RESULTS AND DISCUSSION

I. Analysis of variance:

The analysis of variance for the obtained data at each location and combination between both locations is presented in Table (4). The error variance for the two locations was homogenous for all the studied traits, consequently the combined analysis would be valid. Highly significant differences existed among the two locations for all traits except head diameter, indicating overall differences between the two locations. Mean values of L_2 (El-Serw location) for all traits were except for seed husk percentage higher than those of L_1 (Sakha location). Also, the results indicated that selection in separate location would be less effective for improving these traits. Also, the L_1 (Sakha location) produced earlier sunflower plants (Table 5). Densities mean squares were significant for all the studied traits. The effect of spacing (densities) on earliness, yield, and major components as averages of the two locations are shown in Table (6). From the results it is apparent that the distance between hills had significant effects on all traits. The highest mean values for flowering and maturity date, head diameter, 100-seed weight, no of seeds per head, seed husk percentage, seed yield per plant and oil yield per plant were obtained when hills were spaced 40 cm apart on the ridge (D_3). Also, these traits were significantly decreased with decreasing spacing between hills (from D_3 to D_1) (40 cm to 20 cm) (Table 6). These results are in agreement with those of **Miseta (1969), Sturma (1970), Curotti and Rosania (1971), Monotti (1973), Swallers and Fick (1973), Chaudhari *et al.* (1975), Vijay Lakshmi *et al.* (1975), Chaudhari *et al.* (1978), Akhanda (1979), Robinson *et al.* (1980), Smith *et al.* (1981), Moursi *et al.* (1983), Attia (1985), Nasr Allah *et al.* (1994), Allam *et al.* (1996), Geweifel *et al.* (1997) and Mohamed (1997).**

Table (4): Combined analysis for the studied traits over two locations.

S.O.V.	d.F.		50% flowering date			Physiological maturity date			Plant height			Stem diameter		
	Single	Combined	L_1	L_2	Combined	L_1	L_2	Combined	L_1	L_2	Combined	L_1	L_2	Combined
Location	-	1	-	-	1598.011**	-	-	360.045**	-	-	52.186**	-	-	0.969**
R/L	2	4	1.927	0.760 *	1.343	6.018	0.919	3.468	53.955**	60.037**	56.996**	0.027	0.033	0.030
Densities	2	2	106.821**	298.124**	379.782**	76.404**	119.654**	193.569**	1308.608**	3534.627**	4570.946**	3.647**	2.682**	6.255**
L x D	-	2	-	-	25.163**	-	-	2.489	-	-	272.289**	-	-	0.074*
Error	4	8	0.931	0.078	0.504	4.631	0.415	2.523	1.545	2.484	2.015	0.019	0.011	0.015
Genotypes	43	43	103.941**	106.999**	203.632**	39.033**	34.082**	71.030**	5556.738**	6029.523**	11549.521**	1.042**	0.926**	1.899**
L x G	-	43	-	-	7.309**	-	-	2.084**	-	-	36.751**	-	-	0.070**
D x G	86	86	0.800**	0.622*	1.044*	0.642	0.587	1.054*	4.542	3.138	4.088	0.015	0.023**	0.016
L x D x G	-	86	-	-	0.379	-	-	0.175	-	-	3.593	-	-	0.022*
Error	258	516	0.495	0.432	0.464	1.114	0.604	0.859	4.889	6.502	5.696	0.016	0.013	0.015

L_1 : Sakha L_2: El-Serw R: Replicate D: Density G: Genotypes

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

Table (4): Cont.

S.O.V.	d.F.		Head diameter			100-seed weight			Seed husk percent			Number of seeds/head		
	Single	Combined	L_1	L_2	Combined	L_1	L_2	Combined	L_1	L_2	Combined	L_1	L_2	Combined
Location	-	1	-	-	3.069	-	-	13.447**	-	-	244.597**	-	-	764047.709**
R/L	2	4	0.518	0.582	0.550	0.139	1.282**	0.710	0.352	0.081	0.217	4740.044	1180.960	2960.502
Densities	2	2	66.561**	22.684**	83.260**	10.255**	15.689**	25.628**	75.227**	173.672**	238.537**	285336.499**	687427.714**	923745.136**
L x D	-	2	-	-	5.985*	-	-	0.315	-	-	10.363**	-	-	49019.077
Error	4	8	1.067	0.473	0.770	0.474	0.039	0.257	0.506	0.293	0.399	18402.357	4719.471	11560.914
Genotypes	43	43	79.088**	67.279**	144.746**	4.330**	6.037**	9.754**	50.593**	64.548**	113.555**	61832.276**	61909.047**	114445.647**
L x G	-	43	-	-	1.621**	-	-	0.613**	-	-	1.586**	-	-	9295.676**
D x G	86	86	0.810	0.283	0.616*	0.044	0.094*	0.087	0.171	0.283**	0.319*	1444.879	4948.189**	3411.405
L x D x G	-	86	-	-	0.477	-	-	0.050	-	-	0.135	-	-	2981.664
Error	258	516	0.720	0.255	0.488	0.161	0.078	0.120	0.335	0.186	0.261	4672.091	3947.029	4309.560

Table (4): Cont.

S.O.V.	d.F.		Seed yield/plant			Oil percentage			Oil yield/plant			Seed yield/fed.		
	Single	Combined	L_1	L_2	Combined	L_1	L_2	Combined	L_1	L_2	Combined	L_1	L_2	Combined
Location	-	1	-	-	5778.541**	-	-	11.961**	-	-	1221.701**	-	-	3003803.508**
R/L	2	4	2.049	27.795	14.922	0.353*	1.233**	0.793**	0.418	7.021	3.720	616.659	12617.949**	6617.304
Densities	2	2	2589.529**	5936.383**	8163.591**	15.458**	12.031**	27.311**	445.723**	1080.227**	1453.154**	4757001.632**	4112072.483**	8808356.084**
L x D	-	2	-	-	362.321**	-	-	0.178*	-	-	72.796**	-	-	60718.031**
Error	4	8	6.821	7.451	7.136	0.050	0.020	0.035	1.401	1.393	1.397	6392.338	3909.806	5151.072
Genotypes	43	43	101.481**	247.760**	311.912**	72.332**	71.737**	143.774**	34.381**	67.993**	95.293**	63451.836**	135066.948**	180896.613**
L x G	-	43	-	-	37.329**	-	-	0.295**	-	-	7.082**	-	-	17622.171**
D x G	86	86	2.288	15.849**	10.639**	0.139	0.145	0.238**	0.526	3.420**	2.547**	3693.779	6289.527**	6601.873**
L x D x G	-	86	-	-	7.499**	-	-	0.046	-	-	1.399**	-	-	3381.433
Error	258	516	5.568	5.433	5.500	0.156	0.178	0.167	1.124	1.099	1.111	4142.395	4058.638	4100.516

Table (5): The average of location effect on the studied traits.

Location	50% flowering date	Physiological maturity date	Plant height (cm)	Stem diameter (cm)	Head diameter (cm)	100-seeds weight (g)
L_1	55.30 b	76.42 b	129.122 b	1.807 b	14.934	5.015 b
L_2	58.14 a	77.77 a	129.635 a	1.877 a	14.809	5.275 a
L.S.D.	0.1164	0.2602	0.2325	0.0202	N.S	0.0832

Table (5): Cont.

Location	Seed husk percent	Number of seeds/head	Seed yield (g/plant)	Oil percentage	Oil/yield (g/plant)	Seed yield (kg/fed.)
L_1	21.141 a	698.595 b	35.098 b	43.942 b	15.429 b	860.655 b
L_2	20.030 b	764.576 a	40.501 a	44.187 a	17.913 a	989.824 b
L.S.D.	0.1037	18.7134	0.4376	0.0307	0.1937	11.76

L_1 : Sakha, L_2: El-Serw.

Table (6): The average values of the studied traits as affected by different densities.

Distance	50% flowering date	Physiological maturity date	Plant height (cm)	Stem diameter (cm)	Head diameter (cm)	100-seeds weight (g)
D_1	55.409 c	76.205 c	134.165 a	1.684 c	14.254 c	4.794 c
D_2	56.992 b	77.163 b	127.349 b	1.850 b	15.008 b	5.254 b
D_3	57.761 a	77.913 a	126.622 c	1.992 a	15.352 a	5.387 a
L.S.D.	0.1425	0.3189	0.2850	0.0219	0.1761	0.1017

Table (6): Cont.

Distance	Seed husk percent	Number of seeds/head	Seed yield g/plant	Oil percentage	Oil/yield gm/plant	Seed yield kg/fed.
D_1	19.601 c	662.045 c	31.631 c	44.404 a	14.061 c	1107.047 a
D_2	20.657 b	748.446 b	39.339 b	44.026 b	17.349 b	917.867 b
D_3	21.498 a	784.265 a	42.428 a	43.764 c	18.604 a	741.804 c
L.S.D.	0.1269	22.9190	0.5361	0.0355	0.2374	14.4031

D_1 35000 plant/fed — 20 cm between plant in one side of the ridge
D_2 23333 plant/fed — 30 cm between plant in one side of the ridge
D_3 17500 plant/fed — 40 cm between plant in one side of the ridge

On the other hand, the highest mean values for plant height, oil percentage and seed yield/fed. were significantly increased by decreasing spacing between hills (from D_3 to D_1) 40 cm to 20 cm. These results are in agreement with those of **Miseta (1969), Sturma (1970), Swallers and Fick (1973), Vijaylakshmi *et al.* (1975), Rao *et al.* (1976), Robinson *et al.* (1980), Smith *et al.* (1981), Attia (1985), Nasr Allah (1994), Allam *et al.* (1996) and Mohamed (1997).**

The highest mean value of plant height at D_1 was mainly due to the increase in competition among sunflower plants grown in dense population. Also, the previous results illustrated remarkable increase in seed yield/fed. with decreasing spacing between hills (from 40 cm to 20 cm) D_3 to D_1. Although the individual sunflower plant grown in dense population (lower spacing between hills) yielded lower seed yield in comparison with the seed yield per plant at the 20 cm spacing between hills, but the greater plants number per unit area due to the high density compensated the lower plant yield and raised the seed yield per feddan. These results are in agreement with those obtained by **Curotti (1971), Swallers and Fick (1973), Chaudhari *et al.* (1975), Vijaylakshmi *et al.* (1975), Miller and Fick (1978), Akhanda (1979), Robinson *et al.* (1980), Stner (1981), Attia (1985), Nasr Allah *et al.* (1996), Allam *et al.* (1996) and Mohamed (1997).**

The mean squares of interaction between densities (spacing) and location were significant for all traits except days to physiological maturity, 100-seed weight and number of seeds/head indicating that the effect of densities was fluctuated by locations (Table 4). The mean values for all traits of sunflower as affected by the interaction between location x density in the combined analysis are presented in (Table 7). D_3 gave the highest mean values for flowering and maturity dates, stem diameter, seed yield per plant, 100-seed weight, oil yield g/plant and number of seeds per plant at location two. Also, this density had the highest mean values for head diameter and husk percentage in location one. However, D_1 had the highest mean values for oil percentage and seed yield/fed. in location two followed by D_2 in the same location. It could be concluded that location two was unstressed for sunflower plants and D_1 gave the highest mean values for seed and oil yields/fed.

Genotypes mean squares were significant for all the studied traits at both locations as well as the combined analysis (Table 4), indicating the wide diversity between the parental materials used in the present study. Significant genotypes x location mean squares were obtained for all the studied traits, revealing that the tested genotypes varied from each other and ranked differently from location to another.

The mean performances for the genotypes of sunflower at separate location as well as the combined analysis are presented in (Table 8). The parental line A_3 and testers R_8, and top crosses A_1 x R_8, A_{10}xR_8 and A_9 x R_8 gave the lowest values for number of days to 50% flowering and physiological maturity and were significantly earlier than the check hybrids, in both locations as well as the combined analysis. On the other hand, the top cross A_1 x R_{14}, A_6 x R_8 and both check hybrids Eirflor and Malabar were the latest with regard to number of days to 50% flowering and physiological maturity, in both location as well as the combined analysis. For plant height, the parental line A_6 and tester R_8, and top crosses between A_6 and each of R_3, R_4, R_8 and R_{12} recorded the lowest values for this trait in both locations as well as the combined data. This result revealed that the genes responsible for dwarfeness were found in inbred line A_6. On the contrary, the top cross A_1 x R_{14}, Eirflor and Malabar gave the tallest plants. For stem diameter, the top cross A_6 x R_8 gave significant highest values followed by top cross A_6 x R_4 compared with the other genotypes in both locations as well as the combined data.

Table (7): The average values of the studied traits on sunflower as affected by the interaction between locations x spacing (densities) (combined data of both locations).

Distance / Location	50% flowering (days)			Physiological maturity (days)			Plant height (cm)		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
L_1	54.295	55.576	56.030	75.621	76.500	77.136	132.736	127.659	126.970
L_2	56.523	58.409	59.492	76.788	77.826	78.689	135.594	127.039	127.273
L.S.D.	0.2015			N.S			0.4027		

Table (7): Cont.

Distance / Location	Stem diameter (cm)			Head diameter (cm)			100-seed weight (g)		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
L_1	1.631	1.829	1.961	14.144	15.137	15.520	4.703	5.101	5.240
L_2	1.738	1.870	2.023	14.364	14.878	15.185	4.884	5.407	5.535
L.S.D.	0.0349			0.249			N.S.		

Table (7): Cont.

Distance / Location	Seed husk percent			No of seeds/plant			Seed yield/plant (g)		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
L_1	20.374	21.166	21.883	645.750	706.460	743.574	30.281	36.019	38.995
L_2	18.828	20.148	21.113	678.340	790.433	824.956	32.981	42.658	45.862
L.S.D.	0.1763			N.S			0.7581		

Table (7): Cont.

Distance / Location	Oil percentage			Oil yield/plant (g)			Seed yield/fed (kg)		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
L_1	44.310	43.882	43.633	13.424	15.830	17.033	1059.803	840.408	681.753
L_2	44.498	44.170	43.895	14.697	18.868	20.174	1154.292	995.326	801.855
L.S.D.	0.0532			0.3355			20.3692		

L_1 = Sakha, L_2 = El-Serw, D_1 = 35,000 plant/fed, D_2 = 23,333 plant/fed, D_3 = 17,500 plant/fed.

Table (8): Mean performances of the genotypes in both locations as well as the combined over them.

Genotypes	50% flowering date			Physiological maturity date			Plant height (cm)			Stem diameter (cm)		
	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.
Lines A_1	57.444	61.000	59.222	76.778	78.111	77.444	123.651	120.722	122.189	1.278	1.356	1.317
A_3	50.111	53.778	51.944	72.667	74.000	73.333	123.967	120.767	122.367	1.322	1.378	1.350
A_4	51.667	55.667	53.667	74.333	75.778	75.056	121.422	115.967	118.694	1.311	1.389	1.350
A_6	58.111	61.667	59.889	77.889	78.778	78.333	63.889	58.367	61.128	2.078	2.167	2.122
A_9	52.889	58.667	55.778	75.667	77.110	76.389	122.667	119.678	121.172	2.033	2.133	2.083
A_{10}	52.000	56.556	54.278	74.667	76.000	75.333	137.778	134.789	136.283	1.878	1.967	1.922
Testers R_3	55.444	60.111	57.778	76.889	78.111	77.500	122.378	119.367	120.872	1.256	1.378	1.317
R_4	53.444	58.778	56.111	75.556	77.000	76.278	120.533	115.800	118.167	1.156	1.222	1.189
R_8	48.667	52.556	50.611	71.333	73.000	72.167	86.122	85.344	85.733	1.044	1.078	1.061
R_{12}	52.222	58.000	55.111	74.667	76.333	75.500	123.222	119.933	121.578	1.200	1.211	1.206
R_{14}	53.000	58.333	55.667	75.667	76.556	76.111	127.022	124.378	125.700	1.378	1.433	1.406
Cross												
A_1 R_3	54.889	57.000	55.944	75.333	76.333	75.833	151.522	153.733	152.628	1.600	1.589	1.594
R_4	57.556	58.667	58.111	75.778	77.556	76.667	147.422	150.033	149.100	1.611	1.756	1.683
R_8	50.111	50.333	50.222	71.444	73.778	72.611	105.289	107.822	106.556	2.100	1.944	2.022
R_{12}	58.111	60.667	59.389	76.444	77.556	77.000	141.456	143.889	142.672	1.733	1.867	1.800
R_{14}	59.333	61.556	60.444	76.556	77.778	77.167	160.133	164.778	162.456	1.744	1.911	1.828
A_3 R_3	56.333	58.000	57.167	76.444	78.222	77.333	152.411	155.078	153.744	1.678	1.833	1.756
R_4	56.000	58.222	57.111	77.111	78.222	77.667	140.689	145.233	142.961	1.722	1.911	1.817
R_8	50.778	51.778	51.278	76.778	77.889	77.333	146.522	149.411	147.967	1.833	1.656	1.744
R_{12}	57.000	59.667	58.333	77.222	77.333	77.278	144.333	143.711	144.022	1.689	1.744	1.717
R_{14}	54.667	57.222	55.944	77.222	77.444	77.333	151.389	154.589	152.989	1.811	1.922	1.867
A_4 R_3	55.556	57.889	56.722	76.889	78.111	77.500	127.700	131.478	129.589	1.778	1.944	1.861
R_4	56.778	59.667	58.222	77.889	78.667	78.278	124.578	132.056	130.817	1.811	1.911	1.861
R_8	50.000	52.556	51.278	76.111	79.333	77.722	139.067	143.189	141.128	2.022	2.100	2.061
R_{12}	56.889	59.556	58.222	76.889	77.778	77.333	145.311	148.289	146.800	1.722	1.900	1.811
R_{14}	58.000	60.667	59.333	77.556	78.111	77.833	151.444	157.711	156.078	1.833	1.989	1.911
A_6 R_3	58.000	60.333	59.167	77.889	78.667	78.278	76.978	76.767	76.872	2.344	2.089	2.217
R_4	58.111	60.556	59.333	79.111	79.111	79.111	82.411	84.367	83.389	2.444	2.256	2.350
R_8	58.444	61.778	60.111	79.222	82.444	80.833	75.900	75.956	75.928	2.422	2.511	2.467
R_{12}	58.222	60.333	59.278	77.556	78.333	77.944	79.378	81.111	80.244	2.322	2.033	2.178
R_{14}	57.778	60.444	59.111	78.111	79.111	78.611	110.433	111.556	110.994	2.144	2.011	2.078
A_9 R_3	56.889	59.222	58.056	78.556	79.778	79.167	130.500	132.267	131.383	1.722	1.911	1.817
R_4	56.667	58.667	57.667	77.000	79.000	78.000	124.600	125.367	124.983	1.711	1.911	1.811
R_8	49.667	51.333	50.500	70.889	72.667	71.778	128.233	131.844	130.039	1.844	2.044	1.944
R_{12}	57.667	60.111	58.889	77.778	78.778	78.278	132.300	135.522	133.911	1.889	2.022	1.956
R_{14}	57.444	60.444	58.944	77.222	78.667	77.444	144.367	146.211	145.289	1.967	2.078	2.022
A_{10} R_3	56.111	58.556	57.333	77.333	78.778	78.056	152.167	154.167	153.228	1.867	2.000	1.933
R_4	56.333	58.444	57.389	77.667	79.222	78.444	140.256	142.089	141.172	1.844	2.022	1.933
R_8	45.000	46.444	45.722	72.222	75.000	73.611	129.756	130.944	130.350	2.167	2.100	2.133
R_{12}	56.778	59.556	58.167	77.333	78.333	77.833	153.578	153.500	153.539	2.011	2.133	2.072
R_{14}	55.333	60.111	57.722	76.222	78.556	77.389	153.344	152.211	152.778	1.944	2.067	2.006
Eirflor	59.111	61.000	60.056	79.333	80.778	80.056	162.467	163.200	162.833	2.111	2.267	2.189
Malabar	59.556	61.667	60.611	79.333	80.667	80.000	161.133	157.667	159.400	1.944	2.167	2.056
Vidoic	59.111	60.667	59.889	77.889	79.000	78.444	133.511	132.344	132.928	2.189	2.278	2.233
L.S.D.	0.6502	0.6072	0.4448	0.9750	0.7181	0.6056	2.0628	2.3557	1.5589	0.1164	0.1067	0.0790

L_1 = Sakha
L_2 = El-Serw

Table (8): Cont.

