Minufiya J. Agric. Res. Vol. 28 No. 1: 31 - 57 (2003)

BREEDING STUDIES ON BREAD WHEAT UNDER RAINFED CONDITIONS

I. H. I. Darwish
Agron. Dept., Fac. Agric., Minufiya University

(Received: Nov., 17, 2002)

ABSTRACT: *The aim of this study was to analyze the genetic system covering sixteen traits including heading date, osmotic pressure (OP), no. of stomata mm², relative water content (R.W.C.), leaf area, flag leaf area, plant height, no. of spikes per plant, no. of spiklets per spike, no. of grains per spike, no. of grains per spikelets , spike length, density of spike, grain yield per plant, 1000 kernel weight and protein content.*

Five diverse wheat spring genotypes (Triticum aestivum L. An Thell) were crossed in all possible combinations, excluding reciprocals in 1999/2000 season at Fac. of Agric., Menofiya University, Egypt. The parents and hybrids were sown on normal and late sowing dates under rain-fed conditions only at Fac. of Agric., Ege University, Izmir, Turkey.

Results could be summarized as follows:

1. *Sowing dates mean squares were highly significant for all the studied traits, indicating over all differences between the normal and late sowing dates.*
2. *Mean squares for genotypes and its components, i.e.; parents, crosses and parents vs. crosses were significant for all traits in both sowing dates as well as the combined analysis except crosses mean squares for protein content in late sowing date, parents vs. crosses mean squares for density of spike in late sowing date, and protein content in normal sowing date, indicating wide diversity between the parents used in the present study for these traits. Also, genotypes x sowing dates interaction mean squares were significant for all traits.*
3. *The cross (P2 x P4) for R.W.C., no. of spikelets/spike, no. of kernels/spike, spike length and grain yield/plant gave the best positive heterotic effects. Also, the crosses (P1 x P2) for OP, LA and FLA, (P1 x P3) for HD, (P1 x P4) for no. of spikes/plant and H.D., and (P3 x P4) for no. of stomata/mm² gave the best negative heterotic effects.*
4. *General and specific combining ability mean squares were significant for all studied traits. High GCA/SCA ratio largely exceeded the unity were obtained for most traits in both sowing dates and the combined analysis, indicating that the largest part of the total genetic variability associated with these cases was a result of additive and additive by additive gene action types.*
5. *The interactions between sowing dates and both types of combining ability were significant for all studied traits.*

6. *The parent (P1) was good combiner for heading date in late sowing OP, R.W.C., and 1000 kernel weight. The parent P2 expressed significant desirable (gi) effects for R.W.C., no. of spikes/plant, no. of grains/spike, no. of grains spikelet, density of spike, and grain yield per plant. The parent (P3), had good combiner for heading date, OP, no. of spikelets per spike, spike length, 1000 kernel weight and protein content. The parent (P4) had significant desirable (gi) effects for OP, spike length, heading date, leaf area, and plant height. The parent (P5), seemed to be good combiner for protein content and spike length.*
7. *The crosses (P1 x P4) and (P2 x P4) gave the highest desirable sij effects for grain yield and most studied traits in both sowing dates and the combined analysis.*

Key words: *Wheat, Heterosis, General and Specific Combining Ability, yield, rain-fed., Sowing dates.*

INTRODUCTION

Wheat is one of the most important food crops. It is grown under a wide range of climatic conditions and subjected to various stresses throughout the growing season (Masoud, 1986 and Kheiralla and Sherif, 1992).

Wheat production under rain-fed or minimum irrigation conditions becomes an objective in north coast of Egypt as well as many areas worldwide suffering from the limitations of water supply. Also, breeding for earliness together with maintaining stabilized productivity is a major concern of wheat breeders, especially for its important escape mechanism from terminal heat and drought stresses, and for cropping intensification. Heat stress is known to cause stunted plant growth, reduced tillering and accelerated development and lead to small heads, shriveled grains and low yields.

By using some characters such as days to heading and maturity, plant height and grain yield, we are attempting to find an easily identifiable characters as indices for heat tolerance (Elahmadi, 1993 and Kheiralla *et al.* 2001).

Photosynthetic activity traits and the concept of drought resistance is differently by molecular biologists biochemists, physiologists and agronomists. The major concern is to enhance the biomass return under limited input of water, which is a characteristic feature of rainfed agriculture.

Leaf characteristics could conserve tissue water by stomatal and cuticular functions (Black *et al.*, 1984) as important avoidance characteristics which favour maintenance of higher tissue water content under moisture stress. Breeder practice selection in one environment and evaluated selections in another one. Therefore, it is necessary for breeding materials to be evaluated under different environments. It is important to understand more fully the nature of genotype x environment interaction to make tests and select the more efficient genotype. Nachit and Ketata (1987) and Kheiralla *et al.* (2001) stated that number of days to heading tended to decrease by delaying sowing date. The optimum date of wheat sowing was 10-november in Bornova (Izmir, Turkey) has a close climate to Egypt as Mediterranean Sea climate.

Dessouki *et al.* (1974) reported that the optimum date of wheat sowing was mid-November in lower Egypt and 10 days later in Upper Egypt.

Few studies have been reported on the nature and magnitude of gene action for traits related to wheat productivity under drought and heat stress.

The present study may help wheat breeder for producing new genotypes of high yielding ability under drought and heat stress conditions.

MATERIALS AND METHODS

Five common wheat cultivars and/or lines (*Triticum aestivum* L.), representing a wide range of diversity for several agronomic characters, were selected for drought and heat resistance for the study. The names, pedigree and origin of these cultivars and/or lines are presented in Table (1). The investigation was carried at two locations. In 1999-2000 growing season, grains from each of the parental cultivars and/or lines were sown at various dates in order to overcome the differences in time of heading at Fac. of Agric., Minufiya University, Shebin El-Kom, Egypt. During this season, all possible parental combinations without reciprocals were made between the five parents giving a total of ten crosses.

Table (1): The names and pedigree of the parental varieties and/or lines.

No.	Entry name/cross	Pedigree	Origin
1	Giza 164	KZ2/Buha"s"//Kal/BbCM33029-F-15M-500Y.	Egypt
2		$D6301^2xP_1$ 190982 32D-45-45-ItL-3D-2D-0D	USA
3	PFAU/SERI//Bow	CM85295-0/0/Y-2M-0Y-0m-IY.0M	Mexico
4	UP 2338-OINND 49		Mexico
5	Bacandra T.88 21		Mexico

In 2000/2001 season, the five parental genotypes and their ten F_1 crosses were grown in three replications on two different sowing dates (D_1 = favourable, at 20th of November) and (D_2 = late sowing date, at 15th of December heat stress) under rain-fed only at Faculty of Agric., Ege University, Bornova, Izmir, Turkey.

The experimental plot consisted of one row three meters long with 30 cm between rows and plants within row were 20 cm apart, allowing a total of 15 plants per plot. Dry method of planting was used in this concern. The other cultural practices of growing wheat were practiced.

The mean temperature and relative air humidity as well as the amount of total rainfall during growing season were recorded in Table (2).

The studied traits were heading date (HD) in days, Osmotic pressure (OP, MPa). (estimated by method outlined by Gosev, 1960), number of stomata in mm^2 (N.O.S), relative water content (R.W.C.%) (Determined by method of Barrs and Weathelay, 1962), leaf area (LA, cm^2), flag leaf area (FLA, cm^2), plant height (cm), number of spikes per plant, number of spikelets per spike, number of kernels per spike, number of kernels per spikelet, spike length (cm), density of spike, grain yield per plant (g), 1000-kernel weight (g) and protein content (%).

General and specific combining ability estimates (GCA and SCA) were obtained by employing Griffing's diallel cross analysis (1956) designated as method 2 model I. Heterosis was determined for each cross as the percentage deviation of F_1 mean performance from its mid-parent value. The combined analysis was conducted for the data of the two experiments (sowing dates) according to Cochran and Cox (1957).

Table (2): Comparison between the rain fall in Bornova, Izmir, Turkey during the experimental time (2000-2001) and the average rain fall in Egypt (Alexandria, Rashid) (Av. of 30 years).

Months	Rainfall (ml)		
	Bornova*	Alexandria**	Rashid**
November	38.46	30.10	33.80
December	33.00	52.90	53.50
January	74.90	53.10	65.50
February	90.30	59.50	30.30
March	15.50	15.30	19.80
April	69.20	4.50	6.90
May	28.70	0.70	1.10

* Fac. of Agric., Ege Univ., Turkey.
** Egyptian Meteorological Authority, June 2002.

RESULTS AND DISCUSSION

Analysis of variance and performance of wheat genotypes:

The analysis of variance for the studied characters under normal and late sowing dates is presented in Table (3). The results indicated that sowing dates mean squares were highly significant for all the studied traits, indicating overall differences between normal and late sowing dates.

The mean squares due to genotypes, (parents and F_1 crosses) were highly significant for all traits in both environments as well as the combined analysis, except parents mean squares for protein content in late sowing date, parents vs. crosses mean squares for protein content, in late planting date and density of spike and number of stomata in normal sowing date indicating wide diversity between the parents used in the present study for these traits.

Table (3): The observed mean squares from analysis of variance for all studied traits.

S.O.V.	df		Heading date (days)			Osmotic pressure (MPa)			No. of stomata/mm^2			Relative water content (%)		
	Single	Comb.	I	II	C	I	II	C	I	II	C	I	II	C
S. dates (D)	-	1			3434**			87.1**			5748170**			51.8**
Replication	2	4	0.066	0.155	0.111	0.124	0.067	0.270	46488*	33562	40025	12.85**	1.86	7.83**
Genotype (g)	14	14	11.91**	13.93**	15.2**	4.47**	6.41**	9.71**	376674**	860082**	897254**	43.19**	45.78**	68.64**
Parents (P)	4	4	21.23**	8.57**	24.80**	8.74**	13.40**	21.7**	785625**	1479788**	1637986**	58.23**	80.12**	82.95**
Crosses (F_1's)	9	9	8.82**	15.24**	10.3**	2.24*	2.77**	3.40**	2344734**	502918**	573448**	20.98**	28.44**	44.09**
P.vs.F_1's	1	1	2.50*	23.51**	20.72**	7.51*	11.16**	18.55**	20677	1595936**	848574**	182.9**	64.50**	232.3**
G x D		14			10.65**			1.17**			400080**			20.34**
P x D		4			8.99**			0.445**			315231**			56.39**
F_1's x D		9			13.76**			1.61**			15701**			5.34**
P. vs F_1s x D		1			5.29**			0.119			768039**			15.03**
Error	28	56	0.424	0.608	0.516	0.11	0.051	0.081	8635	22767	15701	2.426	1.075	1.75

Table (3): Cont..

