IV. RESULTS AND DISCUSSION

1. First experiment:

The present study was carried out to investigate types of gene action, the heterosis and their interactions with environments (irrigation treatments i.e. sprinkler irrigation every 4, 8 and 12 days) for plant height, peduncle length, number of spikes per plant, number of kernels per spike, 1000-grain weight, straw yield, grain yield and biological yield (protein content, wet gluten %, dry gluten % and semolina %).

Six parental varieties namely; Bani Sweif 1 (p_1), Bani Sweif 2 (p_2), Bani Sweif 3 (P_3), Sohag 1 (P_4), Sohag 2 (P_5) and Sohag 3 (P_6), representing wide range of variability in most of the studied traits, were utilized. A half diallel set of crosses involving six parents, evaluated under three sprinkler irrigation every 4, 8 and 12 days at three separate experiments; were used herein as a first approach to investigate genetic variance.

For better representation and discussion of the results obtained herein, it was performed to outline these results into two main parts, i.e. 1) yield, yield components and some agronomic attributes and 2) quality characters.

1.1. Yield, yield components and some agronomic attributes:

1.1.1. Analysis of variance, mean performances and heterosis:

The analysis of variance for each experiment and the combined analysis between them for; plant height, height of flag region, number of spikes per plant, number of grains per spike, 1000-kernel weight, straw yield, grain yield and biological yield/plant are presented in Table (10).

Irrigation mean squares were significant for all the studied traits, indicating overall differences between the three irrigation treatments.

Table (11) presents mean values for all the studied traits at different sprinkler irrigations. The effect of sprinkler irrigation every 8 days (I2) increased significantly all the studied traits when compared with irrigation every 4 or 12 days. In most traits, the high mean values were obtained by irrigation every 8 days followed by irrigation every 4 days and then by irrigation every 12 days. The appreciable decrease in mean values for all traits detected herein by sprinkler irrigation every 12 days could attributed to retardation in cell division and cell expansion (**Kramer, 1963**). Also, such increase may be interpreted by the fact that sufficient soil moisture in the root zone increases the ability of plants to growth habit and yield (**Pandey and Hague, 1965**). In addition, increase in grain, straw and biological yields were logically due to the achieved increase in its components. These results are in harmony with those obtained by **Abd-Mottaleb (1978)** and **Moursi *et al.* (1979)** who reported that increasing soil moisture stress by decreasing amount of available water of the soil irrigation depressed grain, straw and biological yields of wheat.

Mean squares for; genotypes, parental variety, and F_1 hybrids were highly significant for all the studied traits in separate experiments and the combined over them except parent mean squares for number of spikes in the combined. Also, mean squares for parent vs crosses were significant for all traits except straw yield at the

Table (10): Observed mean squares from analysis of variance for yield and its components of separate irrigation experiments (S) as well as the combined analysis (C).

Source of Variations	D.F. S	D.F. C	I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C
			Plant height (cm)				**Peduncle length (cm)**				**No. of spikes/plant**				**No. of kernels/spike**			
Irrigations		2	-	-	-	84715.12**	-	-	-	15721.21**	-	-	-	401.659**	-		-	51563.800**
Replication/Irritation	2	6	23.391	0.875	15.297	13.188**	0.752	12.367	3.9805	5.699	0.221	0.730	0.368	0.438	4.430	0.859	2.324	2.538
Genotypes	20	20	80.491**	80.109**	47.838**	133.397**	28.684**	44.946**	21.818**	63.211**	2.122**	2.933**	1.668**	1.162**	128.148**	116.796**	148.395**	181.202**
Parents	5	5	81.937**	28.914**	24.398*	42.000**	9.736**	50.511**	32.367**	54.254**	1.016**	1.577**	1.949**	0.382	293.869**	224.907**	204.583**	315.858**
Crosses	14	14	54.231**	80.055**	52.880**	118.259**	36.144**	37.965**	18.057**	61.650**	1.067**	2.960**	0.725**	1.371**	58.909**	86.527**	98.169**	108.002**
Parents vs/ crosses	1	1	440.910**	336.852**	94.461**	802.313**	18.993**	114.861**	21.732**	129.848**	13.906**	9.338**	3.447**	2.134**	268.899**	0.012**	570.609**	532.711**
Genotypes x Irrigation		40				37.51**				16.12**				6.747**				106.07**
Parents x Irrigation		10				46.625**				19.180**				2.079**				203.750**
Crosses x Irrigation		28				34.453**				15.258**				1.995**				67.801**
Parents vs. Crosses x Irrig.		2				34.736**				12.86**				24.557**				153.400**
Error	40	120	8.643	7.184	9.397	8.408	2.107	5.354	2.790	3.417	0.134	0.289	0.092	0.1714	5.828	7.157	6.409	6.465
			1000 grain weight (gm)				**Straw yield/plant**				**Grain yield/plant**				**Biological yield/plant**			
Irrigations		2	-	-	-	19635.210**	-	-	-	5934.629**	-	-	-	783.545**	-	-	-	10888.95**
Replication/Irritation	2	6	7.109	2.502	2.701	4.104	0.736	2.580	1.589	1.635	0.269	1.149	0.069	0.496	0.110	1.519	1.476	1.035**
Genotypes	20	20	81.834**	59.985**	40.749**	73.805**	56.233**	82.479**	38.154**	52.425**	9.494**	11.314**	6.851**	23.876**	80.778**	98.434**	40.178**	89.855**
Parents	5	5	29.048**	44.956**	29.907**	51.502**	52.279**	103.119**	42.741**	58.253**	2.709**	1.382**	4.230**	7.026**	69.104**	89.741**	42.126**	57.336**
Crosses	14	14	55.454**	56.392**	45.785**	57.178**	39.108**	72.775**	38.412**	53.773**	7.286**	7.839**	3.996**	14.456**	40.789**	108.566**	41.010**	85.678**
Parents vs/ crosses	1	1	715.089**	185.427**	24.447*	418.102**	315.742**	115.124**	11.605*	4.400	74.331**	109.625**	59.925**	239.999**	698.996**	0.058	18.793**	310.932**
Genotypes x Irrigation		40				54.380**				62.220**				1.890**				64.760**
Parents x Irrigation		10				26.205**				69.943**				0.648**				71.817**
Crosses x Irrigation		28				50.226**				48.261**				2.332**				52.344**
Parents vs. Crosses x Irrig.		2				253.430**				219.030**				1.940**				203.460**
Error	40	120	6.249	4.224	3.868	4.780	3.968	4.477	2.260	3.568	0.123	0.088	0.091	0.100	3.825	4.593	1.941	3.453

*** and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.**
I1, I2 and I3 refer to sprinkler irrigation every 4, 8 and 12 days, respectively.

Table (11): The average values of irrigation treatment effects on yield and yield components of half diallel durum wheat in 1997/98 season.

Irrigaion	Plant height (cm)	Peduncle length (cm)	Number of spikes/m²	Number of kernels/spike	1000-grain weight (gm)	Straw yield (gm/plant)	Grain yield (gm/plant)	Biological yield (gm/plant)
I1	62.39 b	27.06 b	4.47 b	47.06 b	28.02 b	17.78b	5.48 b	23.26 b
I2	66.60a	27.83 a	4.72 a	54.34 a	31.98 a	18.19 a	6.90 a	25.09 a
I3	60.93 b	27.16 b	3.51 c	45.09 c	31.32 a	12.05 c	5.43 b	17.48 c

I1 : referees to sprinkler irrigation treatment every 4 days.

I2 : referees to sprinkler irrigation treatment every 8 days.

I3: referees to sprinkler irrigation treatment every 12 days.

combined analysis and biological yield at sprinkler irrigation every 8 days, indicating the wide diversity among the studied wheat genotypes.

Significant mean squares of genotypes by irrigation treatments, parent by irrigation, F_1 hybrids by irrigation and parent vs hybrids by irrigations were obtained for all traits, indicating that genotypes behaved some what differently from sprinkler irrigation to another.

The mean performances of the six parents of durum wheat at separate sprinkler irrigation as well as the combined analysis are showed in Table (12). Parental cultivar Sohag 1 (P_4) was on the highest of the parental varieties in straw, biological yields, number of spikes per plant, peduncle length and plant height, and it gave the moderate values for other traits. The parental cultivar Bani Sweif 1 (P_1) almost expressed moderate values for most traits under study. Meanwhile, it was on the second rank of the tested genotypes for number of kernels per spike. The parental variety Bani Sweif 2 (P_2) gave the highest value for 100-seed weight and the second of the tested varieties for grain, straw and biological yields. While, it gave intermediate in the other traits. The parental variety Bani Sweif 3 (P_3) expressed the lowest values for plant height, peduncle length and it gave moderate values for other traits. The parental variety P_6 gave the lowest mean values for straw and biological yield and it gave the lowest value for plant height in the combined analysis. Also, it gave moderate values for other traits.

The mean performance of F_1 crosses in each sprinkler irrigation treatment and the combined over them are presented in Table (12).

Table (12): Mean performance of genotypes for yield, its components and yield attributes of half diallel (6x6) durum wheat at separate experiments as well as the combined data.

Genotypes	I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined
	Plant height (cm)				**Peduncle length (cm)**				**No. of spikes/plant**				**No. of kernels/spike**			
1- Bani Sewef 1	57.667	65.133	60.900	61.23	26.733	25.733	22.867	25.11	4.067	5.900	2.267	4.08	53.400	66.033	33.487	50.97
2- Bani Sewef 2	60.400	63.533	59.667	61.20	27.600	27.800	28.733	28.04	4.267	4.800	2.733	3.93	35.667	40.867	37.667	38.07
3- Bani Sewef 3	53.867	62.000	57.133	57.67	27.733	22.867	22.400	24.33	3.133	5.933	2.467	3.84	53.933	61.067	32.667	49.22
4- Sohag 1	55.267	67.133	63.067	61.82	26.600	32.533	30.800	29.98	3.533	5.400	4.400	4.44	33.133	52.967	39.800	41.97
5- Sohag 2	67.667	61.733	55.000	61.47	25.600	24.400	25.667	25.22	4.333	4.133	3.600	4.02	50.867	54.200	55.133	53.40
6- Sohag 3	54.400	58.133	58.233	56.92	22.867	20.867	26.933	23.56	3.000	5.800	3.400	4.07	35.733	51.267	43.267	43.42
1 x 2	57.933	67.667	56.200	60.60	26.933	27.133	25.533	26.53	3.733	3.400	4.267	3.80	44.867	54.733	45.067	48.22
1 x 3	58.200	64.133	59.467	60.60	24.667	24.333	26.067	25.02	4.600	4.867	3.133	4.20	52.067	67.067	52.000	57.04
1 x 4	67.300	76.067	69.467	70.94	34.067	34.000	30.733	32.93	5.400	3.867	4.333	4.53	49.433	45.833	51.067	48.78
1 x 5	60.033	60.800	61.400	60.74	29.600	24.467	23.333	25.80	4.800	4.000	3.600	4.13	47.867	55.000	41.400	48.09
1 x 6	58.733	66.267	61.400	62.13	24.667	25.400	25.600	25.22	4.800	3.467	3.000	3.76	37.600	55.367	46.867	46.61
2 x 3	60.267	71.067	62.933	64.76	28.400	28.933	26.467	27.93	4.467	3.600	4.267	4.11	48.333	54.867	54.733	52.64
2 x 4	67.000	64.867	60.333	64.07	28.733	28.067	30.467	29.09	4.667	3.600	3.733	4.00	46.800	55.600	40.733	47.71
2 x 5	67.600	70.067	72.600	70.09	28.267	27.133	30.533	28.64	4.600	5.667	3.733	4.67	51.267	47.600	41.067	46.64
2 x 6	63.000	60.600	57.867	60.49	24.667	26.000	28.067	26.24	4.667	3.867	4.267	4.27	46.733	54.933	40.933	47.53
3 x 4	65.600	65.867	61.400	64.29	33.000	36.133	29.667	32.93	6.067	5.133	3.067	4.67	45.267	55.533	37.467	46.09
3 x 5	65.400	74.667	58.367	66.14	24.267	29.200	24.800	26.09	4.667	4.733	4.067	4.49	55.533	58.600	54.533	56.22
3 x 6	64.467	63.267	60.333	62.69	20.800	28.200	29.333	26.11	4.600	5.533	3.067	4.40	44.533	53.533	54.667	50.91
4 x 5	72.667	77.200	61.800	70.56	29.933	33.000	30.267	31.07	4.600	6.867	3.533	5.00	49.400	46.067	48.200	47.89
4 x 6	66.600	68.333	61.333	65.42	27.067	26.533	25.600	26.40	3.400	4.533	3.200	3.71	52.200	58.900	47.867	52.99
5 x 6	66.200	70.067	60.733	65.67	26.000	31.800	26.533	28.11	6.367	4.000	3.667	4.68	53.533	51.067	48.333	50.98
LSD at 5%	4.849	4.421	5.056	2.707	2.394	3.816	2.755	1.725	0.603	0.887	0.499	0.386	3.982	4.412	4.175	2.373
1%	6.481	5.909	6.758	3.581	3.200	5.101	3.682	2.283	0.805	1.186	0.667	0.511	5.322	5.898	5.581	3.140

Table (12): Cont.

