	-9.30**
M. 25	-0.38	0.32	0.06	-33.08**	8.27*	24.81**
M. 26	-0.21	-0.01	0.23	-5.80	-16.12**	21.92**
M. 27	-1.66	1.04	0.61	3.31	10.65**	-13.97**
M. 28	-1.77	-0.73	2.50**	-25.24**	3.43	21.81**
M. 29	-2.27*	0.07	2.34	0.48	-9.35**	8.87**
M. 30	-1.94*	-0.07	2.00	0.48	15.32**	-15.80**
M. 31	0.23	0.10	-0.33	9.70*	-4.29	-5.41
M. 32	-0.27	-2.40	2.67**	-41.13**	36.04**	5.09
M. 33	-0.44	0.93	-0.50	-3.69	-4.85	8.53
M. 34	-2.38*	2.66**	-0.27	2.31	-15.85**	13.53**
M. 35	0.95	0.32	-1.27	3.92	-10.73**	6.81*
M. 36	2.34*	1.21	-3.55**	1.70	-8.29*	6.59*
M. 37	-2.71**	1.32	1.39	30.98**	-28.18**	-2.80
M. 38	0.34	0.04	-0.39	-26.58**	22.60**	3.98
S.E. (S_{ij}- S_{ij})		1.75			6.03	
S.E. (S_{ij}- S_{kl})		2.47			8.53	

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

For grain yield/ plant, eleven, eleven and fourteen top crosses exhibited significant and positive SCA effects for the testers Giza- 2, S.C. 10 and M 13, respectively (Table 22). However, the most desirable SCA effects were detected for the top crosses M 4 x S.C. 10 (45.32), M 22 x Giza- 2 (39.70), M 32 x S.C. 10 (36.04), M 13 x S.C. 10 (31.04) and M 14 x S.C. 10 (31.21). Therefore, the immediate use of lines M 4 and M 32 as parents in the development of 3- way crosses with S.C. 10 could be recommended.

It is clear that the tester S.C. 10 expressed the highest SCA effect as compared to other tester, whereas the tester Giza- 2 exhibited the widest range between SCA effects (-41.13 to 39.70 g) as compared to S.C. 10 (-28.18 to 45.32 g) and M 13 (-39.41 to 24.81 g).

4.4 Heterosis :

Heterosis for grain yield/ plant was computed for individual top crosses as the percentage increase of hybrid performance relative to Giza- 2 and S.C. 10 combined over two years (Table 23). Results indicated that the best heterosis in the top crosses involving the tester Giza- 2 were detected in six and two crosses relative to Giza 2 and S.C. 10, respectively. However, the best heterosis for grain yield/ plant were obtained in the top crosses M 36 x Giza 2 (39.89 and 25.05 %) and M 27 x Giza 2 (27.46 and 13.96 %) relative to Giza 2 and S.C. 10, respectively. Also the top cross (M 1 x Giza 2) expressed the third best heterosis for grain yield (21.39%) relative to Giza- 2 variety.

Table (23): Heterosis percentage for grain yield/ plant relative to Giza-2 and S.C. 10 combined over two seasons.