S.O.V.	df		Leaf area (cm^2)			Flag leaf area (cm^2)			Plant height (cm)			No. of spikes per plant		
	Single	Comb.	I	II	C	I	II	C	I	II	C	I	II	C
S. dates (D)	-	1			581.9**			1871**			5491**			446**
Replication	2	4	5.83**	0.53	3.17**	3.03	0.140	1.58	0.29	4.27	2.28	1.36	0.47	0.91
Genotype (g)	14	14	25.51**	31.61**	39.68**	70.03**	61.04**	90.30**	96.7**	38.7**	108.8**	7.47**	4.39**	8.61**
Parents (P)	4	4	44.39**	59.46**	100.68**	118.80**	140.2**	235.6**	56.1**	20.6**	51.0**	3.77**	6.06**	4.78**
Crosses (F_1's)	9	9	14.98**	19.16**	16.92**	54.3**	26.10**	28.8**	90.2**	47.1**	113.9**	4.40**	2.53**	4.71**
P.vs.F_1's	1	1	44.74**	32.24**	0.509	16.68**	59.40**	69.51**	317.3**	36.1**	383.8**	49.8**	14.4**	58.9**
G x D		14			17.44**			40.76**			27.3**			3.25**
P x D		4			3.126**			233.6**			25.6**			5.05**
F_1's x D		9			17.22**			52.3**			23.2**			2.22**
P. vs F_1s x D		1			76.46**			6.6			69.7**			5.33**
Error	28	56	1.291	0.696	0.993	3.45	1.20	2.32	1.17	1.60	1.38	0.379	0.728	0.554

I = Normal sowing date, II = Late sowing date, C = Combined analysis

*and ** significant at 5%, 1%, respectively

Table (3): Cont..

S.O.V.	df		No. of spikelets per spike			No. of grains per spike			No. of grains per spikelet			Spike length (cm)		
	Single	Comb.	I	II	C	I	II	C	I	II	C	I	II	C
S. dates (D)	-	1			11.92**			1432**			1.88**			33.67**
Replication	2	4	0.183	0.091	0.318	7.67	1.73	4.70	0.0012	0.0013	0.0012	0.310	0.158	0.234
Genotype (g)	14	14	6.09**	1.956**	5.54**	123.5**	145.9**	291.3**	0.239**	0.215**	0.352**	4.21**	3.09**	6.98**
Parents (P)	4	4	6.413**	0.704	3.1**	101.5**	85.1**	146.8**	0.213**	0.118**	0.216**	8.50**	7.74**	16.08**
Crosses (F_1's)	9	9	3.90**	1.99**	4.15**	194.8**	181.6**	353.5**	0.259**	0.274**	0.451**	1.90**	0.617**	2.106**
P.vs.F_1's	1	1	23.69**	6.58**	22.78**	272.8**	69.1**	308.6**	0.174**	0.014**	0.016**	7.81**	6.87**	14.54**
G x D		14			2.46**			28.26			0.103**			0.316
P x D		4			4.02**			39.82**			0.113**			0.169
F_1's x D		9			1.75**			22.53**			0.082**			0.91
P. vs F_1s x D		1			2.71**			33.56**			0.233**			0.214
Error	28	56	0.281	0.303	0.292	3.145	3.095	3.12	0.013	0.016	0.00145	0.057	0.193	0.158

Table (3): Cont..

S.O.V.	df		Density of spike			Grain yield per plant (g)			1000-kernel weight (g)			Protein content (%)		
	Single	Comb.	I	II	C	I	II	C	I	II	C	I	II	C
S. dates (D)	-	1			0.425**			10685			1556.9**			8.25**
Replication	2	4	0.0014	0.0083	0.00485	9.11	1.65	5.36	2.55	0.81	1.68	0.021	0.11	0.065
Genotype (g)	14	14	0.149**	0.207**	0.334**	219.4**	55.3**	218.9**	93.0**	111.2**	161.8**	1.19**	0.899**	1.27**
Parents (P)	4	4	0.387**	0.602**	0.964**	44.59**	45.15**	40.76**	61.85**	217.6**	219.7**	0.854**	0.096	0.95**
Crosses (F_1's)	9	9	0.0498**	0.050*	0.076**	255.8**	46.30**	242.1**	105.7**	64.9**	130.1**	1.473**	0.698**	2.17**
P.vs.F_1's	1	1	0.093**	0.04	0.128**	590.5**	189.30**	724.3**	104.0**	101.8**	214.9**	0.007	5.14**	5.14**
G x D		14			0.023**			55.71**			42.43**			0.761**
P x D		4			0.025**			45.97**			59.68**			0.555**
F_1's x D		9			0.024**			60.1**			40.52**			0.672**
P. vs F_1s x D		1			0.005			55.47**			0.301			2.394**
Error	28	56	0.0041	0.012	0.0078	2.85	1.32	2.08	2.046	2.599	2.322	0.034	0.079	0.056

Genotypes x sowing dates, parent x sowing dates and F_1 x sowing dates means squares were significant for all traits except spike length. Significant P. vs. crosses x sowing dates mean squares were detected for all traits except osmotic pressure, spike length, density of spike, flag leaf area and 1000-kernel weight.

These results indicated that wheat genotypes responded differently to the drought and heat stresses, suggesting the importance of assessment of wheat genotypes under different environments. These results agree with those reported by Abdel-Karim (1998), Darwish (1998), El-Morshidy *et al.* (2001) and El-Gamal (2002).

The mean performance of genotypes for all traits studied in both sowing dates (normal and late sowing dates) as well as the combined analysis are presented in Table (4).

The parent (P_1) gave the lowest value for number of stomata in both sowing dates as well as the combined analysis, while, it was gave the highest values for R.W.C. in normal sowing date and the combined analysis, leaf area, flag leaf area in both sowing dates and their combined and grain yield per plant in late sowing date. The parent P_2 gave the lowest values for plant height in late sowing date, while, it gave the highest values for number of stomata in normal sowing date, number of kernels per spike, and density of spike in both sowing dates and their combined, grain yield, in the combined and number of spikelets per spike in normal as well as the combined analysis and protein content in late sowing dates. The parent P_3 gave the lowest values for plant height in normal sowing date, while it gave the highest values, relative water content (R.W.C.) in late sowing date, 1000 kernel weight, in both sowing dates and their combined and protein content in normal sowing date and the combined analysis.

The parent P_4 gave the least days for heading date in both sowing dates as well as the combined analysis, leaf area in late sowing date and plant height in late sowing and combined data. While, it gave the highest values for osmotic pressure, spike length in both treatments and the combined analysis, number of spikes and grain yield per plant in normal sowing date.

The parent P_5 gave moderate values for most traits except low values for no. of spikelets/spike in normal sowing dates, no. of grains/spikelet and protein in late sowing date and grain yield in the combined analysis. While, it gave the tallest plant in both dates and combined and high number of stomata in combined analysis.

The hybrids mean values were within the range of parental genotypes in most cases.

For heading date, the cross P_3 x P_4 in normal sowing date, the crosses P_1 x P_3, P_1 x P_4 and P_2 x P_4 in late sowing date, and the cross P_1 x P_4 in the combined analysis, exhibited the low values for this trait.

Table 4: The genotypes mean performance for all studied traits.

	Heading date (days)			Osmotic pressure (MPa)			No. of stomata/mm²			Relative water content (%)		
	I	II	C	I	II	C	I	II	C	I	II	C
P_1	129	114.6	121.8	14.2	12.3	13.3	3603	3491	3547	71.0	68.3	69.7
P_2	130	117.6	123.8	10.73	8.3	9.5	4984	4446	4715	70.5	63.7	67.1
P_3	125.6	114.0	119.8	14.4	12.8	13.6	4516	5273	4894	62.3	71.3	66.8
P_4	123.3	113.6	118.4	15.1	13.5	14.3	4117	5226	4671	61.7	57.7	59.7
P_5	12[illegible].7	123.0	124.8	13.0	10.1	11.6	4437	4559	4498	67.3	64.6	65.9
$P_1 \times P_2$	127.6	114.6	121.1	14.7	13.3	13.9	4753	5279	5016	70.0	65.0	67.5
$P_1 \times P_3$	126.[illegible]	111.6	119.1	15.2	13.8	14.5	4571	4918	4744	70.7	67.0	68.9
$P_1 \times P_4$	126.0	111.0	118.5	13.9	12.7	13.3	4264	4824	4544	71.3	70.0	70.7
$P_1 \times P_5$	127.7	113.3	120.5	13.9	12.8	13.4	4386	4811	4598	69.0	65.7	67.4
$P_2 \times P_3$	127.0	116.3	121.7	14.3	11.1	12.7	3590	5865	4727	74.7	73.0	73.9
$P_2 \times P_4$	128.6	109.6	119.1	13.6	13.3	13.5	4021	4918	4469	74.3	71.6	72.9
$P_2 \times P_5$	128.3	116.0	122.2	13.1	10.8	12.0	4524	4860	4692	73.3	68.7	71.0
$P_3 \times P_4$	123.0	114.3	118.7	16.2	12.4	14.3	3950	4257	4103	70.5	64.7	67.6
$P_3 \times P_5$	124.3	115.0	119.7	14.[illegible]	12.0	13.0	4213	5157	4685	66.7	67.0	66.9
$P_4 \times P_5$	125.7	115.3	120.5	14.4	12.2	13.3	4137	4896	4516	68.0	64.0	66.0
Mean	126.6	119.2	120.4	14.1	12.1	13.1	4340	4852	4596	69.4	66.8	58.1
L.S.D. 5%	1.073	1.284	1.178	0.546	0.372	0.459	153.11	248.60	200.8	2.566	1.708	2.130
L.S.D. 1%	1.468	1.759	1.610	0.748	0.509	0.628	209.63	340.30	274.9	3.540	2.339	2.926

Table 4: Cont.