Genotypes	I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined
	1000 Grain weight (gm)				Straw yield (gm)/plant				Grain yield (gm)/plant				Biological yield (gm)/plant			
1- Bani Sewef 1	18.100	33.600	35.400	29.03	8.633	23.867	12.233	14.91	3.900	4.533	3.100	3.84	12.533	28.367	15.333	18.74
2- Bani Sewef 2	24.867	33.367	37.133	31.79	18.267	20.433	9.900	16.20	3.667	4.833	4.000	4.17	21.933	25.267	13.900	20.37
3- Bani Sewef 3	19.300	24.467	31.267	25.01	13.200	26.367	10.600	16.72	3.267	3.800	2.600	3.22	16.467	30.167	13.200	19.94
4- Sohag 1	24.533	30.867	30.133	28.51	11.767	24.133	20.233	18.71	2.867	4.867	3.300	3.68	14.633	29.000	23.533	22.39
5- Sohag 2	25.400	26.500	29.767	27.22	19.100	16.533	11.800	15.81	5.567	5.900	5.933	5.80	24.667	22.433	17.733	21.61
6- Sohag 3	21.533	26.800	30.133	26.16	10.967	10.633	11.600	11.07	3.333	4.933	4.367	4.21	14.300	15.567	15.967	15.28
1 x 2	26.500	33.033	30.333	29.96	13.767	11.900	15.667	13.78	4.967	7.167	5.933	6.02	18.733	19.067	21.600	19.80
1 x 3	26.833	30.767	29.233	28.94	23.567	18.697	11.800	18.11	3.400	6.133	4.767	4.77	26.967	25.100	16.567	22.88
1 x 4	34.433	25.033	34.500	31.32	18.933	19.433	18.267	18.88	6.067	9.467	7.700	7.74	25.000	28.900	25.967	26.62
1 x 5	24.800	25.533	29.300	26.54	18.867	12.267	14.333	15.16	5.733	5.600	4.467	5.27	24.600	17.867	18.800	20.42
1 x 6	24.600	27.833	28.400	26.94	22.867	9.867	11.333	14.69	4.400	5.400	4.000	4.60	27.267	15.300	15.333	19.30
2 x 3	33.367	32.300	23.633	29.77	14.267	24.633	17.233	18.71	7.333	6.400	5.567	6.43	21.600	31.032	22.800	25.14
2 x 4	33.933	34.600	35.267	34.60	18.800	12.767	8.733	13.43	4.500	6.200	5.333	5.34	23.300	18.967	14.067	18.78
2 x 5	34.100	40.200	25.733	33.34	17.633	19.400	12.600	18.54	8.067	9.567	6.933	8.19	25.700	28.967	19.533	24.73
2 x 6	30.367	33.867	34.467	32.90	17.567	13.033	13.067	14.56	6.733	7.300	6.033	6.69	24.300	20.333	19.100	21.24
3 x 4	33.567	34.733	30.033	32.78	22.600	19.900	11.233	17.91	9.333	9.200	6.533	8.36	31.933	29.100	17.767	26.27
3 x 5	23.667	35.500	34.600	31.26	15.567	15.667	5.467	12.23	6.200	8.300	7.733	7.41	21.767	23.967	13.200	19.64
3 x 6	27.267	33.733	36.867	32.62	17.100	19.000	10.067	15.39	5.567	7.500	6.300	6.46	22.667	26.500	16.367	21.84
4 x 5	35.500	35.867	34.567	35.31	18.267	27.233	9.967	18.49	7.900	10.700	6.833	8.48	26.367	37.933	16.800	27.03
4 x 6	32.067	33.800	27.400	31.09	13.967	15.367	6.800	12.04	6.433	9.000	5.200	6.88	20.400	24.367	12.000	18.92
4 x 6	25.200	39.187	29.567	31.31	25.400	20.600	10.100	18.70	5.933	8.033	7.300	7.09	31.333	28.633	17.400	25.92
LSD at 5%	4.123	3.390	3.244	2.041	3.285	3.490	2.480	1.763	0.577	0.490	0.496	0.296	3.226	3.535	2.298	1.734
1%	5.511	4.531	4.336	2.700	4.392	4.664	3.314	2.333	0.772	0.654	0.663	0.391	4.311	4.724	3.071	2.295

I1 : referees to sprinkler irrigation treatment every 4 days.

I2 : referees to sprinkler irrigation treatment every 8 days.

I3: referees to sprinkler irrigation treatment every 12 days.

The cross P_1 x P_4 gave the highest value for plant height in the combined analysis, but without significant superiority over these crosses P_2 x P_5 and P_4xP_5. The cross P_3xP_6 gave the shortest plants.

The cross P_3xP_4 and P_1xP_4 exhibited significant high value of peduncle length in the combined analysis over the other crosses.

For number of spikes per plant, four crosses between P_5 and each of P_4, P_2, P_3 and P_6 gave the highest mean values in the combined analysis.

The four crosses (P_1xP_3, P_3xP_5, P_4xP_6 and P_5xP_6) and one cross (P_1xP_3); five crosses (P_1xP_3, P_1xP_4, P_2xP_3, P_3xP_5 and P_3xP_6) and two crosses (P_1xP_3 and P_3xP_5) gave the highest number of kernels per spike at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis.

For 1000-kernel weight, six crosses (P_1xP_4, P_2xP_3, P_2xP_4, P_2xP_5, P_3xP_4 and P_4xP_5) at sprinkler irrigation every 4 days two crosses (P_2xP_5 and P_5xP_6) at sprinkler irrigation every 8 days; six hybrids (P_1xP_4, P_2xP_4, P_2xP_6, P_3xP_5, P_3xP_6, P_4xP_5) at sprinkler irrigation every 12 days, and three crosses (P_2xP_4, P_2xP_5 and P_4xP_5) in the combined analysis gave the highest values for this trait.

Four crosses; (P_1xP_3, P_1xP_6, P_3xP_4 and P_5xP_6), two crosses (P_2xP_3 and P_4xP_5), two crosses (P_1xP_4 and P_2xP_3), and six crosses (P_1xP_3, P_1xP_4, P_2xP_3, P_2xP_5, P_3xP_4, P_4xP_5 and P_3xP_6) showed the highest values for straw yield/plant at sprinkler irrigation every 4, 8 and 12 days as well as the combined over them, respectively. The high straw yield per plant in the previous crosses could be attributed to the high number of tillers/plant (no. of spikes/plant) and plant height.

The durum wheat crosses i.e., (P_3xP_4), one cross (P_4xP_5), three crosses (P_1xP_4, P_3xP_5 and P_5xP_6) and three crosses (P_2xP_5, P_3xP_4 and P_4xP_5) gave the highest grain yield/plant at sprinkler irrigation every 4, 8, 12 days and the combined analysis, respectively. The cross P_4xP_5 had the highest grain yield per plant, but without significant superiority over the two crosses P_2xP_5 and P_3xP_4 in the combined analysis. The superiority in grain yield/plant in the previous crosses could be attributed to the superiority in one or more of its components (Table 12). It can be concluded that these crosses would be efficient and prospective in durum wheat breeding programs for improving grain yield per plant.

Two, one and four hybrids gave the highest values for biological yield at sprinkler irrigation every 4, 8, 12 days and the combined analysis, respectively. In the combined analysis, the cross P_4xP_5 had the highest value for biological yield/plant but without significant superiority over those of crosses P_1xP_4, P_3xP_4 and P_5xP_6. The superiority in biological yield per plant in the previous crosses could be attributed to the superiority in both grain and straw yields and some of its components (Table 12).

1.1.2. Heterosis:

Mean squares for parent vs. crosses as an indication to average heterosis overall crosses was significant for all traits in separate irrigation experiment as well as the combined over them except straw yield at the combined analysis and biological yield at sprinkler irrigation every 8 days (12) (Table 11). F_1 means were significantly higher than parental mean for most traits. Significant interaction between parents vs. crosses and irrigation treatment was detected for all the studied traits. This result indicates that the heterotic effects were affected by the effect of sprinkler irrigation treatments.

Heterosis expressed as the percentage deviation of F_1 mean performance from its mid-parent and better parent average values for all traits studied at three sprinkler irrigation treatments and an average over the three irrigation treatments, are presented in Table (13).

For plant height, eight, seven, three and eleven hybrids exhibited significant positive heterotic effects relative to mid-parent at sprinkler irrigation every 4, 8, 12 days as well as the combined analysis, respectively. Also, eleven, nine, six and thirteen parental combinations had significant positive heterotic effects relative to better parent in the same order. Significant positive heterotic effects for plant height over mid-parent and/or better parent were recorded by **Dechev (1985).**

For peduncle length, five, seven, five and seven parental combinations expressed significant positive heterotic effects relative to mid-parent value at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. Also, four, five, three and four hybrids of the previous crosses had significant positive heterotic effects relative to better parent value in the same order. The cross P_5xP_6 gave the highest values of heterosis for this trait at the combined analysis followed by crosses P_1xP_4 and P_3xP_4. In this respect, positive heterotic effects for peduncle length were recorded by **Dechev (1985), Pace *et al.* (1985)** and **Ronga *et al.* (1985).**

Table (13): Percentage of heterosis over mid-parent (MP) and better parent (BP) for yield, its components and yield attributes at separate irrigation experiments as well as the combined analysis at Ismailia experimental station.

Cross		I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C
			Plant height (cm)				Peduncle length (cm)				No. of spikes/plant				No. of kernels/spike		
1 x 2	MP	-1.863	5.181	-6.774	-1.007	-0.859	1.370	-1.034	-0.167	-10.400	-36.449**	70.667**	-5.132	0.749	2.401	26.710**	8.324**
	BP	0.461	6.507	-5.811	0.980	-2.415	-2.398	-11.127*	-5.373	-12.363	-42.373**	56.288**	-6.812	-15.980**	-17.108**	19.667**	-5.372**
1 x 3	MP	4.363	0.891	0.762	1.934	-9.425*	0.137	15.169**	1.213	27.778**	-17.746**	32.394**	6.031	-2.981	5.534	57.258**	13.874**
	BP	8.044	3.440	4.085	5.081*	-11.047*	-5.428	14.027*	-0.350	13.300**	-17.514*	27.371*	2.997	-3.455	1.570	55.408**	11.940**
1 x 4	MP	19.185**	15.020**	12.073**	15.305**	27.750**	16.705**	14.534**	19.564**	42.105**	-31.563**	30.000**	6.389	14.253**	-22.969**	39.399**	4.974*
	BP	21.772**	16.787**	14.067**	15.858**	27.447**	4.519	-0.216	9.888**	33.005**	-34.463**	-1.515	2.000	-7.428**	-30.587**	28.308**	-4.282**
1 x 5	MP	-4.819	-4.151	5.953	-0.987	13.121**	-2.394	-3.846	2.517	14.286*	-20.266*	22.727**	2.058	-8.184*	-8.511**	-6.546	-7.846**
	BP	4.103	-1.511	11.636*	0.800	10.737**	-4.910	-9.067	2.300	18.227	-32.203	0.000	1.362	-10.362	-16.705	-24.905**	-9.946**
1 x 6	MP	4.819	7.518*	3.078	5.172*	-0.538	9.013	2.811	3.653	35.849**	-40.741**	5.882	-7.776	-15.632**	-5.598	22.155**	-1.236
	BP	7.965	13.992**	5.438	9.153**	-7.719	-1.283	-4.939	0.447	18.227**	-41.243**	-11.765	7.902	-29.588	-16.149	8.337	-8.534**
2 x 3	MP	5.484	13.224**	7.763*	8.955**	2.651	14.211*	3.520	6.661*	20.721**	32.919**	64.103**	5.714	7.887*	7.652*	55.640**	20.621**
	BP	11.881*	14.624**	10.152*	12.294**	2.416	4.077**	-7.878**	-0.380	4.851	-38.983**	56.288**	4.520	-10.378**	-10.143**	45.335**	6.957**
2 x 4	MP	15.850**	-0.714	-1.684	4.155*	6.027	-6.961	2.352	0.268	19.658**	-29.412**	4.673	-4.509	36.047**	18.508**	5.164	19.228**
	BP	21.230**	2.010	1.116	4.690*	4.106	-13.721*	-1.082	-2.940	9.546**	-33.333**	-15.152*	-10.000*	31.239**	4.985	2.345	13.706**
2 x 5	MP	5.570	11.868**	26.628**	14.275**	6.266	3.959	12.255**	7.551**	6.977	26.866**	17.895*	17.318**	18.490**	0.140	-11.494**	1.992
	BP	11.921**	13.500**	32.000**	14.526**	2.415	-2.398	6.277**	2.156	6.236	18.056**	3.704	16.022**	0.800	-12.177**	-25.509**	-12.651**
2 x 6	MP	9.756*	-0.384	-1.838	2.417	-2.246	6.849	0.838	1.723	28.440**	-27.044**	39.130**	6.667	30.906**	19.247**	1.153	16.662**
	BP	15.809**	4.244	-0.629	6.272*	-10.628	-6.475**	-2.309	-6.404**	9.546**	-33.333**	25.490**	4.918	30.796**	7.166	-5.378	9.473**
3 x 4	MP	20.220**	2.013	2.163	7.606**	21.472**	30.445**	11.529*	21.277**	82.000**	-9.412	-10.680	14.745**	3.982	-2.602	3.404	1.084
	BP	21.781**	6.237	7.469	11.479**	19.005**	11.077**	-3.680	9.888**	71.860**	-13.435	-30.303**	7.000	-16.064**	-9.051	-5.863	-6.361**
3 x 5	MP	7.625	20.690**	4.102	11.043**	-9.000*	23.554**	3.190	5.291	25.000**	-5.960	34.066**	14.124**	5.980	1.677	24.222**	9.571**
	BP	21.410**	20.952**	6.122	14.687**	-12.489	19.672*	-3.352	3.445	7.775	-20.180	12.963	11.602*	2.973*	-4.029	-1.082	5.285*
3 x 6	MP	19.089**	5.327	4.594	9.415**	-17.787**	28.963**	18.919**	9.049**	50.000**	-5.682	4.545	11.236**	-0.669	-4.688	43.986**	9.906**
	BP	19.678**	8.831*	5.600	10.137**	-24.991	23.360**	8.924**	7.321**	48.387**	-6.689	-9.804	10.000	-17.424**	-12.327	26.368**	3.436**
4 x 5	MP	18.221**	19.814**	4.687	14.456**	14.687**	15.925**	7.202	12.560**	16.949*	44.056**	-11.667*	18.110**	17.619**	-14.028**	1.545	0.431
	BP	31.484**	25.059**	12.364**	14.788**	12.531**	1.445	-1.732	3.659	6.236	27.160**	-19.697	12.500**	-2.871	-15.006**	-12.570**	-10.320**
4 x 6	MP	21.459**	9.101**	1.127	10.196**	9.434*	-0.624	-11.316**	-1.370	4.082	-19.048**	-17.949**	-12.794**	51.597**	13.016**	15.249**	24.112**
	BP	22.426**	17.546**	5.323	14.933**	1.754*	-18.434**	-16.883	-11.912**	-3.683	21.839**	-27.273	-16.500	46.096**	11.216**	10.649*	22.038**
5 x 6	MP	8.465*	16.908**	7.271	10.934**	7.290	40.500**	0.887	15.262**	73.636*	-19.463*	4.762	15.650**	23.634**	-3.161	-1.762	5.302*
	BP	21.691**	20.529**	10.424*	15.372**	1.562	30.328**	-1.473	11.464**	47.036**	31.034**	1.852	15.027**	5.256**	-5.781	-12.328*	-4.536**

For number of spikes per plant, twelve, three, eight, and six hybrids showed significant positive heterosis over the mid-parent value at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. While, eight, two, four and four parental combination from the previous crosses showed significant positive heterotic effects relative to better parent in the same order. The two crosses P_2xP_5 and P_5xP_6 gave the highest values of heterosis in the combined analysis for this trait. Heterotic effects for number of spikes per plant were also found by **Pace *et al.* (1985)** and **Ronga *et al.* (1985)**.

For number of kernels per spike, eight, four, eight and ten hybrids significantly exceeded the mid-parent value at sprinkler irrigation every 4, 8 and 12 days as well as the combined over them, respectively. Also, four, one, three and seven crosses from the previous hybrids showed significant positive heterotic effects relative to better parent in the same order. The crosses P_4xP_6, P_2xP_4 and P_1xP_3 had the most desirable heterotic effects for this trait. Significant positive heterotic effect for number of kernels/spike was reached before by **Pace *et al.* (1985)** and **Ronga *et al.* (1985)**.

Thousand kernel weight, twelve, nine, three and eleven crosses exceeded significant out of respective mid-parent value at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. Also, ten, seven, three and ten crosses showed significant positive heterotic effect relative to better parent in the same order. Also, the crosses P_3xP_6, P_4xP_5, P_5xP_6, P_3xP_4 and P_3xP_5 gave the highest values of heterosis in the combined analysis for this trait.

Significant positive heterotic effects for kernel weight were recorded before by **Pace *et al.* (1985)** and **Ronga *et al.* (1985)**.