Genotypes		Head diameter (cm)			100-seeds weight (g)			Seed husk percentage			No. of seeds/head		
		L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.
Lines													
	A_1	12.233	12.844	12.539	4.289	4.456	4.372	18.391	17.178	17.784	685.511	679.122	682.317
	A_3	11.278	11.711	11.494	4.489	4.633	4.561	20.722	20.044	20.383	663.322	664.800	664.061
	A_4	13.000	13.922	13.461	4.433	4.344	4.389	20.167	18.956	19.561	678.911	712.789	695.850
	A_6	13.878	15.033	14.456	4.544	4.644	4.594	25.233	24.289	24.761	723.044	742.178	733.611
	A_9	14.422	14.967	14.694	3.978	4.100	4.039	20.333	19.644	19.989	833.989	845.600	839.794
	A_{10}	12.856	13.644	13.250	4.433	4.611	4.522	21.578	20.667	21.122	705.256	757.800	731.528
Testers													
	R_3	9.611	9.739	9.700	3.567	3.667	3.617	20.656	19.122	19.889	882.478	913.553	898.231
	R_4	7.756	7.756	7.756	3.811	3.878	3.844	20.722	19.667	20.194	848.701	892.496	870.916
	R_8	5.567	5.967	5.767	4.056	4.122	4.089	24.033	23.122	23.578	701.578	747.477	724.700
	R_{12}	8.856	8.967	8.911	4.544	4.489	4.517	23.000	22.378	22.689	678.059	742.793	710.162
	R_{14}	10.800	10.933	10.867	3.622	3.578	3.600	20.589	20.022	20.306	861.099	956.764	908.639
Cross													
A_1	R_3	13.978	13.289	13.633	4.200	4.400	4.300	16.844	16.533	16.689	1051.733	1104.791	1078.262
	R_4	15.600	15.833	15.717	5.944	5.589	5.767	18.033	17.500	17.767	730.133	822.711	776.422
	R_8	14.022	14.000	14.111	4.667	4.556	4.611	28.000	27.300	27.650	755.911	806.533	781.222
	R_{12}	15.156	15.267	15.211	5.111	5.222	5.167	22.922	22.078	22.500	847.489	918.696	883.042
	R_{14}	16.433	15.478	15.956	5.722	5.789	5.756	22.633	22.100	22.367	658.767	788.389	723.578
A_3	R_3	15.222	14.922	14.922	4.767	5.111	4.939	18.511	16.378	17.444	730.111	825.556	777.833
	R_4	16.167	15.700	15.933	6.333	5.533	5.933	19.667	18.622	19.144	544.100	752.656	648.378
	R_8	13.156	13.256	13.206	4.400	4.478	4.439	22.344	21.578	21.961	804.078	850.133	827.106
	R_{12}	15.511	15.722	15.617	5.378	5.533	5.456	22.478	20.289	21.383	653.333	793.100	723.217
	R_{14}	16.800	16.100	16.450	5.411	5.856	5.633	20.667	19.744	20.206	681.556	766.311	723.933
A_4	R_3	15.378	16.556	15.967	4.978	5.411	5.194	19.956	18.289	19.122	667.356	735.011	701.183
	R_4	16.556	16.689	16.622	5.700	5.700	5.700	20.478	19.167	19.822	679.922	747.789	713.856
	R_8	14.133	13.800	13.967	4.467	4.567	4.517	18.589	16.344	17.467	763.311	833.322	798.317
	R_{12}	16.422	16.189	16.306	5.300	5.478	5.389	20.767	19.444	20.106	718.544	760.889	739.717
	R_{14}	16.711	15.356	16.033	5.978	6.122	6.050	19.889	17.744	18.817	617.333	684.433	650.883
A_6	R_3	17.289	16.578	16.933	4.400	5.100	4.750	26.144	25.833	25.989	789.978	843.100	816.539
	R_4	17.256	16.611	16.933	5.500	6.344	5.922	19.344	17.356	18.350	670.356	706.878	688.617
	R_8	15.789	15.822	15.806	5.256	5.344	5.300	17.289	15.111	16.200	654.933	822.356	738.644
	R_{12}	15.600	15.000	15.300	5.433	5.667	5.550	24.256	23.633	23.944	690.056	786.400	738.228
	R_{14}	17.422	16.811	17.117	5.711	6.211	5.961	23.322	22.178	22.750	644.944	735.567	690.256
A_9	R_3	16.900	15.589	16.244	5.378	6.122	5.750	18.335	16.511	17.423	657.289	666.378	661.833
	R_4	16.722	15.722	16.222	5.378	6.178	5.778	17.456	15.978	16.717	667.244	693.656	680.450
	R_8	14.856	14.233	14.544	4.811	4.789	4.800	22.200	20.600	21.400	706.622	820.900	763.761
	R_{12}	15.856	16.167	16.011	5.733	6.400	6.067	19.289	17.978	18.633	654.456	736.767	695.611
	R_{14}	18.711	17.944	18.328	6.322	6.389	6.356	19.733	18.333	19.033	629.567	721.733	675.650
A_{10}	R_3	16.600	16.544	16.572	5.256	5.944	5.600	23.967	23.500	23.733	682.800	734.589	708.694
	R_4	16.744	16.544	16.644	5.144	6.022	5.583	21.611	19.744	20.678	644.633	678.811	661.772
	R_8	15.500	15.144	15.322	5.367	5.356	5.361	20.156	19.367	19.761	653.178	728.156	690.667
	R_{12}	16.467	16.456	16.461	5.456	6.200	5.828	22.556	22.244	22.400	644.344	698.567	671.456
	R_{14}	16.644	16.644	16.644	5.633	6.456	6.044	21.467	20.167	20.817	655.344	711.344	683.344
Eirflor		19.733	19.011	19.372	5.022	6.067	5.544	22.044	21.978	22.011	681.367	714.378	697.872
Malabar		18.778	18.883	18.806	5.400	5.622	5.511	22.578	21.678	22.128	662.133	766.211	714.172
Vidoic		18.711	18.356	18.533	5.322	6.033	5.678	21.267	20.922	21.094	660.244	660.078	660.161
L.S.D.		0.7840	0.4664	0.4562	0.3714	0.2586	0.2262	0.5349	0.3988	0.337	63.1450	58.0389	42.831

Table (8): Cont.

Genotypes		Seed yield/plant (g)			Oil percentage			Oil yield/plant (g)			Seed yield/fed (g)		
		L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.
Lines	A_1	29.456	30.300	29.878	47.244	47.644	47.444	13.911	14.411	14.161	722.11	746.52	734.32
	A_3	29.867	30.898	30.378	43.556	44.378	43.967	13.011	13.656	13.333	732.08	758.01	745.04
	A_4	30.189	30.844	30.517	43.900	44.700	44.300	13.222	13.767	13.494	736.56	759.62	748.09
	A_6	33.000	34.478	33.739	38.967	39.933	39.246	12.844	13.611	13.228	809.51	850.378	829.94
	A_9	33.222	34.733	33.978	42.967	44.017	43.300	14.256	15.156	14.705	817.98	858.47	838.22
	A_{10}	31.289	32.989	32.139	42.789	43.583	43.006	13.378	14.244	13.811	768.83	809.64	789.24
Testers	R_3	31.478	33.500	32.489	44.844	46.000	45.272	14.100	15.300	14.700	773.16	821.72	797.44
	R_4	32.344	34.611	33.878	45.211	45.967	45.494	14.589	15.844	15.217	795.06	852.24	823.65
	R_8	28.456	30.811	29.633	39.467	40.583	39.850	11.211	12.378	11.794	697.28	753.40	725.34
	R_{12}	30.811	33.344	32.078	39.956	40.783	40.122	12.289	13.422	12.856	755.66	818.76	787.21
	R_{14}	31.189	34.233	32.711	43.656	44.783	43.994	13.556	15.178	14.367	765.60	839.03	802.32
Cross													
A_1	R_3	43.989	48.578	46.283	47.133	47.211	47.172	20.722	22.922	21.822	1082.22	1185.92	1134.07
	R_4	43.178	46.611	44.894	46.667	46.600	46.633	20.156	21.678	20.917	1063.47	1137.26	1100.36
	R_8	35.322	36.844	36.083	37.600	37.767	37.683	13.289	13.900	13.594	865.28	897.43	881.36
	R_{12}	42.978	48.111	45.544	42.300	42.400	42.350	18.178	20.456	19.317	1058.41	1170.41	1114.41
	R_{14}	37.378	45.600	41.489	43.678	43.867	43.772	16.333	20.000	18.167	916.63	1095.11	1005.87
A_3	R_3	34.867	42.411	38.639	47.000	47.011	47.006	16.356	19.978	18.167	849.46	1019.28	934.37
	R_4	34.522	41.922	38.222	46.011	46.133	46.072	15.878	19.344	17.611	839.37	1003.40	921.38
	R_8	35.511	38.233	36.873	42.222	42.333	42.278	15.000	16.184	15.592	866.26	929.71	897.98
	R_{12}	34.678	43.778	39.228	42.367	42.467	42.717	14.678	18.589	16.633	851.20.	1054.42	952.81
	R_{14}	36.933	45.144	41.039	45.400	45.567	45.483	16.778	20.556	18.667	904.82	1083.90	994.36
A_4	R_3	33.389	39.822	36.606	45.556	45.722	45.639	15.200	18.200	16.700	820.46	957.31	888.88
	R_4	37.400	42.444	39.922	45.033	45.111	45.072	16.833	19.144	17.989	919.79	1041.51	980.65
	R_8	34.256	38.244	36.250	48.533	48.667	48.600	16.611	18.600	17.606	832.08	926.91	879.49
	R_{12}	37.922	41.678	39.800	43.667	43.622	43.644	16.522	18.178	17.350	935.86	1026.07	980.96
	R_{14}	36.467	41.544	39.006	45.778	45.967	45.872	16.611	19.078	17.844	892.51	1012.39	952.45
A_6	R_3	34.744	43.144	38.944	38.411	38.411	38.411	13.344	16.556	14.950	849.26	1036.23	942.74
	R_4	36.911	44.956	40.933	47.133	47.822	47.228	17.400	21.267	19.333	912.87	1092.19	1002.53
	R_8	34.478	44.122	39.300	49.544	49.722	49.633	17.078	21.933	19.506	841.87	1073.20	957.53
	R_{12}	37.400	44.567	40.983	40.522	40.467	40.494	15.022	18.022	16.522	913.50	1076.96	995.23
	R_{14}	36.856	45.878	41.367	42.533	42.700	42.617	15.656	18.589	17.622	898.02	1107.94	1002.98
A_9	R_3	35.433	40.844	38.139	47.789	47.967	47.878	16.922	19.589	18.256	867.80	990.30	929.05
	R_4	35.967	43.067	39.517	48.944	49.378	49.161	17.600	21.244	19.422	883.31	1040.40	961.86
	R_8	34.089	39.511	36.800	43.133	43.444	43.289	14.700	17.156	15.928	832.02	956.00	849.01
	R_{12}	37.578	47.367	42.472	46.067	46.133	46.100	17.300	21.856	19.578	928.28	1141.11	1034.69
	R_{14}	39.289	46.033	42.661	45.489	45.600	45.544	17.867	20.989	19.428	977.20	1128.62	1052.91
A_{10}	R_3	35.989	43.967	39.978	40.089	40.356	40.222	14.444	17.733	16.089	878.77	1043.99	961.38
	R_4	33.267	41.133	37.200	44.067	44.233	44.150	14.678	18.189	16.433	815.03	992.06	903.54
	R_8	35.089	39.078	37.083	44.122	44.089	44.106	15.478	17.233	16.356	862.94	961.14	912.04
	R_{12}	35.044	43.511	39.278	42.044	42.078	42.061	14.733	18.311	16.522	862.43	1051.88	957.16
	R_{14}	36.933	46.189	41.561	44.667	44.889	44.778	16.500	20.744	18.622	910.41	1115.33	1012.87
Eirflor		34.356	43.733	39.044	42.211	42.222	42.217	14.500	18.467	16.483	834.21	1045.47	939.83
Malabar		35.578	43.289	39.433	42.678	42.833	42.756	15.189	18.544	16.867	873.38	1049.10	961.24
Vidoic		35.232	39.933	37.583	42.489	42.522	42.506	14.956	16.978	15.967	855.90	977.52	916.71
L.S.D.		2.1797	2.1534	1.5321	0.3656	0.3899	0.2672	0.9794	0.9686	0.6887	58.8538	59.4579	41.8302

Eirflor, Malabar, Vidoic and the top cross $A_9 \times R_{14}$ recorded the highest mean values for head diameter in the combined analysis. However, R_8 recorded the lowest value. The top crosses $A_4 \times R_{14}$, $A_9 \times R_{12}$, $A_9 \times R_{14}$ and $A_{10} \times R_{14}$ recorded significantly higher values of 100-seed weight compared to the best check hybrid in the combined data. However, the five testers gave the lowest values. The top crosses, A_1xR_3, $A_9 \times R_3$, $A_1 \times R_4$, $A_1x R_8$, $A_1 \times R_{12}$, $A_3 \times R_3$, $A_3 \times R_8$, $A_4 \times R_8$, $A_6 \times R_3$ and $A_9 \times R_8$ produced significantly higher number of seeds per head compared to the best check hybrids in both locations as well as the combined data (Table 8).

The top cross $A_6 \times R_8$ gave the lowest value for seed husk percentage followed by top cross $A_1 \times R_3$ in both locations as well as the combined analysis. However, the top crosses A_1xR_8, $A_6 \times R_3$, $A_6 \times R_{12}$, and $A_{10} \times R_3$ showed the highest ones. Twenty one out of thirty top crosses showed significant increases in oil percentage compared to the best check hybrid at the combined analysis. Also, the top crosses $A_6 \times R_8$, $A_9 \times R_4$, $A_4 \times R_8$, $A_1 \times R_3$, $A_3 \times R_3$, $A_6 \times R_4$ and $A_9 \times R_3$ recorded the highest oil percentages.

With regard to seed yield and oil yield (g/plant), the top crosses, $A_1 \times R_3$, $A_1 \times R_4$, $A_1 \times R_{12}$, $A_1 \times R_{14}$, $A_3 \times R_{14}$, $A_6 \times R_4$, $A_9 \times R_{12}$, $A_9 \times R_{14}$ and $A_{10} \times R_{14}$ showed significant increases compared to the best of check hybrid. This result indicated that the inclusion of A_1 or R_{12} and R_{14} gave the highest seed and oil yield/plant. Also, it could be concluded that increasing oil yield was due to the increase in seed yield/plant and oil percentage. Moreover, the previous top crosses showed significant increases in one or more of the traits contributing to seed yield. While, the top crosses A_3 x R_3, A_3 x R_4, A_4 x R_4, A_4 x R_8, A_4 x R_{14}, A_6 x R_8, A_9 x R_3 and A_9 x R_4 gave significantly increases in oil/plant compared to the best check hybrid. The higher oil yield/plant in these crosses was attributed to high oil percentages no more.

With regard to seed yield/fed., the top crosses A_1 x R_3, A_1 x R_4, A_1 x R_{12}, A_1, x R_{14}, A_9 x R_{12}, A_9 x R_{14} and A_{10} x R_{14} showed significant increases compared to the best check hybrid in both locations as well as the combined analysis. The high seed yield/fed. in the previous crosses could be attributed to high seed yield/plant and its components. It could be concluded that these crosses would be efficient and prospective in sunflower breeding program for seed and oil yields. Hence, it could be concluded that these crosses offer possibility for improving seed yield of sunflower.

Data presented in (Table 4) showed that (spacing) densities x genotypes mean squares were significant for all traits one or both locations as well as the combined data except plant height in both locations as well as the combined analysis. Also, significant mean squares due to interaction between densities, genotypes and location were detected for stem diameter, seed yield per plant and oil yield per plat indicating that the performance of genotypes differed from density to another. The mean performances of the tested genotypes at the three densities in the combined analysis over the two locations are presented in Table (9).

Flowering and maturity dates earliness were detected by most top crosses compared by the earliest check hybrid. While the best top crosses for earliness were A_1 x R_8, A_9 x R_8 and A_{10} x R_8. It is worth noting that R_8 as the earliest parent among the tested, was able to transmit it superiority to its hybrids.

For stem diameter, the top cross A_6 x R_8 was significantly higher compared to best check hybrids (Table 8) for these traits. The other top crosses were significantly lower than best check hybrids under the three densities. However none of the top hybrids surpassed the highest performance check hybrids for head diameter.

For husk percentage, the top crosses A_1 x R_3, A_1 x R_4, A_3 x R_3, A_4 x R_8, A_6 x R_8, A_9 x R_3 and A_9 x R_4 were significantly lower compared to best check hybrids at the three densities in the combined data.

Nineteen top crosses gave significantly higher oil percentage at the three densities. These crosses were A_1 x R_3, A_1 x R_4, A_3 x R_3, A_3 x R_4, A_3 x R_{14}, A_4 x R_3, A_4 x R_4, A_4 x R_8, A_4 x R_{12}, A_4 x R_{14}, A_6 x R_4, A_6 x R_8, A_9 x R_3, A_9 x R_4, A_9 x R_{12}, A_9 x R_{14}, A_{10} x R_4, A_{10} x R_8 and A_{10} x R_{14}.

The three top crosses A_1 x R_3, A_1 x R_4 and A_1 x R_{12} gave significantly higher seed yield/plant at D_3 over the best check hybrid. Meanwhile, the previous three top crosses and the three top crosses A_4 x R_{12}, A_9 x R_{12} and A_9 x R_{14} significantly exceeded the best check hybrid, in seed yield/fed. at D_1 (20 cm/plant). Hence it could be concluded that these crosses may be useful for improving seed and oil yields in sunflower.

Table (9): The average values of the studied traits as affected by genotypes x densities (combined data).