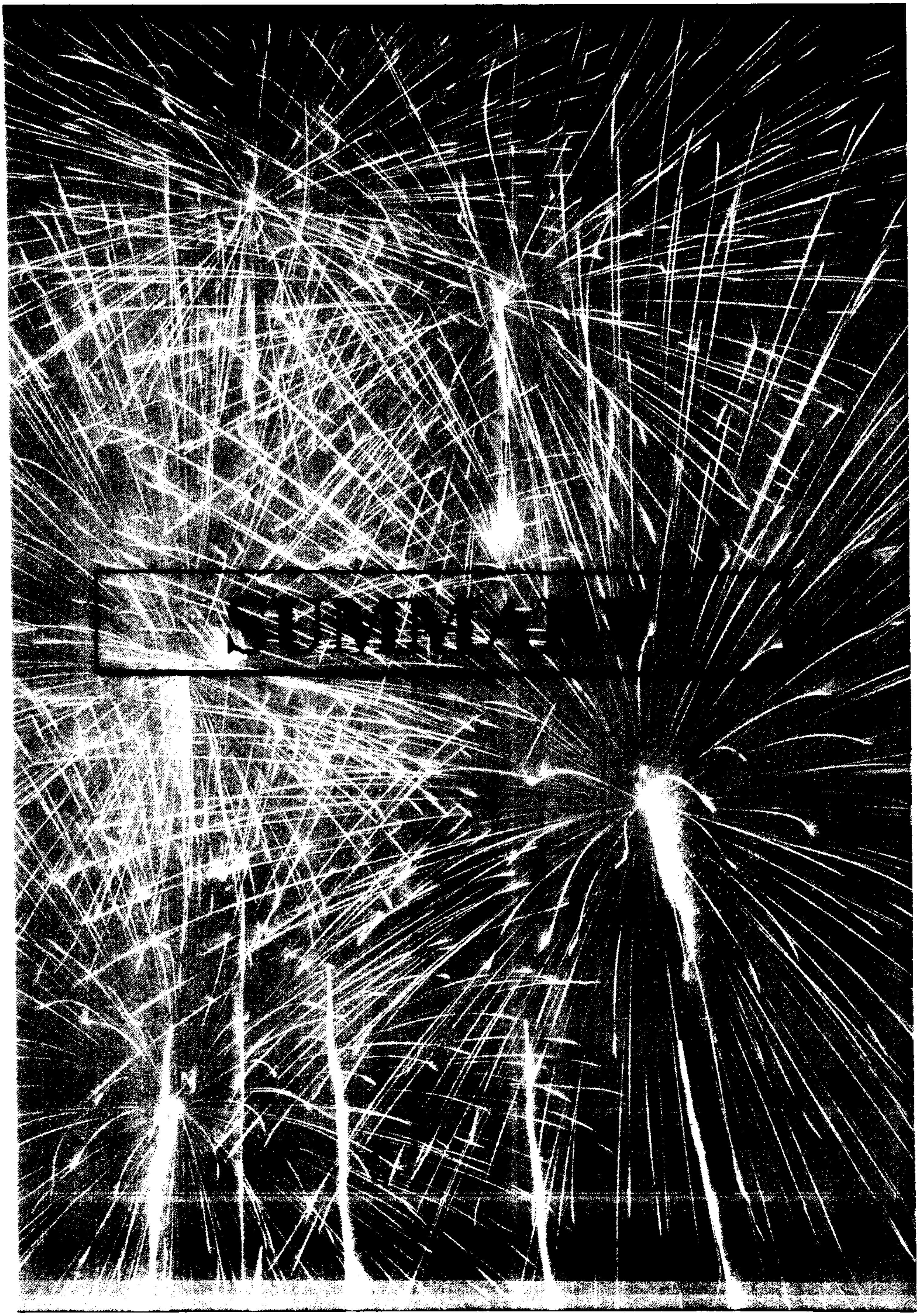
Crosses	Relative to Giza2	Relative to S.C.10	Crosses	Relative to Giza2	Relative to S.C.10	Crosses	Relative to Giza2	Relative to S.C.10
M. 1 x Giza2	21.39**	8.51	M. 1 x S.C 10	29.95**	16.16**	M. 1 x M.13	18.72**	6.12
M. 2 x Giza2	-28.56**	-36.14**	M. 2 x S.C 10	-17.75**	-26.48**	M. 2 x M.13	-33.69**	-40.73**
M. 3 x Giza2	-32.73**	-39.87**	M. 3 x S.C 10	-21.07**	-29.45**	M. 3 x M.13	-22.89**	-31.07**
M. 4 x Giza2	-21.71**	-30.02**	M. 4 x S.C 10	27.17**	13.67**	M. 4 x M.13	-29.95**	-37.38**
M. 5 x Giza2	14.76**	2.58	M. 5 x S.C 10	4.60	-6.50	M. 5 x M.13	15.51**	3.25
M. 6 x Giza2	-20.21**	-28.68**	M. 6 x S.C 10	-12.41*	-21.70**	M. 6 x M.13	-22.14**	-30.40**
M. 7 x Giza2	-3.10	-13.38**	M. 7 x S.C 10	-3.96	-14.15**	M. 7 x M.13	-40.96**	-47.23**
M. 8 x Giza2	-3.85	-14.05**	M. 8 x S.C 10	10.27	-1.43	M. 8 x M.13	7.91	-3.54
M. 9 x Giza2	-16.36**	-25.24**	M. 9 x S.C 10	-3.42	-13.67**	M. 9 x M.13	-24.28**	-32.31**
M. 10 x Giza2	-18.18**	-26.86**	M.10 x S.C 10	-12.83*	-22.08**	M. 10 x M.13	-24.81**	-32.79**
M. 11 x Giza2	-26.42**	-34.23**	M.11 x S.C 10	-18.18**	-26.86**	M. 11 x M.13	-29.95**	-37.38**
M. 12 x Giza2	-27.27**	-34.99**	M. 12 x S.C 10	-30.37**	-37.76**	M. 12 x M.13	-20.96**	-29.35**
M. 13 x Giza2	9.41	-2.20	M. 13 x S.C 10	31.34**	17.40**	M. 13 x M.13	-25.24**	-33.17**
M. 14 x Giza2	-12.51*	-21.80**	M. 14 x S.C 10	19.36**	6.69	M. 14 x M.13	-27.59**	-35.28**
M. 15 x Giza2	-22.25**	-30.50**	M. 15 x S.C 10	-41.82**	-47.99**	M. 15 x M.13	-28.56**	-36.14**
M. 16 x Giza2	-20.32**	-28.78**	M. 16 x S.C 10	-19.04**	-27.63**	M. 16 x M.13	-24.17**	-32.22**
M. 17 x Giza2	-17.01**	-25.81**	M. 17 x S.C 10	-4.60	-14.72**	M. 17 x M.13	-19.89**	-28.39**
M. 18 x Giza2	-22.78**	-30.98**	M. 18 x S.C 10	-31.44**	-38.72**	M. 18 x M.13	-24.39**	-32.41**