Concerning grain yield per plant, fourteen, four teen, thirteen and fifteen crosses, significantly exceeded out of respective mid-parent value at sprinkler irrigation every 4, 8 and 12 days as well as the combined data, respectively. Also, thirteen crosses at separate irrigation experiment and fourteen hybrids at the combined analysis from the previous hybrids showed significant positive heterotic effects relative to better parent. Also, the crosses P_1xP_2, P_1xP_4, P_2xP_3, P_2xP_5, P_3xP_4, P_4xP_5, P_3xP_5 and P_5xP_6 had the highest grain yield per plant (Table 11). These hybrids exhibited heterosis for one or more of traits contributing yield. The heterotic magnitude, however, differed from case to case. This finding agrees with the general trend where the expression of heterosis for a complex trait could be explained on the basis of component interaction, as the numerical value recorded for a complex trait is always a function of its components. It could be concluded that these crosses would be efficient and prospective in wheat breeding programs for improving grain yield per plant. Significant positive heterotic effects relative to higher yielding parents were also reached before by **Pace *et al.* (1985)** and **Ronga *et al.* (1985)**.

With respect to straw yield per plant, eleven, two, four and five crosses significantly exceeded the respective mid-parent value at sprinkler irrigation every 4, 8 and 12 days as well as the combined over them, respectively. Also, seven, two three and two parental combinations from the previous crosses exhibited significant positive heterotic effects relative to better parent in the same order. The two crosses P_2xP_3 and P_5xP_6 showed high desirable heterotic effects for this trait at the combined analysis.

Regarding biological yield/plant, eleven, five, seven and ten hybrids showed significant positive heterosis over the mid-parent value at sprinkler irrigation every 4, 8, and 12 days as well as the combined analysis, respectively. Also, nine, three, five and eight hybrids from the previous cross had significant positive heterotic effects relative to better parent value in the same order. The crosses P_1xP_3, P_1xP_4, P_2xP_3, P_2xP_5, P_3xP_4, P_3xP_6, P_4xP_5, P_4xP_6 and P_5xP_6 showed significant positive heterotic effect relative to better parent in the combined analysis.

1.1.3. Combining ability

Analysis of variance for combining ability as outlined by **Griffing's (1956)** method-2, model-1 in separate sprinkler irrigation treatments as well as the combined analysis for all the studied traits is shown in Table (14). The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were significant for all the studied traits in separate irrigation as well as the combined analysis, except GCA for 1000-kernel weight at sprinkler irrigation every eight days. It is evident that both additive and non-additive gene effects were involved in determining the performance of single cross progeny. Also, when GCA/SCA ratio was used, it was found that grain yield/plant at the three irrigation treatments as well as the combined analysis, straw yield at sprinkler irrigation every four days, biological yield at sprinkler irrigation every 4 days (I1) and 12

Table (14): The observed mean squares from general and specific combining ability from diallel cross (6x6) analysis in durum wheat for all studied traits.

Source of Variations	D.F. S	D.F. C	I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C
			Plant height (cm)				Peduncle length (cm)				No. of spikes/plant				No. of kernels/spike			
Genotypes	20	20	26.83**	26.70**	15.44**	14.82**	9.56**	14.98**	7.27**	7.02**	0.71**	0.98**	0.56	0.13**	42.71**	38.93**	49.46**	20.13**
GCA	5	5	44.347**	25.27**	9.53*	17.60**	18.15**	27.15**	16.69**	16.35**	0.22**	0.61**	0.37**	0.15*	72.88**	79.47**	36.89**	36.21**
SCA	15	15	20.99**	27.18**	18.09**	18.58**	6.69**	10.92**	4.13**	3.92**	0.88**	1.10**	0.40**	0.12**	32.66**	25.42**	53.66**	14.77**
Genotypes x Irrigation		40				27.31**				12.39**				0.46**				55.49**
GCA x Irrigation		10				30.77**				22.82**				0.52**				76.52**
SCA x Irrigation		30				23.84**				8.91*				1.13**				49.68**
Error	40	120	2.881	2.395	3.132	2.803	0.702	1.785	0.929	1.139	0.045	0.096	0.031	0.0 57	1.943	2.386	2.136	2.155
GCA/SCA			2.110	0.930	0.527	0.947	2.714	2.486	4.041	4.170	0.248	0.549	0.915	1.204	2.232	3.126	0.688	2.451
GCA x Irrig./SCA						1.748				1.396				3.524				2.113
SCA x Irrig. /SCA						1.283				2.273				9.202				3.363
			1000 grain weight (gm)				Straw yield (gm)/plant				Grain yield (gm)/plant				Biological yield (gm)/plant			
Genotypes	20	20	27.27**	19.99**	13.58**	8.20**	18.74**	27.49**	12.72**	5.82**	3.16**	3.77**	2.28**	2.65**	26.92**	32.80**	13.39**	9.98**
GCA	5	5	36.69**	14.81**	2.12	10.53**	5.87**	41.74**	12.05**	6.54**	2.23**	2.85**	1.98**	2.09**	14.09**	49.89**	9.23**	10.94**
SCA	15	15	24.14**	21.72**	17.40**	7.42**	23.04**	22.74**	12.94**	5.59**	3.47**	4.08**	2.39**	2.84**	31.20**	27.12**	14.78	9.66**
Genotypes x Irrigation		40				26.32**				26.56**				3.28**				31.57**
GCA x Irrigation		10				21.54**				26.57**				2.48**				31.14**
SCA x Irrigation		30				27.92**				26.56**				3.55**				31.72**
Error	40	120	2.082	1.408	1.289	1.593	1.323	1.492	0.75	1.19	0.041	0.029	0.030	0.034	1.275	1.531	0.647	1.15
GCA/SCA			1.520	0.682	0.122	1.419	0.255	1.836	0.931	1.171	0.644	0.698	0.827	0.737	0.452	1.839	0.624	1.133
GCA x Irrig./SCA						2.045				4.059				1.185				2.845
SCA x Irrig. /SCA						3.761				4.753				1.250				3.282

* and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.
I1 : referees to sprinkler irrigation treatment every 4 days.
I2 : referees to sprinkler irrigation treatment every 8 days.
I3: referees to sprinkler irrigation treatment every 12 days.
C: Refers to the combined analysis.
S : Separate experiment.

days (I3), plant height at sprinkler irrigation every 12 days (I3), number of spikes per plant at the sprinkler irrigation every 4 and 8 days (I2 and I3), number of kernels per spike at sprinkler irrigation every 12 days (I3), and 1000-kernel weight at sprinkler irrigation every 8 and 12 days (I2 and I3) exhibited low GCA/SCA ratio less than unity indicating the predominance of non-additive gene action in the inheritance of such cases. While the magnitude of additive and non-additive types of gene action were similar for plant height at sprinkler irrigation every 8 days as well as the combined analysis, number of spikes per plant and straw yield per plant at sprinkler irrigation every 12 days.

On the other hand, high GCA/SCA ratio which exceeded than the unity were detected for other cases, such results indicated that additive and additive x additive of gene action were more important than non additive gene effects controlling in these cases. For the exceptional case (1000-kernel weight at sprinkler irrigation every 12 days (I3), it is evident that non-additive type of gene action was the more important part of the total genetic variability for this case.

The genetic variance was previously reported by several investigators (**Verma *et al.*, 1984; Ali-Zad and Aleksanyan, 1986; Bhatiya *et al.*, 1986; Raghavalah and Joshi, 1986; Singh *et al.*, 1990; Abul-Naas *et al.*, 1991; Bebyakin and Starichkova, 1992c; Mann and Sharma, 1995a and b; Mariani *et al.*, 1995** and **Ronga *et al.*, 1995**), they reported both additive and non-additive types of gene action were responsible for controlling the inheritance of yield and some of its components.

The mean squares of interaction between both types of combining ability and irrigation treatment were significant for all studied traits, indicating that both additive and non-additive types of gene action varied from irrigation treatment to another. It is fairly evident that mean squares of SCA x irrigation/SCA was higher than GCA x irrigation/GCA for all traits except plant height. Such results indicated that non-additive effects were more influenced by the irrigation treatments (Environmental conditions) than the additive genetic effects in these traits. For the exceptional traits, however, the higher magnitude of GCA x irrigation/GCA showed that the additive and additive x additive effects were more affected by environment than the non additive effects. These results are in agreement with those reported by **Singh and Gautam (1986), Bebyakin and Starichkova (1992b, c and d), Mann and Sharma (1995), Mariani *et al.* (1995)** and **Ronga *et al.* (1995)**.

General combining ability effects

Estimates of GCA effects (g_i) for individual parental variety in each trait in the three irrigation treatments as well as their combined analysis are presented in Table (15). General combining ability effects computed herein were found to differ significantly from zero in all cases except 1000-kernel weight at sprinkler irrigation every 12 days. High positive value would be interest under all traits in question except plant height where high negative effects would be useful from the breeder point of view.

Table (15): Estimates of general combining ability effects for the six durum genotypes.

Genotypes		I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined
		Plant height (cm)				Peduncle length (cm)				No. of spikes/plant				No. of kernels/spike			
1		-2.403**	-0.125	0.399	-0.710	0.500	-1.006*	-1.642**	-0.716**	0.026	-0.204*	-0.217**	-0.132	1.156*	3.713**	-1.359**	1.110*
2		-0.019	-0.608	0.340	-0.096	0.350	-0.247	1.050**	0.384	-0.074	-0.413**	0.142*	-0.115	-2.507**	-3.863**	-2.222**	-2.864**
3		-1.886**	-0.400	-1.222*	-1.169*	-0.350	-0.289	-1.125**	-0.588	-0.074	0.337**	-0.258**	0.002	3.264**	3.921**	0.386	2.444**
4		1.618**	2.550**	1.740**	1.969**	2.075**	3.494**	2.275**	2.615**	-0.007	0.221*	0.258**	0.157*	-2.503**	-1.563**	-1.339**	-1.801**
5		3.810**	1.258*	-0.206	1.621**	-0.017	-0.056	-0.417	-0.163	0.306**	0.063	0.150*	0.173*	3.743**	-1.704**	3.519**	1.853**
6		-1.119*	-2.675**	-1.051	-1.615**	-2.558**	-1.897**	-0.417	-1.532**	-0.178*	-0.004	-0.075	-0.086	-2.915**	-0.504	1.194*	-0.742
LSD gi-gj	5%	1.715	1.564	1.788	1.657	0.846	1.349	0.975	1.057	0.213	0.313	0.177	0.237	1.408	1.561	1.477	1.453
	1%	2.295	2.093	2.392	2.191	1.133	1.806	1.304	1.396	0.285	0.419	0.236	0.313	1.216	2.088	1.976	1.920
LSD gi	5%	1.107	1.009	1.154	1.070	0.547	0.871	0.629	0.682	0.138	0.203	0.114	0.153	0.909	1.008	0.953	0.938
	1%	1.481	1.359	1.545	1.414	0.731	1.166	0.842	0.901	0.184	0.271	0.153	0.202	1.216	1.348	1.276	1.239
r		0.73**	0.77**	0.77**	0.75**	0.71**	0.87**	0.65**	0.93**	0.82**	0.28	0.88**	0.52**	0.99*	0.93**	0.87**	0.94**
		1000 Grain weight (gm)				Straw yield(gm)/plant				Grain yield (gm)/plant				Biological yield (gm)/plant			
1		-2.493**	-1.807**	0.415	-1.295**	-0.638	-0.896*	1.440**	-0.031	-0.753**	-0.681**	-0.614*	-0.682**	-1.399**	-1.581**	0.826**	-0.718*
2		1.836**	2.109**	0.557	1.501**	-0.225	-0.592	-0.344	-0.157	0.068	-0.247**	-0.022	-0.067	-0.165	0.839*	0.322	-0.227
3		-1.251*	0-.986*	-0.293	-0.844*	-0.108	2.946**	-0.918**	0.639	-0.003	-0.393**	-0.235**	-0.210*	-0.119	2.553**	-1.528**	0.427
4		3.157**	0.239	0.349	1.248**	-0.533	1.954**	1.390**	0.937**	0.197**	0.753**	0.028	0.326**	-0.319	2.707**	1.418**	1.269**
5		0.094	0.676	-0.743*	0.009	1.696**	0.113	-1.035	0.258	0.822**	0.715**	0.894**	0.811**	2.535**	0.828*	-0.140	1.074**
6		-1.343**	-0.232	-0.285	-0.619	-0.192	-3.525**	-1.222**	-1.646**	-0.332**	-0.147*	-0.051	-0.177**	-0.532	-3.668**	-1.274**	-1.825**
LSD gi-gj	5%	1.458	1.199		1.250	1.162	1.234	0.877	1.080	0.204	0.173	0.176	0.181	1.140	1.250	0.813	1.062
	1%	1.951	1.604		1.652	1.554	1.652	1.174	1.427	0.273	0.232	0.235	0.239	1.527	1.673	1.087	1.404
LSD gi	5%	0.941	0.774		0.807	0.750	0.797	0.566	0.697	0.132	0.112	0.113	0.117	0.737	0.807	0.525	0.686
	1%	1.259	1.036		1.066	1.004	1.066	0.757	0.921	0.176	0.150	0.152	0.155	0.985	1.079	0.702	0.906
r		0.83**	0.18		0.66**	0.74**	0.83**	0.56*	0.96**	0.54*	0.69**	0.88**	0.68**	0.84**	0.75**	0.35	0.96**

* and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.
r = Correlation coefficient between parental performance and their GCA effects.
I1 : referees to sprinkler irrigation treatment every 4 days.
I2 : referees to sprinkler irrigation treatment every 8 days.
I3: referees to sprinkler irrigation treatment every 12 days.

The parental variety Bani Sweif 1 (P_1) expressed significant positive GCA effects for number of kernels/spike at sprinkler irrigation every 4 and 8 days as well as the combined analysis and straw yield at sprinkler irrigation every 12 days, while it was poor combiner for yield and most of yield components (Table 15). While, it gave significant negative GCA effects for plant height at sprinkler irrigation every 4 days.

The parental variety Bani Sweif 2 (P_2) exhibited significant positive GCA effects for 1000-kernel weight at sprinkler irrigation every 4 and 8 days as well as the combined analysis. However, it gave undesirable GCA effects for other characters under study.

The parental variety Bani Sweif 3 (P_3) had significant desirable GCA effects for plant height at sprinkler irrigation every 4 and 12 days as well as the combined analysis, number of spikes/plant at I2 (sprinkler irrigation every 8 days, number of kernels per spike at sprinkler irrigation every 4 and 8 days as well as the combined analysis, and straw and biological yields at sprinkler irrigation every 8 days. While, it gave undesirable GCA effects for other cases.

The parental variety Sohag 1 (P_4) exhibited significant positive GCA effects for peduncle length, at three sprinkler irrigation treatments as well as the combined, number of spikes per plant, straw yield and biological yield at sprinkler irrigation every 8 and 12 days and combined analysis, 1000-kernel weight at sprinkler irrigation every four days as well as the combined and grain yield per plant at sprinkler irrigation every 4 and 8 days as well the combined analysis. Also, it gave significant positive GCA effects for plant height at three irrigation treatments as well as the combined analysis. While, it had either significant negative or insignificant GCA effects for other cases.