Genotypes	50% flowering			Physiological maturity date			Head diameter (cm)			Seed husk percent		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
Lines A_1	57.667	59.333	60.167	76.500	77.500	78.333	11.883	12.783	12.950	16.817	17.786	18.750
A_3	50.333	52.333	53.167	72.500	73.500	74.000	10.283	11.933	12.267	19.650	20.317	21.183
A_4	51.667	54.167	55.167	74.167	75.167	75.833	12.300	13.950	14.133	18.583	19.633	20.467
A_6	58.500	60.500	60.667	77.333	78.500	79.167	13.583	14.783	15.000	23.883	24.733	25.667
A_9	54.167	56.167	57.000	75.333	76.500	77.333	13.733	15.133	15.217	19.117	20.050	20.800
A_{10}	52.500	54.667	55.667	74.167	75.333	76.500	12.150	13.700	13.900	20.433	21.083	21.850
Testers												
R_3	55.833	58.333	59.167	76.500	77.667	78.333	9.383	9.650	10.067	18.917	19.883	20.867
R_4	54.000	56.667	57.667	75.333	76.333	77.167	7.417	7.783	8.067	19.250	20.050	21.283
R_8	48.500	51.167	52.167	71.167	72.167	73.167	5.517	5.800	5.983	22.967	23.467	24.000
R_{12}	53.000	55.833	56.500	74.667	75.500	76.333	8.583	8.900	9.250	22.083	22.750	23.233
R_{14}	53.667	56.000	57.333	75.000	76.167	77.167	10.533	10.850	11.217	19.200	20.317	21.400
Cross												
A_1 R_3	55.333	56.000	56.500	75.667	75.833	76.000	12.783	13.933	14.183	15.950	16.650	17.467
R_4	57.333	58.167	58.333	76.333	76.500	77.167	15.217	15.783	16.150	17.150	17.950	18.200
R_8	48.333	50.833	51.500	70.667	73.000	74.167	13.317	14.350	14.667	26.983	27.683	28.283
R_{12}	58.667	59.500	60.000	76.167	77.167	77.667	14.483	15.467	15.683	21.733	22.700	23.067
R_{14}	59.500	60.667	61.167	76.667	77.000	77.833	15.200	16.150	16.517	21.467	22.517	23.117
A_3 R_3	56.167	57.333	58.000	76.667	77.333	78.000	14.233	14.833	15.700	16.383	17.600	18.350
R_4	55.667	57.333	58.333	77.000	77.667	78.333	15.150	16.050	16.600	18.067	19.333	20.033
R_8	49.500	51.833	52.500	75.333	77.667	79.000	12.433	13.367	13.817	21.067	22.050	22.767
R_{12}	57.333	58.500	59.167	76.667	77.000	78.167	15.367	15.483	16.000	20.283	21.533	22.333
R_{14}	54.667	56.000	57.167	76.500	77.500	78.000	15.867	16.500	16.983	18.967	20.350	21.300
A_4 R_3	55.500	57.000	57.667	77.000	77.500	78.000	16.267	16.517	16.965	18.300	19.133	19.933
R_4	57.333	58.333	59.000	77.667	78.333	78.333	16.450	16.500	16.917	18.783	19.933	20.750
R_8	49.667	51.667	52.500	76.000	78.000	79.167	13.200	14.200	14.500	15.950	17.600	18.850
R_{12}	57.333	58.500	58.833	76.667	77.333	78.000	15.850	16.367	16.700	19.000	20.200	21.117
R_{14}	58.333	59.500	60.167	77.167	77.833	78.500	14.883	16.267	16.950	17.600	18.883	19.967
A_6 R_3	57.833	59.500	60.167	77.500	78.333	79.000	16.317	17.117	17.367	24.983	26.183	26.800
R_4	58.167	59.500	60.333	78.500	79.167	79.667	16.617	16.900	17.283	16.933	18.500	19.617
R_8	58.500	60.500	61.333	79.500	81.000	82.000	15.000	16.150	16.267	15.033	16.167	17.400
R_{12}	58.333	59.333	60.167	77.167	78.000	78.667	14.533	15.500	15.867	22.917	24.033	24.883
R_{14}	58.167	59.167	60.000	78.333	78.500	79.000	16.833	17.050	17.467	21.733	22.800	23.717
A_9 R_3	56.833	58.167	59.167	78.667	79.333	79.500	15.067	16.550	17.117	16.283	17.467	18.520
R_4	56.500	57.833	58.667	77.167	78.167	78.667	15.550	16.550	16.567	15.317	16.800	18.033
R_8	48.167	51.333	52.000	69.667	72.167	73.500	13.567	14.883	15.183	20.433	21.533	22.233
R_{12}	57.667	59.000	60.000	77.667	78.167	79.000	15.683	16.017	16.333	17.433	18.650	19.817
R_{14}	58.000	59.000	59.833	77.000	78.000	78.833	17.683	18.233	19.067	17.733	19.100	20.267
A_{10} R_3	56.500	57.333	58.167	77.167	78.167	78.333	16.317	16.450	16.950	23.033	23.867	24.300
R_4	56.333	57.500	58.333	77.500	78.667	79.167	16.200	16.550	17.183	19.300	20.850	21.883
R_8	45.000	45.667	46.500	71.667	74.000	75.167	14.650	15.517	15.800	18.867	19.767	20.650
R_{12}	57.167	58.333	59.000	77.000	77.833	78.667	16.067	16.433	16.883	21.450	22.517	23.233
R_{14}	56.500	57.833	58.833	76.500	77.333	78.333	16.050	16.700	17.183	19.773	20.917	21.800
Eirflor	59.000	60.167	61.000	79.833	80.000	80.333	19.000	19.433	19.683	21.233	22.167	22.633
Malabar	60.000	60.667	61.167	79.500	80.000	80.500	18.133	18.850	19.433	21.200	22.167	23.017
Vidoic	58.833	60.00	60.833	77.833	78.333	79.167	17.850	18.417	19.333	20.250	21.250	21.783
L.S.D.	0.7705			1.0478			.7901			0.5779		

D_1 = 35,000 plant/fed. D_2 = 25,300 plant/fed. D_3 = 17,500 plant/fed.

II. Analysis of variance for combining ability:

As mentioned above, mean square associated with genotypes was found herein to reach the level of significance in all traits studied at both locations (Table 4). Therefore, the line by tester analysis according to Kempthorne (1957) would be valid. Table (10) represents such analysis for each density and over the studied three densities at both locations of investigation. Densities mean squares were highly significant for all traits. Such result indicated that there were differences between the three densities in both locations. The differences among densities or spacings were discussed in the first part.

Top crosses mean squares were significant for all the studies traits at separate density as well as the combined average in both locations (Table 10). Such results indicated a wide range of variability among the parental materials and testers. While insignificant mean squares due to top crosses x densities interaction were detected for all the studied traits, except stem diameter in El-Serw location, indicating that top crosses responded in a similar manner to the three densities used in this study. On the contrary, for the exceptional trait (stem diameter in El-Serw location) which showed significant top crosses by densities, it indicated that the performance of top crosses differed from density to another.

Results showed that mean squares due to inbred lines were significant for all traits in each density as well as the combined average at both locations, except seed husk, oil percentage and oil yield/plant in the three densities as well as their combined average at both locations, flowering date, and maturity date in El-Serw location, 100-seed weight in Sakha location, flowering date at D_1 and D_2 in Sakha location, maturity date and number of seeds/head at D_1 in Sakha location, and yield/plant and yield/fed. at D_1 in El-Serw location.

Table (10): Analysis of variance of top crosses for all traits of sunflower in separate densities and the combined over them in both locations and estimates of general and specific combining ability.

S.O.V.	d.F		50% flowering date								Physiological maturity date							
	Single	Comb.	L1				L2				L1				L2			
			D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Densities	-	2	-	-	-	49.85**	-	-	-	179.94**	-	-	-	54.45**	-	-	-	81.38**
R within D	2	6	1.01	1.24	0.63	0.96	0.31	0.81	2.74	1.29	8.53	1.20	8.61	6.11	0.41	0.13	0.68	0.41
Crosses	29	29	38.38**	31.89**	28.21**	97.30**	42.51**	39.00**	42.27**	121.54**	15.88**	10.90**	9.26**	34.38**	12.94**	9.00**	8.23**	28.60**
(L) lines	5	5	27.69	30.07	30.61*	87.50	32.09	32.81	32.12	94.53	8.02	18.98*	17.64*	53.95*	15.43	12.40	14.14	40.95
(T) testers	4	4	188.96**	137.53**	112.57**	433.74**	193.42**	162.68**	182.76**	537.02**	56.67**	22.46*	13.09	83.71*	25.87	6.01	1.86	25.51
L x T	20	20	10.94**	11.22**	10.75**	32.46**	14.93**	15.82**	16.71**	45.20**	7.19**	6.57**	6.39**	19.62**	9.73**	8.74**	8.03**	26.13**
Crosses x D	-	58	-	-	-	0.60	-	-	-	1.12	-	-	-	0.83	-	-	-	0.78
L x D	-	10	-	-	-	0.43	-	-	-	1.25	-	-	-	0.35	-	-	-	0.51*
T x D	-	8	-	-	-	2.66**	-	-	-	0.92	-	-	-	4.25**	-	-	-	4.12**
L x T x D	-	40	-	-	-	0.22	-	-	-	1.13	-	-	-	0.26	-	-	-	0.19
Error	58	174	0.48	0.54	0.44	0.49	1.45	0.43	1.41	1.10	0.88	1.30	1.44	1.21	0.89	0.70	0.29	0.63
G.C.A			5.90	4.40	3.69	4.58	5.93	4.97	5.50	5.47	1.83	0.86	0.54	0.95	0.66	0.03	0.00	0.10
S.C.A			3.49	3.56	3.44	3.58	4.49	5.13	5.10	4.90	2.10	1.76	1.65	2.15	2.94	2.68	2.58	2.88
G.C.A/S.C.A			1.69	1.24	1.07	1.30	1.32	0.97	1.08	1.12	0.87	0.49	0.33	0.44	0.23	0.01	0.0	0.04
G.C.A x D						0.08				0.00				0.12				0.13
S.C.A. x D						-0.09				0.01				-0.13				-0.15

L_1 = Sakha, L_2 = El-Serw, D_1 = 35,000 plant/fed, D_2 = 23,333 plant/fed, D_3 = 17,500 plant/fed.

Table (10): Cont.

S.O.V.	d.F		Plant height								Stem diameter							
	Single	Comb.	L_1				L_2				L_1				L_2			
			D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Densities	-	2	-	-	-	1302.39**	-	-	-	2355.66**	-	-	-	2.50**	-	-	-	1.88**
R within D	2	6	22.12	14.90	7.33	14.78	20.78	17.14	8.75	15.55	0.01	0.03	0.04	0.03	0.01	0.01	0.02	0.01
Crosses	29	29	1934.77**	1769.14**	1788.12**	5487.00**	1999.75**	1890.34**	1832.84**	5716.06**	0.12**	0.23**	0.20**	0.51**	0.16**	0.11**	0.07**	0.27**
(L) lines	5	5	8821.52**	7916.97**	8100.86**	24821.24**	9072.67**	8573.30**	8358.79**	25984.41**	0.48**	0.96**	0.84**	2.22**	0.74**	0.21*	0.18*	0.92**
(T) testers	4	4	1531.24**	1483.47**	1434.21**	4497.22**	1573.15**	1423.07**	1385.54**	4375.70**	0.06	0.27**	0.20**	0.45**	0.02	0.24*	0.05	0.20
L x T	20	20	293.79**	289.32**	270.71**	851.40**	316.84**	313.06**	290.82**	917.05**	.0.04*	0.04	0.04**	0.09**	0.04**	0.05**	0.05**	0.13**
Crosses xD	-	58	-	-	-	2.52	-	-	-	3.44	-	-	-	0.02	-	-	-	0.03**
L x D	-	10	-	-	-	9.06**	-	-	-	10.18**	-	-	-	0.03**	-	-	-	0.10**
T x D	-	8	-	-	-	0.85	-	-	-	3.03	-	-	-	0.04**	-	-	-	0.05**
L x T x D	-	40	-	-	-	1.21	-	-	-	1.83	-	-	-	0.01	-	-	-	0.01
Error	58	174	6.45	6.89	4.27	5.87	6.80	6.15	6.90	6.62	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
G.C.A			295.91	267.33	274.05	278.87	303.40	283.95	277.66	288.05	0.01	0.03	0.03	0.02	0.02	0.01	0.00	0.01
S.C.A			95.78	94.14	88.81	94.47	103.35	102.30	94.54	101.69	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
G.C.A/S.C.A			3.09	2.84	3.09	2.95	2.94	2.78	2.94	2.83	1.00	-	3.00	2.00	2.00	1.00	0.00	1.00
G.C.A x D						0.23				0.29				0.00				0.00
S.C.A. x D						-1.55				-1.60				0.00				0.00

Table (10): Cont.

S.O.V.	d.F		Head diameter								100-seeds weight							
	Single	Comb.	L_1				L_2				L_1				L_2			
			D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Densities	-	2	-	-	-	59.68**	-	-	-	10.42**	-	-	-	7.98**	-	-	-	12.28**
R within D	2	6	1.23	0.73	0.92	0.96	0.49	0.26	0.24	0.33	0.82	0.16	0.32	0.43	0.34	0.12	0.11	0.19
Crosses	29	29	4.95**	3.82**	4.99**	12.67**	4.58**	3.39**	3.13**	10.91**	0.92**	0.86**	0.94**	2.62**	1.14**	1.21**	1.20**	3.37**
(L) lines	5	5	7.77**	6.89**	6.86**	20.70**	6.21*	5.03	4.61*	15.72*	0.37	0.25	0.32	0.83	1.55**	2.35**	2.20**	5.93**
(T) testers	4	4	15.86**	13.57**	20.35**	48.39**	15.71**	8.96**	8.57**	32.43**	4.29**	3.41**	3.65**	11.16**	4.81**	4.65**	4.70**	13.78**
L x T	20	20	2.06	1.10	1.45**	3.52**	1.95**	1.86**	1.67**	5.41**	0.38	0.51*	0.55**	1.36**	0.30*	0.24**	0.25**	0.65**
Crosses x D	-	58	-	-	-	0.54	-	-		0.09	-	-	-	0.05	-	-	-	0.09
L x D	-	10	-	-	-	0.41	-	-		0.06	-	-	-	0.05	--	-	-	0.08
T x D	-	8	-	-	-	0.69	-	-	-	0.40**	-	-		0.09*	-	-	-	0.19*
L x T x D	-	40	-	-	-	0.54	-	-	-	0.04	-	-	-	0.04	-	-	-	0.07
Error	58	174	1.21	1.03	0.58	0.94	0.56	0.17	0.08	0.27	0.37	0.22	0.06	0.21	0.16	0.10	0.04	0.10
G.C.A			0.59	0.55	0.74	0.63	0.55	0.31	0.30	0.37	0.12	0.08	0.09	0.09	0.17	0.20	0.19	0.18
S.C.A			0.28	0.02	0.29	0.33	0.46	0.56	0.53	0.60	0.00	0.10	0.16	0.15	0.05	0.05	0.07	0.06
G.C.A/S.C.A			2.11	27.5	2.55	1.91	1.20	0.55	0.57	0.62		0.8	0.56	0.60	3.4	4.00	2.70	3.00
G.C.A x D						0.00				0.01				0.00				0.00
S.C.A. x D						-0.13				-0.08				-0.06				-0.01

Table (10): Cont.

S.O.V.	d.F		Seed husk percent								Numbers of seeds/head							
	Single	Comb.	L_1				L_2				L_1				L_2			
			D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Densities	-	2	-	-	-	54.85**	-	-	-	136.43**	-	-	-	199402**	-	-	-	649426**
R within D	2	6	0.54	0.30	0.18	0.35	0.45	0.04	0.08	0.19	22959	7770	10099	13610	6927	2586	17644	9052
Crosses	29	29	21.45**	20.74**	19.78**	61.78**	29.22**	26.84**	23.93**	79.43**	22788**	26583**	26738**	73557**	23842**	26241**	34534**	72826**
(L) lines	5	5	22.41	18.42	16.64	56.45	37.78	33.41	27.04	96.77	37990	59268*	44917*	140269*	51088*	67799**	99424**	202787**
(T) testers	4	4	18.63	17.39	17.51	53.33	22.37	19.49	19.17	60.69	31008	41206	54959*	123816	31571	29431	49043*	100804*
L x T	20	20	21.78**	21.99	21.01**	64.81**	28.45**	26.67**	24.10**	78.85**	17344**	15487**	16550**	46827**	15485**	15213**	15410	34740**
Crosses xD	-	58	-	-	-	0.17	-	-	-	0.28	-	-	-	1276	-	-	-	5896
L x D	-	10	-	-	-	0.39**	-		-	0.73**	-	-	-	953	-	-	-	7762
T x D	-	8	-	-	-	0.12	-	-	-	0.17	-	-	-	1678	-	-	-	4620
L x T x D	-	40	-	-	-	0.12	-	-	-	0.19	-	-	-	1277	-	-	-	5685
Error	58	174	0.82	0.16	0.10	0.36	0.30	0.21	0.22	0.25	7737	6387	2174.73	5433	5321	5143	8997	6487
G.C.A			-0.08	-0. 25	-0.24	-0.20	0.10	-0.01	-0.06	-0.01	1039	2106	2023	1720	1566	2024	3565	2354
S.C.A			6.99	7.28	6.97	7.19	9.38	8.82	7.96	8.74	3202	3033	4791	5061	3387	3356	2137	3228
G.C.A/S.C.A			-0.01	-0.03	-0.03	-0.03	0.01	-0.001	-0.008	-0.001	0.33	0.69	0.42	0.34	0.46	0.60	1.67	0.73
G.C.A x D						0.01				0.02				2.36				30.68
S.C.A. x D						-0.08				-0.02				-1385				-267

Table (10): Cont.

S.O.V.	d.F		Yield/plant								Oil percentage							
	Single	Comb.	L_1				L_2				L_1				L_2			
			D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Densities	-	2	-	-	-	1871.49**	-	-	-	5292.83**	-	-	-	5.74**	-	-	-	5.74**
R within D	2	6	5.37	8.12	5.32	6.27	1.95	23.40	19.39	14.91	0.06	0.08	0.07	0.07	0.33	0.05	0.24	0.07
Crosses	29	29	26.28**	25.69**	18.13**	65.85**	23.14**	39.83**	37.71**	84.56**	26.87**	25.89**	26.22**	78.84**	27.51**	26.15**	26.78**	78.84**
(L) lines	5	5	56.08*	81.56**	52.24**	180.82**	31.73	63.46*	44.91*	114.50*	28.28	24.86	25.25	78.10	28.49	26.81	27.30	78.10
(T) testers	4	4	42.48	18.31	12.30	64.55	42.70	129.31**	142.22**	286.20**	29.97	26.44	27.33	83.52	30.75	28.06	30.51	83.52
L x T	20	20	15.59*	13.19*	10.76*	37.36**	17.08**	16.03**	15.00**	36.75**	25.89**	26.03**	26.24**	78.09**	26.62**	25.60**	25.90**	78.09**
Crosses x D	-	58	-	-	-	2.12	-	-	-	8.06	-	-	-	0.07	-	-	-	0.07
L x D	-	10	-	-	-	4.53**	-	-	-	12.79*	-	-	-	0.14**	-	-	-	0.14**
T x D	-	8	-	-	-	4.27**	-	-	-	14.02*	-	-		0.11*	-	-	-	0.11*
L x T x D	-	40	-	-	-	1.09	-	-	-	5.68	-		-	0.04	-	-	-	0.04
Error	58	174	7.96	6.36	5.40	6.57	7.43	5.69	4.95	6.03	0.09	0.06	0.03	0.06	0.16	0.13	0.11	0.06
G.C.A			2.04	2.23	1.30	1.66	1.22	4.87	4.76	3.15	0.20	-0.02	0.00	0.05	0.18	0.11	0.18	0.05
S.C.A			2.54	2.28	1.79	4.03	3.22	3.45	3.35	3.45	8.60	8.66	8.74	8.67	8.82	8.49	8.60	8.67
G.C.A/S.C.A			0.80	0.98	0.73	0.41	0.38	1.41	1.42	0.91	0.02	-0.002	0.00	0.005	0.02	0.01	0.02	0.008
G.C.A x D						0.20				0.47				0.01				1.01
S.C.A. x D						-1.83				-0.11				-0.01				-0.01

Table (10): Cont.