	Leaf area (cm²)			Flag leaf area (cm²)			Plant height (cm)			No. of spikes per plant		
	I	II	C	I	II	C	I	II	C	I	II	C
P_1	36.1	37.1	36.6	43.5	37.9	40.7	92.0	72.3	82.2	9.0	6.3	7.7
P_2	29.4	28.5	29.0	37.2	22.8	30.0	87.0	78.3	82.6	11.3	8.7	9.9
P_3	26.3	25.5	25.9	27.8	20.8	24.3	84.3	75.6	79.9	9.7	6.7	8.2
P_4	28.5	23.5	26.0	36.5	22.4	29.5	87.0	72.0	79.5	11.7	4.7	8.2
P_5	32.9	30.8	31.8	40.6	28.8	34.7	95.0	78.3	86.6	10.7	6.7	8.7
$P_1 \times P_2$	36.3	21.4	28.8	39.8	23.7	31.8	80.3	71.0	80.7	12.0	6.7	9.3
$P_1 \times P_3$	32.6	25.6	29.1	[illegible].4	26.5	30.0	92.7	76.0	84.4	11.0	7.0	9.0
$P_1 \times P_4$	35.1	25.4	3[illegible].2	[illegible]	28.4	33.7	100.0	83.0	91.5	14.7	9.0	11.8
$P_1 \times P_5$	35.2	28.5	[illegible]1.9	42.[illegible]	28.0	35.1	105.0	82.3	93.7	11.7	9.3	10.5
$P_2 \times P_3$	29.4	30.3	29.8	28.[illegible]	33.5	31.9	101.0	78.0	89.5	12.3	7.0	9.7
$P_2 \times P_4$	33.5	28.4	31.0	41.4	27.6	34.5	95.0	81.3	88.2	13.7	8.0	10.8
$P_2 \times P_5$	31.2	28.3	29.8	[illegible]	31.3	35.1	91.7	81.0	86.4	13.0	8.7	10.8
$P_3 \times P_4$	32.1	21.2	26.6	[illegible]	32.6	36.5	89.0	75.0	82.0	11.7	7.3	10.5
$P_3 \times P_5$	31.6	25.[illegible]	28.7	35.[illegible]	27.6	31.5	89.3	74.3	86.8	11.3	7.3	9.3
$P_4 \times P_5$	33.2	25.3	29.2	38.[illegible]	29.[illegible]	34.0	93.0	76.0	84.5	13.7	7.7	10.7
Mean	32.15	27.1	29.6	37.[illegible]	28.[illegible]	32.6	92.8	77.2	85.0	12.0	7.4	9.7
L.S.D. 5%	1.872	1.[illegible]70	1.623	3.06	1.[illegible]5	2.[illegible]32	1.782	2.084	1.933	1.014	1.405	1.209
L.S.D. 1%	2.563	1.[illegible]82	2.222	4.19	[illegible].471	3.336	2.44	2.853	2.646	1.388	1.924	1.656

Table 4: Cont.

	No. of spikelets per spike			No. of grains per spike			No. of grains per spikelet			Spike length (cm)		
	I	II	C	I	II	C	I	II	C	I	II	C
P_1	20.6	19.4	20.0	59.3	55.4	57.4	2.88	2.76	2.82	11.85	10.73	11.29
P_2	21.4	20.5	21.0	71.7	63.3	67.5	3.35	3.08	3.22	8.52	7.40	7.96
P_3	21.2	20.6	20.9	56.4	58.0	57.2	2.66	2.91	2.78	12.57	10.97	11.77
P_4	21.2	17.3	19.3	60.5	49.1	54.8	2.80	2.73	2.76	12.58	11.20	11.89
P_5	20.3	20.7	20.5	62.0	53.0	57.5	3.06	2.56	2.81	11.70	11.00	11.35
$P_1 \times P_2$	21.8	20.7	21.2	66.1	55.8	60.9	3.04	2.67	2.85	10.85	10.65	10.74
$P_1 \times P_3$	21.4	19.0	20.2	57.0	50.0	53.5	2.65	2.63	2.64	11.61	10.73	11.17
$P_1 \times P_4$	22.2	20.3	21.2	72.1	62.3	62.2	3.25	2.55	2.90	12.96	11.00	11.98
$P_1 \times P_5$	21.1	21.9	21.5	63.7	53.3	58.5	2.99	2.39	2.69	12.17	11.00	11.58
$P_2 \times P_3$	22.5	22.6	22.5	76.3	73.5	74.9	3.38	3.34	3.36	12.46	10.57	11.51
$P_2 \times P_4$	23.5	22.5	23.0	80.4	69.2	74.8	3.42	3.04	3.23	12.86	11.63	12.25
$P_2 \times P_5$	21.4	21.9	21.6	74.3	63.7	69.0	3.48	2.90	3.19	11.51	10.64	11.08
$P_3 \times P_4$	21.5	21.2	21.4	60.3	56.0	58.2	2.81	2.66	2.74	13.44	11.71	12.57
$P_3 \times P_5$	21.5	22.0	21.7	59.0	57.7	55.4	2.75	2.34	2.55	12.53	11.30	11.92
$P_4 \times P_5$	20.6	22.4	20.5	63.0	55.0	59.0	3.07	2.69	2.88	12.90	11.63	12.26
Mean	21.5	20.7	21.1	65.48	57.5	61.49	3.04	2.75	2.895	12.03	10.81	11.42
L.S.D. 5%	0.873	0.906	0.889	2.922	2.898	2.910	0.1878	0.208	0.1979	0.393	0.7238	0.558
L.S.D. 1%	1.195	1.242	1.218	4.000	3.968	3.984	0.2570	0.285	0.271	0.538	0.991	0.764

Table 4: Cont.

	Density of spike			Grain yield/plant (g)			1000-kernel weight (g)			Protein content (%)		
	I	II	C	I	II	C	I	II	C	I	II	C
P_1	1.74	1.81	1.78	32.5	16.1	24.3	45.3	42.2	43.7	15.96	14.52	15.24
P_2	2.51	2.78	2.65	35.6	14.5	25.1	36.7	27.7	32.2	15.31	14.68	14.99
P_3	1.69	1.88	1.78	31.4	15.6	23.5	49.0	46.3	47.6	16.12	14.36	15.24
P_4	1.69	1.69	1.65	36.0	7.3	21.6	43.7	28.5	36.1	14.78	14.52	14.66
P_5	1.73	1.88	1.81	26.4	10.6	18.5	42.0	31.0	36.5	15.45	14.21	14.83
$P_1 \times P_3$	2.01	1.95	1.98	34.7	12.5	23.6	39.1	35.3	37.2	13.67	14.71	14.19
$P_1 \times P_3$	1.85	1.77	1.81	37.1	15.7	26.4	56.6	44.6	50.6	15.65	15.00	15.33
$P_1 \times P_4$	1.71	1.86	1.78	54.3	21.9	38.1	56.1	40.8	48.5	15.80	16.12	15.96
$P_1 \times P_5$	1.74	1.99	1.86	32.3	16.1	24.2	45.0	35.6	40.3	15.74	14.33	15.04
$P_2 \times P_3$	1.86	2.15	2.01	44.3	18.8	31.5	45.6	38.4	42.0	16.12	15.16	15.64
$P_2 \times P_4$	1.83	1.94	1.88	56.9	24.3	40.6	49.0	45.2	47.1	15.57	15.32	15.45
$P_2 \times P_5$	1.85	2.07	1.96	36.4	19.9	28.2	40.0	39.0	39.5	15.48	15.13	15.31
$P_3 \times P_4$	1.59	1.80	1.69	40.6	14.9	27.8	46.8	30.1	38.5	15.43	15.00	15.22
$P_3 \times P_5$	1.71	1.95	1.83	28.9	14.3	21.6	45.6	40.0	42.8	15.96	15.40	15.68
$P_4 \times P_5$	1.60	1.75	1.67	35.2	13.1	24.2	43.0	34.3	38.7	16.10	15.56	15.81
Mean	1.80	1.94	1.87	37.5	15.8	26.6	37.5	31.4	34.5	16.1	14.93	15.23
L.S.D. 5%	0.1055	0.180	0.142	2.781	1.893	2.340	2.356	2.656	2.506	0.304	0.463	0.383
L.S.D. 1%	0.144	0.247	0.195	3.80	2.591	3.195	3.226	3.636	3.431	0.415	0.634	0.524

For osmotic pressure, the two crosses P_1 x P_3 and P_3 x P_4 in both normal and late sowing dates as well as the combined analysis exhibited the highest values for this trait.

For number of stomata, the lowest values were detected from cross P_2 x P_3 in normal sowing date and the cross P_3 x P_4 in late sowing date and their combined, while the highest values were detected from the cross P_1 x P_2 in normal sowing date and combined data and the cross P_2 x P_3, in late sowing date.

For relative water content (R.W.C), the two crosses P_2 x P_3 and P_2 x P_4 in both sowing dates as well as the combined analysis expressed the highest values.

For leaf area, the cross P_3 x P_4 in late sowing date and combined data and cross P_2 x P_3 in normal sowing date expressed the lowest values.

For flag leaf area, the lowest values were revealed from the crosses P_2 x P_3 in normal sowing date, P_1 x P_2 in late sowing date and P_1 x P_3 in the combined data.

For plant height, the crosses P_3 x P_4 and P3 x P5 in normal sowing date and P_1 x P_2 in late sowing and combined data in late sowing date expressed the lowest values, while the cross P_1 x P_5 in normal and late sowing dates as well as the combined analysis expressed the highest values.

For number of spikes per plant, the cross P_1 x P_4 in normal, and late sowing dates as well as the combined analysis, expressed the highest values.

For number of spikelets per spike, the cross P_3 x P_4 in normal and late sowing as well as the combined analysis expressed the highest values.

For number of grains per spike, the crosses P_2 x P_3 in sowing dates as well as the combined analysis, and the cross P_2 x P_4 in normal sowing date and combined data, exhibited the highest values.

For number of grains per spikelet, the cross P_2 x P_3, in both sowing dates as well as the combined analysis, the cross as P_2 x P_4 and P_2 x P_5 in normal sowing date expressed the highest values.

The cross P_3 x P_4 had the high values for spike length in both sowing dates as well as the combined analysis.

For the density of spike, the crosses P_1 x P_2 in normal sowing date and P_2 x P_3 in late sowing date and combined data, gave the highest values.

For grain yield per plant, the cross P_2 x P_4, at normal and late sowing dates as well as the combined analysis, and the cross P_1 x P_4, at normal sowing date, gave the highest values.

For 1000-kernel weight, the crosses P_1 x P_3 in normal and late sowing dates and their combined, P_1 x P_4 in normal sowing date and the cross P_2 x P_4 in late sowing date, expressed the highest values.

For protein content, the cross P_4 x P_5 at normal and late sowing dates as well the combined analysis, P_2 x P_3 at normal sowing date and P_1 x P_4 at late sowing date and combined data, gave the highest values.

Heterosis:

Mean squares for parents vs. crosses as an indication to average heterosis over all crosses were significant for all traits in both sowing dates as well as the combined analysis, except number of stomata and protein content in normal sowing date, and density of spike in late sowing date. F_1 mean performance were significantly higher than parental mean values for all measurements except spike length. Significant interaction mean squares between parents vs. crosses and sowing date were detected for all traits except OP, FLA, spike length, density of spike and 1000-kernel weight. These results indicated that heterotic effects were affected by the sowing dates.

Heterosis expressed as the percentage deviation of F_1 mean performance from the mid-parent values for all the studied measurements at both sowing dates and their averages are presented in Table (5).

For heading date, three, five and four crosses expressed significant negative heterotic effects relative to mid-parent in the normal, late sowing dates as well as the combined analysis, respectively. The best cross recorded was P_1 x P_3 (-1.45%). Significant negative heterotic effect for earliness was previously detected by Hendawy (1990), Darwish (1992), and Ashoush *et al.* (2001).