The parental variety Sohag 2 (P_5) expressed significant positive GCA effects for grain yield per plant at the sprinkler irrigation treatments as well as the combined analysis, biological yield at sprinkler irrigation every 4 and 8 days as well as the combined analysis, number of spikes per plant at sprinkler irrigation every 4 days as well as the combined analysis, number of kernels per spike at sprinkler irrigation every 4 and 12 days as well as the combined analysis and straw yield at sprinkler irrigation every four days. Also, it undesirable GCA effects for other cases.

The parental variety Sohag 3 (P_6) had significant negative GCA effects for plant height at sprinkler irrigation every 4 and 8 days as well as the combined analysis. While it was a poor one for other cases (Table 15).

Generally, the parental variety P4 exhibited significant desirable GCA effects for straw, grain and biological yields, 1000-kernel weight, number of spikes per plant and peduncle length at the combined analysis. Also, the parental variety P5 had significant positive GCA effects for grain and biological yields/plant, number of spikes per plant and number of kernels per spike.

Significant correlation coefficient between the parental performance and its GCA effects were obtained for all traits except number of spikes per plant and 1000-kernel weight at sprinkler irrigation every 8 days and biological yield/plant at sprinkler irrigation every 12 days (Table 15). These finding indicate that the parental varieties gave a good index of intrinsic performance of their GCA effect. Therefore, selection among the tested parental population for initiating any proposed breeding program could be practiced either on mean performance or GCA effects basis with similar efficiency.

For the exceptional cases, insignificant correlation coefficient values were detected between the two variables. This disagreement revealed that hybrids characterized with high values could be expected by crossing between varieties of low performance for these cases. A rather good agreement between ranking of parental performance was reported by **Pace** ***et al.*** **(1985), Raghavalah and Joshi (1986), Bebyakin and Starichkova (1991a, b)** and **Mann and Sharma (1995a, b).**

Specific combining ability effects (S_{ij})

Specific combining ability effects of the parental combinations were computed for all traits (Table 16).

Regarding plant height, six, seven, three and four crosses showed significant positive SCA effects at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. However, one, four , two and one parental combination gave significant negative SCA effects in the same order. Both Crosses P_1xP_4 and P_2xP_5 had the highest positive SCA effects. Also, the cross P_1xP_5 gave the highest negative SCA effects at sprinkler irrigation every 4 and 8 days as well as the combined analysis.

For peduncle length, five, four, four and three parental combinations had significantly positive SCA effects at sprinkler

Table (16): Estimates of specific combining ability effects for the studied durum wheat crosses.

Crosses		I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C
		Plant height (cm)				Peduncle length (cm)				No. of spikes/plant				No. of kernels/spike			
1 x 2		-2.038	1.800	-5.474**	-1.904	-0.974	0.551	-1.037	-0.487	-0.685**	-0.702**	0.827**	-0.187	0.837	0.545	3.736**	1.148
1 x 3		0.095	-1.942	-0.645	-0.830	-2.540**	-2.204*	1.671*	-1.025	0.182	0.014	0.094	0.097	0.829	5.095**	8.061**	4.662**
1 x 4		5.691**	7.042**	6.393**	6.375**	4.435**	3.676**	2.938**	3.683**	0.915**	-0.869**	0.777**	0.275	3.725**	-10.655**	8.852**	0.641
1 x 5		-3.767**	-6.933**	0.272	-3.476**	2.060**	-2.307*	-1.770*	-0.673	0.003	-0.577*	0.152	-0.141	-4.087**	-1.346	-5.673**	-3.702
1 x 6		-0.138	2.467*	1.118	1.149	-0.332	0.468	0.221	0.119	0.486*	-1.044**	-0.223	-0.260	-7.696**	-2.180	2.119	2.586*
2 x 3		-0.221	5.475**	2.880*	2.711*	1.343*	1.635	-0.620	0.786	0.149	-1.044**	0.869**	-0.009	0.758	0.470	11.477**	4.235*
2 x 4		3.008*	-3.675**	-2.682*	-1.116	-0.749	-3.015**	-0.020	-1.262	0.282	-0.927**	-0.181	-0.275	4.754**	6.687**	-0.798	3.548**
2 x 5		1.416	2.817*	11.530**	5.254**	0.876	-0.399	2.738**	1.072	-0.097	1.298**	0.073	0.376	2.975**	-1.171	-5.323**	-1.173
2 x 6		1.745	-2.717*	-2.357	1.110	-0.182	0.310	-0.004	0.041	0.453	-0.436	0.686**	0.234	5.100**	4.962**	-3.131**	2.310*
3 x 4		3.474**	-2.883*	-0.053	0.179	4.218**	5.093**	1.355	3.555**	1.682**	-0.144	-0.448**	0.363	-2.313*	-1.163	-6.673**	-3.383**
3 x 5		1.083	7.208**	-1.140	2.384	-2.424**	1.710	-0.820	-0.512	-0.030	-0.386	0.661**	0.082	1.708	2.045	5.536**	3.096**
3 x 6		5.079**	-0.258	1.672	2.164	-3.349**	2.551*	3.438**	0.880	0.386	0.481*	-0.114	0.251	-2.633*	-4.221**	7.994**	0.380
4 x 5		4.845**	6.792**	-0.670	3.656**	0.818	1.726	1.246	1.263	-0.164	1.864**	-0.389**	0.437*	1.104	-5.005**	0.927	-0.991
4 x 6		3.708**	1.858	-0.290	1.759	0.493	-2.899**	-3.695**	-2.034*	-0.880-**	-0.402	-0.498**	-0.593**	10.563**	6.629**	2.919**	6.703**
4 x 6		1.116	4.883**	1.055	2.352	1.518*	5.918**	-0.070	2.455**	1.774**	-0.777**	0.077	0.358	5.650**	-1.063	-1.473	1.038
LSD (Sij-Sik)	5%	4.538	4.137	4.737	4.385	2.241	3.571	2.578	2.795	0.564	0.830	0.467	0.626	3.728	4.129	3.908	3.845
	1%	6.072	5.535	6.331	5.796	2.998	4.778	3.450	3.695	0.754	1.111	0.625	0.827	4.986	5.525	5.228	5.082
LSD (Sij - Ski)	5%	4.201	3.830	4.381	4.059	2.074	3.307	2.387	2.588	0.522	0.769	0.433	0.579	3.450	3.823	3.618	3.560
	1%	5.621	5.125	5.861	5.366	2.775	4.424	3.194	3.421	0.699	1.028	0.579	0.766	4.616	5.115	4.841	4.705
LSD (Sij)	5%	2.512	2.289	2.618	2.426	1.240	1.976	1.426	1.546	0.312	0.459	0.259	0.419	2.062	2.285	2.162	2.130
	1%	3.359	3.063	3.503	3.210	1.659	2.644	1.909	2.044	0.417	0.614	0.346	0.554	2.758	3.057	2.893	2.812

Table (16): Cont.

Crosses		I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C
		1000 Grain weight (gm)				Straw yield (gm)/plant				Grain yield (gm)/plant				Biological yield (gm)/plant			
1 x 2		-0.459	0.751	-1.960*	-0.556	-2.566**	-4.803**	1.833**	-1.845*	0.167	1.198**	1.144**	0.836**	-2.392**	-3.601**	2.977**	-1.005
1 x 3		2.962**	1.580	-2.210*	0.778	7.117**	-1.274	-0.771	1.691*	-1.329**	0.310*	0.190	-0.276*	5.796**	-0.960	-0.582	1.418
1 x 4		6.154**	-5.378**	2.415**	1.064	2.909**	0.185	3.387**	2.160**	1.138**	2.498**	2.861**	2.165**	4.029**	2.686**	6.248**	4.321**
1 x 5		-0.417	-5.315**	-1.693*	-2.475**	0.613	-5.140**	1.879**	-0.883	0.180	-1.332**	-1.239**	-0.797**	0.775	-6.468**	0.639	-1.685*
1 x 6		0.820	-2.107*	-3.051**	-1.446	6.501**	-3.903**	-0.934	0.555	0.001	-0.669**	-0.760**	-0.476*	6.508**	-4.539**	-1.694**	0.092
2 x 3		5.166**	-0.803	-7.951**	-1.196	-2.595**	4.089**	5.758**	2.417**	1.784**	0.143	0.398**	0.775**	-0.804	4.232**	6.156**	3.195*
2 x 4		1.324	0.272	3.040**	1.546	2.363**	-6.786**	-5.051**	-3.158**	-1.249**	-0.202	-0.098	-0.850**	1.096	-7.989**	-5.148**	-4.014**
2 x 5		4.554**	5.435**	-5.401**	1.529	-1.033	1.689	1.241	0.632	1.692**	2.202**	0.636**	1.510**	0.642	3.890**	1.877**	2.136**
2 x 6		2.258**	0.010	2.874**	1.714	0.788	-1.040	1.895**	0.548	1.513**	0.798**	0.682**	0.997**	2.308**	-0.247	2.577**	1.546
3 x 4		4.045**	3.501**	-1.343	2.068*	6.046**	-3.190**	-1.288*	0.523	3.655**	1.943**	1.315**	2.304**	9.683**	-1.247	0.027	2.821**
3 x 5		-2.792*	3.830**	4.315**	1.785	-3.216**	-5.582**	-4.630**	-4.476**	-0.104	1.081**	1.648**	0.875**	-3.337**	-4.501**	-2.982**	-3.607**
3 x 6		2.245*	2.972**	6.124**	3.780*	0.205	1.389	0.158	0.584	0.417**	1.143**	1.161**	0.907**	0.629	2.528**	1.318*	1.492
4 x 5		4.633**	2.972**	3.640**	3.748*	-0.091	6.976**	-2.438**	1.482	1.396**	2.335**	0.486**	1.406**	1.462	9.311**	-1.952**	2.940*
4 x 6		2.637*	1.814*	-3.985**	0.155	-2.504**	-1.253	-5.417**	-3.058**	1.084**	1.498**	-0.202	0.793**	-1.437	0.240	-5.619**	-2.272**
4 x 6		-1.167	6.743**	-0.726	1.616	6.700**	5.822**	0.308	4.277**	-0.041	0.565**	1.032**	0.520*	6.642**	6.386**	1.339*	4.789**
LSD (Sij-Sik)	5%	3.859	3.172	3.036	3.306	3.075	3.266	2.321	2.857	0.540	0.458	0.464	0.479	3.019	3.308	2.150	2.810
	1%	4.996	4.244	4.062	4.370	4.114	4.370	3.105	3.776	0.723	0.613	0.621	0.634	4.039	4.426	2.877	3.714
LSD (Sij - Ski)	5%	3.572	2.937	2.811	3.061	2.847	3.024	2.149	2.645	0.500	0.424	0.430	0.444	2.795	3.063	1.961	2.601
	1%	4.780	3.930	3.760	4.045	3.809	4.046	2.875	3.450	0.670	0.568	0.575	0.587	3.739	4.098	2.624	3.438
LSD (Sij)	5%	2.135	1.755	1.680	1.829	1.701	1.807	1.284	1.580	0.299	0.253	0.257	0.265	1.670	1.830	1.190	1.554
	1%	2.856	2.348	2.247	2.417	2.276	2.418	1.718	2.090	0.400	0.339	0.344	0.351	2.235	2.449	1.592	2.050

* and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.

I1 : referees to sprinkler irrigation treatment every 4 days.

I2 : referees to sprinkler irrigation treatment every 8 days.

I3: referees to sprinkler irrigation treatment every 12 days.

C: Refers to the combined analysis.

irrigation every 4, 8 and 12 days as well as combined analysis, respectively. The highest positive SCA effects was obtained by cross P_1xP_4 followed by the cross P_3xP_4 at the combined analysis.

Four, three, five and one parental combinations exhibited significant positive SCA effects for number of spikes per plant at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. The cross P_4xP_5 had significant SCA effects at the combined analysis.

Six, four, seven and six crosses had significant positive SCA effects for number of kernels per spike at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. The best cross was P_4xP_6 at the three irrigation treatments as well as the combined analysis for this trait.

Considering 1000-kernel weight, nine, seven, six and three crosses had significant positive SCA effects at sprinkler irrigation every 4, 8, and 12 days and the combined analysis, respectively. Both crosses P_3xP_6 and P_4xP_5 had the highest SCA effects at the three irrigation treatments as well as the combined analysis, respectively.

Six, three, five and four crosses showed significant positive SCA effects for straw yield at sprinkler irrigation every 4, 8 and 12 days and the combined analysis, respectively. The four crosses P_1xP_3, P_1xP_4, P_2xP_4 and P_5xP_6 expressed significant positive SCA effects for the combined analysis for this trait.

Regarding grain yield per plant, eight, eleven, ten and eleven parental combinations showed significant positive SCA effects at sprinkler irrigation every 4, 8 and 12 days and the combined analysis, respectively. In conclusion, the best combinations were P_1xP_4, P_2xP_5, PxP_6, P_3xP_4, $_P3xP_6$ and P_4xP_5 at the three irrigation treatments as well as the combined analysis. It could be concluded that the previous crosses seemed to be the best combinations, where it had significant positive SCA effects for grain yield per plant as well as most of yield components over the three irrigation treatments.

Concerning biological yield, six, six, seven and six parental combinations showed significant positive SCA effects at sprinkler irrigation every 4, 8 and 12 days as well as the combined data, respectively. The crosses P_1xP_4, P_2xP_3 and P_5xP_6 had significant SCA effects for straw, grain and biological yields, respectively in the combined analysis. The mentioned combinations might be of interest in breeding programs aimed to produce pure line varieties for high straw, grain and biological yields.

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

1.2. Quality characters

1.2.1. Analysis of variance, means and heterosis

The analysis of variance for each irrigation experiment as well as the combined data for quality characters is presented in Table (17). Sprinkler irrigation mean squares were significant for all traits, indicating an overall differences between the three sprinkler irrigation treatments.

Results in Table (18) indicate the effect of irrigation treatments on the four quality characters.

Semolina mean values reported in Table (18) indicated that the plants received sprinkler irrigation every 4 or 12 days exhibited significant increase in this trait compared with those received sprinkler irrigation every 8 days.

Protein content mean values detected herein indicated that plants received sprinkler irrigation every 4 days expressed a significant increase in protein percentage compared with those received by sprinkler irrigation every 8 or 12 days. It could be concluded that the decrease in interval irrigation might be due to the increasing protein content.

For dry and wet gluten mean values detected herein, it indicated that plant received sprinkler irrigation every 4 or 8 days expressed a significant increase in both dry and wet gluten compared with those received sprinkler irrigation every 12 days (Table 18).

Significant genotypes mean squares were detected for the studied quality traits in separate irrigation experiments as well as the combined

Table (17): Observed mean squares from analysis of variance for quality characters at separate irrigation experiments (S) as well as the combined analysis (C).