S.O.V.	d.F		Oil yield/plant								Yield/fed.							
	Single	Comb.	L1				L2				L1				L2			
			D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Densities	-	2	-	-	-	336.43**	-	-	-	1005.01**	-	-	-	3612357.21**	-	-	-	2760096.87**
R within D	2	6	1.03	1.40	1.04	1.16	0.53	4.90	4.49	3.31	6584.1	19916.2	1409.9	9303.41	3153.3	12724.3	5929.8	7269.13
Crosses	29	29	8.42**	9.62**	8.79**	25.88**	9.42**	14.06**	15.16**	35.33**	32189.9**	12254.2	5629.1**	35937.23**	28244.8**	21671.2**	11545.2**	49313.89**
(L) lines	5	5	11.96	16.55	12.33	39.15	8.11	8.36	8.88	20.78	68702.8*	13073.1	16670.5**	80123.54*	38258.8	34479.5*	13761.1*	66146.18*
(T) testers	4	4	10.05	7.65	6.68	22.66	10.06	26.95	31.84	63.32	52038.9	15618.0	3520.4	46640.31	50471.2	70335.1**	435512**	155871.40**
L x T	20	20	7.20**	8.28**	8.33**	23.20**	9.62**	12.91**	13.39**	33.37**	19091.9*	11376.7	3315.5*	22750.03**	21296.1**	8736.3**	4590.1**	23794.32**
Crosses xD	-	58	-	-	-	0.48	-	-	-	1.66	-	-	-	7067.98	-	-	-	6073.68
L x D	-	10	-	-	-	0.85*	-	-	-	2.29	-	-	-	9111.42	-	-	-	10176.63
T x D	-	8	-	-	-	0.86*	-	-	-	2.77	-	-	-	12268.51*	-	-	-	4243.08
L x T x D	-	40	-	-	-	0.31	-	-	-	1.28	-	-	-	5517.01	-	-	-	5414.06
Error	58	174	1.58	1.28	1.05	1.30	1.43	1.15	1.03	1.20	9753.8	13173.1	1594.5	8173.78	9048.4	3090.5	1518.9	4552.58
G.C.A			0.23	0.23	0.07	0.14	-0.03	0.29	0.42	0.15	2501.8	179.93	407.87	716.34	1398.1	2646.7	1458.5	1725.63
S.C.A			1.87	2.33	2.43	2.54	2.74	3.92	4.12	3.57	3112.7	-598.82	573.70	1914.78	4082.6	1881.9	1023.7	2042.25
G.C.A/S.C.A			0.12	0.10	0.03	0.06	-0.01	0.07	0.10	0.04	0.80	-0.301	0.77	0.374	0.34	1.406	1.42	0.845
G.C.A x D						0.03				0..08				313.51				108.84
S.C.A. x D						-0.33				0.03				-885.59				287.16

Also, significant mean squares due to testers were obtained for all the studied traits except maturity date at separate densities as well as their combined average in El-Serw location, husk percentage, oil percentage and oil yield/plat at separate densities as well as the combined data in both locations, number of seeds/head., seed yield/plant and seed yield/fed in separate densities and the combined data in Sakha location, flowering date at D_1, D_2 as well as the combined analysis in Sakha location, maturity date at D_3 in Sakha location, number of seeds/head at D_1 and D_2 in El-Serw location, stem diameter at D_3 as well as the combined data in El-Serw location and seed yield per plant or per fed at D_1 in El-Serw location.

Also, significant mean squares due to lines x testers were detected for all traits except stem diameter and seed yield/fed. at D_2 in Sakha location and head diameter at D_1 and D_2 in Sakha location.

The mean performances of the tested parental lines, testers as well as crosses in separate densities and locations were discussed in the first part.

The estimates of the variance due to general combining ability (σ^2 GCA), and specific combining ability (σ^2SCA) presented in (Table 10) showed that σ^2 GCA played the major contribution in the inheritance of plant height at separate densities as well as the combined average of both locations, flowering date at D_1 and D_2 as well as the combined data in Sakha location, flowering date at D_1 and the combined data in El-Serw location, stem diameter and head diameter at D_1, D_2, D_3 and the combined analysis in Sakha location, and D_1 in El-Serw location, 100-seed weight at the three densities and the combined average in El-Serw location, and at D_1 in Sakha location, seed yield per plant at D_2 and D_3 in El-Serw location, and seed yield/fed. at D_3 in El-Serw location. Such results indicated that additive and additive x additive types of gene action were more important than non-additive in controlling these traits. The additive genetic variance was previously reported to be important by **Alba *et al.* (1979), Rozhkova *et al.* (1981), Dua *et al.* (1983), Manjunath *et al.* (1983), Shankava (1983), Kadkol *et al.* (1984), Cherzhentseva (1985), Kesteloot *et al.* (1985), Cruz (1986), Sun (1986), Gumenyuk (1987), Giriraj *et al.* (1987), Marinkovic *et al.* (1987), Naik *et al.* (1987), Vanisree *et al.* (1988), Jukic (1990), Pet *et al.* (1992), Rao *et al.* (1992a), Madrap *et al.* (1993), Marinkovic (1993), Ortegon *et al.* (1993), Tersac *et al.* (1993), Li *et al.* (1995), Kashef (1996) and Ahmed (1999).**

While, the magnitude of additive and nonadditive types of gene action were similar for flowering date at D_3 in Sakha location, D_2 and D_3 in El-Serw location, stem diameter at D_1 at Sakha location, D_2 and the combined data in El-Serw location and seed yield/plant at D_2 at Sakha location. On the other hand, the σ^2 SCA played the major contribution in the inheritance of the rest cases, indicating that the largest part of the total genetic variability associated with these cases was the result of nonadditive type of gene action. These results support the findings of **Alba *et al.* (1979), Rozhkova *et al.* (1981), Dua *et al.* (1983), Manjunath *et al.* (1983), Shankara (1983), Kadkol *et al.* (1984), Cherzhentseva (1985), Kesteloot *et al.* (1985), Pathak *et al.* (1985), Sheriff *et al.* (1985), Giriraj *et al.* (1987), Marinkovic *et al.* (1987), Naik *et al.* (1987), Vanisree *et al.* (1988), Pet (1992), Marinkovic (1993), Ortegon *et al.* (1993), Tersac *et al.* (1993), Li *et al.* (1995), Kashef (1996) and Ahmed (1999).**

The magnitudes of the interaction for GCA by densities were generally higher than those for SCA ones for the studied traits. These findings indicate that additive and additive by additive types of gene action appeared to be more affected by environments than the non additive genetic types. These results are in harmony with those previously reached by **Alba *et al.* (1979), Rozhkova *et al.* (1981), Dua *et al.* (1983), Manjunath *et al.* (1983), Shankava (1983), Kadkol *et al.* (1984), Cherzhentseva (1985), Kesteloot *et al.* (1985), Pathak *et al.* (1985), Sheriff *et al.* (1985), Cruz (1986), Sun (1986), Gumenyuk (1987), Giriraj *et al.* (1987), Naik *et al.* (1987), Vanisree *et al.* (1988), Jukic (1990), Rao *et al.* (1992a), Marinkovic (1993), Tersac *et al.* (1993), Li *et al.* (1995), Kashef (1996) and Ahmed (1999).**

a. General combining ability effect:

The general combining ability effects $\hat{g}_i$ of testers and lines for all traits in the three densities and the combined analysis in separate in (Table 11). High negative values observed for flowering and physiological maturity date, plant height and seed husk percentage from one side and high positive values observed for other traits (yield, yield components and oil percentage) from other side would be useful from breeders point of view.

i. Inbred lines:

The parental inbred line A_1 expressed desirable significant $\hat{g}_i$ effects for maturity date, number of seed/head, yield/plant and seed yield/fed. at the three densities as well as the combined analysis and oil yield in the combined data in separate locations.

The parental inbred line A_3 exhibited significant negative $\hat{g}_i$ effects for flowering date at D_1, D_2 as well as the combined analysis in both location. Also, it gave undesirable $\hat{g}_i$ effects for other traits.

Table (11): Estimates of general combining ability effects for the studied traits of sunflower in separate densities and the combined over them in both locations.

Traits.	50% flowering								Physiological maturity date							
Locations	L_1				L_2				L_1				L_2			
Densities	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Lines																
A_1	0.41	0.38	0.17	0.32*	0.01	-0.39	-0.44	-0.27	-1.37**	-1.70**	-1.58**	-1.55**	-1.31**	-1.33**	-1.61**	-1.42**
A_3	-0.92**	-0.62*	-0.63*	-0.73**	-0.99*	-1.06**	-0.78	-0.94**	0.10	0.30	0.49	0.30	-0.11	-0.27	-0.21	-0.20
A_4	-0.26	-0.09	-0.37	-0.24	0.28	0.01	0.16	0.15	0.43	0.43	0.36	0.41	0.49	0.33	0.32	0.38
A_6	2.41**	2.38**	2.50**	2.43**	2.74**	2.74**	2.82**	2.77**	1.83**	1.70**	1.62**	1.72**	1.69**	1.47**	1.39**	1.51**
A_9	-0.12	-0.09	0.17	-0.01	-0.92*	0.14	-0.44	-0.41	-0.30	-0.37	-0.44	-0.37	-0.51	-0.13	-0.08	-0.24
A_{10}	-1.52**	-1.96**	-1.83**	-1.77**	-1.12*	-1.46**	-1.31**	-1.30**	-0.70*	-0.37	-0.44	-0.50*	-0.24	-0.07	0.19	-0.04
L.S.D.(g_i) 5%	0.51	0.54	0.48	0.28	0.88	0.48	0.88	0.45	0.68	0.82	0.88	0.45	0.68	0.62	0.40	0.34
1%	0.68	0.72	0.64	0.38	1.17	0.64	1.17	0.60	0.90	1.09	1.17	0.60	0.90	0.83	0.53	0.45
L.S.D.(g_i-g_j) 5%	0.71	0.76	0.68	0.43	1.25	0.68	1.22	0.62	0.96	1.19	1.25	0.65	0.99	0.85	0.57	0.48
1%	0.94	1.02	0.90	0.57	1.66	0.90	1.62	0.83	1.28	1.58	1.66	0.87	1.32	1.13	0.75	0.64
Testers																
R_3	0.81**	0.61*	0.42	0.61**	0.67	0.42	0.66	0.58**	0.72*	0.40	0.12	0.41*	0.62*	0.27	0.00	0.30
R_4	1.31**	1.22**	1.14**	1.23	1.22**	0.92**	1.21**	1.12**	1.00**	0.68	0.62	0.77**	0.84**	0.66*	0.33	0.61**
R_8	-5.74**	-4.89**	-4.41**	-5.01**	-5.78**	-5.24**	-5.62**	-5.55**	-3.17**	-1.99**	-1.49**	-2.21**	-2.10**	-0.90**	-0.50**	-1.17**
R_{12}	1.98**	1.78**	1.53**	1.76**	1.72**	1.87**	2.04**	1.88**	0.72*	0.46	0.46	0.54*	0.18	-0.12	-0.06	0.00
R_{14}	1.64**	1.28**	1.31**	1.41**	2.17**	2.03**	1.71**	1.97**	0.72*	0.46	0.29	0.49*	0.46	0.10	0.22	0.26
L.S.D.(g_i) 5%	0.45	0.48	0.45	0.28	0.79	0.43	0.79	0.40	0.62	0.76	0.79	0.41	0.62	0.57	0.37	0.31
1%	0.60	0.64	0.60	0.38	1.06	0.57	1.06	0.53	0.83	1.02	1.06	0.57	0.83	0.75	0.49	0.41
L.S.D.(g_i-g_j) 5%	0.65	0.71	0.62	0.37	1.13	0.62	1.13	0.57	0.88	1.08	1.13	0.60	0.91	0.79	0.51	0.43
1%	0.87	0.94	0.83	0.49	1.51	0.83	1.51	0.75	1.17	1.43	1.51	0.79	1.21	1.06	0.68	0.57

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

L_1 = Sakha, L_2 = El-Serw, D_1 = 35,000 plant/fed, D_2 = 23,333 plant/fed, D_3 = 17,500 plant/fed.

Table (11): Cont.

Traits.	Plant height								Stem diameter							
Locations	L_1				L_2				L_1				L_2			
Densities	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Lines																
A_1	10.38**	9.05**	8.97**	9.46**	10.18**	10.74**	10.07**	10.33**	-0.15**	-0.15**	-0.17**	-0.15**	-0.19**	-0.14**	-0.15**	-0.16**
A_3	16.06**	14.85**	14.87**	15.26**	15.79**	15.77**	15.70**	15.75**	-0.15**	-0.17**	-0.17**	-0.16**	-0.21**	-0.14**	-0.12**	-0.16**
A_4	7.61	7.44**	7.51**	7.52**	7.97**	8.97**	9.14**	8.70**	-0.05	-0.10	-0.08	-0.08	-0.05	0.02	0.01	0.00
A_6	-48.19**	-45.69**	-46.16**	-46.68**	-49.06**	-47.63**	-47.01**	-47.90**	0.33**	0.49**	0.45**	0.42**	0.40**	0.12**	0.11**	0.21**
A_9	0.20	0.44	0.26	0.30	0.99	0.13	0.06	0.39	-0.05	-0.11*	-0.09*	-0.08**	-0.02	0.03	0.06	0.02
A_{10}	13.96**	13.91**	14.55**	14.14**	14.14**	12.02**	12.03**	12.73**	0.07	0.04	0.05	0.06*	0.07	0.12**	0.09*	0.09**
L.S.D.(g_i) 5%	1.87	1.93	1.50	1.02	1.90	1.81	1.93	1.08	0.11	0.11	0.09	0.06	0.09	0.09	0.09	0.06
1%	2.49	2.56	2.00	1.36	2.52	2.41	2.56	1.43	0.15	0.15	0.11	0.08	0.11	0.11	0.11	0.08
L.S.D.(g_i-g_j) 5%	2.63	1.87	2.12	1.44	2.69	2.58	2.72	1.53	0.14	0.14	0.11	0.09	0.11	0.11	0.11	0.06
1%	3.50	3.62	2.83	1.92	3.58	3.43	3.62	2.03	0.19	0.19	0.15	0.11	0.15	0.15	0.15	0.08
Testers																
R_3	0.07	0.14	0.37	0.19	-0.33	0.45	0.08	0.07	-0.07	-0.09*	-0.07	--0.08**	-0.05	-0.11**	-0.07*	-0.08**
R_4	-4.15**	-4.15**	-4.33**	-4.21**	-4.06**	-3.96**	-3.59**	-3.87**	-0.01	-0.07	-0.08	-0.05	0.00	-0.03	0.00	-0.01
R_8	-10.93**	-10.78**	-11.01**	-10.91**	-11.02**	-10.57**	-10.38**	-10.66**	0.07	0.21**	0.18**	0.15**	0.00	0.19**	0.07*	0.09**
R_{12}	0.76	0.80	1.24	0.93*	0.90	0.36	0.20	0.49	-0.02	-0.02	0.00	-0.02	0.00	-0.06	-0.01	-0.02
R_{14}	14.25**	13.98**	13.72**	13.99**	14.51**	13.73**	13.69**	13.98**	0.04	-0.03	-0.02	0.00	0.04	0.02	0.01	0.02
L.S.D.(g_i) 5%	1.70	1.76	1.39	0.93	1.73	1.64	1.76	0.99	0.09	0.09	0.09	0.06	0.09	0.09	0.06	0.03
1%	2.26	2.34	1.85	1.24	2.30	2.19	2.34	1.32	0.11	0.11	0.11	0.08	0.11	0.11	0.08	0.04
L.S.D.(g_i-g_j) 5%	2.41	2.46	1.95	1.33	2.46	2.35	2.49	1.42	0.14	0.14	0.11	0.09	0.11	0.11	0.09	0.06
1%	3.20	3.28	2.60	1.77	3.28	3.13	3.32	1.88	0.19	0.19	0.15	0.11	0.15	0.15	0.11	0.08

Table (11): Cont.

Traits.	Head diameter								100-seed weight							
Locations	L_1				L_2				L_1				L_2			
Densities	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Lines																
A_1	-1.09**	-0.82*	-1.06**	-0.99**	-0.96**	-0.80**	-0.79**	-0.85**	-0.14	-0.17	-0.23**	-0.18	-0.42**	-0.51**	-0.51**	-0.48**
A_3	-0.65	-0.78*	-0.55	-0.66**	-0.59*	-0.62**	-0.54**	-0.58**	-0.12	-0.01	-0.01	-0.04	-0.29*	-0.31**	-0.28**	-0.29**
A_4	0.11	0.00	0.10	0.07	0.10	0.05	0.02	0.06	-0.11	0.00	0.06	-0.02	-0.10	-0.17	-0.15*	-0.14*
A_6	0.72	0.66	0.54	0.64**	0.55*	0.54**	0.43**	0.50**	0.01	-0.08	-0.06	-0.04	0.20	0.11	0.10	0.14*
A_9	0.32	0.72	0.69*	0.58**	0.25	0.28	0.29**	0.27*	0.26	0.21	0.21*	0.22*	0.38**	0.38**	0.37**	0.38**
A_{10}	0.59	0.22	0.27	0.36	0.66*	0.54**	0.60**	0.60**	0.11	0.06	0.04	0.07	0.24	0.49**	0.47**	0.40**
L.S.D.(g_i) 5%	0.79	0.74	0.57	0.40	0.54	0.31	0.20	0.23	0.45	0.34	0.17	0.20	0.28	0.23	0.14	0.14
1%	1.06	0.98	0.75	0.53	0.72	0.41	0.26	0.30	0.60	0.45	0.23	0.26	0.38	0.30	0.19	0.19
L.S.D.(g_i-g_j) 5%	1.13	1.05	0.79	0.57	0.76	0.43	0.31	0.31	0.62	0.48	0.26	0.28	0.43	0.34	0.20	0.20
1%	1.51	1.39	1.06	0.75	1.02	0.57	0.41	0.41	0.83	0.64	0.40	0.38	0.57	0.45	0.26	0.26
Testers																
R_3	-0.08	0.06	0.23	0.07	-0.05	-0.15	-0.20*	-0.13	-0.54**	-0.47**	-0.41**	-0.47**	-0.39*	-0.18	-0.18*	-0.25**
R_4	0.65	0.42	0.39	0.49*	0.61*	0.46**	0.48**	0.52**	0.29	0.36*	0.41**	0.36**	0.18	0.35**	0.36**	0.30**
R_8	-1.51**	-1.27**	-1.58**	-1.45**	-1.55**	-1.13**	-1.07**	-1.25**	-0.50*	-0.43**	-0.50**	-0.47**	-0.67**	-0.78**	-0.79**	-0.74**
R_{12}	0.04	-0.28	-0.35	-0.19	0.17	0.14	0.11	0.14	0.21	0.06	0.03	0.10	0.26*	0.09	0.11	0.15**
R_{14}	0.90*	1.07**	1.30**	1.09**	0.82**	0.67**	0.69**	0.73**	0.53**	0.47**	0.47**	0.49**	0.61**	0.51**	0.50**	0.54**
L.S.D.(g_i) 5%	0.74	0.68	0.51	0.37	0.51	0.28	0.20	0.20	0.40	0.31	0.17	0.17	0.26	0.20	0.14	0.13
1%	0.98	0.90	0.68	0.48	0.68	0.38	0.26	0.26	0.53	0.41	0.23	0.23	0.40	0.26	0.19	0.15
L.S.D.(g_i-g_j) 5%	1.05	0.96	0.71	0.54	0.71	0.40	0.28	0.28	0.57	0.43	0.28	0.26	0.37	0.31	0.17	0.17
1%	1.39	1.28	0.94	0.72	0.94	0.53	0.38	0.38	0.75	0.57	0.30	0.34	0.49	0.41	0.23	0.23

Table (11): Cont..