For osmotic pressure; six, seven and six crosses exhibited significant positive heterotic effects relative to mid-parent in the normal, late sowing date as well as the combined analysis, respectively. The best cross recorded was P_1 x P_2 (23%). The extent of osmotic adjustment with prolonged stress or repeated stress cycles was limited (Cutler *et al.*, 1980). Genetic variation in osmotic adjustment was found in wheat (Fischer and Sanchez, 1979 and Darwish, 1998 and El-Gamal, 2002).

For number of stomata; five, one and three crosses expressed significant negative heterotic effects relative to mid-parent in normal, late sowing date as well as the combined analysis, respectively. The best cross recorded was P_3 x P_4 (-13.6%). While, four, seven and six crosses exhibited significant positive heterotic effects relative to mid-parent in the same order.

For relative water content; seven, five and six crosses exhibited significant positive heterotic effects relative to mid parent in normal, late sowing dates as well as the combined analysis, respectively. The best cross recorded was P_2 x P_4 (15.3%). The reduction in RWC under water stress condition was explained by Gawish (1992).

Genetic variation in RWC was found in wheat (Collinson *et al.*, 1997; Darwish, 1998 and El-Gamal, 2002). They reported that the RWC in bean leaves decreased as the level of soil moisture decreased and this may be due to relatively low root ability to absorb water from the soil decreased hydraulic conductivity of soil under drought condition, which reflected in reduction of plant growth.

Table 5: Percentages of heterosis over mid-parent (m.p) for all studied traits.

	Heading date			Osmotic pressure			No. of stomata/mm^2			Relative water content		
	I	II	C	I	II	C	I	II	C	I	II	C
$P_1 \times P_2$	-1.46*	-1.291*	-1.4**	17.609**	28.46**	23.0**	10.71**	33.0**	27.2**	1.060	1.493	1.28
$P_1 \times P_3$	-0.549	-2.362**	-1.45**	6.290**	9.52**	8.1**	12.61**	12.23**	12.4**	5.920**	-4.032**	0.94
$P_1 \times P_4$	-0.1189	-2.716**	-1.42**	-4.780**	-1.31	-3.0*	10.46**	10.69**	10.5**	7.430**	11.146**	9.3**
$P_1 \times P_5$	-0.102	-1.83**	-0.96	2.426	13.98**	8.2**	9.10**	19.52**	14.3**	0.238	-1.96	-0.86
$P_2 \times P_3$	0.625	0.43	0.53	14.040**	4.68**	9.4**	-2.69	20.70**	9.0**	12.42**	8.148**	10.28**
$P_2 \times P_4$	1.539**	-6.19**	-1.83**	5.460**	22.01**	13.7**	-11.62**	1.69	-4.96**	12.430**	18.12**	15.30**
$P_3 \times P_5$	-0.027	-0.812	-0.42	10.660**	17.00**	13.8**	-3.94**	7.95**	2.0*	6.406**	7.03**	6.70**
$P_3 \times P_4$	-1.165**	0.439	-0.36	9.970**	-5.59**	2.19	-8.48**	-18.8**	-13.8**	13.72**	0.2558	6.98**
$P_3 \times P_5$	-1.43**	-0.130	-0.78	2.700	4.66**	3.68*	-5.87**	4.902*	-0.48	2.838	-1.416	2.13
$P_4 \times P_5$	0.549	0.330	0.44	2.630	3.38*	3.0	-3.27*	0.08	-1.6*	6.430**	4.669**	5.05**

Table 5: Cont.

	Leaf area			Flag leaf area			Plant height			No. of spikes per plant		
	I	II	C	I	II	C	I	II	C	I	II	C
$P_1 \times P_2$	10.70**	-34.81**	-12.1**	-2.12	-21.8**	-11.9**	0.927	7.55**	4.24**	18.22**	-11.14	3.5
$P_1 \times P_3$	4.46	-18.24**	-6.89**	-5.05	-9.87**	-7.5**	5.10**	0.728	2.9**	17.84**	8.10	12.9*
$P_1 \times P_4$	8.54**	-16.35**	-3.9	-2.861	-5.96*	-4.4	11.73**	12.69**	12.2**	42.01**	63.78**	52.8**
$P_1 \times P_5$	1.97	-16.09**	-7.0**	0.190	-15.93**	-7.8*	12.29**	7.17**	9.7**	18.65**	44.53**	31.6**
$P_2 \times P_3$	5.64	13.84**	9.69**	-11.6**	53.5**	20.9**	17.90**	1.36	9.6**	17.59**	8.61	13.1*
$P_2 \times P_4$	15.62**	9.14**	12.40**	12.347**	22.07**	17.2**	9.19**	8.23**	8.7**	18.98**	20.12*	19.6*
$P_2 \times P_5$	2.95	-4.44**	-0.75	0.02	21.5**	11.3**	0.736	3.42**	2.08	18.34**	13.18	15.7
$P_3 \times P_4$	16.95**	-13.36**	1.78	27.41**	50.82**	39.1**	3.89**	1.626	2.76**	28.08**	29.50**	28.8**
$P_3 \times P_5$	6.71*	2.928	4.82	4.737	11.31**	8.0**	-0.368	-3.42**	-1.89	11.4*	10.06	10.7
$P_4 \times P_5$	7.83**	-6.90**	0.46	0.641	15.55**	8.09*	2.197*	1.11	1.65	22.46**	35.51**	28.9**

Table (5) Cont.

	No. of spikelets/spike			No. of grains/spike			No. of grains/spikelets			Spike length		
	I	II	C	I	II	C	I	II	C	I	II	C
$P_1 \times P_2$	3.65	3.71	3.68	0.86	-6.12	-2.13	2.538	-8.758**	-3.1	6.529**	17.15**	11.84**
$P_1 \times P_3$	-5.04**	2.63	-1.2	1.494	-11.78*	-5.14	29.51**	-7.329*	11.10*	-4.91**	-1.105	-3.01
$P_1 \times P_4$	10.74**	6.13**	8.4**	20.35**	0.136	10.24**	14.46**	-7.27*	3.6	6.09**	-0.319	2.88
$P_1 \times P_5$	8.99**	3.52	6.2**	4.96*	-1.62	1.67	0.841	-10.18**	-4.67	3.354	1.242	2.298
$P_2 \times P_3$	9.58**	5.30**	7.4**	19.15**	21.27**	20.2**	12.54**	11.51**	12.03**	18.16**	15.07**	16.60**
$P_2 \times P_4$	19.16**	10.32**	14.7**	21.15**	23.17**	22.2**	11.18**	4.61	7.89**	21.89**	25.05**	23.40**
$P_2 \times P_5$	6.37**	2.40	4.39**	11.16**	9.58*	10.3**	8.54**	2.945	5.74**	23.74**	15.65**	19.60**
$P_3 \times P_4$	12.20**	3.47	7.84**	3.03	4.575	3.80	2.89	-5.707	-1.4	6.87**	5.63	6.25
$P_3 \times P_5$	6.60**	3.52	5.06**	0.337	-6.84	-3.25	-3.88	-14.23**	-9.06**	3.25*	2.867	3.06
$P_4 \times P_5$	7.39**	-0.627	3.40*	2.84	7.73	5.28	4.88	1.96	3.42	6.26**	4.77	5.52

Table 5: Cont.

	Density of spike			Grain yield/plant			1000-kernels weight			Protein content (%)		
	I	II	C	I	II	C	I	II	C	I	II	C
$P_1 \times P_2$	-6.7**	-15.03**	-10.86**	1.908	-18.3**	-8.19	-4.52	0.901	-1.8	-12.56**	-6.36**	-9.46**
$P_1 \times P_3$	7.87**	-4.06	1.90	16.11**	-0.946	7.58	16.69**	0.734	8.7**	-2.43**	8.39**	2.97*
$P_1 \times P_4$	-0.291	6.28	2.99	58.54**	87.1**	72.82**	26.06**	15.22**	20.60**	2.797**	8.81**	5.8**
$P_1 \times P_5$	0.268	7.86	4.06	9.67**	20.59**	15.13**	3.09	-2.58	0.26	0.197	9.57**	4.88**
$P_2 \times P_3$	-11.42**	-7.72*	-9.57**	32.2**	24.91*	28.55**	6.45	3.75	5.1	2.57**	11.02**	6.79**
$P_2 \times P_4$	-12.85**	-12.66**	-12.75**	58.93**	122.93**	90.93**	14.39**	60.79**	37.6**	3.48**	6.64**	5.06**
$P_2 \times P_5$	-12.73**	-11.15**	-11.94**	17.41**	59.12**	38.26	-0.46	32.97**	16.28**	0.65	7.20**	3.93**
$P_3 \times P_4$	-5.91*	0.84	-2.53	20.47**	30.13**	25.3**	1.036	-19.51	-9.24	-0.129	7.60**	3.74**
$P_3 \times P_5$	0.05	5.31	2.68	0.04	9.16**	4.6	21.97**	3.54	12.75	1.108**	11.72**	6.41**
$P_4 \times P_5$	-6.43*	-1.96	-4.19	12.82**	46.70**	29.76**	35.0**	18.37**	26.70**	6.25**	11.79**	9.02**

For leaf area, seven and three crosses expressed significant negative heterotic effects relative to mid-parent in late sowing date and the combined analysis, respectively. The best cross recorded was P_1 x P_2 (-12.1%). While, six, two and two crosses expressed significant positive heterotic effects relative to mid-parent value in the normal, late sowing date as well as the combined analysis in the same order.

For flag leaf area, one, four and three crosses expressed significant negative heterotic effects relative to mid-parent in the normal, late sowing dates as well as the combined, respectively. The best cross recorded was P_1 x P_2 (-11.9%). While, two, six and six crosses expressed significant positive heterotic effects relative to mid-parent value in the normal, late sowing date as well as the combined analysis in the same order.

For plant height, seven, five and seven hybrids exhibited significant positive heterotic effects relative to mid-parent in the normal, late sowing dates as well as the combined analysis, respectively. The best cross recorded was P_1 x P_4 (12.2%). Significant positive heterotic effects were previously reached by Darwish (1992); Ashoush (1996) and Ashoush *et al.* (2001).

For number of spikes per plant, ten, five and seven hybrids exhibited significant positive heterotic effects relative to mid-parent in the normal late sowing dates as well as the combined analysis, respectively. The best cross recorded was P_1 x P_4 (52.8%) Significant positive heterotic effects were previously reported by Darwish (1992), Ashoush (1996) and Ashoush *et al.* (2001).

For number of spikelets per spike; eight, three and eight hybrids exhibited significant positive heterotic effects relative to mid-parent in the normal, late sowing dates as well as the combined analysis, respectively. The best cross P_2 x P_4 (14.7%).