M. 19 x Giza2	-20.3**	-28.87**	M. 19 x S.C 10	-14.44**	-23.52**	M. 19 x M.13	-3.96	-14.15**
M. 20 x Giza2	7.70	-3.73	M. 20 x S.C 10	3.85	-7.17	M. 20 x M.13	-20.11**	-28.59**
M. 21 x Giza2	-25.45**	-33.37**	M. 21 x S.C 10	-20.86**	-29.25**	M. 21 x M.13	-30.91**	-38.24**
M. 22 x Giza2	13.37*	1.34	M. 22 x S.C 10	-18.07**	-26.77**	M. 22 x M.13	-28.24**	-35.85**
M. 23 x Giza2	-28.34**	-35.95**	M. 23 x S.C 10	-23.42**	-31.55**	M. 23 x M.13	-41.93**	-48.09**
M. 24 x Giza2	-1.60	-12.05*	M. 24 x S.C 10	-10.48*	-19.98**	M. 24 x M.13	-22.68**	-30.88**
M. 25 x Giza2	-14.12**	-23.23**	M. 25 x S.C 10	19.79**	7.07	M. 25 x M.13	19.04**	6.41
M. 26 x Giza2	-30.27**	-37.67**	M. 26 x S.C 10	-29.52**	-37.00**	M. 26 x M.13	-16.47**	-25.33**
M. 27 x Giza2	27.46**	13.96**	M. 27 x S.C 10	39.57**	24.76**	M. 27 x M.13	12.41*	0.48
M. 28 x Giza2	-18.82**	-27.44**	M. 28 x S.C 10	6.95	-4.40	M. 28 x M.13	7.38	-4.02
M. 29 x Giza2	-17.97**	-26.67**	M. 29 x S.C 10	-16.90**	-25.72**	M. 29 x M.13	-16.58**	-25.43**
M. 30 x Giza2	-2.57	-12.91**	M. 30 x S.C 10	14.33**	2.20	M. 30 x M.13	-17.01**	-25.81**
M. 31 x Giza2	5.03	-6.12	M. 31 x S.C 10	3.42	-7.55	M. 31 x M.13	-8.66	-18.36**
M. 32 x Giza2	-17.22**	-26.00**	M. 32 x S.C 10	39.68**	24.86**	M. 32 x M.13	8.45	-3.06
M. 33 x Giza2	-16.47**	-25.33**	M. 33 x S.C 10	-9.84	-19.41**	M. 33 x M.13	-12.62*	-21.89**
M. 34 x Giza2	-25.78**	-33.65**	M. 34 x S.C 10	-30.05**	-37.48**	M. 34 x M.13	-22.57**	-30.78**
M. 35 x Giza2	12.51*	0.57	M. 35 x S.C 10	10.48*	-1.24	M. 35 x M.13	10.37*	-1.34
M. 36 x Giza2	39.89**	25.05**	M. 36 x S.C 10	40.86**	25.91**	M. 36 x M.13	39.04**	24.28**
M. 37 x Giza2	2.99	-7.93	M. 37 x S.C 10	-27.59**	-35.28**	M. 37 x M.13	-22.67**	-30.88**
M. 38 x Giza2	-15.83**	-24.76**	M. 38 x S.C 10	23.10**	10.04*	M. 38 x M.13	-0.21	-10.80*