Traits.	Seed husk percent								Number of seed/head							
Locations	L_1				L_2				L_1				L_2			
Densities	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Lines																
A_1	1.01**	0.75**	0.44**	0.72**	1.74**	1.37**	1.01**	1.37**	98.83**	122.71**	109.40**	110.31**	111.02**	108.57**	124.61**	114.73**
A_3	-0.37	-0.17	-0..16	-0.23	-0.32	-0.37*	-0.53**	-0.41**	-17.39	-15.69	-13.87	-15.65	-2.45	34.08	41.89	24.51
A_4	-1.19**	-0.94	-0.96**	-1.03**	-1.55**	-1.64**	-1.40**	-1.53**	-4.59	-5.31	-17.07	-8.99	0.55	-39.38	-23.44	-20.76
A_6	1.07*	1.04**	-1.20**	1.11**	0.97**	1.15**	1.16**	1.09**	-6.97	-9.14	-8.55	-8.22	-14.55	19.62	12.37	5.82
A_9	-1.60**	-1.63**	-1.46**	-1.56**	-2.12**	-1.83**	-1.60**	-1.85**	-28.47	-40.97	-36.28	-35.24*	-44.52	-52.45*	-38.50	-45.16*
A_{10}	1.08**	0.96**	0.92**	0.99**	1.28**	1.32**	1.36**	1.32**	-41.41	-51.61	-33.63	-42.21**	-50.04	-70.46**	-116.94**	-79.14**
L.S.D.(g_i) 5%	0.65	0.28	0.23	0.26	0.40	0.34	0.34	0.20	64.29	58.43	94.08	31.11	53.33	52.43	69.33	34.00
1%	0.87	0.38	0.30	0.34	0.53	0.45	0.45	0.26	85.55	77.75	45.35	41.40	70.97	69.99	92.23	45.24
L.S.D.(g_i-g_j) 5%	0.93	0.43	0.34	0.37	0.57	0.48	0.48	0.28	90.93	82.60	48.21	43.99	75.41	74.14	98.06	48.07
1%	1.24	0.57	0.45	0.49	0.75	0.64	0.64	0.38	120.99	109.92	64.15	58.54	100.35	98.66	130.49	63.96
Testers																
R_3	-0.16	-0.41**	-0.42**	-0.34**	-0.09	-0.18	-0.28	-0.18	58.29	68.84*	67.68**	64.94**	42.93	42.40	50.25	45.19**
R_4	-1.64**	-1.48**	-1.49**	-1.53**	-1.78**	-1.62**	-1.61**	-1.67**	-34.49	-38.63	-54.06**	-42.39**	-19.73	-53.29*	-39.32	-37.45*
R_8	0.46	0.45**	0.48**	0.47**	0.38*	0.26	0.32*	0.32**	13.84	20.09	40.24*	24.72	41.08	25.99	37.85	34.97*
R_{12}	1.07**	1.09**	1.08**	1.08**	1.27**	1.24**	1.14**	1.22**	7.67	-0.08	1.70	3.10	-9.44	16.05	21.47	9.36
R_{14}	0.26	0.35**	0.35**	0.32**	0.22	0.29	0.43**	0.32**	-45.31	-50.22	-55.56**	-50.36**	-54.84*	-31.15	-70.24*	-52.08**
L.S.D.(g_i) 5%	0.60	0.26	0.23	0.23	0.37	0.31	0.31	0.20	58.68	53.33	31.11	28.39	46.67	47.84	60.30	31.03
1%	0.79	0.34	0.30	0.30	0.49	0.41	0.41	0.26	78.09	70.97	41.40	37.78	64.75	63.66	84.23	41.29
L.S.D.(g_i-g_j) 5%	0.85	0.37	0.31	0.34	0.51	0.43	0.45	0.28	83.00	75.41	43.99	40.17	68.85	67.69	89.51	43.88
1%	1.13	0.49	0.41	0.45	0.68	0.57	0.60	0.38	110.45	100.35	58.54	53.45	91.62	90.07	119.11	58.39

Table (11): Cont.

Traits.	Yield/plant								Oil percentage							
Locations	L_1				L_2				L_1				L_2			
Densities	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Lines																
A_1	3.56**	4.65**	3.75**	3.98**	2.26*	1.80*	1.93*	2.00**	-1.01**	-1.03**	-0.89**	-0.98**	-0.99**	-1.12**	-0.98**	-0.98**
A_3	-1.91	-0.97	-0.96	-1.28*	-2.00*	-0.41	-0.15	-0.85	0.28*	0.11	0.05	0.15**	0.13	0.13	0.19	0.15**
A_4	-1.15	-0.43	-0.51	-0.70	-0.64	-3.55**	-3.02**	-2.41**	1.21**	1.29**	1.29**	1.26**	1.20**	1.27**	1.26**	1.26**
A_6	-0.18	-0.77	-0.76	-0.57	0.68	2.26*	1.34	1.43**	-0.95**	-0.77**	-0.75**	-0.82**	-0.85**	-0.80**	-0.90**	-0.82**
A_9	0.54	0.59	-0.29	-0.11	0.37	-0.08	0.35	0.21	1.95**	1.67**	1.79**	1.83**	2.02**	1.88**	1.89**	1.83**
A_{10}	-0.86	-1.87*	-1.22	-1.32*	-0.66	-0.02	-0.45	-0.38	-1.47**	-1.37**	-1.49**	-1.44**	-1.51**	-1.37**	-1.46**	-1.44**
L.S.D.(g_i) 5%	2.07	1.84	1.70	1.08	1.98	1.76	1.61	1.05	0.23	0.17	0.14	0.11	0.28	0.26	0.23	0.11
1%	2.75	2.45	2.26	1.43	2.64	2.34	2.15	1.39	0.30	0.23	0.19	0.15	0.38	0.34	0.30	0.15
L.S.D.(g_i-g_j) 5%	2.92	2.60	2.41	1.53	2.83	2.46	2.29	1.47	0.31	0.26	0.20	0.14	0.43	0.37	0.34	0.14
1%	3.88	3.47	3.20	2.03	3.77	3.28	3.05	1.96	0.41	0. 34	0.26	0.19	0.57	0.49	0.45	0.19
Testers																
R_3	-0.86	-0.01	0.32	-0.18	-0.87	0.33	0.47	-0.02	-0.04	-0.12	-0.17*	-0.11**	-0.15	-0.15	-0.09	-0.11**
R_4	0.36	0.41	0.11	0.29	0.39	-0.15	0.37	0.20	1.96**	1.77**	1.84**	1.86**	1.92**	1.84**	1.90**	1.86**
R_8	-2.20*	-1.73*	-1.44	-1.79**	-2.21*	-4.41**	-4.82**	-3.81**	-0.27	-0.23**	-0.28**	-0.26**	-0.20	-0.26*	-0.25*	-0.26**
R_{12}	1.55	0.74	0.59	0.96	1.54	1.75*	1.86*	1.72**	-1.66**	-1.62**	-1.59**	-1.62**	-1.74**	-1.65**	-1.75**	-1.62**
R_{14}	1.15	0.59	0.43	0.73	1.15	2.47**	2.12**	1.91**	0.02	0.19*	0.20**	0.14**	0.17	0.20	0.19	0.14**
L.S.D.(g_i) 5%	1.90	1.67	1.56	0.99	1.81	1.59	1.47	0.93	0.20	0.17	0.11	0.09	0.26	0.23	0.23	0.09
1%	2.52	2.22	2.07	1.32	2.41	2.11	1.95	1.24	0.26	0.23	0.15	0.11	0.34	0.30	0.30	0.11
L.S.D.(g_i-g_j) 5%	2.66	2.38	2.18	1.39	2.58	2.46	2.10	1.33	0.28	0.23	0.17	0.17	0.37	0.27	0.31	0.14
1%	3.54	3.16	2.90	1.85	3.43	3.01	2.79	1.77	0.38	0.30	0.23	0.19	0.49	0.45	0.41	0.19

Table (11): Cont.

Traits.	Oil yield/plant								Seed yield/fed							
Locations	L_1				L_2				L_1				L_2			
Densities	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
Lines																
A_1	1.33**	1.72**	1.37**	1.47**	0.75	0.42	0.48	0.55*	124.52**	55.25	66.63**	82.13**	79.96*	42.10*	33.74*	51.93**
A_3	-0.77	-0.40	-0.40	-0.52*	-0.86	-0.12	0.05	-0.31	-66.81	-12.09	-15.85	-31.58	-69.38	-9.57	-2.55	-27.17
A_4	-0.17	0.25	0.20	0.09	0.06	-1.06**	-0.80*	-0.60**	-40.21	0.55	-7.93	-15.86	-21.78	-82.81**	-52.85**	-52.48**
A_6	-0.39	-0.65	-0.65	-0.56*	-0.01	0.61	0.10	0.23	-6.38	-7.41	-18.36	-10.72	19.76	52.62*	23.45	31.94*
A_9	0.88	0.39	0.59	0.62*	0.87	0.82*	1.10**	0.93**	19.06	-36.23	-4.07	3.92	13.69	-1.78	6.07	5.99
A_{10}	-0.84	-1.33**	-1.12**	-1.10**	-0.80	-0.66	-0.94*	-0.80**	-30.18	-33.07	-20.41	-27.89	-22.24	-0.54	-7.86	-10.22
L.S.D.(g_i) 5%	0.91	0.82	0.74	0.48	0.88	0.79	0.74	0.45	72.19	83.88	29.19	38.16	69.53	40.62	28.48	28.48
1%	1.21	1.09	0.98	0.64	1.17	1.06	0.98	0.60	96.06	111.61	38.84	50.78	92.52	54.06	37.90	37.90
L.S.D.(g_i-g_j) 5%	1.30	1.16	1.05	0.68	1.25	1.10	1.05	0.65	102.08	118.64	41.27	53.96	97.30	57.47	53.60	40.25
1%	1.58	1.54	1.39	0.90	1.66	1.47	1.39	0.87	135.83	144.121	54.92	65.54	129.47	76.47	48.93	53.56
Testers																
R_3	-0.37	-0.02	0.10	-0.10	-0.42	0.06	0.12	-0.08	-30.02	10.50	6.54	-4.33	-29.83	7.78	8.18	-4.62
R_4	0.80*	0.87*	0.82*	0.83**	0.83*	0.77*	1.11**	0.90**	12.56	-33.07	2.85	-5.89	14.51	-3.51	6.49	5.83
R_8	-1.08*	-0.87*	-0.76*	-0.90**	-1.02*	-2.00**	-2.19**	-1.74**	-77.08*	-29.81	-25.28	-43.72*	-76.49*	-102.78**	-84.42**	-87.90**
R_{12}	0.13	-0.30	-0.40	-0.19	0.04	-0.01	-0.05	-0.01	54.17	27.89	11.40	31.15	50.87	40.80*	32.64*	41.44**
R_{14}	0.52	0.33	0.24	0.36	0.57	1.18**	1.01**	0.92**	40.37	24.5	3.49	22.79	40.95	57.70**	37.11**	45.25**
L.S.D.(g_i) 5%	0.80	0.76	0.68	0.45	0.79	0.71	0.68	0.43	65.90	76.57	26.64	34.82	63.47	37.08	26.02	25.99
1%	1.13	1.02	0.90	0.60	1.06	0.94	0.90	0.57	87.69	101.90	35.45	46.33	84.45	49.35	34.62	34.58
L.S.D.(g_i-g_j) 5%	1.19	1.08	0.96	0.62	1.13	1.02	0.96	0.60	93.19	108.31	37.68	49.26	89.77	52.46	36.77	36.77
1%	1.58	1.43	1.28	0.83	1.51	1.36	1.28	0.79	124.01	144.12	50.14	65.54	119.45	69.80	48.93	48.93

The parental inbred line A_4 gave desirable $\hat{g}_i$ effects for seed husk and oil percentages at the three densities as well as the combined analysis in separate locations. while, it was the poorest combiner for other traits.

The parental inbred line A_6 expressed desirable significant $\hat{g}_i$ effect for plant height in the combined data in separate locations, stem diameter at the three densities as well as the combined data in separate locations, head diameter at the three densities as well as the combined data in the second location (El-Serw) and the combined data in first location (Sakha), 100-seed weight in the combined data in the second location (El-Serw), and seed yield/fed. at D_2 and the combined data in El-Serw location (L_2). Also, it was undesirable combiner for other cases.

The parental inbred line A_9 expressed desirable $\hat{g}_i$ effects for oil percentage, and husk percentage at the 3 densities as well as the combined data in separate locations, head diameter at D_3 as well as the combined data in separate locations, 100-seed weight at D_3 and the combined data in Sakha location (L_1) and at three densities as well as the combined data in El-Serw location (L_2), and oil yield/plant in the combined data in separate locations and at D_2 and D_3 in the second location El-Serw.

The parental line A_{10} exhibited significant desirable $\hat{g}_i$ effects for flowering date at the three densities as well as the combined data in separate locations, maturity date at D_1 as well as the combined data in Sakha location (L_1), head diameter at the three densities as well as the combined data in El-Serw location (L_2), and 100-seed weight at D_2, D_3 and the combined analysis in El-Serw location (L_2). But it showed undesirable $\hat{g}_i$ effects for other cases.

ii. **Testers:**

The parental tester R_3 expressed significant desirable $\hat{g}_i$ effects for husk percentage and number of seeds per head at D_2, D_3 and the combined data in Sakha location (L_1), and number of seeds per head in the combined analysis in El-Serw location (L_2). It had undesirable $\hat{g}_i$ effects for other cases.

The parental tester R_4 exhibited significant desirable $\hat{g}_i$ effects for plant height, husk percentage, oil percentage and oil yield per plant at the three densities as well as the combined data in separate location, head diameter in the combined data in the first location Sakha and the three densities as well as the combined data over them in second location (El-Serw), and 100-seed weight at D_1, D_2, D_3 and the combined data in Sakha location and at D_2, D_3 as well as the combined data in El-Serw location.

The parental tester R_8 expressed significant desirable $\hat{g}_i$ effects for flowering and maturity dates, plant height at the three densities as well as the combined data in separate locations, stem diameter at D_2, D_3 and the combined data in separate locations, and number of seeds per head at D_3 in Sakha location and the combined data in El-Serw location.

The parental tester R_{12} gave significant positive $\hat{g}_i$ effects for 100-seed weight at D_1 and the combined data in El-Serw location, seed yield per plant and seed yield/fed at D_2, D_3 as well as the combined analysis in El-Serw location.

The parental tester R_{14} exhibited significant positive $\hat{g}_i$ effects for head diameter and 100-seed weight at the three densities as well as the combined data in separate location, seed yield per plant and seed yield/fed. and oil yield per plant at D_2, D_3 as well as the combined data in El-Serw location.

b. Specific combining ability effects:

Specific combining ability effects of the test crosses for all traits at the three densities as well as the combined data in separate locations are presented in (Table 12).

Seven, eight, nine, six and nine crosses in the first location (Sakha location), and four, six, three and six crosses in the second location (El-Serw) exhibited significantly negative S_{ij} effects for flowering date at D_1, D_2, D_3 as well as the combined analysis over them, respectively. Also, the best S_{ij} effects for this trait were showed for the top cross A_{10} x R_8 followed by cross A_6 x R_{14} which gave significant negative S_{ij} effects at the three spacings as well as the combined data in both locations (Table 12).

For physiological maturity date, four, one, one and four hybrids in the first location, four, three, eight, and six crosses in the second location expressed significantly negative S_{ij} effects at D_1, D_2, D_3 as well as the combined data, respectively. The most desirable S_{ij} effects were obtained by top cross A_9 x R_8 and A_1 x R_8.

In both previous traits, flowering and physiological maturity dates, the other top crosses gave significantly positive or insignificant S_{ij} effects.

For plant height, the top crosses A_1 x R_8, A_3 x R_{12}, A_3 x A_{14}, A_4 x R_3, A_4 x R_4, A_6 x R_3, A_6 x R_{12}, A_{10} x R_8 and A_{10} x R_{14} expressed significantly negative S_{ij} effects at the three densities as well as the combine data in separate locations. While, the most desirable S_{ij} effects were obtained by the top cross A_1 x R_8 followed by A_4 x R_3, A_6 x R_3 and A_3 x R_{14}. However, eleven crosses at the three densities in both locations exhibited significantly positive S_{ij} effects. While, the other crosses gave insignificant S_{ij} effects.

Table (12): Specific combining ability effects for the studied traits of sunflower plants in separate densities and the combined analysis over them in both location.