Source of Variations	D.F. S	D.F. C	I1	I2	I3	C	I1	I2	I3	C
			Semolina %				Protein %			
Irrigations		2	-	-	-	70646.30**	-	-	-	5326.00**
Replication/Irrigation	1	3	5.719	13.891**	27.406**	15.67**	0.051	0.023	0.007	0.027
Genotypes	20	20	41.466**	40.304**	55.252**	30.07**	5.462**	5.559**	5.264**	8.548**
Parents	5	5	30.319**	57.101**	67.533**	9.20	3.546**	2.894**	5.019**	9.276**
Crosses	14	14	44.053**	23.866**	29.762**	39.50**	6.053**	6.858**	5.574**	8.805**
Parents vs/ crosses	1	1	60.984**	186.449**	350.711**	2.36	6.767**	0.704**	2.136**	1.313**
Genotypes x Irrigation		40				53.48**				3.868**
Parents x Irrigation		10				72.88**				1.091**
Crosses x Irrigation		28				29.09**				4.840**
Parents vs. Crosses x Irrig.		2				297.76				4.150**
Error	20	60	4.328	4.279	4.620	4.41	0.006	0.0002	0.002	0.003
			Dry glutien %				Wet glutien %			
Irrigations		2	-	-	-	12983.00**	-	-	-	29158.600**
Replication/Irrigation	1	3	4.523	15.609**	1.387	7.173	6.961	24.992	0.086	106.800**
Genotypes	20	20	91.071**	45.686**	69.578**	63.655**	95.186**	100.403**	106.323**	84.166**
Parents	5	5	187.580**	51.594**	82.551**	72.463**	145.817**	130.582**	87.563**	58.181**
Crosses	14	14	63.059**	46.739**	65.560**	63.474**	73.085**	95.998**	107.082**	78.850**
Parents vs/ crosses	1	1	0.691	1.403	60.962**	22.148**	151.447**	11.184	189.496**	288.500**
Genotypes x Irrigation		40				71.340**				108.873**
Parents x Irrigation		10				124.631**				152.890**
Crosses x Irrigation		28				55.942**				98.657**
Parents vs. Crosses x Irrig.		2				20.450**				31.810**
Error	20	60	3.035	2.823	3.570	3.143	4.941	2.890	2.407	3.413

* and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.
I1 : referees to sprinkler irrigation treatment every 4 days.
I2 : referees to sprinkler irrigation treatment every 8 days.
I3: referees to sprinkler irrigation treatment every 12 days.

data, indicating the wide diversity between the parental materials used in the present study. Also, significant genotypes x irrigation treatments mean squares were obtained for four quality traits under study. Such results indicated that the tested genotypes varied from each other, and ranked differently from irrigation treatment to another.

Table (18): Effect of irrigation treatments on the quality characters.

Irrigation treatment	Semolina %	Protein %	Dry gluten %	Wet gluten %
I1	71.10 a	13.27 a	31.40 a	46.77 a
I2	70.39b	12.68 b	31.37 a	47.67 a
I3	71.60a	11.34 c	28.04b	41.30b

Results also showed that mean squares due to parents were significant for all quality characters in separate irrigation treatments as well as the combined data except semolina percentage in the combined data. Significant mean squares due to interaction between parental varieties and irrigation treatments were obtained for all traits. These findings indicate that parental varieties differed in their performances in these quality traits. Also, it revealed that parental varieties varied in their response to irrigation treatments in these traits.

Highly significant F_1 hybrids mean squares along with highly significant F_1 hybrids by irrigation treatments were detected, revealing an overall differences between these hybrids and its varied in their response to irrigation treatments.

The mean performances of genotypes in each irrigation treatments as well as the combined data are presented in Table (19). The three crosses (P_1xP_5, P_1xP_6 and P_4xP_5), seven crosses (P_2xP_3, P_2xP_5, P_2xP_6, Table (19): Genotypes mean performance for quality characters of durum wheat at separate experiments as well as the combined data.

Genotypes	I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined
	Semolina %				Protein %				Dry gluten %				Wet gluten %			
1 Bani Sewef 1	64.20	65.45	80.05	69.90	15.29	13.25	11.47	13.34	20.60	31.30	27.80	26.57	33.25	47.25	42.20	40.90
2 Bani Sewef 2	66.45	70.20	79.65	72.10	14.18	11.80	9.96	11.98	26.15	29.60	31.50	29.08	40.25	46.45	46.20	44.30
3 Bani Sewef 3	70.40	64.15	71.95	68.83	12.67	11.87	8.88	11.14	24.45	27.05	22.35	24.62	37.90	40.70	34.00	37.53
4 Sohag 1	70.90	76.50	66.65	71.35	12.36	11.86	10.22	11.48	34.85	30.65	34.60	33.37	51.10	45.90	41.35	46.12
5 Sohag 2	67.90	62.75	81.90	70.85	13.40	14.34	12.22	13.32	36.80	40.80	17.10	31.57	43.95	61.85	27.85	44.55
6 Sohag 3	75.30	63.30	76.80	71.80	15.54	14.20	13.15	14.29	46.75	27.10	23.45	32.43	56.15	38.95	36.05	43.72
1 x 2	75.70	66.55	65.25	69.17	12.37	9.37	10.86	10.86	29.60	31.20	31.35	30.72	47.25	45.90	44.25	45.80
1 x 3	68.10	66.10	64.35	66.18	12.70	13.46	14.11	13.42	33.20	29.55	26.90	29.88	49.85	45.85	40.10	45.27
1 x 4	74.50	70.60	67.45	70.85	10.88	11.70	9.36	10.65	23.00	19.05	28.10	23.38	38.30	30.40	44.15	37.62
1 x 5	79.60	70.05	73.15	74.27	9.21	15.19	9.74	11.38	24.30	31.95	25.00	27.08	38.75	52.05	38.45	43.08
1 x 6	80.15	71.20	69.25	73.53	13.30	11.06	10.99	11.78	25.50	29.40	31.55	28.82	40.25	44.70	46.70	43.88
2 x 3	71.15	73.15	66.95	70.42	12.79	12.10	11.12	12.00	35.05	39.30	30.15	34.83	51.10	57.25	44.40	50.92
2 x 4	69.75	69.75	67.10	68.87	12.07	9.16	9.76	10.33	35.50	29.40	27.70	30.87	49.60	43.85	41.40	44.95
2 x 5	67.15	74.25	71.15	70.85	12.08	12.76	11.95	12.26	29.10	27.80	35.25	30.72	52.55	43.00	53.20	49.58
2 x 6	68.25	72.35	70.60	70.40	12.17	12.98	12.63	12.59	30.75	30.15	22.70	27.87	49.50	45.90	35.60	43.67
3 x 4	68.70	75.95	72.10	72.25	15.22	15.66	9.91	13.59	27.55	32.85	33.40	31.27	45.50	50.15	46.10	47.25
3 x 5	71.75	74.55	74.90	73.73	15.86	11.77	10.56	12.73	28.45	34.40	33.90	32.25	43.75	52.25	48.70	48.23
3 x 6	69.55	68.65	63.55	67.25	13.89	13.24	15.01	14.04	34.55	38.70	23.00	32.08	49.55	59.85	34.85	48.08
4 x 5	66.65	69.95	76.10	70.90	13.07	12.81	10.88	12.04	40.25	29.65	14.70	28.20	61.70	45.70	24.85	44.08
4 x 6	78.75	74.15	72.00	74.97	14.85	13.19	13.05	13.69	30.10	34.40	36.10	33.53	51.65	51.05	53.20	51.97
4 x 6	68.15	78.60	72.65	73.13	14.79	14.57	12.32	13.89	42.80	34.50	32.20	36.50	50.25	52.00	43.70	48.65
LSD at 5%	4.348	4.323	4.492	2.425	0.16	0.03	0.10	0.06	3.641	3.511	3.949	2.047	4.646	3.553	3.243	2.133
1%	5.929	5.895	6.126	3.225	0.22	0.04	0.13	0.08	4.965	4.788	5.385	2.733	6.335	4.845	4.422	2.848

I1 : referees to sprinkler irrigation treatment every 4 days.
I2 : referees to sprinkler irrigation treatment every 8 days.
I3: referees to sprinkler irrigation treatment every 12 days.

P_3xP_4, P_3xP_5, P_4xP_6 and P_5xP_6) and parental variety Sohag 1 (P_4), parental variety Sohag 2 (P_5) and five crosses (P_1xP_5, P_1xP_6, P_3xP_5, P_4xP_6 and P_5xP_6) gave the highest values for semolina % at sprinkler irrigation every 4, 8 and 12 and the combined data, respectively.

The crosses P_3xP_5, P_3xP_4, P_3xP_6 and parental variety Sohag 3 (P_6) had the highest values of protein % at sprinkler irrigation every 4, 8, 12 days as well as the combined data, respectively. The hybrid mean values were within the range of parental varieties for this trait.

The cross P_4xP_5 at sprinkler irrigation every 4 days, parental variety Sohag 2 (P_5) and the cross P_3xP_6 at sprinkler irrigation every 8 days, two crosses P_2xP_5 and P_4xP_5 at irrigation every 12 days and two crosses P_2xP_3 and P_4xP_6 in the combined data gave the highest value for wet gluten %. The two crosses P_2xP_3 and P_5xP_6 gave the highest values of dry gluten % in the combined data. It could be concluded that the previous crosses would be efficient and prospective in durum wheat breeding programs for improving quality characters.

In all quality traits, the mean values were mostly differed from irrigation treatment to another. This finding coincides with that reached before for genotypes by irrigation treatments mean squares (Table 17).

1.2.2. Heterosis

Mean squares for parent vs. crosses as an indication to average heterosis overall crosses was significant for all quality characters except semolina % in the combined analysis and dry gluten % at sprinkler irrigation every 4 and 8 days (Table 17). F_1 means were significantly higher than parental mean for all traits except semolina percentage at sprinkler irrigation every 12 days, and protein content at sprinkler irrigation every 4, 5 days as well as the combined analysis (Table 19).

Significant interaction mean squares between parents vs. crosses and irrigation treatments were detected for all quality traits, indicating that the heterosis effects were affected by irrigation treatments.

Heterosis expressed as the percentage deviation of F_1 performance from its mid-parent and better parent average value for all traits studied at separate irrigation experiments as well as the combined analysis, are presented in Table (20).

For semolina percentage, five, ten and five crosses manifested significant positive heterotic effects from the mid-parents at sprinkler irrigation every 4, 8 days as well as the combined data. Also, five, eight and three parental combinations from the previous crosses had significant positive heterotic effects relative to better parent in the same order. The other crosses exhibited significant negative or insignificant effects relative to mid- or better parent, for this trait. Heterotic effects for semolina % was also reached before by **Johnston *et al.* (1983)**.

Concerning protein percentage, four, seven, eight and seven parental combinations significantly exceeded mid-parent value at sprinkler irrigation every 4, 8, and 12 days as well as the combined analysis, respectively. Also, two, five, five and three crosses from the previous hybrids showed significant positive heterotic effects relative

Table (20): Percentage of heterosis over mid-parent (MP) and better parent (BP) for quality characters in half diallel cross (6x6) at separate irrigation experiments as well as the combined analysis (C).

Crosses		Semolina % I1	Semolina % I2	Semolina % I3	Semolina % C	Protein % I1	Protein % I2	Protein % I3	Protein % C	Dry gluten % I1	Dry gluten % I2	Dry gluten % I3	Dry gluten % C	Wet gluten % I1	Wet gluten % I2	Wet gluten % I3	Wet gluten % C
1 x 2	MP	15.882**	-1.880	-18.284**	-2.582	-16.05**	-25.19**	1.35**	-14.22**	26.63**	2.46	5.73	10.39**	28.57**	-2.03	0.11	7.51**
	BP	13.920**	-5.199	-18.488**	-4.068*	-19.10**	-29.28**	-5.32**	-18.59**	13.19	-0.32	-0.48	5.62	17.39**	-2.86	-4.22	3.39
1 x 3	MP	1.189	2.006	-15.329**	-4.589**	-9.16**	7.17**	38.67**	9.64**	47.39**	1.29	7.28	16.77**	40.13**	4.26	5.25	15.43**
	BP	-3.267	0.993	-19.613**	-5.317*	-16.94**	1.58**	23.02**	0.60**	35.79**	-5.59	-3.24*	12.48**	31.53**	-2.96**	-4.98**	10.68**
1 x 4	MP	10.289**	-0.528	-8.044**	0.319	-21.30**	-6.81**	30.11**	-14.18**	-17.04**	-38.50**	-9.94	-21.97**	-9.19	-34.73**	5.69	-13.54**
	BP	5.078*	-7.712**	-15.740	-0.701	-28.84***	-11.70**	-18.40**	-20.16**	-34.00**	-39.14**	-18.79**	-29.92**	-25.05**	-35.66**	4.62	-18.43**
1 x 5	MP	20.515**	9.282**	-9.663**	5.530**	-35.80**	10.11**	-13.69**	-14.63**	-15.33**	-11.37*	11.36	-6.82*	0.39	-4.58	9.78*	0.84
	BP	17.231**	7.028**	-10.684**	4.822**	-39.76**	5.93**	-20.29**	-14.69**	-33.97**	-21.69**	-10.07**	-14.20**	-11.83*	-15.85**	-8.89**	-3.29
1 x 6	MP	14.910**	10.602**	-11.699**	3.787*	-13.72**	-19.42**	-17.77**	-14.73**	-24.28**	0.69	23.12**	-2.32	-9.96*	3.71	19.36**	3.72
	BP	6.441*	8.785**	-13.492**	2.414	-14.41**	-22.11**	-16.43**	-17.77**	-45.46**	-6.07	13.49**	-11.15**	-28.32**	-5.40**	10.66**	7.29
2 x 3	MP	3.982	8.895**	-11.675**	-0.071	-4.73**	2.24*	-10.72**	3.81**	38.54**	38.75**	11.98	29.73**	30.77**	31.38**	10.72**	24.44**
	BP	1.065	4.202**	-15.945*	-2.335	-9.80	1.94**	11.65**	0.67**	34.03**	32.77**	-4.29**	19.77**	26.96**	23.25**	-3.90**	14.94**
2 x 4	MP	1.565	-4.908	-8.271**	-3.985**	-9.04**	-22.57**	-3.27**	-11.94**	16.39**	-2.41	-16.19**	-1.15	8.59	-5.04	-5.43	-0.57
	BP	-1.622	-8.824**	-15.756	-4.485*	-14.88**	-22.77**	-43.50**	-13.77**	1.87	-4.08	-19.94**	-7.49*	-2.94	-5.60	-10.39	-2.53
2 x 5	MP	-0.037	11.696**	-11.916**	-0.874	-12.40**	-2.37**	7.75**	-3.08**	-7.55	-21.02**	45.06**	1.29	24.82**	-20.59**	43.69**	11.61**
	BP	-1.105	5.769**	-13.126**	-1.734	-14.81**	-11.02**	-2.21**	-7.96**	-20.92*	-31.86**	11.91**	-2.69	19.57**	-30.48**	15.15**	11.30**
2 x 6	MP	-3.704	8.390**	-9.748**	-2.154	-18.10**	-0.15	9.30**	-4.15**	-15.64**	6.35	-17.38**	-9.40**	2.70	7.49*	-13.44**	-0.78
	BP	-9.363*	3.063**	-11.362**	-2.358	-81.69**	-8.59**	-3.95**	-11.90**	-34.23**	1.86	-27.94	-14.08**	-11.84**	-1.18**	-22.94	-1.43
3 x 4	MP	-2.760	7.999**	4.040	3.079*	21.61**	31.98**	3.77**	20.16**	-7.08	13.87*	17.300	7.85*	2.25	15.82**	22.48**	12.97**
	BP	-3.103	-0.719	0.208*	1.261	20.13**	31.93**	-3.03**	18.38**	-20.95**	7.18	-1.77	-6.29*	-10.96*	9.26*	11.49**	2.46
3 x 5	MP	3.760	17.494**	-2.632	5.572**	21.67**	-10.19**	0.09	4.09**	-7.10	1.40	71.86**	14.80**	6.90	1.90	57.48**	17.52**
	BP	1.918	16.212**	-8.547**	4.070*	18.36**	-17.92**	-13.58**	-4.43**	-22.64**	-15.69**	51.68**	2.17	-0.46	-15.52**	43.24**	8.27**
3 x 6	MP	-4.530	7.729*	-14.555**	-4.361**	-1.52**	1.57**	36.27**	10.42**	-2.95	42.94**	0.44	12.47**	5.37	50.28**	-0.50	18.36**
	BP	-7.636*	7.015*	-17.253**	-6.337**	-10.62**	-6.76**	14.14**	-1.75**	-26.10**	42.80**	-1.92	-1.08	-11.75**	47.05**	-3.33	9.99**
4 x 5	MP	-3.963	0.467	2.457	0.281	1.48-*	-2.21**	-3.03**	-2.90**	12.35**	-17.01**	-43.13**	-13.14**	29.83**	-15.17**	-28.18**	-2.76
	BP	-5.994*	-8.562**	-7.082*	-0.631	-2.69**	-10.67**	-10.97**	-9.61**	9.38	-27.33**	-57.51	-15.49**	20.74**	-26.11**	-39.90	-4.41
4 x 6	MP	7.729**	6.080*	0.383	4.739**	6.45**	0.69**	11.68**	6.25**	-26.23**	19.13**	24.38**	1.93	-3.68	20.33**	37.47**	15.70**
	BP	4.582*	-3.072**	-6.250*	4.410*	-4.44**	-7.11**	-0.76**	-6.30**	-35.62**	12.24**	4.34**	0.50	-8.01	11.22**	28.66**	12.69**
5 x 6	MP	-4.818*	24.712**	-8.444**	2.535	2.21**	2.10**	-2.88**	0.62	2.45	1.62	58.82**	14.06**	0.40	3.18	36.78**	10.23**
	BP	-9.495**	24.171**	-11.294*	1.857	-4.83**	1.60**	-6.31	-2.80**	-8.45*	-15.44**	37.31**	12.54**	-10.51*	-15.93**	21.22**	9.20**