For number of kernels per spike, five, four and five crosses significantly exceeded the mid-parent values in normal, late sowing dates as well as the combined analysis, respectively. Significant positive heterotic effect for number of kernels per spike was also reached by Darwish (1992), Ashoush (1996) and Shoush *et al.* (2001).

For number of kernels per spikelets, five, one and four crosses exhibited significant positive heterotic effects relative to mid-parent in the normal late sowing dates as well as the combined analysis, respectively. The best cross recorded was P_2 x P_4 (22%).

Concerning spike length seven, four and four crosses significantly exceeded mid-parent value in the normal and late sowing dates as well as the combined analysis, respectively. The best cross recorded was P_2 x P_4 (23.4%). These results are in agreement with those of Ashoush (1996) and Ashoush *et al.* (2001).

Concerning grain yield per plant, eight, seven and six crosses significantly positive exceeded mid-parent value in the normal, late sowing dates as well as the combined analysis, respectively. The best cross recorded P_2 x P_4 (90.9%). These hybrids exhibited heterosis for one or more of traits contributed grain yield. This finding agrees with the general trend where the expression of heterosis 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 under stresses condition. Significant heterotic effects for grain yield was also reached by Darwish (1998) and El-Gamal (2002).

Four 1000-kernel weight, five, four and five crosses showed significant positive heterotic effects relative to mid-parent in the normal, and late sowing dates as well as the combined analysis, respectively.

For protein content, five, nine and nine crosses showed significant positive heterotic effects relative to mid-parent in the normal, and late sowing dates as well as the combined analysis, respectively. The best cross recorded P_1 x P_3 (10%).

Table (6) presents the mean squares for combining ability (GCA, SCA and ratio) for the studied traits in both sowing dates (normal and late) and the combined analysis.

The mean squares associated with general and specific combining ability were significant for all studied traits. High GCA/SCA ratios largely exceeded the unity were obtained for all studied traits, except plant height and protein content in both sowing dates and the combined analysis, number of spikes per plant in late sowing and the combined analysis, flag leaf area in late sowing date, indicating that the largest part of the total genetic variability associated with those traits was a result of additive and additive x additive types of gene action. The genetic variance mostly due to additive types was previously reported by Chowdhry *et al.* (1996), Ashoush (1996), Darwish (1998) and El-Gamal (2002).

The mean squares of interaction between sowing dates and both types of combining ability were significant for all traits, except spike length in SCA x sowing date, indicating that the magnitude of all types of gene action varied from sowing date to another. It is fairly evident that ratios for SCA x sowing dates/SCA was much higher than ratios of GCA x sowing dates GCA for all measurements, except plant height, number of spikes per plant and protein content. Such result indicated that non-additive gene effects were more influenced by the sowing dates. Specific combining ability studied by several investigators was more sensitive to environmental changes than GCA (Gilbert, 1958 and Darwish, 1998).

General combining ability effects ($\hat{g}_i$) of each parent for all traits studied at normal and late sowing dates as well as the combined analysis in Table (7). Such effects are being used to compare the average performance of each variety with other varieties and facilitate selection of varieties for further improvement to drought and heat resistance.

Table (6): Observed mean squares for general and specific combining ability from diallel cross analysis for all studied traits.

S.O.V.	Df		Heading date			Osmotic pressure			No. of stomata/mm²			Relative water content		
	I	II	I	II	C	I	II	C	I	II	C	I	II	C
Rep.	2	4	0.066	0.155	0.111	0.124	0.067	0.0955	46488	33562	40025	12.85**	1.86	7.83*
Gen.	14	14	11.91**	13.93**	15.2**	4.47**	6.41**	9.71**	376674**	860082**	897254**	43.19**	45.78**	68.64
GCA	14	4	35.27**	19.35**	160.1**	10.25**	13.59**	23.05**	679738**	850707**	1130266	55.44**	52.14**	69.38**
SCA	10	10	2.57**	11.75**	55.5**	2.16**	3.53**	4.38**	255448**	863832**	804049**	38.29**	43.24**	38.34**
GCAxD		4			14.0**			0.79**			400080**			38.2**
SCAxD.		10			8.8**			1.323**			315231*			43.19**
Er.	28	56	0.424	0.608	0.516	0.11	0.051	0.0806	8635	22767	15701	2.46	1.75	1.75
GCA/SCA			13.72	1.64	2.88	4.7	3.84	5.3	2.66	0.984	1.4	1.44	1.2	1.8

Table (6): Cont.

S.O.V.	Df		Leaf area			Flag leaf area			Plant height			No. of spikes per plant		
	I	II	I	II	C	I	II	C	I	II	C	I	II	C
Rep.	2	4	5.83*	0.53	3.17	3.03	0.142	1.58	0.29	4.27	2.78	1.36	0.47	0.91
Gen.	14	14	25.57**	31.61**	39.68**	70.03**	61.04**	90.30**	96.1**	38.7**	108.8**	7.47**	4.39**	8.61**
GCA	14	4	69.4**	60.18**	112.85**	163.01**	34.22**	150.5**	74.65**	16.46**	68.45**	9.96**	3.176**	5.625
SCA	10	10	8.02**	20.178*	13.05**	32.8**	71.76**	66.7**	105.46**	47.59**	123.9**	6.47**	4.87**	9.798**
GCAxD		4			16.85**			46.67**			22.66**			7.51**
SCAxD.		10			15.03**			38.38**			29.15**			1.554*
Er.	28	56	1.291	0.696	0.993	3.451	1.204	2.327	1.169	1.60	1.384	0.379	0.728	0.554
GCA/SCA			8.6	2.9	8.6	4.96	0.47	2.25	0.71	0.35	0.55	1.54	0.65	0.57

*and ** significant at 5%, 1%, respectively

Table (6): Cont.

S.O.V.	Df		No. of spikelets/spike			No. of grains/spike			No. of grains per spikelet			Spike length (cm)		
	I	II	I	II	C	I	II	C	I	II	C	I	II	C
Rep.	2	4	0.183	0.091	0.318	7.67	1.73	4.070	0.0012	0.0013	0.0012	0.310	0.158	0.234
Gen.	14	14	6.09**	1.956**	5.54**	173.5**	145.9**	291.3**	0.239**	0.215**	0.357**	4.21**	3.09**	6.98**
GCA	14	4	8.05**	2.902**	5.38**	360.51**	283.96**	581.4**	0.565**	0.469**	0.808**	9.86**	6.54**	15.91**
SCA	10	10	5.24**	1.578**	5.603**	98.75**	90.80**	175.2**	0.1098**	0.1137**	0.17**	1.949**	1.707**	3.419**
GCAxD		4			5.57**			63.08**			0.226**			0.463*
SCAxD.		10			1.219**			14.33**			0.053*			0.277
Er.	28	56	0.281	0.303	0.292	3.14	3.095	3.11	0.013	0.016	0.0145	0.057	0.193	0.158
GCA/SCA			1.54	1.84	0.96	3.65	3.13	3.32	5.14	4.12	4.75	5.06	.3.83	4.65

Table (6): Cont.

S.O.V.	Df		Density of spike			Grain yield/plant (g)			1000-kernel weight (g)			Protein content (%)		
	I	II	I	II	C	I	II	C	I	II	C	I	II	C
Rep.	2	4	0.0014	0.0083	0.008	9.11	1.65	5.36	2.55	0.81	1.68	0.021	0.11	0.065
Gen.	14	14	0.149**	0.207**	0.334**	219.4**	55.3**	218.9**	93.0**	111.2**	161.8**	1.19**	0.844**	1.27**
GCA	14	4	0.427**	0.576**	0.975**	169.95**	139.4**	262.1**	341.0**	26.02**	223.25**	1.018**	0.314**	0.398**
SCA	10	10	0.038**	0.060**	0.0765**	62.25**	99.9**	121.82**	170.67**	67.06**	217.25**	1.26**	1.056**	1.624**
GCAxD		4			0.028*			48.33**			143.78**			0.9312**
SCAxD.		10			0.0208*			40.07**			20.47**			0.693**
Er.	28	56	0.0041	0.012	0.0078	2.85	1.32	2.08	2.046	2.599	2.322	0.034	0.079	0.056
GCA/SCA			11.17	9.58	12.75	2.73	1.39	2.15	1.99	1.03	1.02	0.807	0.294	0.245

*and ** significant at 5%, 1%, respectively

Table (7): Estimates of general combining ability effects of parents for all studied traits.

S.O.V.	Heading date (days)			Osmotic pressure (MPa)			No. of stomata/mm^2			Relative water content (%)		
	I	II	C	I	II	C	I	II	C	I	II	C
P_1	0.9142**	-0.781**	0.067	0.255**	0.636**	0.446**	-122.7**	-322.5**	-222.6**	0.918**	0.44**	0.679**
P_2	1.62857**	0.933**	1.281**	-1.021**	-1.064**	-1.047**	264.1**	106.1*	185.9**	2.433**	0.678**	1.556**
P_3	-1.038**	-0.019	-0.529**	0.6076**	0.341**	0.474**	49.9	210.1**	130.0**	-1.334**	1.916**	0.291
P_4	-1.466**	-1.114**	-1.29**	0.560**	0.727**	0.643**	-204.8**	39.3	-82.8	-1.297**	-2.179**	-1.738**
P_5	-0.038	0.981**	0.471*	-0.402**	-0.640**	-0.521**	13.6	-33.0	-9.7	-0.691*	-0.908**	-0.799**
LSD 5% gi	0.0975	0.139	0.118	0.0253	0.0117	0.018	71.15	102.8	86.97	0.558	0.247	0.403
LSD 1% gi	0.1335	0.191	0.162	0.0346	0.065	0.0498	97.4	140.76	119.08	0.764	0.338	0.551
LSD 5% g_i-g_j	0.244	0.350	0.292	0.063	0.0294	0.0462	100.1	162.5	131.3	1.398	0.6198	1.01
LSD 1% g_i-g_j	0.334	0.479	0.406	0.086	0.040	0.063	137.6	222.56	180.08	1.915	0.848	1.382

Table (7): Cont.