Cross			50% flowering								Physiological maturity date							
			L_1				L_2				L_1				L_2			
			D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
A_1	R_3		-1.41*	-1.88**	-1.89**	-1.73**	-1.07	-1.22*	-1.39	-1.23*	0.14	-0.13	-0.59	-0.19	-0.36	-0.67	-0.67	-0.56
	R_4		0.42	0.18	0.39	0.33	0.04	-0.06	-0.28	-0.10	0.20	-0.41	-0.09	-0.10	0.42	0.28	0.33	0.34
	R_8		-1.19*	-0.71*	-0.72	-0.87**	-2.29*	-1.56**	-1.44	-1.76**	-1.63*	-1.41	-1.31	-1.45**	-1.97*	-1.50*	-1.50**	-1.66**
	R_{12}		0.42	0.29	0.33	0.35	1.54	1.00	0.89	1.14*	0.48	1.14	0.74	0.79	0.76	1.06	1.06*	0.96*
	R_{14}		1.76**	2.12**	1.89**	1.92**	1.77	1.83**	2.22*	1.94**	0.81	0.81	1.24	0.96	1.14	0.83	0.78	0.92*
A_3	R_3		0.92	0.79*	0.58	0.76*	0.60	0.44	0.28	0.44	-0.66	-1.13	-0.99	-0.93	0.22	0.27	0.27	0.10
	R_4		-0.24	-0.16	-0.14	-0.18	-0.29	0.28	0.39	0.13	-0.27	-0.74	-0.82	-0.6	-0.44	-0.12	-0.07	-0.21
	R_8		0.81	0.96*	0.74	0.84*	0.38	0.44	0.22	0.35	1.90*	2.26**	1.96*	2.04**	1.17	1.10	1.43**	1.23**
	R_{12}		0.42	0.29	0.13	0.28	1.21	0.67	0.56	0.81	-0.32	-0.52	0.01	-0.28	-0.11	-0.68	-0.68	-0.49
	R_{14}		-1.91**	-1.88**	-1.31*	-1.70**	-1.90	-1.83**	-1.44	-1.73**	-0.66	0.14	-0.16	-0.22	-0.39	-0.57	-0.96*	-0.64
A_4	R_3		-0.74	-0.41	-0.36	-0.50	-1.00	-0.62	-0.66	-0.76	-0.66	-0.60	-0.52	-0.59	-0.49	-0.67	-0.60	-0.59
	R_4		0.42	-0.02	-0.08	0.11	0.44	0.54	0.46	0.48	0.07	0.12	-0.02	0.06	-0.38	-0.39	-0.27	-0.34
	R_8		-0.52	-0.58	-0.19	-0.43	0.11	0.04	-0.04	0.04	1.23	1.12	1.42	1.26*	2.23**	2.17**	1.90**	2.10**
	R_{12}		-0.24	-0.24	-0.47	-0.32	-0.06	-0.40	-0.71	-0.39	-0.66	-0.66	-0.86	-0.72	-0.71	-0.61	-0.54	-0.62
	R_{14}		1.09	1.26*	1.09*	1.14**	0.50	0.43*	0.96	0.63	0.01	0.01	-0.02	0.00	-0.66	-0.50	-0.49	-0.55
A_6	R_3		-1.08	-0.54	-0.56	-0.73*	-1.13	-0.69	-0.99	-0.94	-1.39	-0.87	-0.46	-0.90	-1.36	-1.13	-1.00*	-1.16**
	R_4		-1.24*	-1.16*	-1.28*	-1.23**	-1.36	-1.19*	-1.21	-1.25*	-0.33	0.19	0.04	-0.03	-0.91	-1.19	-1.00*	-1.03**
	R_8		5.48**	5.29**	5.28**	5.35**	6.64**	6.64**	6.62**	6.64**	3.50**	2.86**	2.82**	3.06**	4.37**	4.03**	3.83**	4.08**
	R_{12}		-1.58**	-1.71**	-1.67**	-1.65**	-1.86	-2.47**	-2.38*	-2.23*	-1.39*	-1.26	-1.46	-1.37*	-1.58*	-1.08	-0.94*	-1.20**
	R_{14}		-1.58**	-1.88**	-1.78**	-1.74**	-2.30*	-2.30**	-2.04*	-2.21**	-0.39	-0.92	-0.96	-0.76	-0.52	-0.63	-0.89*	-0.68
A_9	R_3		0.46	0.59	0.78	0.61	1.53	0.58	1.28	1.13*	2.08**	1.87*	1.61	1.85**	1.84*	1.80*	1.47**	1.70**
	R_4		-0.38	-0.02	-0.28	-0.23	0.64	-0.59	0.06	0.04	-0.20	-0.08	0.11	-0.06	0.62	0.74	0.47	0.61
	R_8		-0.99	-0.91*	-1.06	-0.99**	-1.36	-0.42	-0.11	-0.63	-3.37**	-3.08**	-3.11**	-3.19**	-4.10**	-4.03**	-3.70**	-3.94**
	R_{12}		-0.04	0.09	0.67	0.24	-1.86	0.13	0.56	-0.39	1.08	0.81	0.94	0.94	1.29	0.86	0.86	1.00**
	R_{14}		0.96	0.26	-0.11	0.37	1.03	0.30	-1.78	-0.15	0.41	0.48	0.44	0.44	0.34	0.63	0.91*	0.63
A_{10}	R_3		1.86**	1.46*	1.44**	1.59**	1.07	1.51**	1.48	1.35**	0.48	0.87	0.94	0.76	0.58	0.40	0.53	0.50
	R_4		1.02	1.18*	1.39*	1.20**	0.51	1.01	0.59	0.70	0.53	0.92	0.78	0.74	0.69	0.68	0.53	0.63
	R_8		-3.59**	-4.04**	-4.06**	-3.90**	-3.49**	-5.16**	-5.24**	-4.63**	-1.63*	-1.74	-1.78	-1.72**	-1.70*	-1.77*	-1.97**	-1.81**
	R_{12}		1.02	1.29	1.00	1.10**	1.01	1.07	1.09	1.06*	0.81	0.48	0.61	0.63	0.36	0.46	0.26	0.36
	R_{14}		-0.31	0.12	0.22	0.01	0.90	1.57**	2.09*	1.52**	-0.19	-0.52	-0.56	-0.42	0.08	0.23	0.64	0.32
L.S.D (S_{ij}-S_{ik})		0.05	1.13	0.69	1.08	0.65	1.95	1.08	1.95	1.00	1.53	1.87	1.95	1.05	1.56	1.36	0.88	0.74
		0.01	1.51	1.62	1.43	0.87	2.59	1.43	2.60	1.32	2.03	2.48	2.60	1.39	2.07	1.81	1.17	0.98
L.S.D (S_{ij}-S_{kl})		0.05	1.61	1.70	1.53	0.93	2.72	1.53	2.74	1.39	2.18	2.63	2.74	1.47	2.18	1.93	1.24	1.05
		0.01	2.14	2.26	2.03	1.24	3.69	2.03	3.65	1.84	2.90	3.50	3.69	1.96	2.90	2.56	1.66	1.39

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

L_1 = Sakha, L_2 = El-Serw, D_1 = 35,000 plant/fed, D_2 = 23,333 plant/fed, D_3 = 17,500 plant/fed.

Table (12): Cont.

Cross		Plant height								Stem diameter							
		L1				L2				L1				L2			
		D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
A_1	R_3	10.49**	9.92**	10.09**	10.16**	10.61**	10.11**	7.74**	9.49**	-0.15**	-0.06	-0.03	-0.08	-0.14	-0.13	-0.18*	-0.15*
	R_4	10.04**	10.84**	10.52**	10.47**	9.97**	10.38**	11.05**	10.47**	-0.11	-0.09	-0.08	-0.09	-0.06	-0.04	-0.04	-0.05
	R_8	-25.89**	-25.02**	-24.00**	-24.97**	-26.46**	-25.98**	-24.67**	-25.70**	0.18	0.20	0.19	0.19**	0.11	0.00	0.01	0.04
	R_{12}	-0.57	-0.71	-0.65	-0.64	-0.45	-1.14	-0.75	-0.78	0.07	-0.06	-0.03	-0.01	0.04	0.09	0.10	0.08
	R_{14}	5.94**	4.98*	4.04*	4.98**	6.33**	6.62**	6.63**	6.53**	0.01	0.01	-0.05	-0.01	0.04	0.08	0.11	0.07
A_3	R_3	5.07*	5.52*	5.19**	5.26**	5.97**	4.95*	5.31*	5.41**	0.05	0.00	-0.02	0.01	0.09	0.10	0.10	0.10
	R_4	-2.04	-2.13	-2.01	-2.06	-1.30	0.12	-0.32	-0.50	0.06	0.01	0.02	0.03	0.10	0.09	0.13	0.11*
	R_8	10.90**	10.98**	9.53**	10.47**	10.90**	10.40**	10.10**	10.46**	-0.06	-0.04	-0.11	-0.07	-0.23*	-0.26**	-0.25**	-0.24**
	R_{12}	-4.18*	-4.84*	-3.314	-4.11**	-5.96**	-6.90**	-6.28**	-6.38**	-0.13	-0.04	0.04	-0.04	-0.06	-0.01	-0.06	-0.05
	R_{14}	-9.74**	-9.52**	-9.40**	-9.55**	-9.61**	-8.57**	-8.80**	-8.99**	0.08	0.07	0.06	0.07	0.10	0.08	0.08	0.08
A_4	R_3	-10.98**	-12.20**	-11.96**	-11.71**	-11.68**	-10.99**	-10.70**	-11.12**	0.06	0.03	-0.02	0.02	0.02	0.07	0.06	0.05
	R_4	-5.06*	-5.58*	-5.66**	-5.43**	-5.66*	-7.08**	-7.13**	-6.62**	0.00	0.00	0.10	0.03	-0.03	-0.07	-0.04	-0.05
	R_8	10.98**	10.79**	10.49**	10.75**	11.88**	11.16**	10.86**	11.30**	-0.02	0.06	0.07	0.04	0.07	0.04	0.02	0.04
	R_{12}	4.53*	5.57*	5.37**	5.16**	5.09*	5.40**	5.28*	5.26**	-0.06	-0.08	-0.15	-0.09	-0.06	-0.05	-0.03	-0.05
	R_{14}	0.54	1.42	1.76	1.24	0.37	1.50	1.69	1.19	0.02	-0.01	0.00	0.00	0.00	0.01	-0.02	0.00
A_6	R_3	-8.25**	-8.21**	-8.25**	-8.24**	-9.32**	-9.72**	-8.71**	-9.25**	0.08	0.10	0.08	0.09	0.08	-0.06	-0.06	-0. 01
	R_4	2.64	1.08	1.08	1.60	2.94	2.25	1.66	2.29	0.15	0.17	0.16	0.16**	0.12	0.13	0.00	0.09
	R_8	1.11	1.92	2.33	1.79	0.58	0.83	0.58	0.66	0.04	-0.10	-0.13	-0.07	0.13	0.137	0.29**	0.24**
	R_{12}	-6.77**	-6.27**	-6.69**	-6.58**	-6.04**	-4.90*	-5.04*	-5.33**	-0.04	0.03	0.02	0.00	-0.11	-0.17	-0.09	-0.12*
	R_{14}	11.27**	11.48**	11.53**	11.43**	11.84**	11.53**	11.51**	11.63**	-0.23*	-0.20	-0.13	-0.19**	-0.22*	-0.22*	-0.15	-0.19**
A_9	R_3	-2.47	-1.11	-1.51	-1.69	-2.30	-2.21	-1.61	-2.04	-0.01	-0.03	-0.04	-0.02	-0.04	0.00	0.02	0.00
	R_4	-3.98	-3.05	-2.54	-3.19**	-4.20	-5.57**	-5.24*	-5.01**	-0.07	-0.05	-0.06	-0.06	-0.09	-0.08	-0.04	-0.07
	R_8	7.93**	6.78**	6.71**	7.14**	8.20**	8.47**	8.11**	8.26**	-0.12	-0.16	-0.12	-0.14*	-0.05	-0.04	-0.02	-0.04
	R_{12}	-0.02	-0.70	-1.17	-0.63	0.24	1.34	0.80	0.79	0.10	0.10	0.03	0.08	0.11	0.05	0.00	0.05
	R_{14}	-1.45	-1.92	1.49	-1.62	-1.94	-2.03	-2.05	-2.01	0.11	0.14	0.18	0.14*	0.07	0.07	0.04	0.06
A_{10}	R_3	6.14**	6.09**	6.44**	6.22**	6.72**	7.86**	7.98**	7.52**	-0.03	-0.05	0.02	-0.0	-0.02	0.01	0.05	0.01
	R_4	-1.58	-1.15	-1.39	-1.37	-1.76	-0.10	-0.01	-0.62	-0.03	-0.04	-0.14	-0.07	-0.04	-0.03	-0.02	-0.03
	R_8	-5.03*	-5.45*	-5.05**	-5.18**	-5.09*	-4.89**	-4.96*	-4.98**	-0.01	0.05	0.10	0.05	-0.04	-0.06	-0.06	-0.05
	R_{12}	7.02**	6.96**	6.44**	6.81**	7.12**	6.18**	5.99**	6.43**	0.05	0.05	0.08	0.06	0.09	0.09	0.09	0.09
	R_{14}	-6.54**	-6.45**	-6.44**	-6.48**	-6.99**	-9.06**	-8.99**	-8.35**	0.02	-0.01	-0.07	-0.02	0.02	-0.02	-0.07	-0.02
L.S.D ($S_{ij}-S_{ik}$)	0.05	4.16	4.30	3.37	2.29	4.27	4.04	4.30	2.43	0.23	0.23	0.20	0.11	0.20	0.20	0.17	0.11
	0.01	5.53	5.72	4.48	3.05	5.68	5.38	5.72	3.24	0.30	0.30	0.26	0.15	0.26	0.26	0.23	0.15
L.S.D ($S_{ij}-S_{kl}$)	0.05	5.85	6.05	4.78	3.22	6.02	5.74	6.08	3.42	0.31	0.34	0.28	0.23	0.28	0.26	0.23	0.14
	0.01	7.79	8.05	6.36	4.29	8.01	7.64	8.09	4.55	0.41	0.45	0.38	0.30	0.38	0.34	0.30	0.19

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

Table (12): Cont.

Cross		Head diameter L1 D1	L1 D2	L1 D3	L1 Comb.	L2 D1	L2 D2	L2 D3	L2 Comb.	100-seeds weight L1 D1	L1 D2	L1 D3	L1 Comb.	L2 D1	L2 D2	L2 D3	L2 Comb.
A_1	R_3	-1.27	-0.98	-1.14	-1.13*	-1.44*	-1.33**	-1.41**	-1.39**	-0.42	-0.41	-0.50*	-0.45*	-0.33	-0.49	-0.58**	-0.47**
	R_4	0.20	-0.02	0.03	0.07	0.57	0.42	0.52*	0.50*	0.32	0.49	0.44*	0.42*	-0.10	0.25	0.38*	0.18
	R_8	0.73	0.14	0.44	0.44	0.57	0.68*	0.67**	0.64**	0.07	-0.02	0.02	0.02	0.18	0.25	0.20	0.21
	R_{12}	0.15	0.45	0.34	0.31	0.21	0.35	0.39	0.31	-0.17	-0.10	-0.04	-0.11	-0.08	-0.06	0.00	-0.05
	R_{14}	0.19	0.41	0.32	0.31	0.09	-0.12	-0.16	-0.06	0.21	0.05	0.08	0.11	0.33	0.06	0.01	0.13
A_3	R_3	-0.32	-0.39	0.05	-0.22	-0.31	-0.35	-0.32	-0.33	-0.25	0.02	0.17	-0.02	-0.17	0.15	0.18	0.06
	R_4	-0.18	0.54	0.55	0.31	-0.01	0.18	0.14	0.10	0.66	0.76*	0.75**	0.72**	0.13	-0.15	-0.19	-0.07
	R_8	-0.62	-0.76	-0.91	-0.76	-0.67	-0.60	-0.45	-0.57*	-0.29	-0.42	-0.44*	-0.38	-0.12	-0.05	-0.07	-0.08
	R_{12}	0.67	0.11	0.23	0.33	0.64	0.50	0.37	0.50*	0.17	0.00	-0.10	0.02	0.15	0.05	0.03	0.08
	R_{14}	0.44	0.50	0.08	0.34	0.35	0.27	0.26	0.29	-0.29	-0.35	-0.38	-0.34	0.00	0.00	0.04	0.01
A_4	R_3	1.00	0.26	0.06	0.44	1.00	0.92**	0.99**	0.97**	0.18	0.11	0.21	0.17	0.38	0.11	0.12	0.20
	R_4	0.54	-0.27	-0.17	0.03	0.44	0.44	0.48*	0.45	0.08	-0.02	0.11	0.06	0.11	-0.13	-0.15	-0.05
	R_8	-0.54	-0.41	-0.59	-0.51	-0.66	-0.73*	-0.61*	-0.67**	-0.23	-0.36	-0.44*	-0.34	-0.21	-0.13	0.10	-0.14
	R_{12}	0.41	0.50	0.64	0.52	0.42	0.43	0.15	0.33	-0.14	-0.04	-0.07	-0.08	-0.20	-0.10	-0.09	-0.13
	R_{14}	-1.41	-0.08	0.06	-0.48	-1.20	-1.07**	-1.00**	-1.09**	0.11	0.31	0.19	0.20	-0.09	0.25	0.21	0.13
A_6	R_3	0.48	0.74	0.42	0.55	0.55	0.50	0.58*	0.55*	-0.24	-0.44	-0.47*	-0.39	-0.62	-0.31	-0.23	-0.39**
	R_4	0.26	-0.10	0.13	0.10	-0.01	-0.08	-0.13	-0.07	-0.17	-0.07	-0.10	-0.11	0.38	0.29	0.27	0.31*
	R_8	0.52	0.56	0.63	0.57	0.83	1.05**	0.85**	0.91**	0.45	0.49	0.48*	0.47*	0.29	0.39	0.38*	0.36*
	R_{12}	-1.53	-0.53	-0.57	-0.88	-1.33*	-1.42	-1.16**	-1.30**	0.17	0.07	-0.02	0.08	0.00	-0.31	-0.35*	0.22
	R_{14}	0.27	-0.67	-0.62	-0.34	-0.05	-0.05	-0.14	-0.08	-0.21	-0.05	0.11	-0.05	-0.05	-0.06	-0.07	-0.06
A_9	R_3	-0.48	0.50	0.64	0.22	-0.28	-0.21	-0.15	-0.21	0.31	0.37	0.29	0.33	0.29	0.46	0.43**	0.39**
	R_4	-0.51	0.04	-0.65	-0.38	-0.67	-0.72*	-0.79**	-0.73**	-0.35	-0.56	-0.60**	-0.50*	-0.07	-0.11	-0.11	-0.10
	R_8	-0.42	-0.27	-0.21	-0.30	-0.41	-0.46	-0.47	-0.45	-0.33	-0.20	-0.19	-0.24	-0.39	-0.47	-0.46**	-0.44**
	R_{12}	0.10	-0.83	-0.95	-0.56	0.04	0.11	0.15	0.10	0.06	0.08	0.18	0.11	0.21	0.32	0.28	0.27
	R_{14}	1.31	0.56	1.17	1.01*	1.32*	1.27**	1.26**	1.29**	0.31	0.30	0.31	0.31	-0.04	-0.20	-0.15	-0.13
A_{10}	R_3	0.58	-0.13	-0.04	0.14	0.47	0.46	0.31	0.41	0.42	0.35	0.29	0.36	0.44	0.08	0.07	0.20
	R_4	-0.31	-0.20	0.10	-0.14	-0.32	-0.25	-0.20	-0.26	-0.54	-0.61	-0.60**	-0.58**	-0.46	-0.15	-0.20	-0.27
	R_8	0.32	0.73	0.64	0.56	0.35	0.04	0.01	0.13	0.32	0.51	0.58**	0.47*	0.25	0.01	0.05	0.10
	R_{12}	0.20	0.30	0.31	0.27	0.02	0.04	0.10	0.05	-0.09	0.00	0.05	-0.02	-0.08	0.11	0.12	0.05
	R_{14}	-0.79	-0.71	-1.01	-0.84	-0.53	-0.29	-0.22	-0.35	-0.11	-0.25	-0.32	-0.23	-0.16	-0.04	-0.04	-0.08
L.S.D ($S_{ij}-S_{ik}$)	0.05	1.81	167	1.24	0.91	1.22	0.68	0.18	0.48	0.99	0.76	0.40	0.42	0.65	0.51	0.31	0.28
	0.01	2.41	2.22	1.66	1.20	1.62	0.90	0.64	0.64	1.32	1.02	0.53	0.56	0.87	0.68	0.41	0.38
L.S.D ($S_{ij}-S_{kl}$)	0.05	2.55	2.35	1.75	1.30	1.73	0.96	0.68	0.71	1.41	1.08	0.54	0.62	0.93	0.74	0.45	0.42
	0.01	3.39	3.12	2.33	1.73	2.29	1.28	0.90	0.94	1.88	1.43	0.72	0.83	1.24	0.98	0.60	0.56

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

Table (12): Cont.