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

The second set of top crosses which involved the tester S.C. 10, ten and seven top crosses exhibited significant and positive heterosis relative to Giza- 2 and S.C. 10, respectively. However, the best desirable heterotic effects for grain yield in this set of crosses were detected in the top cross M 36 x S.C. 10 (40.86 and 25.91%) followed by the cross M32 x S.C. 10 (39.68 and 24.86%) then the cross M 27 x S.C. 10 (39.57 and 24.76%) relative to the checks Giza- 2 and S.C. 10, respectively. Moreover, in this set of top crosses, four inbred lines namely, M 13, M27, M 32 and M 36 expressed desirable heterosis in their top crosses for grain yield relative to both checks (Giza- 2 and S.C. 10).

For the third set of top crosses which involved the tester M 13, six and one top crosses expressed significant and positive heterosis relative to the two checks Giza-2 and S.C. 10. However, the best heterosis for gain yield/ plant in this group of crosses was obtained for the cross M 36 x M 13 which recorded 39.04 % and 24.28 % relative to Giza- 2 and S.C. 10, respectively.

It is also clear that the inbred line M 36 expressed the best heterosis for grain yield all over tested lines since it exhibited highly significant and positive heterotic effects in the three top crosses relative to both checks (Giza- 2 and S.C. 10). The inbred line M 27 ranked the second best in its top crosses followed by the inbred line M 32 and then the line M 1. High percentage of heterosis in maize was previously



SUMMARY

The main objective of the present work was to evaluate some new inbred lines of maize through line x tester analysis. Thirty eight new inbreds were isolated from different sources until S_6 stage of inbreeding. In 1995 season, the inbred lines were topcrossed to each of three testers of different genetic base namely, Giza- 2 (broad genetic base), S.C. 10 (medium genetic base) and inbred line M 13 (narrow genetic base. The resultant 114 top crosses along with two checks (Giza- 2 and S.C. 10) were evaluated in 1996 and 1997 seasons in a randomized complete block design using three replications. Data were recorded for days to 50 % tasseling, days to 50 % silking, plant height, ear height, ear length, ear diameter, number of rows/ ear, number of kernels/ row, 100- kernel weight and grain yield/ plant. Line x tester analysis according to Kempthorne (1957) was practiced for the combined data of two years.

The results of the present study combined over two years could be summarized as follows :

1- The inbred line M 1 was the best among all studied lines for silking date and plant height. Since it expressed the most desirable effects over all top crosses as compared with the check variety S.C. 10. Also, this line ranked the second best for number of kernels/ row and ranked the third best for ear height and grain yield/ plant. Inbred line M 5 was the best for ear length, while inbred M 27 was the best for ear length and grain