S.O.V.	Leaf area (cm^2)			Flag leaf area (cm^2)			Plant height (cm)			No. of spikes per plant		
	I	II	C	I	II	C	I	II	C	I	II	C
P_1	2.64**	1.696**	2.168**	2.410**	1.863**	2.136**	2.152**	0.0286	1.0905**	-0.628**	0.0380	-0.295**
P_2	-0.418**	0.908**	0.245*	-0.051	-0.949**	-0.500	-0.745**	0.685**	-0.0098	0.276**	0.467**	0.3713**
P_3	-2.322**	-1.434**	-1.878**	-4.675**	-0.938**	-2.806**	-2.323**	-1.171**	-1.747**	-0.580**	-0.343**	-0.461**
P_4	-0.517**	-2.169**	-1.128**	0.575	-0.783**	-1.04*	-0.848**	-0.504**	-0.6758**	1.038**	-0.438**	0.300**
P_5	0.617**	0.986**	0.818**	1.746**	0.808**	1.277**	1.724**	1.019**	1.3714**	-0.104*	0.276**	0.086
LSD 5% gi	0.296	0.160	0.228	0.793	0.2769	0.535	0.268	0.368	0.318	0.087	0.167	0.127
LSD 1% gi	0.406	0.219	0.313	1.087	0.379	0.733	0.368	0.504	0.436	0.1193	0.229	0.174
LSD 5% g_i-g_j	0.744	0.401	0.573	1.989	0.694	1.341	0.674	0.922	0.837	0.218	0.419	0.318
LSD 1% g_i-g_j	1.0191	0.549	0.784	2.724	0.950	1.837	0.922	1.263	1.090	0.299	0.574	0.436

Table (7): Cont.

S.O.V.	No. of spikelets/spike			No. of grains/spike			No. of grains per spikelet			Spike length (cm)		
	I	II	C	I	II	C	I	II	C	I	II	C
P_1	-0.5386**	-0.1676**	-0.3531**	-2.189**	-2.787**	-2.488*	-0.0272**	-0.105**	-0.091**	-0.1325**	-0.0064	-0.0694**
P_2	0.6141**	0.4466**	0.5304**	6.820**	6.241**	6.530**	0.255**	0.230**	0.242**	-1.068**	-0.942**	-1.005**
P_3	0.2237**	0.217**	0.1439*	-2.424**	0.308	-1.058**	-0.189**	0.042**	-0.074**	0.425**	0.2007**	0.313**
P_4	-0.778**	0.187**	-0.295**	0.5676	-1.564**	-0.498	-0.0127**	-0.014**	-0.0131**	0.733**	0.517**	0.625**
P_5	0.4699**	-0.534**	-0.0322	-1.270	-2.197**	-1.734**	0.0247**	-0.1525**	-0.064**	0.0441**	0.246**	0.145**
LSD 5% gi	0.064	0.069	0.067	0.722	0.712	0.717	0.0029	0.0036	0.00325	0.0131	0.044	0.028
LSD 1% gi	0.088	0.095	0.092	0.989	0.974	0.982	0.0041	0.0050	0.0045	0.0179	0.06	0.0389
LSD 5% g_i-g_j	0.162	0.174	0.168	1.81	1.784	1.797	0.0075	0.0092	0.00835	0.0328	0.111	0.0719
LSD 1% g_i-g_j	0.222	0.239	0.231	2.478	2.443	2.460	0.0103	0.0126	0.011	0.044	0.152	0.098

Table (7): Cont.

S.O.V.	Density of spike			Grain yield/plant (g)			1000-kernel weight (g)			Protein content (%)		
	I	II	C	I	II	C	I	II	C	I	II	C
P_1	-0.0091**	-0.0628**	-0.0359**	-0.228	0.593	0.1825	2.008**	2.726**	2.367**	-0.689**	-0.058**	-0.0634**
P_2	0.2476**	-0.2855**	0.266**	2.634**	1.461	2.0476**	-3.767**	-1.2008**	-2.484**	-0.254**	0.0105	-0.128**
P_3	-0.0643**	-1.632**	-0.847**	-1.614**	0.083	-0.766**	2.76**	3.429**	3.095**	0.3081**	-0.0476**	0.1778**
P_4	-0.1056**	-0.158**	-0.132**	4.85**	-0.769*	2.041**	1.2609**	-2.01**	-0.375*	-0.1152**	0.2042**	0.0445**
P_5	-0.0686**	-0.0191**	-0.0438**	-5.640**	-1.368**	-2.137**	-2.263**	-1.514**	-0.1888	0.2181**	-1085**	0.0547**
LSD 5% gi	0.00094	0.0027	0.0018	0.470	0.597	0.533	0.655	0.3036	0.479	0.0078	0.018	0.0129
LSD 1% gi	0.00129	0.00377	0.0025	0.644	0.818	0.731	0.897	0.415	0.656	0.01	0.0246	0.017
LSD 5% g_i-g_j	0.0024	0.0069	0.00465	1.179	1.498	1.340	1.643	0.761	1.202	0.02	0.045	0.0325
LSD 1% g_i-g_j	0.0032	0.0094	0.0063	1.615	2.051	1.830	2.245	1.042	1.645	0.027	0.062	0.044

General combining ability effects of parents in this study were found to be significantly different from zero for all traits studied.

High positive or negative values of drought and heat tolerance investigated.

The parental variety P_1 expressed significantly desirable positive ($\hat{g}$) effect for OP, R.W.C. and 1000 kernel weight in normal and late sowing dates as well as the combined analysis. While, it had significantly desirable negative ($\hat{g}_i$) affect for number of stomata in both planting dates and the combined analysis and heading date in late sowing date.

The parent (P_2) expressed significantly prospective positive ($\hat{g}_i$) effect for R.W.C., number of spikes per plant, number of spikelets per spike, number of grains per spike, number of grains per spikelet, density of spike and grain yield in both sowing dates and the combined analysis.

The parent (P_3) gave desirable ($\hat{g}_i$) effects for heading date, OP, number of spikelets per spike, spike length, protein content and 1000-kernel weight in normal and late sowing dates as well s the combined analysis. Also, it seemed to be good combiner for plant height, leaf area and flag leaf area.

The parent (P_4) expressed significantly positive ($\hat{g}_i$) effect for spike length in both sowing dates and the combined analysis and grain yield in normal sowing date and the combined analysis. While, it had significantly negative ($\hat{g}_i$) effects for heading date, leaf area and plant height in both sowing dates and the combined analysis and flag leaf area in late sowing date and combined data.

The parent (P_5) seemed to be good combiner for spike length in both sowing dates and the combined analysis and protein content in normal sowing date and the combined analysis.

Specific combining ability effects of the parental combinations computed for all traits studied in both sowing dates as well as the combined analysis are presented in Table (8).

For heading date, four, four and six parental combinations exhibited significant desirable negative S_{ij} effects in normal and late sowing dates, as well as the combined analysis, respectively. The crosses (P_1 x P_5) and (P_2 x P_4) gave the highest desirable S_{ij} effects for this trait.

For osmotic pressure (OP), four, six and six parental combinations exhibited significant positive S_{ij} effects in normal and late sowing dates as well as the combined analysis, respectively. The crosses P_1 x P_2, P_1 x P_3 andP_2 x P_5 had the highest desirable S_{ij} effects for this trait in both sowing dates as well as the combined analysis.

For number of stomata, three, one and two parental combinations exhibited significant negative S_{ij} effects in normal and late sowing dates as well as the combined analysis, respectively. The crosses P_3 x P_4 and P_2 x P_4 gave the highest desirable S_{ij} effects for this trait.

For relative water content (R.W.C.), three, four and four parental combinations exhibited significant positive S_{ij} effects in normal and late

Table (8): Estimates of specific combining ability effects for crosses studied.

S.O.V.	Heading date			Osmotic pressure			No. of stomata/mm^2			Relative water content		
	I	II	C	I	II	C	I	II	C	I	II	C
$P_1 \times P_2$	-1.4764**	0.2696	-0.603*	1.3746**	1.603**	1.49**	271.426**	650.38**	460.90**	-2.734*	-2.985**	-2.86**
$P_1 \times P_3$	0.190	-1.778**	-0.794**	0.279**	0.732**	0.506**	303.99**	185.34	244.66**	1.664	-2.224**	-0.28
$P_1 \times P_4$	-0.0478	-1.349**	-0.698**	-0.936**	-0.387**	-0.66**	251.75**	261.53*	256.64**	2.226	4.871**	3.55**
$P_1 \times P_5$	-1.476**	-1.111**	-1.293**	0.0222	0.712**	0.367**	154.902**	320.817**	237.8**	-0.6445	-0.738	-0.69
$P_2 \times P_3$	-0.1907	1.174**	0.492*	-0.044	-0.3017**	-0.173**	-31.526	703.10**	335.7**	4.179**	3.585**	3.88**
$P_2 \times P_4$	1.2378**	-5.492**	-2.13**	0.00317	1.546**	0.775**	-378.43**	-72.37	-225.4*	3.807**	6.347**	5.08**
$P_2 \times P_5$	0.1426	-0.1389	-0.0082	0.498**	0.413**	0.46**	-93.288	-58.42	-75.85	2.203	2.071**	2.14*
$P_3 \times P_4$	-1.1095**	1.222**	0.056	0.9746**	-0.692**	0.141**	-235.19**	-838.08**	-536.6**	3.712**	-1.8907**	0.91
$P_3 \times P_5$	-1.9707**	-0.206	-1.09	-0.1968**	0.2077**	0.0055	-190.716**	134.198	-28.3	-0.725	-0.8335	-0.779
$P_4 \times P_5$	0.571**	1.222**	0.896**	-0.777**	0.022	-0.399**	-11.288	44.72	16.72	0.569	0.2616	0.415
LSD 5% S_{ij}	0.407	0.584	0.495	0.1056	0.048	0.0768	129.3	209.8	169.0	2.286	1.013	1.649
LSD 1% S_{ij}	0.557	0.796	0.678	1.446	0.065	0.084	1771.3	287.3	238.0	3.130	1.387	2.258
LSD 5% S_{ij}-S_{iJ}	0.733	1.051	0.892	0.190	0.088	0.139	173.59	281.8	227.0	4.195	1.859	3.027
LSD 1% S_{ij}-S_{iJ}	1.003	1.439	1.221	0.200	0.120	0.190	237.0	385.9	311.0	5.744	2.545	4.140
LSD 5% S_{ij}-S_{ik}	1.466	2.102	1.784	0.380	0.176	0.278	254.0	398.6	326.0	8.391	3.718	5.785
LSD 1% S_{ij}-S_{ik}	2.000	2.879	2.439	0.5209	0.241	0.3809	336.1	545.0	440.0	11.480	5.090	8.280

Table (8): Cont.