Cross		Seed husk percent								Number of seeds/head							
		L1				L2				L1				L2			
		D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
A_1	R_3	-4.34**	-4.65**	-4.39**	-4.50**	-4.66**	-4.47**	-4.02**	-4.38**	188.09*	171.37*	175.18**	178.21**	169.33**	189.82**	156.31*	171.82**
	R_4	-1.96**	-2.14**	-2.29**	-2.12**	-1.68**	-1.86**	-2.26**	-1.93**	-38.04	-37.89	-35.58	-37.17	40.52	-34.79	-55.32	-16.53
	R_8	5.84**	5.86**	5.81**	5.85**	5.93**	5.79**	5.91**	5.88**	-74.87	-77.74	-79.58*	-77.40*	-112.59	-150.10*	-125.89	-129.53**
	R_{12}	0.16	0.26	0.01	0.15	-0.39	-0.19	-0.15	-0.24	43.00	33.53	30.89	35.81	24.00	29.34	11.32	21.55
	R_{14}	0.31	0.67*	0.87**	0.62*	0.79	0.73	0.53	0.66**	-118.18	-89.27	-90.91*	-99.45**	-121.27*	-34.27	13.59	-47.31
A_3	R_3	-2.05**	-1.83**	-1.79**	-1.88**	-2.83**	-2.73**	-2.72**	-2.76**	25.40	-32.50	-45.25	-17.45	28.84	-36.90	-43.51	-17.19
	R_4	0.46	0.51	0.44	0.47	1.18*	0.91*	0.81*	0.97**	-109.52	-87.80	-91.07*	-96.13**	-52.91	9.03	21.53	-7.45
	R_8	1.29	1.11**	1.04**	1.14**	2.09**	1.93**	1.78**	1.93**	85.44	101.69	103.06**	96.73**	44.89	15.79	-7.84	17.61
	R_{12}	0.78	0.51	0.71**	0.66*	-0.46	-0.11	-0.17	-0.25	-34.48	-45.31	-17.37	-32.39	-24.06	4.96	-22.33	-13.81
	R_{14}	-0.47	-0.29	-0.40	0.39	0.02	0.00	0.30	0.11	33.17	63.93	50.63	49.24	3.24	7.12	52.15	20.84
A_4	R_3	0.63	0.27	0.14	0.36	0.37	0.28	0.18	0.28	-100.47	-80.02	-80.12*	-86.87*	-116.76	-36.40	-34.25	-62.47
	R_4	2.31**	2.01**	1.91**	2.07**	2.82**	2.65**	2.44**	2.64**	58.24	33.06	7.80	33.03	32.76	47.25	18.82	62.95
	R_8	-2.22**	-1.75**	-1.46**	-1.81**	-2.58**	-2.06**	-1.88**	-2.17**	16.41	62.71	68.66	49.26	17.42	60.08	60.69	46.06
	R_{12}	-0.37	-0.22	-0.16	-0.25	0.17	-0.01	-0.07	0.03	39.08	22.97	16.43	26.16	53.51	-33.51	-22.27	-0.76
	R_{14}	-0.35	-0.31	-0.43	-0.37	-0.78	-0.86*	-0.67	-0.77**	-13.27	-38.72	-12.77	-21.59	13.07	-37.42	-22.99	-15.78
A_6	R_3	4.20**	4.56**	4.45**	4.41**	5.38**	5.32**	4.89**	5.20**	9.95	43.42	51.59	34.99	49.66	11.60	-4.12	19.05
	R_4	-1.06	-1.27**	-1.25**	-1.19**	-2.30**	-1.71**	-1.38**	-1.80**	44.96	12.62	10.50	22.70	-24.51	-36.91	-42.18	-34.54
	R_8	-5.36**	-5.27**	-5.12**	-5.25**	-6.06**	-6.19**	-5.84**	-6.03**	-63.00	-56.93	-59.60	-59.84	12.51	16.75	-3.69	8.52
	R_{12}	1.17	1.10**	1.05**	1.10**	1.69**	1.57**	1.53**	1.60**	-14.33	3.14	1.91	-3.09	-33.73	18.52	9.76	-1.82
	R_{14}	1.05	0.87**	0.87**	0.93**	1.30**	1.02**	0.81*	1.04**	22.42	-2.25	-4.40	5.26	-3.94	-.9.95	40.23	8.87
A_9	R_3	-0.86	-0.70*	-0.66*	-0.73*	-1.20**	-1.20**	-1.15**	-1.18**	-70.02	-71.79	-70.24	-70.68*	-67.96	-124.66*	-127.48	-106.70**
	R_4	0.65	-0.36	-0.23	-0.41	-0.18	-0.36	-0.16	-0.23	22.26	48.48	69.07	46.60	-9.04	5.83	12.86	3.21
	R_8	2.52**	2.34**	2.14**	2.33**	2.62**	2.59**	1.98*	2.40**	25.32	4.67	26.60	18.86	25.92	75.59	72.62	58.04
	R_{12}	-1.13	-1.26**	-1.19**	-1.19**	-1.23**	-1.19**	-0.94*	-1.12**	-13.84	-1.87	-19.33	-11.68	-17.49	14.09	1.96	-0.48
	R_{14}	0.12	-0.02	-0.07	0.01	-0.02	0.16	0.27	0.14	36.28	20.51	-6.10	16.90	68.57	29.15	40.04	45.92
A_{10}	R_3	2.43**	2.34**	2.27**	2.35**	2.94**	2.81**	2.82**	2.86**	-52.95	-30.48	-13.16	-38.20	-63.11	-3.46	53.05	-4.50
	R_4	0.90	1.25**	1.43**	1.19**	0.16	0.38	0.55	0.36	22.10	31.52	39.28	30.97	13.18	9.60	44.29	22.36
	R_8	-2.06**	-2.29**	-2.43**	-2.26**	-2.00**	-2.06**	-1.94*	-2.00**	10.70	-34.39	-59.12	-27.61	11.84	-18.11	4.12	-0.72
	R_{12}	-0.61	-0.39	-0.43	-0.48	0.21	-0.07	-0.20	-0.02	-19.43	-12.46	-12.55	-14.81	-2.24	-33.40	21.56	-4.69
	R_{14}	-0.66	-0.91**	-0.84**	0.81**	-1.31**	-1.06**	-1.23**	-1.20**	39.59	45.81	63.55	49.65	40.32	43.36	-123.03	-12.45
L.S.D (S_{ij}-S_{ik})	0.05	1.47	0.65	0.51	0.57	0.91	0.74	0.76	0.48	143.65	130.50	76.13	69.50	119.12	117.11	154.90	75.90
	0.01	1.96	0.87	0.68	0.75	1.20	0.98	1.02	0.64	191.30	173.50	101.30	92.40	158.40	115.80	205.86	101.00
L.S.D (S_{ij}-S_{kl})	0.05	2.09	0.93	0.74	0.79	1.27	1.05	1.10	0.65	203.11	184.60	107.70	98.30	168.40	165.60	219.00	107.40
	0.01	2.78	1.24	0.98	1.05	1.69	1.39	1.48	0.87	270.13	245.50	143.20	130.7	224.00	220.30	291.30	142.80

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

Table (12): Cont.

Cross		Yield/plant								Oil percentage							
		L_1				L_2				L_1				L_2			
		D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
A_1	R_3	4.06	3.33	3.42	3.60**	4.42	3.78	2.16	3.45**	3.88**	3.74**	3.69**	3.77**	3.82**	3.49**	3.74**	3.68**
	R_4	2.15	2.68	2.13	2.32	1.92	0.63	1.22	1.26	1.21**	1.31**	1.48**	1.33**	1.04**	1.27**	1.18**	1.16**
	R_8	-2.86	-3.71	-3.79	-3.45**	-4.08	-4.75*	-4.65*	-4.49**	-5.59**	-5.65**	-5.60**	-5.62**	-5.46**	-5.53**	-5.64**	-5.54**
	R_{12}	0.96	1.55	1.84	1.45	1.14	1.19	1.40	1.24	0.36	0.54**	0.44**	0.45**	0.51	0.59	0.60*	0.57**
	R_{14}	-4.31	-3.84	-3.59	-3.92**	-3.40	-0.86	-0.13	-1.46	0.14	0.06	-0.01	0.06	0.09	0.18	0.12	0.13
A_3	R_3	0.20	-0.65	-0.30	-0.25	0.69	-0.21	-0.07	0.14	2.46**	2.53**	2.55**	2.51**	2.54**	2.54**	2.50**	2.53**
	R_4	-1.89	-0.57	-0.76	-1.07	-1.61	-0.39	0.26	-0.58	-0.44	-0.43*	-0.47**	-0.45**	-0.54	-0.45	-0.45	-0.48**
	R_8	2.18	2.01	1.82	2.00	0.85	-0.43	-1.18	-0.25	-2.05**	-2.16**	-2.15**	-2.12**	-2.18**	-2.15**	-2.14**	-2.16**
	R_{12}	-1.01	-2.40	-1.35	-1.58	-0.50	0.44	-0.66	-0.24	-0.66**	-0.60**	-0.57**	-0.61**	-0.54	-0.59	-0.50	-0.54**
	R_{14}	0.52	1.61	0.59	0.91	0.57	0.59	1.65	0.93	0.69**	0.65**	0.64**	0.66**	0.71*	0.66*	0.59*	0.65**
A_4	R_3	-2.63	-2.33	-1.99	-2.32	-2.41	-0.43	0.14	-0.90	-0.04	-0.01	-0.09	-0.05	0.03	0.03	0.04	-0.03
	R_4	1.92	0.66	1.09	1.22	2.36	1.65	0.47	1.49	-2.48**	-2.53**	-2.60**	-2.54**	-2.71**	2.56**	-2.52**	-2.60**
	R_8	-0.42	0.70	0.20	0.16	-0.74	1.87	2.80	1.31	3.09**	3.07**	3.09**	3.08**	3.05**	3.11**	3.10**	3.09**
	R_{12}	1.70	0.99	0.53	1.08	1.61	-2.55	-1.42	-0.79	-0.26	-0.54**	-0.47**	-0.42**	-0.38	-0.53	-0.54*	-0.48**
	R_{14}	-0.57	-0.03	0.17	-0.15	-0.83	-0.54	-1.98	-1.12	-0.31	0.01	0.07	-0.07	0.01	-0.05	-0.08	-0.05
A_6	R_3	-1.10	-1.15	-1.00	-1.08	-1.83	-1.25	-1.16	-1.41	-5.08**	-5.15**	-5.09**	-5.11**	-5.32**	-5.13**	-5.10**	-5.18**
	R_4	1.42	0.43	-0.03	0.61	0.84	-0.10	-0.22	0.17	1.62**	1.69**	1.63**	1.65**	1.67**	1.68**	1.77**	1.71**
	R_8	-0.15	0.37	0.56	0.26	2.81	3.79	3.47	3.36**	6.18**	6.13**	6.22**	6.18**	6.36**	6.18**	6.16**	6.23**
	R_{12}	0.27	0.53	0.02	0.10	-1.31	-1.33	-1.88	-1.51	-1.57**	-1.41**	-1.47**	-1.48**	-1.53**	-1.49**	-1.61**	-1.54**
	R_{14}	0.09	-0.19	0.45	0.12	-0.51	-1.12	-0.21	-0.61	-1.15**	-1.26**	-1.29**	-1.23**	-1.18**	-1.24**	-1.22**	-1.21**
A_9	R_3	-0.99	-0.50	-1.08	-0.86	-1.05	-3.24	-3.20	-2.50*	1.38**	1.72**	1.75**	1.62**	1.51**	1.69**	1.57**	1.59**
	R_4	-1.17	-0.85	-0.37	-0.79	-1.09	-0.69	0.27	-0.50	0.98**	0.69**	0.73**	0.80**	1.40**	0.84**	0.71*	0.98**
	R_8	-1.04	-0.87	0.15	-0.59	-1.19	0.27	0.80	-0.04	-2.99**	-2.77**	-2.91**	-2.89**	-2.94**	-2.80**	-2.74**	-2.83**
	R_{12}	0.01	0.35	0.08	0.15	0.03	3.71	3.11	2.28	1.53**	1.32**	1.36**	1.41**	1.20**	1.36**	1.46**	1.34**
	R_{14}	3.20	1.87	1.21	2.09	3.29	-0.04	-0.98	0.76	-0.92**	-0.96**	-0.93**	-0.93**	-1.18**	-1.09**	-1.01**	-1.09**
A_{10}	R_3	0.45	1.31	0.96	0.91	0.17	1.34	2.13	1.22	-2.60**	-2.82**	-2.81**	-2.74**	-2.56**	-2.63**	-2.74**	-2.64**
	R_4	-2.43	-2.37	-2.07	-2.29	-2.43	-1.11	-2.00	-1.85	-0.90**	-0.75**	-0.76**	-0.80**	-0.87**	-0.78*	-0.70*	-0.78**
	R_8	2.30	1.51	1.06	1.62	2.34	-0.75	-1.24	0.12	1.37**	1.39**	1.36**	1.37**	1.16**	1.18**	1.25**	1.20**
	R_{12}	-1.39	-1.03	-1.12	-1.18	-0.98	-1.45	-0.53	-0.98	0.59*	0.68**	0.70**	0.66**	0.73*	0.67*	0.58*	0.66**
	R_{14}	1.07	0.58	1.18	0.94	0.89	1.97	1.65	1.50	1.54**	1.50**	1.51**	1.52**	1.55**	1.56**	1.61**	1.57**
L.S.D (S_{ij}-S_{ik})	0.05	4.61	4.13	3.29	2.40	4.44	3.90	3.65	2.32	0.48	0.40	0.31	0.23	0.65	0.60	0.54	0.23
	0.01	6.13	5.49	5.04	3.20	5.91	5.19	4.85	3.08	0.64	0.53	0.41	0.30	0.87	0.79	0.72	0.30
L.S.D (S_{ij}-S_{kl})	0.05	6.50	5.83	8.37	3.42	6.31	5.52	5.15	3.28	0.68	0.54	0.42	0.31	0.93	0.82	0.76	0.31
	0.01	8.65	7.75	7.15	4.55	8.39	7.33	6.85	4.36	0.90	0.72	0.56	0.41	1.24	1.09	1.02	0.41

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

Table (12): Cont.

Cross		Oil yield/plant								Seed yield/fed							
		L_1				L_2				L_1				L_2			
		D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.	D_1	D_2	D_3	Comb.
A_1	R_3	3.16**	2.99**	3.10**	3.08**	3.34**	3.46**	2.83**	3.21**	142.26	130.81	58.78	110.62*	153.96	88.19	37.80	93.32**
	R_4	1.39*	1.77	1.62	1.59**	1.12	0.76	1.07	0.98	75.17	-150.16	36.24	-12.91	66.46	14.75	21.39	34.20
	R_8	-3.00**	-3.73**	-3.90**	-3.54**	-3.56**	-4.37**	-4.53**	-4.15**	-100.02	-33.48	-67.30*	-66.94	-143.54	-110.78*	-81.37*	-111.90**
	R_{12}	0.39	0.70	0.81	0.63	0.68	0.60	0.73	0.67	33.56	89.22	31.18	51.32	42.93	27.90	24.40	31.75
	R_{14}	-1.94*	-1.73	-1.63	-1.76**	-1.58	-0.45	-0.10	-0.71	-150.97	-36.40	-58.90	-82.09	-119.82	-20.06	-2.23	-47.37
A_3	R_3	0.76	0.58	0.81	0.72	1.12	1.06	1.19	1.12**	6.92	-25.92	-6.30	-8.43	23.29	-4.81	-1.17	5.77
	R_4	-1.04	-0.45	-0.58	-0.69	-0.93	-0.41	-0.13	-0.49	-65.99	29.38	-14.28	-16.97	-57.21	-9.25	4.59	-20.62
	R_8	0.40	0.12	-0.03	0.17	-0.34	-1.14	-1.53	-1.00	76.14	36.19	30.94	47.76	29.13	-10.12	20.58	-0.52
	R_{12}	-0.61	-1.21	-0.78	-0.87	-0.34	-0.10	-0.57	-0.34	-35.27	-66.65	-24.60	-42.17	-14.23	10.44	-11.64	-5.14
	R_{14}	0.50	0.96	0.58	0.68	0.50	0.58	1.03	0.71	18.20	27.00	14.24	19.82	19.02	13.74	28.80	20.52
A_4	R_3	-1.24*	-1.08	-0.86	-1.06	-1.07	-0.16	0.14	-0.36	-92.01	-64.96	-35.82	-64.27	-84.97	-10.10	2.43	-30.88
	R_4	0.09	-0.63	-0.51	-0.35	0.18	-0.36	-1.01	-0.40	67.24	57.94	18.03	47.74	81.86	38.52	8.22	42.87
	R_8	0.70	1.43	1.34	1.16*	0.57	1.98*	2.55**	1.70**	-14.62	5.61	2.59	-2.14	-26.64	43.66	48.96	21.99
	R_{12}	0.75	0.27	0.05	0.36	0.67	-1.25	-0.79	-0.46	59.46	12.71	8.31	26.83	59.50	-59.46	-24.94	-8.30
	R_{14}	-0.30	0.01	-0.02	-0.11	-0.35	-0.20	-0.89	-0.48	-20.07	-11.30	6.89	-8.16	-29.75	-12.62	-34.67	-25.68
A_6	R_3	-1.99*	-2.34*	-2.44**	-2.26**	-2.56*	-2.96**	-2.99**	-2.84**	-38.34	-37.60	-12.56	-29.50	-60.01	-28.93	-20.21	-36.38
	R_4	1.18*	0.83	0.60	0.87	1.02	0.83	0.82	0.89	49.74	52.70	4.56	35.67	33.33	-2.04	-3.92	9.12
	R_8	1.79*	2.37*	2.69**	2.28**	3.51**	4.57**	4.52**	4.20**	-5.29	-1.83	14.75	2.54	102.16	88.70	60.72	83.86*
	R_{12}	-0.63	-0.30	-0.54	0.49	-1.35	-1.36	-1.63	-1.45**	-9.37	1.81	5.34	-0.74	-61.37	-31.82	-32.98	-42.05
	R_{14}	-0.35	-0.56	-0.31	-0.41	-0.61	-1.08	-0.72	-0.80	3.27	-15.08	-12.08	-7.96	-14.12	-25.92	-3.61	-14.55
A_9	R_3	-0.08	0.35	0.15	0.14	-0.04	-0.74	-0.72	-0.50	-34.61	-22.32	-19.85	-25.59	-37.61	-75.59	-55.89	-56.36
	R_4	-0.24	-0.17	0.10	-0.11	0.01	0.02	0.49	0.17	-41.03	22.85	-7.39	-8.52	-38.77	-16.10	4.73	-16.17
	R_8	-1.36*	-1.37	-1.09	-1.27*	-1.57	-1.20	-1.04	-1.27*	-36.56	-31.01	1.63	-21.98	-42.27	6.16	13.94	-7.39
	R_{12}	0.52	0.69	0.62	0.61	0.50	2.40**	2.18**	1.69**	0.19	-2.37	0.38	-0.60	4.20	86.58	54.38	48.39
	R_{14}	1.16*	0.50	0.22	0.63	1.11	-0.48	-0.91	-0.10	112.00	32.84	25.23	56.69	114.45	-1.05	-17.16	32.08
A_{10}	R_3	-0.61	-0.50	-0.77	-0.62	-0.78	-0.66	-0.45	-0.63	15.79	20.00	15.75	17.18	5.33	31.23	37.04	24.53
	R_4	-1.38*	-1.35	-1.22	-1.32*	-1.39	-0.84	-1.24	-1.16*	-85.13	-12.70	-37.16	-45.00	-85.67	-25.88	-35.01	-48.85
	R_8	1.47*	1.18	0.99	1.21*	1.40	0.17	0.03	0.53	80.34	24.51	17.40	40.75	81.16	-17.61	-21.67	13.96
	R_{12}	-0.41	-0.15	-0.16	-0.24	-0.17	-0.29	0.08	-0.13	-48.57	-34.73	-20.62	-34.64	-31.03	-33.66	-9.23	-24.64
	R_{14}	0.93	0.82	1.16	0.97	0.94	1.62	1.59	1.38*	37.57	2.92	24.63	21.71	30.22	45.91	28.87	35.00
L.S.D (S_{ij}-S_{ik})	0.05	1.05	1.84	1.67	1.08	1.95	1.75	1.64	1.05	181.40	187.60	65.30	85.30	155.50	90.90	63.70	63.70
	0.01	2.75	2.45	2.22	1.43	2.60	2.33	2.18	1.39	214.80	249.60	86.80	113.50	206.90	120.90	84.80	84.70
L.S.D (S_{ij}-S_{kl})	0.05	2.41	2.60	2.38	1.53	2.77	2.49	2.35	1.47	228.30	265.30	92.30	120.70	219.90	128.50	90.10	90.10
	0.01	3.87	3.46	3.16	2.03	3.69	3.31	3.12	1.96	303.80	352.90	122.80	160.60	292.60	170.90	119.90	119.80

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

For stem diameter A_1 x R_8, A_6 x R_4 and A_9 x R_{14} in the first location, and A_3 x R_4 and A_6 x R_8 in the second location exhibited significantly positive S_{ij} effects in the combined data. However, other crosses exhibited significantly negative or insignificant S_{ij} effect.