* and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.

I1 : referees to sprinkler irrigation treatment every 4 days.

I2 : referees to sprinkler irrigation treatment every 8 days.

I3: referees to sprinkler irrigation treatment every 12 days.

to better parent value for this trait in the same order. The cross P_3xP_4 showed the high desirable heterotic effects. These results are in agreement with findings of **Levy and Feldman (1985)** and **Autran *et al.* (1990)**.

For wet gluten percentage, five, five, eight and nine parental combinations significantly exceeded the mid-parent value at sprinkler irrigation every 4, 8, 12 days as well as the combined data, respectively. Also, five, four six, and seven crosses from the previous hybrids surpassed the better parent value in the same order. The cross (P_2xP_4) followed by (P_4xP_6) and then by (P_2xP_5) showed the highest desirable heterotic effects in the combined analysis.

For dry gluten percentage, five, four, six and seven parental combination significantly exceeded mid-parental value at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. Also, two, three, five and three crosses from the previous hybrids exhibited significant positive heterotic effects relative to better parent value in the same order. The cross (P_2xP_3) gave the highest positive heterotic effects for this trait.

It could be concluded that the previous crosses would be efficient and prospective in durum wheat breeding programs for improving quality characters.

1.2.3. Combining ability

Analysis of variance for combining ability as outlined by **Griffing's (1956)** method-2, model-1 in separate irrigation treatment as well as the combined analysis, is presented in Table (21). The mean

Table (21): Observed mean squares from general and specific combining ability from diallel cross analysis for quality characters in half diallel (6 x 6) of durum wheat.

Source of Variations	D.F. S	D.F. C	I1	I2	I3	C	I1	I2	I3	C
				Semolina %				Protein %		
Genotypes	20	20	41.47**	40.30**	55.25**	30.07**	5.46**	5.56**	5.26**	8.55**
GCA	5	5	17.34**	19.47**	33.72**	5.36*	2.24**	3.96**	4.20**	2.64**
SCA	14	14	21.86**	20.38**	25.60**	4.89**	2.89**	2.39**	2.11**	1.02**
GCA x Irrigation		10				32.58**				3.88
SCA x Irrigation		15				31.47**				3.19
Error	20	60	2.16	2.14	2.31	2.20	0.003	0.0001	0.001	0.001
GCA/SCA			0.79	0.96	1.32	1.10	0.78	1.66	2.00	2.59
GCA x Irrigation/GCA						6.08				1.47
SCA x Irrigation/SCA						6.44				3.13
				Dry gluten %				Wet gluten %		
Genotypes	20	20	91.07**	45.69**	69.58**	63.66**	95.19**	100.40**	106.32**	84.17**
GCA	5	5	95.99**	23.18**	20.98**	13.56**	87.85**	56.68**	30.97**	12.69**
SCA	14	14	28.72**	22.73**	39.39**	9.63**	34.17**	48.04**	60.56**	14.47**
GCA x Irrigation		10				63.30**				81.41**
SCA x Irrigation		15				40.61**				64.15**
Error	20	60	1.52	1.41	1.79	1.57	2.47	1.44	1.20	1.70
GCA/SCA			3.34	1.02	0.53	1.41	2.57	1.18	0.51	0.89
GCA x Irrigation/GCA						4.67				6.42
SCA x Irrigation/SCA						4.22				4.43

* and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.
I1 : referees to sprinkler irrigation treatment every 4 days.
I2 : referees to sprinkler irrigation treatment every 8 days.
I3: referees to sprinkler irrigation treatment every 12 days.

squares associated with general and specific combining ability (GCA and SCA) were significant for all the studied traits. It is evident that both additive and non-additive gene effects were involved in determining the performance of single cross progeny. Also, when GCA, SCA ratio was used it was found that semolina and protein percentages at sprinkler irrigation every 4 days and wet gluten % in the combined analysis exhibited low GCA/SCA ratio of less than unity indicating the predominance of non additive gene action in the inheritance of such cases. While, the magnitude of additive and non additive types of gene action were similar for semolina %, at sprinkler irrigation every 8 days as well as the combined analysis and dry gluten % at sprinkler irrigation every 8 days.

On the other hand, high GCA/SCA ratios which exceeded unity were detected for other cases. Such results indicated that additive and additive x additive types of gene action were more important in the genetics of these character than non additive ones.

The importance of additive effects of gene were previously reported by **Levy and Feldman (1985)** for protein and gluten content and **Autran *et al.* (1990)** and **Abul-Naas *et al.* (1991)** for protein percentage.

The mean squares of interaction between sprinkler irrigation treatments and both types of combining ability were highly significant for all studied quality characters, indicating that the magnitude of all types of gene action varied from irrigation treatment to another. It is fairly evident that ratios for SCA x irrigation treatment/SCA was much higher than ratios of GCA x irrigation treatments/GCA for four studied quality characters. Such results indicated that non-additive gene effects were much more influenced by irrigation treatments than the additive genetic ones. The interaction between both types of combining ability and environmental changes were reported by **Timariu and Moldoveanu (1982)** and **Levy and Feldman (1985).**

General combining ability effects

General combining ability effects (g_i) of each parental variety for quality traits in separate irrigation treatments as well as the combined data are presented in Table (22). Such effects are being used to compare the average performance of each variety with other varieties and is expected for selection of varieties for further improvement. High positive values would be of interest for all quality characters under study.

The parental variety Bani Sweif 1 (P_1) expressed significantly positive GCA effects for semolina % at sprinkler irrigation every 4 days and wet gluten % at sprinkler irrigation every 12 days, but it gave significant negative or insignificant GCA effects for other cases. The parental variety Bani Sweif 2 (P_2) exhibited significant positive GCA effects for dry gluten % at sprinkler irrigation every 12 days and wet gluten % at sprinkler irrigation every 12 days as well as the combined analysis. Also, it gave significant negative or insignificant GCA effects for other cases. The parental variety Bani Sweif 3 (P_3) expressed significant positive GCA effects for protein % at sprinkler irrigation every 4 and 8 days as well as the combined analysis, wet gluten % and dry gluten at sprinkler irrigation every 8 days. While, it appeared as a poor combiner for other cases. The parental variety Sohag 1 (P_4) appeared to be the best GCA effects for semolina %, dry

Table (22): Estimates of general combining ability effects for quality characters in half diallel (6 x 6) of durum wheat.

Parental variety		I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined	I1	I2	I3	Combined
		Semolina %				**Protein %**				**Dry gluten %**				**Wet gluten %**			
1 Bani Sewef 1		1.10*	-2.17**	-0.20	-0.43	-0.48**	-0.19**	-0.17**	-0.28**	-5.38**	-1.98**	0.28	-2.36**	-5.81**	-2.53**	1.12**	-2.41**
2 Bani Sewef		-1.60**	0.46	-0.10	-0.41	-0.38**	-1.10**	-0.39**	-0.63**	-0.93	-0.32	1.74**	0.16	0.39	-0.61	2.77**	0.85*
3 Bani Sewef		-0.95	-0.75	-1.93**	-1.21*	0.36**	0.15**	-0.12**	0.13**	-1.51*	1.16**	-0.53	-0.29	-1.48**	1.64**	-0.87*	-0.24
4 Sohag 1		0.31	2.58**	-1.64**	0.42	-0.26**	-0.32**	-0.75**	-0.44**	0.79	-1.62**	1.62**	0.26	2.70**	-2.59**	0.41	0.17
5 Sohag 2		-1.07*	0.02	3.82**	0.92	-0.14**	0.88**	0.06**	0.27**	2.34**	2.54**	-2.63**	0.75	0.94	4.38**	-3.06**	0.75
6 Sohag 3		2.22**	-0.15	0.06	0.71	0.90**	0.58**	1.36**	0.95**	4.68**	0.22	-0.48	1.47**	3.26**	-0.28	-0.37	0.87*
LSD gi-gj	5%	1.534	1.526	1.585	1.05	0.056	0.01	0.034	0.02	1.285	1.239	1.394	0.89	1.639	1.253	1.144	0.85
	1%	2.071	2.059	2.139	1.21	0.076	0.014	0.046	0.03	1.734	1.672	1.881	1.02	2.212	1.692	1.544	1.06
LSD gi	5%	0.990	0.985	1.023	0.969	0.036	0.001	0.022	0.025	0.829	0.780	0.900	0.81	1.058	0.809	0.739	0.84
	1%	1.337	1.329	1.381	1.270	0.049	0.009	0.030	0.033	1.119	1.079	1.214	1.08	1.428	1.092	0.997	1.12
r		0.49	0.75**	0.76**	0.63*	0.21	0.79**	0.70*	0.64*	0.96**	0.46	0.97**	0.66*	0.91**	0.56	0.98**	0.48

* and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.
I1 : referees to sprinkler irrigation treatment every 4 days.
I2 : referees to sprinkler irrigation treatment every 8 days.
I3: referees to sprinkler irrigation treatment every 12 days.
r: Correlation coefficient between parental performance and their GCA effects.

gluten and wet gluten % at sprinkler irrigation every 8, 12 and 4 days, respectively. While, it gave significant negative or insignificant GCA effects for other cases. The parental variety Sohag 2 (P_5) appeared to be the best general combiner for protein % at sprinkler irrigation every 8, 12 days as well as the combined data, semolina % at sprinkler irrigation every 12 days, and dry gluten % at sprinkler irrigation every 4 and 8 days, and wet gluten % at sprinkler irrigation every 8 days. Also, the parental variety Sohag 3 (P_6) appeared to be good combiner for protein % at the three irrigation treatments as well as the combined analysis, Semolina % at sprinkler irrigation every 4 days, dry and wet gluten % at sprinkler irrigation every 4 and 8 days as well as the combined analysis. These results suggest that improving opportunity by selection would be possible for quality. It is worthmentioning that an excellent agreement between parental performance and its GCA effects was obtained for all cases except semolina % and protein % at sprinkler irrigation every 8 days and wet gluten % at sprinkler irrigation every 8 days as well as the combined analysis. Therefore, it could be concluded that high performing hybrids could be reached except when crossing is carried out between parental varieties characterized by high mean performance. Such agreement might add another proof for the preponderance of additive genetic variance governing these cases, and coincides with the finding reached above (Table 21). Similar trend was previously mentioned by **Raghavalah and Joshi (1986)** and **Bebyakin and Starichkova (1991a, b).**

For the exceptional cases, low and insignificant correlation values were detected between the two variables. This disagreement revealed that hybrids characterized with high mean performance could be expected by crossing between varieties of low mean performance.

Specific combining ability effects (S_{ij})

Specific combining ability effects of the parental combinations were computed for all studied traits (Table 23).

For semolina %, six, six, two and four crosses expressed significantly positive SCA effects at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. The crosses (P_1xP_5), (P_1xP_6), (P_3xP_5) and (P_4xP_6) gave significant positive SCA effects in the combined analysis.

Regarding protein content, five, eight, seven and seven crosses showed significantly positive SCA effects at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. Both crosses (P_1xP_3) and (P_3xP_4) gave the highest positive SCA effects in the combined analysis for this trait.

Six, five, six and four crosses exhibited significant positive SCA effects for dry gluten percentage at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. The two crosses (P_2xP_3) and P_5xP_6) had the highest positive SCA effects for this content.

Five, five, six and eight parental combinations showed significant positive SCA effects for wet gluten percentage at sprinkler irrigation every 4, 8 and 12 days as well as the combined analysis, respectively. the two crosses (P_2xP_3) and (P_4xP_6) gave the highest positive SCA effects in the combined analysis.

Table (23): Estimates of specific combining ability effects for quality characters in half diallel (6 x 6) of durum wheat.