S.O.V.	Leaf area			Flag leaf area			Plant height			No. of spikes per plant		
	I	II	C	I	II	C	I	II	C	I	II	C
$P_1 \times P_2$	1.900**	-3.619**	-0.860	-6.178**	-5.24**	-5.71**	-3.938**	-6.852**	-5.39**	0.396**	-1.238**	-0.421
$P_1 \times P_3$	0.1219	-1.762**	-0.820	-1.559	-2.516**	-2.04	0.0143	-0.00019	0.0071	0.254	-0.0952	0.079
$P_1 \times P_4$	0.813	-1.251**	-0.219	-1.309	-0.78	-1.04	3.3	6.333**	4.82**	2.301**	1.999**	2.15**
$P_1 \times P_5$	-0.185	-1.287**	-0.736	2.588	-2.706**	-0.059	8.3**	4.142**	6.22**	0.444*	1.619**	1.03**
$P_2 \times P_3$	0.00048	3.720**	1.86**	-4.192**	7.319**	1.56	11.2**	1.285	6.24**	0.682**	-0.524	0.08
$P_2 \times P_4$	2.302**	2.590**	2.45**	3.69*	1.254	2.47*	3.73**	3.952**	3.846**	0.396*	0.571	0.48
$P_2 \times P_5$	-1.126	-0.632	0.879	0.0195	3.406**	1.71	-2.18**	2.095**	-0.043	0.873**	0.523	0.698*
$P_3 \times P_4$	1.0895	-2.268**	-0.589	7.21**	6.25**	6.73**	2.014**	-0.1906	0.912	1.253**	-0.809*	0.222
$P_3 \times P_5$	1.181	-0.797*	0.192	0.67	-0.338	0.166	-3.223*	-1.714	-2.47**	0.063	-0.0005	0.03
$P_4 \times P_5$	0.9228	-0.6214	0.151	-1.261	1.473**	0.106	-0.7	-2.714**	-1.71*	0.777**	0.0952	0.44
LSD 5% S_{ij}	1.216	0.656	0.936	3.252	1.135	2.193	1.1016	1.5078	1.304	0.357	0.686	0.522
LSD 1% S_{ij}	1.665	0.898	1.282	4.452	1.553	3.000	1.508	2.065	1.786	0.489	0.939	0.714
LSD 5% S_{ij}-S_{iJ}	2.233	1.203	1.718	5.968	2.082	4.025	2.021	2.767	2.394	0.655	1.259	0.957
LSD 1% S_{ij}-S_{iJ}	3.056	1.647	2.350	8.170	2.850	5.510	2.768	3.780	3.274	0.897	1.723	1.31
LSD 5% S_{ij}-S_{ik}	4.465	2.407	3.436	11.936	4.160	8.050	4.043	5.534	4.788	1.310	2.518	1.91
LSD 1% S_{ij}-S_{ik}	6.113	3.296	4.700	16.340	5.700	11.020	5.536	7.570	6.553	1.794	3.447	2.62

Table (8): Cont.

S.O.V.	No. of spikelets/spike			No. of grains/spike			No. of grains per spikelet			Spike length (cm)		
	I	II	C	I	II	C	I	II	C	I	II	C
$P_1 \times P_2$	-0.126	0.0197	-0.053	-4.012**	-5.122**	-4.60**	-0.1812**	-0.209**	-0.19**	0.0177	0.7546**	0.386*
$P_1 \times P_3$	-1.435**	0.0649	-0.685*	-4.013**	-5.202**	-4.61**	-0.119**	-0,056**	-0.09**	-0.718**	-0.271**	-0.49**
$P_1 \times P_4$	0.877**	0.6792**	0.778**	8.273**	2.483	5,38**	0.301**	-0.083**	0.11**	0.3229**	0.305**	0.31**
$P_1 \times P_5$	1.198**	0.365*	0.78**	1.644*	2.782	1.21	0.0026	-0.0344**	-0.02**	0.2215**	-0.05	0.085
$P_2 \times P_3$	0.931**	0.55**	0.74**	7.958**	9.415**	8.69**	0.278**	0.3215**	0.29**	1.0705**	0.504**	0.787**
$P_2 \times P_4$	1.933**	1.398**	1.67**	7.530**	7.02**	7.28**	0.1367**	0.0753**	0.11**	1.162**	1.256**	1.21**
$P_2 \times P_5$	0.122	-0.046	0.04	3.301*	2.12	2.71	0.163**	0.0715**	0.12**	0.501**	0.528**	0.51**
$P_3 \times P_4$	1.05**	-0.273	0.39**	-1.855	-0.213	-1.03	-0.029**	-0.0039	-0.034**	0.249**	0.2003*	0.22**
$P_3 \times P_5$	0.599**	0.4649**	0.53**	-1.284	-3.946*	-2.62	-0.128**	-0.297*	-0.21**	0.0133	0.042	0.03
$P_4 \times P_5$	-0.032	-0.520**	-0.28*	-1.779	1.258	0.26	0.0193**	0.110**	0.06**	0.0896**	0.0322	0.06
LSD 5% S_{ij}	0.265	0.285	0.275	2.959	2.973	2.966	0.0123	0.0150	0.0136	0.053	0.1818	0.117
LSD 1% S_{ij}	0.363	0.391	0.377	4.061	4.07	4.060	0.016	0.0206	0.0183	0.073	0.2490	0.161
LSD 5% $S_{ij}-S_{IJ}$	0.485	0.524	0.505	5.430	5.353	5.390	0.022	0.0276	0.0248	0.098	0.3330	0.215
LSD 1% $S_{ij}-S_{IJ}$	0.665	0.717	0.691	7.435	7.328	7.380	0.031	0.037	0.0340	0.135	0.4570	0.296
LSD 5% $S_{ij}-S_{ik}$	0.971	1.048	1.009	10.860	10.700	10.780	0.044	0.055	0.0490	0.197	0.6670	0.432
LSD 1% $S_{ij}-S_{ik}$	1.33	1.430	1.380	14.870	14.657	14.760	0.062	0.0757	0.0680	0.269	0.9140	0.592

Table (8): Cont.

S.O.V.	Density of spike			Grain yield/plant (g)			1000-kernel weight (g)			Protein content (%)		
	I	II	C	I	II	C	I	II	C	I	II	C
$P_1 \times P_2$	-0.0386**	1.08**	0.52**	-5.18**	-5.306**	-5.2**	-4.692**	-2.956**	-3.82**	-1.546**	-0.337**	-0.94**
$P_1 \times P_3$	0.1133**	1.215**	0.67**	1.431	-0.695	0.37	6.312**	1.716**	4.01**	-0.135**	0.169**	0.017
$P_1 \times P_4$	0.0193**	1.436**	0.73**	12.20**	6.423**	9.31**	7.245**	3.357**	5.3**	0.441**	1.034**	0.74**
$P_1 \times P_5$	0.00763**	0.1335**	0.07**	0.659	1.189	0.92	-0.330	-2.240**	-1.285	0.134**	-0.436*	-0.151**
$P_2 \times P_3$	-0.126**	-0.039**	-0.08**	5.80**	1.570	3.68**	1.088	-0.556	0.266	0.598**	0.26**	0.42**
$P_2 \times P_4$	-0.121**	-0.129**	-0.125**	11.94**	7.850**	9.89**	5.922**	11.717**	8.82**	0.401**	0.168**	0.28**
$P_2 \times P_5$	-0.1342**	-0.137**	-0.14**	1.87	4.16**	3.01**	0.446	5.019**	2.73**	0.067**	0.294**	0.18**
$P_3 \times P_4$	-0.0445**	0.0506**	0.002	-0.147	-0.129	-0.138	-2.773*	-7.978**	-5.38**	-0.308**	-0.093	-0.20**
$P_3 \times P_5$	-0.0375*	0.0595**	0.048**	-1.388	-0.110	-0.749	-4.16	1.389*	-1.385	-0.011	0.619**	0.30**
$P_4 \times P_5$	-0.0352*	-0.0131*	-0.024**	-1.569	-0.455	1.01	-1.583	1.164	-0.21	0.512**	0.534**	0.523**
LSD 5% S_{ij}	0.0038	0.0113	0.0075	1.928	2.449	2.18	2.685	1.244	1.964	0.032	0.074	0.053
LSD 1% S_{ij}	0.00529	0.0154	0.010	2.639	3.354	2.996	3.677	1.703	2.690	0.044	0.102	0.073
LSD 5% $S_{ij}-S_{IJ}$	0.00709	0.0207	0.0138	3.538	4.494	3.96	4.928	2.282	3.600	0.0588	0.136	0.097
LSD 1% $S_{ij}-S_{IJ}$	0.00970	0.028	0.0188	4.840	6.154	5.497	6.748	3.130	4.939	0.081	0.187	0.134
LSD 5% $S_{ij}-S_{ik}$	0.014	0.041	0.027	7.076	8.989	8.03	9.857	4.565	7.210	0.273	0.194	0.234
LSD 1% $S_{ij}-S_{ik}$	0.0194	0.0568	0.293	9.680	12.31	10.99	8.49	4.735	9.110	0.374	0.265	0.319

planting dates and the combined analysis, respectively. In conclusion, the best combinations were, P_1 x P_4, P_2 x P_3, P_2 x P_4 and P_2 x P_5 for this trait.

For leaf area (LA); two, two and two parental combinations exhibited significant positive S_{ij} effects in normal and late planting dates and the combined analysis, respectively. The best combination was P_2 x P_4. However, six crosses expressed significant negative S_{ij} effects in late sowing date.

For flag leaf area (FLA); two, four and two parental combinations exhibited significant positive S_{ij} effects in normal and late sowing dates and the combined analysis, respectively. However, two, three and one crosses expressed significant negative S_{ij} effects in normal and late sowing dates as well as the combined analysis in the same order. The cross P_3 x P_4 gave the highest S_{ij} effects, while P_1 x P_2 cross gave the highest negative S_{ij} effects.

For plant height, four parental combinations exhibited significant positive S_{ij} effects in each of the normal and late sowing dates as well as the combined analysis. The two crosses P_1 x P_5 and P_2 x P_4 gave the highest positive S_{ij} effects for this trait. However, three, two and three crosses expressed significant negative S_{ij} effects in normal late sowing dates as well as the combined analysis, respectively. The cross P_1 x P_2 gave the highest negative S_{ij} effects for this trait.

For number of spikes per plant, eight, two and three crosses exhibited significant positive S_{ij} effects in normal and late sowing dates as well as the combined analysis, respectively. The best combination was P_1 x P_4.

For number of spikelets per spike, six, five and six parental combinations expressed significant positive S_{ij} effects in normal, and late sowing dates as well as the combined analysis, respectively. The best combinations were P_1 x P_5, P_2 x P_5 and P_1 x P_4.

For number of grains per spike, five, two and three crosses exhibited significant positive S_{ij} effects in normal, and late sowing as well as the combined analysis, respectively. The best combinations were P_2xP_3 and P_2 x P_4.

For number of grains per spikelet, five, four and five crosses expressed significant positive S_{ij} effects in normal and sowing, late as well as the combined analysis, respectively. The crosses P_2 x P_3, P_2 x P_4 and P_2 x P_5 gave the highest S_{ij} effects.

For spike length, seven, six and six parental combinations showed significant positive S_{ij} effects in normal, late sowing dates as well as the combined analysis, respectively. The best crosses were P_2 x P_3, and P_2 x P_4.