The top cross A_9 x R_{14} in the first location and A_9 x R_{14}, A_1 x R_4, A_1 x R_8, A_3 x R_{12}, A_4 x R_3 and A_6 x R_8 in the second location gave significantly positive S_{ij} effects in the combined analysis for head diameter. However, the other top crosses exhibited significant negative or insignificant S_{ij} effects.

Regarding 100-seed weight, one, four, and four top crosses exhibited significantly positive S_{ij} effects at D_2, D_3 as well as the combined data in Sakha location, respectively. While, three top crosses expressed desirable S_{ij} effects at D_3 as well as the combined data in the second location (El-Serw). The other top crosses gave significantly negative or insignificant S_{ij} effects.

For seed husk percentage, six, ten, ten and nine top cross in the first location (Sakha), and ten, eleven, ten and eleven top crosses in the second location (El-Serw) exhibited significantly negative S_{ij} effects in D_1, D_2, D_3 as well as the combined data, respectively. However, five, ten, eleven and twelve top crosses in the first location (Sakha), nine, nine, nine, ten top crosses in the second location (El-Serw) gave significantly positive S_{ij} effects at D_1, D_2, D_3 as well as the combined data, respectively. The other top crosses showed insignificant S_{ij} effects.

From number of seeds per head, the top cross A_1 x R_3 gave significantly positive S_{ij} effects at the three densities and the combined data in both locations. While, the other top crosses gave significant negative or insignificant S_{ij} effects.

For seed yield per plant and yield kg/fed. the top cross $A_1 \times R_3$ in both locations and cross $A_6 \times R_8$ in the second location (El-Serw) expressed significantly positive S_{ij} effects. The other crosses exhibited significantly negative or insignificant S_{ij} effects for both traits.

Regarding oil percentage, thirteen top cross at D_1 and fourteen hybrids at D_2, D_3 as well as the combined analysis in the first location (Sakha), thirteen crosses at D_1 and D_2 and fourteen top crosses at D_3 as well as the combined analysis in the second location (El-Serw) exhibited significantly positive S_{ij} effects. The other crosses gave either significantly negative or insignificant S_{ij} effects for the traits. The most desirable S_{ij} effects were obtained by top cross $A_6 \times R_8$ followed by $A_1 \times R_3$ and then by $A_4 \times R_8$ at the three densities as well as the combined analysis in both locations. Also, the previous three top crosses gave significantly positive S_{ij} effects for oil yield per plant.

In most traits the values of S_{ij} effect varied from one spacing to another. This finding coincided with that reached before for significant SCA by densities mean squares (Table 12).

Most of the previous top crosses are considered to be promising hybrids for varietal improvement purpose, as they showed significant specific combining ability effects and involved at least one good combiner.

c. Heterosis:

The assessment of magnitude of heterosis in experimental hybrids is a must before their recommendation for commercial production. When performance of hybrid is compared with the average performance of over all crosses it is known as ground mean heterosis. Another term, known as standard or economic heterosis, is frequently used to represent heterosis in terms of heterotic performance of a hybrid over the check hybrid. Although standard heterosis does not fit, in strict sense, with definition of heterosis, its estimation is very important and a common feature of plant breeding programs where objective, in general, is to develop new improved hybrids that are significantly superior than the best ones available. Moreover, it is obvious that the negative value for heterosis will be encountered in cases where average performance of hybrids is lower than the respective grand mean or check values against which it is tested.

Level of hybrid vigor for seed yield per plant, oil percent, oil yield per plant and seed yield per fed were estimated for individual top crosses as the percentage increase of hybrid performance relative to Eirflor, Malabar and Vidoic, combined over the three spacings in each location (Sakha and El-Sew) (Table 13). For seed yield per plant twelve, six and six top crosses exhibited significantly heterotic effects over the three spacings in the Sakha location relative to Eirflor, Malabar and Vidoic, respectively. Also, five, seven and eighteen top crosses out yielded the three check hybrids in El-Serw location in the same order. The five top crosses $A_1 \times R_3$, $A_1 \times R_4$, $A_1 \times R_{12}$, $A_9 \times R_{12}$ and $A_9 \times R_{14}$ significantly outyielded the three check hybrids in both locations.

Table (13): Heterosis percentage for seed and oil yields/pant, oil percentage and seed yield/fed. relative to Euroflor, Malabar and Vidoic hybrids in both locations.

Cross	Yield/plant						Oil percentage					
	L_1			L_2			L_1			L_2		
	Eirflor	Malabar	Vidoic	Eirflor	Malabar	Vidoic	Eirflor	Malabar	Vidoic	Eirflor	Malabar	Vidoic
A_1 R_3	28.04**	23.64**	24.85**	11.08**	12.22**	21.65**	11.66**	10.44**	10.93**	11.66**	10.44**	10.93**
R_4	25.68**	21.36**	22.55**	6.58**	7.67**	16.72**	10.56**	9.35**	9.83**	10.56**	9.35**	9.83**
R_8	2.81	-0.72	0.25	-15.75**	-14.89**	-7.73**	-10.92**	-11.90**	-11.51**	-10.92**	-11.90**	-11.51**
R_{12}	25.10**	20.80**	21.98**	10.01**	11.14**	20.48**	0.21	-0.89*	-0.44	0.21	-0.89*	-0.44
R_{14}	8.80**	5.06	6.09	4.27	5.34*	14.19**	3.47**	2.34**	2.80**	3.47**	2.34**	2.80**
A_3 R_3	1.49	-2.00	-1.04	-3.02	-2.03	6.21*	11.35**	10.13**	10.62**	11.35**	10.13**	10.62**
R_4	0.48	-2.97	-2.02	-4.14	-3.16	4.98	9.00**	7.81**	8.29**	9.00**	7.81**	8.29**
R_8	3.36	-0.19	0.79	-12.58**	-11.68**	-4.26	0.03	-1.07*	-0.63	0.03	-1.07*	-0.63
R_{12}	0.94	-2.53	-1.58	0.10	1.13	9.63**	0.37	-0.73	-0.29	0.37	-0.73	-0.29
R_{14}	7.50	3.81	4.83	3.23	4.29	13.05**	7.55**	6.38**	6.85**	7.55**	6.38**	6.85**
A_4 R_3	-2.81	-6.15	-5.23	-8.94**	-8.01**	-0.28	7.92**	6.74**	7.22**	7.92**	6.74**	7.22**
R_4	8.86**	5.12	6.15	-2.95	-1.95	6.29*	6.69**	5.52**	5.99**	6.69**	5.52**	5.99**
R_8	-0.29	-3.72	-2.77	-12.55**	-11.65**	-4.23	14.98**	13.72**	14.23**	14.98**	13.72**	14.23**
R_{12}	10.38**	6.59*	7.63*	-4.70	-3.72	4.37	3.45**	2.32**	2.77**	3.45**	2.32**	2.77**
R_{14}	6.14	2.50	3.50	-5.00*	-4.03	4.04	8.45**	7.26**	7.74**	8.45**	7.26**	7.74**
A_6 R_3	1.13	-2.34	-1.39	-1.35	-0.33	8.04**	-9.00**	-10.00**	-9.60**	-9.00**	-10.00**	-9.60**
R_4	7.44*	3.75	4.76	2.80	3.85	12.58**	11.66**	10.44**	10.93**	11.66**	10.44**	10.93**
R_8	0.35	-3.09	-2.14	0.89	1.92	10.49**	17.37**	16.09**	16.61**	17.37**	16.09**	16.61**
R_{12}	7.89*	4.18	5.20	2.41	3.46	12.16**	-4.00**	-5.05**	-4.63**	-4.00**	-5.05**	-4.63**
R_{14}	7.28*	3.59	4.61	4.90	5.98*	14.89**	0.76	-0.34	0.10	0.76	-0.34	0.10
A_6 R_3	3.14	-0.41	0.57	-6.60**	-5.65*	2.28	13.21**	11.98**	12.47**	13.21**	11.98**	12.47**
R_4	4.69	1.09	2.08	-1.52	-0.51	7.85**	15.95**	14.68**	15.19**	15.95**	14.68**	15.19**
R_8	-0.78	-4.19	-3.25	-9.65**	-8.73**	-1.06	2.19**	1.07*	1.52**	2.19**	1.07*	1.52**
R_{12}	9.38**	6.62*	6.66*	8.31	9.42**	18.62**	9.13**	7.94**	8.42**	9.13**	7.94**	8.42**
R_{14}	14.36**	10.43**	11.51**	5.26*	6.34*	15.28**	7.77**	6.59**	7.06**	7.77**	6.59**	7.06**
A_{10} R_3	4.75	1.15	2.15	0.53	1.57	10.10**	-4.87**	-5.91**	-5.49**	-4.87**	-5.91**	-5.49**
R_4	-3.17	-6.50	-5.58	-5.94*	-4.98*	3.01	4.40**	3.25**	3.71**	4.40**	3.25**	3.71**
R_8	2.13	-1.37	-0.41	-10.64**	-9.73**	-2.14	4.53**	3.38**	3.84**	4.53**	3.38**	3.84**
R_{12}	2.00	-1.50	-0.54	-0.51	0.51	8.96**	-0.39	-1.48**	-1.05*	-0.39	-1.48**	-1.05*
R_{14}	7.50*	3.81	4.83	5.62*	6.70**	15.67**	5.82**	4.66**	5.13**	5.82**	4.66**	5.13**

L_1 = Sakha L_2 = El-Serw

Table (13): Cont.

Cross	Oil yield/plant (g)						Yield/fed. (kg)					
	L_1			L_2			L_1			L_2		
	Eirflor	Malabar	Vidoic	Eirflor	Malabar	Vidoic	Eirflor	Malabar	Vidoic	Eirflor	Malabar	Vidoic
A_1 R_3	42.91**	36.43**	38.55**	24.06**	23.61**	35.01**	29.7**	23.9**	26.40**	13.40**	13.00**	21.30**
R_4	39.00**	32.70**	34.77**	17.33**	16.90**	27.68**	14.7**	9.60**	11.80**	8.80**	8.40**	16.30**
R_8	-8.35*	-12.51**	-11.15**	-24.77**	-25.04**	-18.13**	3.7	-0.9	1.10	-14.20**	-14.50**	-8.20**
R_{12}	25.36**	19.68**	21.54**	10.71**	10.31**	20.48**	26.9**	21.20**	23.70**	11.90**	11.60**	19.70**
R_{14}	12.64**	7.53*	9.21*	8.25**	7.85**	17.80**	9.9**	5.00	7.10*	4.70	4.40	12.0**
A_3 R_3	12.80**	7.68**	9.36*	8.13**	7.73**	17.67**	1.8	-2.70	-0.80	-2.50	-2.80	4.30
R_4	9.50**	4.53	6.16	4.70	4.32	13.94**	0.6	-3.90	-1.90	-4.00	-4.40	2.60
R_8	3.45	-1.24	0.29	-12.38**	-12.70**	-4.65	3.8	-0.8	1.20	-11.10**	-11.40**	-4.96
R_{12}	1.23	-3.37	-1.86	0.61	0.24	9.49**	2.0	-2.50	-0.50	0.90	0.50	7.90*
R_{14}	15.71**	10.46**	12.18**	11.26**	10.85**	21.07**	8.5*	3.60	5.70	3.70	3.30	10.9**
A_4 R_3	4.83	0.07	1.63	-1.49	-1.86	7.20*	-3.0	-7.30*	-5.40	-8.40**	-8.7**	-2.10
R_4	16.09**	10.83**	12.55**	3.62	3.24	12.76**	10.3**	5.30	7.50*	-0.40	-0.7	6.50*
R_8	14.56**	9.36**	11.07**	0.67	0.30	9.55**	-0.3	-4.70	-2.80	-11.30**	-11.6**	-5.20
R_{12}	13.95**	8.78**	10.47**	-1.61	-1.97	7.07*	12.2**	7.20*	9.30**	-1.90	-2.20	5.00
R_{14}	14.56**	9.36**	11.07**	3.26	2.88	12.37**	7.0	2.20	4.30	-3.20	-3.50	3.60
A_6 R_3	-7.97*	-12.14**	-10.78**	-10.39**	-10.72**	-2.49	1.8	-2.80	-0.80	-0.90	-1.20	6.00
R_4	20.00**	14.56**	16.34**	15.10**	14.68**	25.26**	9.4*	4.50	6.70	4.50	4.10	11.70**
R_8	17.78**	12.44**	14.19**	18.71**	18.28**	29.19**	0.9	-3.60	-1.60	2.60	2.30	9.8**
R_{12}	3.60	-1.10	0.44	-2.46	-2.81	6.15*	9.5**	4.60	6.70	3.00	2.60	10.10**
R_{14}	7.97*	3.07	4.68	6.02	5.63*	15.38**	7.6*	2.80	4.90	6.00*	5.60	13.30**
A_6 R_3	16.70**	11.41**	13.15**	6.02*	5.63*	15.38**	4.0	-0.60	1.40	-5.30	-5.60	1.30
R_4	21.38**	15.87**	17.68**	14.98**	14.56**	25.13**	5.9	1.10	3.20	-0.50	-0.80	6.40*
R_8	1.38	-3.22	-1.71	-7.15**	-7.49**	1.05	-0.3	-4.70	-2.80	-8.60**	-8.90**	-2.20
R_{12}	19.31**	13.90**	15.67**	18.29**	17.86**	28.73**	11.3**	6.30	8.50*	9.10**	8.80**	16.7**
R_{14}	23.22**	17.63**	19.46**	13.60**	13.18**	23.62**	17.1**	11.90**	14.20**	8.00**	7.60**	15.50**
A_{10} R_3	-0.38	-4.90	-3.42	-4.02	-4.37	4.45	5.3	0.60	2.70	0.90	0.60	7.90**
R_4	1.23	-3.37	-1.86	-1.55	-1.91	7.13*	-2.3	-6.70	-4.80	-5.10	-5.40	1.50
R_8	6.74*	1.90	3.49	-6.73*	-7.07**	1.50	3.4	-1.20	0.80	-8.10**	-8.40**	-1.70
R_{12}	1.61	-3.00	-1.49	-0.89	-1.26	7.85**	3.4	-1.30	0.80	0.60	0.30	7.60*
R_{14}	13.79**	8.63**	10.32**	12.28**	11.87**	22.18**	9.1*	4.20	6.40	6.70*	6.30*	14.10**

It is clear that inbred line A_1 expressed the best heterosis for seed yield all over tested lines since it exhibited highly significant and positive heterotic effects with most testers (R) (Table 13). High percentage of heterosis for seed yield per plant in sunflower was previously reported by several workers; **Habura (1958), Putt (1966), Stoyanova (1971), Putt and Dorell (1977), Seetharam (1977), Gorbachenko (1980), Skoric (1980), Nuthan (1981), Shoric (1981), Sing *et al.* (1981), Sudhakar (1981), Toit (1981), Ge (1982), Shvestsova (1983), Shrinivasa (1983), Vranceanu (1983), Shankara (1983), Chaudhary *et al.* (1984), Vagvolgyi (1984), Sheriff *et al.* (1985), Chaudhary *et al.* (1986), Galeev *et al.* (1986), Giriraj *et al.* (1986), Sun (1986), Gumenyuk (1987), Sheriff *et al.* (1987), Vranceanu *et al.* (1988), Rashed *et al.* (1990), Giriraj *et al.* (1992), Dedio (1993), Dozet *et al.* (1995), Kashef (1996) and Ahmed (1999).**

Twenty one top crosses exhibited significantly positive heterotic effects over the three check hybrids, in both locations, for oil percentage (Table 13). The highest heterotic effects were obtained from top crosses A_1 x R_3, A_1 x R_4, A_9 x R_{12}, A_9 x R_{14}, A_3 x R_3, A_4 x R_8, A_6 x R_4, A_6 x R_8, A_9 x R_3 and A_9 x R_4 in both locations. Many investigators reported high heterosis for oil percentage in sunflower, i.e. **Stoyanova (1971), Seetharam (1977), Skoric (1980), Shvestsova (1982), Shrinivasa (1983), Shankara (1983), Chaudhary *et al.* (1984), Galeev *et al.* (1986), Giriraj *et al.* (1986), Sun (1986), Chaudhary *et al.* (1986), Gumenuk (1987), Rashe *et al.* (1990), Dedio (1993), Madrap *et al.* (1993), Dozet *et al.* (1995) and Ahmed (1999).**

For oil yield per plant, twenty one, seventeen and seventeen in Sakha location, and thirteen, fourteen, and twenty four top crosses in El-

Serw location had significantly positive heterotic effects relative to Eirflor, Malabar and Vidoic, respectively. The twelve top cross A_1 x R_3, A_1 x R_4, A_9 x R_{12}, A_9 x R_{14}, A x R_{12}, A_1 x R_{14}, A_3 x R_3, A_3 x R_{14}, A_6 x R_{14}, A_6 x R_8, A_9 x R_4 and A_{10} x R_{14}, moreover, surpassed the check hybrids in oil yield by 12.64 to 42.91% and 8.13 to 24.06, 7.53 to 36.43 and 7.73 to 23.61, 9.21 to 38.55 and 17.67 to 35.01 in the same order. The high heterotic effects in the first four top crosses could be due to its high seed yield per plant and oil percentage. While, the high heterotic effects in top cross A_1 x R_{12} could be attributed to high seed yield per plant. However, with other top crosses, the high heterotic effects of oil yield per plant could be attributed to high oil percentage.

For seed yield per fed., thirteen, five and eight top crosses in Sakha location, seven, six and fifteen top crosses in El-Serw location showed significant positive heterotic effects relative to Eirflor, Malabar and Vidoic, respectively. The four top crosses A_1 x R_3, A_1 x R_4, A_1 x R_{12} and A_9 x R_{14} out yielded the check hybrids in both locations (Table 13). The heterotic effects over two locations and the three check hybrids ranged from 11.6/A_1 x R_4 to 21.82/A_1 x R_3. Hence, it could be concluded that the three crosses may be useful for improving seed yield of sunflower. Many investigators reported high heterosis for yield in sunflower, i.e. **Putt *et al.*** **(1977), Seetharam (1977), Skoric (1980), Nuthan (1981), Singh *et al.*** **(1981), Sudhakar (1981), Toit (1981), Shrinivasa (1983), Vranceanu (1983), Shankara (1983), Chaudhary *et al.*** **(1984), Vagvolgyi (1984), Sheriff *et al.*** **(1985), Cruz (1986), Galeev *et al.*** **(1986), Giriraj *et al.*** **(1986), Sun (1986), Gumenyuk (1987), Sheriff *et al.*** **(1987), Rashed *et al.*** **(1990), Giriraj *et al.*** **(1992), Dozet *et al.*** **(1995), Kashef (1996) and Ahmed (1999).**