Genotypes		I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C	I1	I2	I3	C
		Plant height				**Peduncle height**				**No. of spikes/plant**				**No. of kernels/spike**			
1 x 2		5.10**	-2.14	-6.04**	-1.02	-0.04	-2.03**	0.08**	-0. 66**	4.51**	2.13*	1.30	2.65*	5.90**	1.38	-0.94	2.11*
1 x 3		-3.14**	-1.37	-5.11**	-3.21**	-0.46**	0.82**	3.05**	1.14**	8.68**	-1.00	-0.89	2.26*	10.37**	-0.92	-1.45	2.67**
1 x 4		2.00	-0.21	-2.30	-0.17	-1.65**	-0.48**	-1.06**	-1.06**	-3.82**	-8.72**	-1.83	-4.79**	-5.35**	-12.14**	1.32	-5.39**
1 x 5		8.48**	1.81	-2.06	2.74**	-3.44**	1.82**	-1.49**	-1.04**	-4.07**	0.02	-0.69	-1.58	-3.15*	2.54**	0.91	-0.51
1 x 6		5.74**	3.12*	-2.20	2.22*	-0.39**	-2.02**	-1.55**	-1.32**	-5.20**	-0.21	3.71**	-0.57	-3.97**	-0.15	4.65**	0.18
2 x 3		2.60*	3.05**	-2.61*	1.01	-0.46**	0.37**	0.29**	0.07*	6.10**	7.09**	0.90	4.70**	5.42**	8.56**	1.20	5.06**
2 x 4		-0.06	-3.69**	-2.75*	-2.17	-0.56**	-2.10**	-0.44**	-1.04**	4.25**	-0.03	-3.69**	0.17	-0.25	-0.62	-3.08**	-1.32
2 x 5		-1.28	3.37**	-4.16**	-0.69	-0.67**	0.30**	0.94**	0.19**	-3.70**	-5.79**	8.10**	-0.46	4.45**	-8.44**	12.19**	2.74**
2 x 6		-3.47**	1.64	-0.95	-0.93	-1.61**	0.82**	0.32**	-0.16**	-4.39**	-1.12	-6.60**	-4.04**	-0.92	-0.88	-8.10**	-3.30**
3 x 4		-1.75	3.73**	4.07**	2.02	1.85**	3.14**	-0.57**	1.48**	-3.13**	1.94*	4.27**	1.03	-2.49*	3.44**	5.26**	2.07*
3 x 5		2.68*	4.89**	1.41	2.99**	2.37**	-1.93**	-0.73**	-0.10**	-3.78**	-0.67	9.02**	1.52	-2.48*	-1.43	11.33**	2.47*
3 x 6		-2.81*	-0.84	-6.18**	-3.28**	-0.64**	-0.17**	2.42**	0.54**	-0.02	5.95**	-4.03**	0.63	1.00	10.83**	-5.21**	2.21*
4 x 5		-3.68**	-3.05**	2.32**	-1.47	0.20**	-0.43**	0.22**	-0.003	5.72**	-2.64**	-12.33**	-3.08*	11.30**	-3.76**	-13.80**	-2.09*
4 x 6		5.12**	1.32	1.99	2.81*	0.94**	0.24**	1.10**	0.76**	-6.77**	4.43**	6.92**	1.53	-1.08	6.26**	11.86**	5.68**
5 x 6		-4.10**	8.34**	-2.83*	0.47	0.76**	0.43**	-0.45**	0.25**	4.38**	0.37	7.27**	4.01**	-0.72	0.24	5.83**	1.78
LSD (Sij-Sik)	5%	4.059	4.036	4.194	2.885	0.148	0.027	0.090	1.839	3.400	3.278	3.687	0.411	4.337	3.317	3.028	2.530
	1%	5.478	5.447	5.660	3.317	0.200	0.037	0.122	2.115	4.588	4.424	4.975	0.473	5.853	4.476	4.086	2.909
LSD (Sij - Ski)	5%	3.758	3.737	3.883	2.088	0.137	0.025	0.084	1.331	3.147	3.035	3.413	0.298	4.016	3.071	2.803	1.831
	1%	5.072	8.057	5.240	2.401	0.185	0.034	0.113	1.530	4.247	4.096	4.606	0.342	5.419	4.144	3.783	2.105
LSD (Sij)	5%	2.246	2.233	2.320	2.22	0.082	0.015	0.050	0.057	1.881	1.814	2.040	1.84	2.400	1.835	1.675	1.910
	1%	3.031	3.014	3.131	2.96	0.111	0.020	0.068	0.075	2.538	2.448	2.753	2.44	3.238	2.477	2.261	2.540

*** and ** Significant and highly significant at 0.05 and 0.01 levels, respectively.**

I1 : referees to sprinkler irrigation treatment every 4 days.

I2 : referees to sprinkler irrigation treatment every 8 days.

I3: referees to sprinkler irrigation treatment every 12 days.

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

2. The second experiment

2.1. Yield and yield attributed

2.1.1. Effect of seasons

Results in Table (24) represent averages of the two seasons of the study. From the results, it is evident that all studied characters except plant height, peduncle length and number of kernels/spike were significantly variable from season to another. Higher mean values for all characters were detected in the first season. It could be concluded that the grain yield increase in the first season may be due to the significant increase in number of spikes/m^2 and weight of 1000-grain only (Table 24).

2.1.2. Varietal differences

Data given in Table (25) show the average values of plant height, peduncle length and flag-leaf area as influenced by the different varieties during the two growing seasons as well as the combined analysis. The differences between varieties reached the significant level for all studied characters during the two seasons.

Table (24): The average values of seasonal effect on yield and yield components of wheat in 1996/97 and 1997/98 seasons.

Season	Plant height (cm)	Peduncle length (cm)	Flag leaf area (cm^2)	Number of spikes/m^2	Number of kernels/spike	1000-grain weight (gm)	Straw yield (ton/fed)	Grain yield (ardab/fed.)	Biological yield (ton/fed)
1996/1997	91.86 [a]	41.72 [a]	38.24 [a]	204.90 [a]	44.63 [a]	53.72 [a]	3.19 [a]	12.56 [a]	5.11 [a]
1997/1998	92.69 [a]	36.66 [a]	37.58 [b]	189.00 [b]	47.05 [a]	49.39 [b]	3.14 [b]	9.69 [b]	4.65 [b]

Table (25): Effect of wheat varieties on plant height, peduncle length and flag leaf area during 1996/1997 and 1997/1998 seasons as well as the combined data.

Cultivar	Plant height (cm)			Peduncle length (cm)			Flag leaf area (cm^2)		
	First season	Second season	Combined	First season	Second season	Combined	First season	Second season	Combined
Bani Sewef 1	87.83 c	93.47 ab	90.65 cd	41.09 c	37.47 ab	39.28 cd	35.90 bc	40.16 a	38.03 bc
Bani Sewef 2	93.83 b	91.31 b	92.57 bc	44.73 a	38.45 a	41.59 a	33.84 c	36.34 b	35.09 d
Bani Sewef 3	88.92 c	92.21 b	90.56 cd	43.30 b	38.28 a	40.79 ab	37.25 b	41.54 a	39.39 ab
Sohag 1	90.50 bc	85.83 c	88.16 d	42.95 c	38.27 a	40.61 c	35.76 bc	36.41 b	36.08 cd
Sohag 2	93.25 b	99.16 a	96.20 ab	41.67 bc	36.63 ab	39.15 cd	38.79 b	36.79 b	37.79 cd
Sohag 3	88.75 c	91.39 b	90.07 bc	41.00 c	36.09 b	38.54 d	47.28 a	35.61 b	41.45 a
Gemmeiza 3	100.00 a	97.41 a	98.70 a	37.32 d	31.47 c	34.39 e	38.88 b	36.28 b	37.58 ab
F-test for cultivar x season			*			NS			*

Gemmeiza 3 cultivar gave the highest averages of plant height being 100.00 cm compared with other varieties in the first season. While, in the second season Sohag 2 cultivar had the highest value of plant height (99.16 cm), but with no significant superiority over Gemmeiza 3 cultivar (97.41 cm). On the contrary, in the first season the lowest values of plant height were recorded by Bani Sweif 1 (87.83 cm), Sohag 3 (88.75 cm), Bani Sweif 3 (88.92 cm) and Sohag 1 cultivars (90.50 cm). Also, the differences between these four previous varieties were not reached the level of significance. In the second season, the shortest plants were recorded by Sohag 1 cultivar being 85.83 cm. Gemmeiza 3 cultivar surpassed the other varieties in plant height in the combined data, whereas Sohag 1 cultivar gave the lowest value (Table 25).

In the first season, Bani Sweif 2 cultivar gave the highest value with regard to peduncle length being 44.72 cm compared to other cultivars. The lowest value was obtained by Gemmeiza 3 cultivar being 37.32 cm, while in the second season, the highest values of peduncle length; 38.45, 38.28, 38.27, 37.46 and 36.63 cm were obtained by Bani Sweif 2, Bani Sweif 3, Sohag 1, Bani Sweifl and Sohag 2 cultivars, respectively. However, all differences among them, did not reach the level of significance. On the contrary, Gemmeiza 3 cultivar had the lowest value of peduncle length being 31.47 cm.

In the combined data, Bani Sweif 2 cultivar gave the highest value of peduncle length, whereas the lowest value was obtained by Gemmeiza 3 cultivar (Table 25).

Concerning flag leaf area (cm^2), Sohag 3 cultivar gave the highest value being 47.28 cm^2, while Bani Sweif 2 cultivar gave the lowest one (33.84 cm^2) in the first season. In the second season, Bani Sweif3 gave the highest flag leaf area being 41.54 cm^2 followed by Bani Sweif 1 cultivar which recorded 40.15 cm^2, whereas Sohag 3 cultivar had the lowest value being 35.61 cm^2.

In the combined data, Sohag 3 cultivar surpassed the other varieties in flag leaf area which recorded 41.45 cm^2, while Bani Sweif 2 cultivar gave the lowest value being 35.09 cm^2, Table (25).

The recorded results of yield, yield components and biological yield as affected by the different varieties during the two seasons as well as the combined data are shown in Table (26). The differences among varieties regarding the number of spikes per one square meter, number of kernels/spike, 1000-grain weight, straw yield/feddan, grain yield/feddan and biological yield/feddan reached the significant level (Table 26).

In the first season, Bani Sweif 2, Bani Sweif 2, Bani Sweif 3, Sohag 2 and Sohag 3 cultivars had the highest number of spikes per one square meter which were 213.50, 213.33, 206.17, 211.00 and 208.08, respectively, whereas Gemmeiza 3 cultivar gave the lowest value being 187.25.

In the second season, both cultivars Gemmeiza 3 and Sohag 3 recorded the highest number of spikes per one square meter which were 207.50 and 203.67, respectively, whereas Sohag 1 cultivar had the lowest number of spikes/m^2 being 170.33.

In the combined data, Sohag 3 gave the highest number of spikes per one square meter being 205.88, whereas the lowest value was obtained by Sohag 1 (182.67).

Concerning number of kernels/spike, in the first season Sohag 3 cultivar gave the highest number being 51.25. However, there was no significant differences between Sohag 2, Bani Sweif 3, Bani Sweif 1, Sohag 1 and Sohag 3. The lowest number of kernels/spike was 36.00 was obtained by Gemmeiza 3 cultivar.

In the second season, Sohag 1 cultivar produced the highest number of kernel/spike followed by Sohag 3 and Sohag 2 cultivars which were 51.77, 50.99 and 49.14, respectively. Whereas Gemmeiza 3 cultivar produced the lowest value of number of kernels/spike being 39.06.

In the combined data, both cultivars Sohag 3 and Sohag 2 had the highest number of kernels/spike which were 51.12 and 49.40, whereas Gemmeiza cultivar had the lowest value being 37.53 (Table 26).

In the first season, it is clear that Sohag 1 cultivar had the highest 1000-grain weight followed by Bani Sweif 2, Bani Sweif 1 and Sohag 3 cultivars, which were 56.83, 56.67, 5.67 and 53.92 gm, respectively. While the lowest value was recorded by Bani Sweif 3 cultivar being 49.67 gm.

In the second season, Sohag 3, Bani Sweif 1 and Sohag 1 cultivars had the best average for 1000-grain weight, which were 52.97, 52.63 and 49.91, respectively. In the other side, the lowest value was recorded by Gemmeiza 3 cultivar being 44.40 gm.

Bani Sweif 1 cultivar had the highest average of 1000-grain weight, but without significant superiority over Sohag 3, Sohag 1 and Bani Sweif 2 cultivars in the combined data, while Gemmeiza 3 cultivar gave the lowest 1000-grain weight.

The highest average of straw yield/feddan were 3.58 and 41.8 ton/fed obtained by Gemmeiza 3 cultivar in 1996/1997 and 1997/1998 seasons, respectively. On the other hand, Bani Sweif cultivar gave the lowest values for straw yield/feddan in 1996/1997 and 1997/1998 seasons which were 2.45 and 2.28 ton/fed., respectively.

In the combined data (Table 26), it is clear that Gemmeiza 3 cultivar had the highest straw yield/feddan, but without significant superiority over Bani Sweif 1 cultivar, whereas both Bani Sweif 3 and Sohag 1 cultivars had the minimum straw yield/feddan.

As to the yield of grain/feddan, Bani Sweif 2 cultivar had the highest grain yield/feddan in 1996/1997 and 1997/1998 seasons which were 14.02 and 11.09 ardab/feddan, respectively.

On the other hand, the lowest values for grain yield/fed were recorded by Gemmeiza 3 cultivar (8.76 ardab/fed) and Sohag 1 cultivar (7.85 ardab/fed) in the first and second seasons, respectively. Bani Sweif 2 cultivar had the highest grain yield/fed in the combined data, whereas Gemmeiza 3 cultivar gave the minimum grain yield/fed.

It is evident that the increase in the grain yield of Bani Sweif 2 cultivar primarily due to the increase in number of spikes/m^2 and weight of 1000-grain.

Concerning the biological yield/fed, it is clear from Table (26) that the highest averages of the biological yield/feddan obtained from Sohag 3 cultivar (5.71 ton/fed) and Gemmeiza 3 cultivar (5.50 ton/fed) in 1996/1997 and 1997/1998 seasons, respectively.

On the contrary, the lowest biological yield/feddan recorded by Bani Sweif 3 cultivar (4.36 ton/fed) and Sohag 1 cultivar (3.65 ton/fed) in the first and second seasons, respectively.

The highest biological yield/feddan produced by Bani Sweif 1 cultivar being 5.39 ton/fed in the combined data. While, the lowest biological yield/feddan was obtained by Sohag 1 cultivar being 4.09 ton/fed, Table (26).

Mean squares for cultivars and seasons were significant for all traits except peduncle length (Table 25). This finding revealed that the tested varieties in most traits ranked differently from season to another.

2.1.3. Effect of nitrogen fertilization

Data in Table (27) show the average values of plant height, peduncle length and flag leaf area as affected by the various levels of nitrogen in 1996/1997 and 1997/1998 seasons.

Results indicated that all studied characters were not significantly affected by nitrogen levels during the two seasons.

Data on yield, yield components and biological yield as affected by the various levels of nitrogen in 1996/1997 and 197/1998 seasons as well as the combined data are presented in Table (28). Results indicated that yield as well as yield components were significantly

Table (26): Effect of wheat cultivars on yield and yield components of wheat in 1996/1997 and 1997/1998 seasons and the combined of the two seasons.