For density of spike, three, six and five parental combinations showed significant positive S_{ij} effects in normal, late sowing dates as well as the combined analysis, respectively. The best crosses were P_1 x P_3, P_1 x P_4 and P_1 x P_5.

For grain yield per plant, three, three and four crosses expressed significant positive S_{ij} effects in normal late sowing dates as well as the combined analysis, respectively. The crosses P_1 x P_4 and P_2 x P_4 in normal and late sowing dates as well as the combined analysis had the highest desirable S_{ij} effects for this trait.

For 1000-kernel weight, three, five and four crosses exhibited significant positive S_{ij} effects in normal, late sowing dates as well as the combined analysis, respectively. The best crosses were P_1xP_3, P_1xP_4, P_2xP_4 and P_2 x P_5.

For protein content, six, seven and six parental combinations expressed significant positive S_{ij} effects in normal and late sowing dates as well as the combined analysis, respectively. The best crosses were P_1 x P_4, P_2 x P_3 and P_4 x P_5.

If crosses showing high specific combining ability involved only one good combiner, such combination 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 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.

From the previous results, it could be concluded that both crosses (P_1 x P_4) and (P_2 x P_4) were the best grain yield and most studied traits under rainfed conditions either in normal or late sowing date.

REFERENCES

Abdel-Karim, A. A. (1998). Genetical and agronomic studies on heat tolerance and yield in wheat. Ph.D. Thesis, Fac. of Agric., Assiut Univ., Egypt.

Ashoush, H. A. E. (1996). Analysis of diallel cross of some quantitative characters in common wheat. Ph.D. Thesis, Fac. of Agric., Moshtohor, Zagazig Univ., Egypt.

Ashoush, H. A., A. A. Hamada and I. H. Darwish (2001). Heterosis and combining abilityin F_1 and F_2 diallel crosses of wheat (*Trtiticum aestivum* L.). J. Agric. Sci., Mansoura Univ., 26(5): 2579-2592.

Blake, T. J., T. J. Tschaplinki and A. Eastham (1984). Stomatal control of water use efficiency in poplar clones and hybrids. Can. J. Bot. 62: 1344-1351.

Chowdhry, M. A., M. T. Mahmood and I. Khaliq (1996). Genetic analysis of some drought and yield related characters in Pakistan spring wheat varieties. Wheat Information Service, 82: 11-18.

Clarke, J. M., R. A. Richards and A. G. Condón (1991). Effect of drought stress on residual transpiration and its relationship with water use of wheat. Can. J of Plant Sci. 71(3); 695-702.

Cochran, W. G. and G. M. Cox (1957). Experimental Design, 2^{nd} ed. John Wiley and Sons Inc., NY, USA, 611 p.

Collinson, S. T., E. J. Clawson, S. N. Azam Ali and C. R. Black (1997). Effect of soil moisture deficits on the water relations of bambara ground nut (*Vigna subterranea* L.Verdc.). J. Expt. Bot. 48(3): 877-884.

Cutler, J. M., K. W. Shahan and P. L. Steponkus (1980). Influence of water deficits and osmotic adjustment on leaf elongation in rice. Crop Sci. 20: 314-318.

Darwish, I. H. I. (1992). Breeding studies on wheat. M.SC. Thesis, Fac. of Agric., Menufiya Univ., Egypt.

Darwish, I. H. I. (1998). Breeding wheat for tolerance to some environmental stresses. Ph.D. Thesis, Fac. of Agric., Menufiya Univ., Egypt.

Dessouki, S. M., M. M. Sedek, O. S. Khalil and E. H. Tallat (1974). Cultural requirements of new dwarf wheat for maximum production in Egypt. (C.F. Field Crop Abstr. 31: 3, 1978).

Elahmadi, A. B. (1993). Development of wheat germplasm tolerant to heat stress in Sudan. Proc. of the International Conference on Wheat in Hot, Dry, Irrigated Environment. Wad Medani, Sudan 1-4 Feb., 1993.

El-Gamal, A. A. (2002). Studies on drought tolerance in wheat. M.Sc. Thesis, Fac. of Agric., Menufiya Univ., Egypt.

El-Morshidy, M. A., K. A. Kheiralla, A. M. Abdel-Ghani and A. A. Abdel-Karim (2001). Stability analysis for earliness and grain yield in bread wheat. The Second Pl. Breed. Conf., October (2) Assiut University.

Fischer, R. A. and M. Sanchez (1979). Drought resistance in spring wheat cultivars. II. Effect on plant water relations. Aust. J. Agric. Res. 30: 801-814.

Gawish, Ragaa A. R. (1992). Effect of transpiration application on snap beans (*Phaseolus vulgaris* L.) grown under different irrigation regimes. I. Growth, transpiration rate and leaf content of water, NPK and total carbohydrates. Menufiya J. Agric. Res. 17(3): 1285-1308.

Gilbert, N. E. G. (1958). Diallel cross in plant breeding. Heredity, 12: 477-492.

Griffing, J. B. (1956). Concept of general and specific combining ability in relation to diallel crossing systems. Australian J. Biol. Sci., 9: 463-493.

Hendawy, H. I. (1990). Breeding for yield and its components in wheat. M.Sc. Thesis, Facultyof Agric., Menufiya Univ., Egypt.

Kheiralla, K. A. and Tahany H. I. Sherif (1992). Inheritance of earliness and yield in wheat under wheat stress. Assiut J. of Agric. Sci., 23(1): 105-126.

Kheiralla, K. A., M. A. El-Morshidy and M. M. Zakaria (2001). Inheritance of earliness and yield in bread wheat under favourable and late sowing dates. The Second Pl. Breed. Conf. October 2, Assiut Univ.

Masoud, M. M. (1986). Effect of watering regime on wheat. M.Sc. Thesis, Fac. Agric., Assiut Univ., Assiut, Egypt.

Nachit, M. M. and H. Ketata (1987). Selection for heat tolerance in durum wheat (*T. turgidum* L. var. durum). In Proc. of the International Symposium on improving winter cereals under temperature and salinity. Cordoba, Spain, 26-29 October, 1987.

دراسات على تربية قمح الخبز تحت ظروف الري المطري

إبراهيم حسيني إبراهيم درويش
قسم المحاصيل – كلية الزراعة – جامعة المنوفية

الملخص العربي

أجرى هذا البحث بهدف إمكانية تربية قمح الخبز لتحمل بعض الظروف البيئية القاسية للقمح وقد استخدم لهذا الغرض خمسة آباء (٤ سلالات أجنبية وصنف محلى هو جيزة ١٦٤) تم زراعية الآباء في عروات وتم عمل الهجن التبادلية بين الآباء خلال موسم ١٩٩٩/٢٠٠٠ في مزرعة كلية الزراعة جامعة المنوفية بشبين الكوم. وفى موسم ٢٠٠٠/٢٠٠١ تم زراعة الآباء والهجن الناتجة منها تحت ظروف الري المطري فقط في كلية الزراعة جامعة ايجا بازمير – تركيا في تجربتين: التجربة الأولى زرعت في ميعاد طبيعي والتجربة الثانية زرعت في ميعاد متأخر وتم أخذ القياسات التالية: تاريخ التزهير، الضغط الأسموزي OP وعدد الثغور في mm^2 والمحتوى المائي النسبي للورقة(%) RWC ، مساحة الورقة (سم٢) ، مساحة ورقة العلم (سم٢)، ارتفاع النبات (سم)، عدد السنابل للنبات، عدد السنيبلات في السنبلة، عدد الحبوب في السنبلة، عدد الحبوب في السنيبلة، طول السنبلة (سم)، كثافة السنبلة، وزن الألف حبة (جم)، محصول الحبوب للنبات (جم) ومحتوى البروتين(%). وكانت أهم النتائج:

١- كان التباين الراجع لمواعيد الزراعة معنوي جدا لكل الصفات المدروسة مما يدل على وجود اختلافات بين ميعادي الزراعة الطبيعي والمتأخر.

٢- كان التباين الراجع إلى كل من الآباء والهجن وقوة الهجين معنويا لكل الصفات فى كلا الميعادين وكذلك التحليل المشترك ما عدا التباين الراجع للهجن لصفة محتوى البروتين فى حالة الزراعة المتأخرة، قوة الهجين لصفة كثافة السنبلة فى الميعاد المتأخر ومحتوى البروتين فى الميعاد الطبيعي – كما أظهرت التراكيب الوراثية تفاعلا معنويا مع مواعيد الزراعة لكل الصفات المدروسة.

٣- أعطى الهجين (P_2 x P_4) لصفات RWC وتاريخ التزهير وعدد السنيبلات في السنبلة وعدد الحبوب في السنبلة وطول السنبلة ووزن ألف حبة أحسن قوة هجين موجبة كما أعطت

التراكيب الهجينية $(P_1 \times P_2)$ لصفات الضغط الأسموزي ومساحة الورقة ومساحة ورقة العلم، و$(P_1 \times P_4)$ لصفات عدد السنابل وتاريخ التزهير، و$(P_3 \times P_4)$ لصفة عدد الثغور $(P_1 \times P_3)$ لصفة تاريخ التزهير أحسن قوة هجين سالبة.

٤- كان التباين الراجع لكل من القدرتين العامة والخاصة على التآلف معنويا لكل الصفات المدروسة وكانت النسبة بين التباين الراجع للقدرة العامة على التآلف والقدرة الخاصة على التآلف (GCA/SCA) ذات قيمة تفوق الوحدة لمعظم الصفات المدروسة في كلا الميعادين وكذلك التحليل المشترك مما يدل على أن الجزء الأكبر من الاختلافات الوراثية المرتبطة بهذه الصفات راجع إلى فعل الجينات من النوع المضيف Additive والتفوقي من الطراز Additive x additive.

٥- كان التباين الراجع للتفاعل بين القدرتين العامة والخاصة على التآلف ومواعيد الزراعة معنويا لكل الصفات المدروسة.

٦- كانت احسن الآباء في القدرة العامة على التآلف الأب P_1 لصفات OP, RWC ، ووزن الألف حبة والتبكير في التزهير، والأب P_2 لصفات RWC وعدد السنابل للنبات وعدد الحبوب في السنبلة وعدد الحبوب في السنيبلة وكثافة السنبلة ومحصول الحبوب، والأب P_3 لصفات ميعاد التزهير وOP وعدد السنيبلات في السنبلة وطول السنبلة ووزن الألف حبة ومحتوى البروتين، والأب P_4 لصفات تاريخ التزهير ومساحة الورقة وطول النبات والأب P5 لصفة طول السنبلة ومحتوى البروتين.

٧- سجلت الهجن $(P_1 \times P_4)$, $(P_2 \times P_4)$ قيم عالية مرغوبة للقدرة على التآلف للمحصول ومعظم الصفات المدروسة في كلا ميعادي الزراعة والتحليل المشترك.