Cultivars	First season	Second season	Combined	First season	Second season	Combined	First season	Second season	Combined
	Number of spikes/m²			Number of kernels/spike			1000-grain weight (gm)		
Bani Suef-1	213.33 a	182.50 c	197.92 abc	44.33 ab	47.53 bc	45.93 b	55.67 ab	52.63 a	54.15 a
Bani Suef-2	213.50 a	194.00 b	203.75 ab	41.50 b	42.57 d	42.03 c	56.67 ab	49.36 b	53.02 ab
Bani Suef-3	206.17 a	183.33 c	194.75 bc	46.67 a	48.35 bc	47.51 b	49.67 c	49.90 b	49.78 bc
Sohag 1	195.00 b	170.33 d	182.67 d	43.00 ab	51.77 a	47.38 b	56.83 a	49.91 ab	53.37 a
Sohag 2	211.00 a	181.67 c	196.33 abc	49.67 a	49.14 abc	49.40 ab	51.92 bc	46.63 bc	49.27 c
Sohag 3	208.08 a	203.67 a	205.88 a	51.25 a	50.99 ab	51.17 a	53.92 ab	52.97 a	53.44 a
Gemmeiza 3	187.25 b	207.50 a	197.38 abc	36.00 c	39.06 d	37.53 d	51.42 c	44.40 c	47.91 c
F-test for cultivar x season			*			*			*
	Straw yield (ton/fed.)			Grain yield (ardab/fed.)			Biological yield (ton/fed.)		
Bani Suef-1	3.25 a	3.89 a	3.57 ab	13.82 a	10.67 a	12.25 a	5.31 ab	5.49 a	5.39 a
Bani Suef-2	3.40 a	3.23 b	3.32 bc	14.02 a	11.09 a	12.56 a	5.53 a	4.86 b	5.19 ab
Bani Suef-3	2.45 b	2.28 c	2.37 d	12.74 ab	10.65 a	11.69 ab	4.36 c	4.21 c	4.29 bc
Sohag 1	2.73 b	2.47 c	2.60 d	12.00 b	7.85 c	9.92 bc	4.53 c	3.65 d	4.09 c
Sohag 2	3.55 a	2.59 c	3.07 c	12.74 ab	9.09 b	10.91 ab	5.46 a	3.96 cd	4.71 abc
Sohag 3	3.43 a	3.33 b	3.38 bc	13.87 a	10.40 a	12.14 a	5.71 a	4.89 b	5.30 a
Gemmeiza 3	3.58 a	4.18 a	3.88 a	8.76 c	8.13 bc	8.45 c	4.90 bc	5.50 a	5.20 ab
F-test for cultivar x season			*			*			*

Table (27): Effect of nitrogen fertilizer rates on plant height, peduncle length and flag leaf area during 1996/1997 and 1997/1998 seasons and the combined of the two seasons.

Nitrogen fertilizer	Plant height (m)			Peduncle length (cm)			Flag leaf area (cm^2)		
	First season	Second season	Combined	First season	Second season	Combined	First season	Second season	Combined
75 kg in 3 equal doses	92.46 a	94.01 a	93.24 a	41.98 a	37.16 a	39.57 a	38.99 a	36.85 a	37.92 a
75 kg in 4 equal doses	90.50 a	90.65 a	90.57 a	41.70 a	36.64 a	39.17 a	38.77 a	37.26 a	38.02 a
100 kg in 4 equal doses	91.87 a	94.24 a	93.44 a	41.49 a	36.19 a	38.84 a	36.96 a	38.65 a	37.81a
F-test for nitrogen x seasons			NS			NS			NS

affected by nitrogen levels in both seasons except 1000-grain weight in the first season and number of spikes per one square meter and number of kernels/spike in the second season and biological yield/fed, in both seasons and the combined data.

Number of spikes per square meter and number of kernels/spike gave their highest values being 212.64/m^2 and 47.14 kernels/spike, respectively, when N rates were splitted into four doses up to 100 kg N/fed. The lowest number of spikes/m^2 (193.93) as well as number of kernels/spike (41.07) were obtained by adding N rates in four equal doses up to 75 kg N/fed in 1996/1997 season.

In the combined data, the highest values of number of spikes per one square meter (201.18) and number of kernels/spike (47.07) were obtained by applying N rates in four equal doses up to 100 kg N/fed and N rates up to 75 kg N/fed when were splitted into three doses, respectively.

The highest average of 1000-grain weight was 52.84 g obtained when applying N rates in four equal doses up to 75/kg N/fed, but the differences between this treatment and applying N level of 75 kg N/fed in three doses were not significant and the lowest seed index (46.53 g) was accompanied to N application of 100 kg N/fed in four doses during the second season.

In the combined data, the highest value of 1000-grain weight was obtained by N application level of 75 kg N/fed in four doses being 53.22 g.

The highest average of straw yield/feddan were 3.50 and 3.44 ton/fed obtained when applying N rate in four equal doses up to 75 kg N/fed in the first season and up to 100 kg N/fed in the second season, respectively.

In the other side, the lowest straw yield/fed were 2.78 and 2.97 ton/fed when N rate was splitted into four doses up to 100 kg/fed in the first season and up to 75 kg N/fed in the second season.

Concerning grain yield/feddan, results showed that the highest grain yield/fed was accompanied by N application level of 75 kg N/fed when N rate was splitted into three doses being 13.59 ardab/fed in the first season and four doses being 10.34 ardab/fed in the second season. The lowest averages of the grain yield were recorded by adding N rate in four doses up to 100 kg N/fed being 11.61 ardab/fed in the first season and by adding N rate in three doses up to 75 kg N/fed being 9.09 ardab/fed in the second season.

Generally, the highest values of straw yield (3.24 ton), grain yield (11.58 ardab) and biological yield (5.06 ton) per feddan were obtained by applying N rate in four equal doses up to 75 kg N/fed in the combined data. Similar results were reported by **Kamel *et al.* (1978), Salem (1984), Mosaad and Abdel-Shafi (1990)** and **Shams El-Din and Abdrabou (1995),** who found that wheat grain yield and most grain yield components increased with N level up to 60 kg N/fed. Also, **El-Badry (1989)** found that the highest grain yield of wheat could be achieved by applying 92 kg N/fed. On the other hand, **Tanji and Regeher (1988)** found that nitrogen application had no significant effect on bread and durum wheat.

It is evident that the increase in the grain yield was primarily due to the increase in number of spikes/m^2, number of kernels/spike and 1000 grain weight. In other words, this increase may be due to the ability of studied varieties to respond better to low levels of nitrogen.

The interaction between N treatment and season mean squares were significant for grain yield, biological yield and yield components (Table 28). This finding revealed that these traits differently responded to N levels treatments from year to another. In other word, the effect of nitrogen levels was changeable from season to season. These results might be due to the more heterogeneity in soil fertility as well as the different amount of rainfall, temperature and disease pathogens in both seasons.

2.1.4. Effect of the interaction between varieties and nitrogen fertilizer levels

With the exception of plant height and peduncle length, all studied characters showed significant differences due to the interaction effect between varieties and nitrogen levels (Table 29).

The highest mean values for number of spikes/m^2 were obtained by N3 with Sohag 3, but without significant differed from those of N2 with Sohag 2 and Sohag 3 and N3 with Bani Sweif 1 and Bani Sweif 2.

Concerning 1000-grain weight, the highest mean values were obtained by Bani Sweif 1, Sohag 1 and Sohag 3 under N2, Sohag 1, Bani Sweif 2 and Sohag 3 under N1 and Gemmeiza 3 under N3.

Table (28): Effect of nitrogen fertilizer rates on yield and yield components of wheat in 1996/1997 and 1997/1998 seasons as well as the combined analysis.

Genotypes	First season	Second season	Combined	First season	Second season	Combined	First season	Second season	Combined
	Number of spikes/m²			Number of kernels/spike			1000-grain weight (gm)		
75 kg in 3 equal doses	208.14 a	185.00 a	196.57 ab	45.68 a	48.46 a	47.07 a	53.29 a	48.83 ab	51.06 a
75 kg in 4 equal doses	193.93 b	192.29 a	193.11 b	41.07 b	46.91 a	43.99 b	53.61 a	52.84 a	53.22 a
100 kg in 4 equal doses	212.64 a	189.00 a	201.18 a	47.14 a	45.06 a	46.47 ab	54.29 a	46.53 b	50.41 a
F-test for nitrogen x season			*			*			*
	Straw yield (ton/fed.)			Grain yield (ardab/fed.)			Biological yield (ton/fed)		
75 kg in 3 equal doses	3.31 ab	3.01 b	3.16 a	13.58 a	9.09 b	11.34 a	5.35 a	4.36 a	4.86 a
75 kg in 4 equal doses	3.50 a	2.97 b	3.24 a	12.49 b	10.34 a	11.58 a	5.37 a	4.76 a	5.06 a
100 kg in 4 equal doses	2.78 b	3.44 a	3.11 a	11.61 c	9.69 b	10.48 a	4.62 a	4.84 a	4.73 a
F-test for nitrogen x season			*			*			*

Table (29): The average values of flag leaf area, yield and yield components of wheat as affected by the interaction between nitrogen and varieties in the combined analysis.

Nitrogen rate		varieties	Number of spikes/m²	1000-grain weight	Straw yield (ton/fed)	Grain yield (ardab/fed.)	Biological yield (ton/fed)
75 kg N in 3 equal doses	N1	Bani Sewef 1	193.75	51.90	3.71	12.67	5.61
		Bani Sewef 2	215.75	55.08	2.70	12.34	4.49
		Bani Sewef 3	195.00	50.38	2.37	11.64	4.11
		Sohag 1	194.50	55.96	2.55	10.94	4.19
		Sohag 2	189.50	50.24	3.39	11.00	5.04
		Sohag 3	194.38	53.33	3.36	12.74	5.27
		Gemmeiza 3	193.13	40.51	4.09	8.03	5.31
75 kg N in 4 equal doses	N2	Bani Sewef 1	197.25	58.71	3.73	13.40	5.71
		Bani Sewef 2	186.50	52.56	3.73	12.74	5.64
		Bani Sewef 3	191.50	51.46	2.08	12.80	4.49
		Sohag 1	172.00	55.80	2.87	9.33	4.27
		Sohag 2	212.00	48.46	2.51	11.87	4.29
		Sohag 3	200.75	55.23	3.70	11.10	5.36
		Gemmeiza 3	191.75	50.34	4.05	9.80	5.67
100 kg N in 4 equal doses	N3	Bani Sewef 1	202.75	51.83	3.28	10.67	4.88
		Bani Sewef 2	209.00	51.40	3.53	12.60	5.46
		Bani Sewef 3	197.75	47.51	2.66	10.64	4.26
		Sohag 1	181.50	48.35	2.38	9.50	3.81
		Sohag 2	187.50	49.11	3.33	9.87	4.81
		Sohag 3	222.50	51.78	3.10	12.57	5.29
		Gemmeiza 3	20.73	52.88	3.51	7.50	4.63
LSD at 0.05			15.74	6.18	0.81	2.12	0.99
LSD at 0.01			22.16	8.70	1.13	2.98	1.41

For grain yield/fed, the highest mean value was recorded by Bani Sweif 1 when received N3, but without significant differences over Bani Sweif 1 and Bani Sweif 2 and Sohag 3 with N1, Bani Sweif 1 and Bani Sweif 2 and Sohag 2 with N2, Bani Sweif 2 and Sohag 3 with N3. However, the lowest mean values of grain yield were obtained by Gemmeiza 3 with N1, N2 and N3, Sohag 1 with N2 and N3 and Sohag 2 with N3.

The highest mean values of straw yield/fed were obtained by Gemmeiza 3, Bani Sweif 1 and Sohag 2 and Sohag 3 with N1, Bani Sweif 1 and Bani Sweif 2, Sohag 3 and Gemmeiza 3 with N2 and Bani Sweif 1 and Bani Sweif 2 and Gemmeiza 3 with N3. However, the lowest value of straw yield was detected by Bani Sweif 1 with N2.

2.2. Quality characters

2.2.1. Variatal differences

The varietal differences in chemical components are shown in Table (30). Data indicated that the varieties exhibited significant differences concerning the semolina, dry and wet gluten as well as protein percentages. Sohag 2 cultivar had the highest semolina, protein and wet gluten percentages. Whereas the highest dry gluten percentage was recorded by Bani Sweif 3. On the contrary, Sohag 3 cultivar had the lowest semolina protein percentage and dry gluten percentage. Whereas the lowest wet gluten percentage was recorded by Bani Sweif 1 cultivar.

Concerning protein percentage, Sohag 1 and Sohag 2cultivar gave the highest value, while Sohag 3 cultivar gave the lowest one.

Table (30): The average values of quality characters of wheat grains as affected by varieties in 1997/98 season.

Varieties	Semolina %	Dry gluten %	Wet gluten %	Protein %
Bani Sweif 1	81.150 ab	19.900 c	30.783 d	12.8777 e
Bani Sweif 2	78.267c	22.967 b	34.600 bc	14.215 b
Bani Sweif 3	79.467 bc	22.683 b	34.867 b	14.233 a
Sohag 1	77.850 cd	24.933 a	35.767 ab	13.543 d
Sohag 2	82.283 a	25.800 a	37.367 a	13.903 c
Sohag 3	76.200 d	18.150 d	31.683 d	12.880 e
Gemmieza 3	79.150 c	21.983 b	32.167 cde	9.450 f

2.2.2. Effect of nitrogen fertilization

Data given in Table (31) indicated that only dry gluten and protein percentages significantly affected by nitrogen levels. The application of N levels in four equal doses up to 75 kg N/fed and 100 kg N/fed raised values of protein percentage and dry gluten percentage, respectively. These results explain the role of N in increasing the quality of wheat grain, and agree with those obtained by **Degidio *et al.* (1983a, b)**, **Giorgio *et al.* (1989)** and **Rizzo *et al.* (1990)**, who found that protein content increased with increasing N. Also, **Barnard *et al.* (1981)** found that N application of successive growth stages increased grain protein as well as wet and dry gluten content.

Table (31): The average values of quality characters of wheat grains as affected by nitrogen fertilizer in 1997/98 season.

Varieties	Semolina %	Dry gluten %	Wet gluten %	Protein %
N1	77.636 a	21.10 b	31.636	12.88 c
N2	78.764 a	24.24 a	35.957	12.95 b
N3	81.186 a	21.24 b	34.079	13.27 a

Table (32): The average values of chemical compounds of whcat grains as affected by the interaction between variety x nitrogen in 1997/1998 season.

Varieties	Semolina %			Dry gluten %			Wet gluten %			Protein %		
	N1	N2	N3	N1	N2	N3	N1	N2	N3	N1	N2	N3
Bani Sewef 1	75.40	83.20	84.85	14.95	23.80	20.95	22.80	35.55	34.00	11.09	12.86	14.69
Bani Sewef 2	88.89	74.05	76.95	19.05	24.75	25.10	29.30	37.39	37.15	14.02	14.77	13.86
Bani Sewef 3	72.15	80.50	85.75	23.90	20.00	24.15	36.15	30.85	37.60	14.95	12.69	15.06
Sohag 1	75.85	77.25	80.45	22.15	25.75	26.90	32.50	39.35	35.45	13.23	13.84	13.96
Sohag 2	80.60	82.65	83.60	25.05	28.05	24.30	37.75	37.30	37.05	14.98	13.09	13.64
Sohag 3	79.60	73.75	75.25	19.95	21.70	12.80	29.70	33.20	32.15	11.90	14.28	12.47
Gemmeiza 3	76.05	79.95	81.45	22.65	25.65	17.65	33.25	38.10	25.15	9.97	9.12	9.27
LSD at 5%		3.16			2.70			4.44			0.04	
1%		4.45			3.81			6.24			0.06	