Genetical Studies of Yield and its Components in Durum Wheat Under Heat Stress

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Abstract:

The present study was carried out at Assiut Agricultural Research Station during 2007/2008, 2008/2009, 2009/2010 seasons. Diallel cross without reciprocals among eight parents of durum wheat namely, Sohag 3 (P_1), line #1 (P_2), line# 2 (P_3), Bin- Sweef 1 (P_4), Bin- Sweef 5 (P_5), Karifla (P_6), Altar 84 (P_7) and Admor (P_8) were used to estimate heterosis, and general and specific combining ability under recommended and late planting dates. Mean squares showed that highly significant differences among genotypes, parents and crosses for all studied traits in the F_1's and F_2 generations, except number of spike/plant under late planting date. Moreover, both general (GCA) and specific (SCA) combining abilities were highly significant for most studied traits in the F_1's and F_2 generations under both planting dates except grain yield/plant, biological and number of kernel/spike in the F_1's under late planting date in the SCA .The estimates of heterosis for grain yield/plant indicated that seven crosses out of 28 F_1's hybrids significantly surpassed their better parent with percentage ranged from 8.798 ($P_4 \times P_7$) to 41.22% ($P_1 \times P_6$). These relatively high heterotic percentage along with the variability existed among all diallel set increase the chance of good recombination's that can be isolated in the following generations particularly, when selfing in the following generations gives an essentially homozygous state and enhances the role of selected plants in reducing the effects of dominance. However, the additive gene effect was of great importance in the performance of the most studied trait i.e. No. of spikes/plant, grain yield/plant (g), biological yield/plant (g), number kernel/spike. Moreover, the parents P_7 and P_4 were good combiners for four traits i.e. Number of spikes/plant, grain yield/plant (g), biological yield/plant (g), number kernel/spike while, P_2 was the best for only three traits i.e. days to heading, maturity and number kernel/spike date in the F_1's and F_2 generations. Meanwhile, significant SCA effects for grain yield were found in four out of the 28 F_1's crosses $P_1 \times P_4$, $P_1 \times P_6$, $P_4 \times P_7$ and $P_6 \times P_8$ giving positive values of SCA effects under normal planting date and one cross $P_2 \times P_4$ under late planting date. On the other view, F_2 populations, one crosses $P_3 \times P_8$ gave positive values of SCA effects .while in the F_1'sand F_2 generations , only one cross; $P_3 \times P_8$ gave positive values of SCA effects for 100- kernel weight under both planting date.

Keywords: Diallel, crosses, durum wheat, heterosis, combining ability (GCA & SCA).

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Introduction:

Wheat is one of the most important food crops in the world. The cultivated area in Egypt in 2012/2013 reached 3.5 million feddans with an average yield of 18.00 ardab/feddan. The production was about 9.475 million Metric Tons, (FAO, 2013).

However, it is concentrated in relatively small geographical areas where it often plays a major role in the food security of urban population and in the livelihood and nutrition of urban communities. The productivity of durum wheat is often limited by an array of abiotic stresses that affect a successful growth and a complete grain filling. Heat stress, due to increase temperature, is an agricultural problem in many areas in the world (*Wahid et al*., 2007). A successful breeding program needs continuous information on the genetic variation and systems governing grain yield and its components. Tawfelis (1997), Hamada and Tawfelis (2001), Abd El-Majeed*, et al*. (2004) and El-Sayed (2004) showed that both additive and non-additive gene effects controlled the genetic system number of spikes/plant, number of kernels/spike, kernel weight and grain yield/plant. Uma and Sharma (1997) stated that SCA components of variance were higher than GCA in the inheritance of most of studied traits. Nayeem (1994) reported that both additive and non-additive variation had important role in controlling the inheritance of days to flower and maturity date. Karrar (1980) found significant heterosis in durum wheat for grain yield, No. of spikes/plant, No of kernels/spike, kernel weight, plant height and days to heading comparing to better parent. Meanwhile, Hamada and Tawfelis (2001) reported that heterosis percentage based on better parent varied from -24.09 to12.36, -15.00 to 33.09, -17.15 to 33.52, -35.01 to 53.63 and from -24.15 to 72.16% for plant height, number of spikes/plant, number of kernels/spike, kernels/weight and grain yield/plant, respectively. Abd-Abdel-Kader (2006) found mean square showed that the highly significant differences among genotypes, parents and crosses for all studied traits in the $F_1$and F_2 generations. Moreover, both general and specific combining ability were significant for all studied traits in the $F_1$and F_2 generations. Akicnci (2009) found heterosis percentages for high- parent and mid- parent were -2.16% and -0.74% for heading date; -1.64% and 3.78% for 1000 kernel weight; -2.24%and 5.24%for plant yield, respectively. Moreover, both general and specific combining ability were significant for all studied traits. Irshad *et al*. (2012) found mean squares that highly significant differences among genotype, for days to heading, spike per plant, grain yield per plant. The present investigation was undertaken to were used estimate heterosis, general and specific combining ability in some durum wheat genotype.

Materials and Methods:

This study was conducted at Assiut Agricultural Research Station, ARC, Egypt during the three growing seasons of 2007/08, 2008/09 and 2009/010. The Genetical materials chosen to be used in this study as parents included eight durum wheat cultivars, which represents a wide range of diversity for several traits. The local name, pedigree and origin of these eight varieties are presented in Table (1).

Table (1): Local name, pedigree and origin of the eight parents.

	Name	Pedigree	Origin
P1	**Sohag 3**	MEXI "S" /MGHA/51792//DURUM 6 CD21831-2sh-osh	Egypt
P2	**Line≠1**	SOOTY-9/RASCON-37. CD91B1938-6M-O3OY-O3OM-4Y-OM-OB-1Y-OB-OSH	Egypt
P3	**Line≠2**	BOOMER-21/BUSCA-3 CDSS95YOO1185-8Y-OM-OY-OB-IY-OB-OSD	Egypt
P4	**Bani-Sweef 1**	JO"S" / AA"S" // FG =BITTERN "S" CD9799	Egypt
P5	**Bani-Sweef 5**	Dipperz / bushen3 CDSS92B128-1M-0Y-0M-0Y-3B-0Y-0SD	Egypt
P6	**Karifla**	Shandweel durum wheat breeding program	
P7	**Altar84**	Ruff "S" / FG "S" //MEXI 75/3/SHWA "S" = GA"S"	Mexico
P8	**Edmor**	Edm.	USA

Table (2): Physical and chemical characteristics of representative composite soil sample from the field experimental site.

Soil Properties	**Values**
Particle size distribution Sand (%) Silt (%) Clay (%) Soil texture	 96.72 2.12 1.16 Sandy
Field capacity (%)	9.92
Water saturation (%)	20.58
Total $CaCO_3$ %	35.18
EC mmhos/cm (1 : 1)	0.35
pH (1 : 1 water suspension)	8.65
Organic matter %	0.24
<u>Soluble cations (meq/L) :</u> Ca^{++} Mg^{++} Na^{+} K^{+}	 1.73 1.00 0.56 0.17
<u>Soluble anions (meq/L) :</u> HCO_3^{-} + CO_3^{--} Cl^{-}	 1.70 1.34
Total nitrogen (%)	0.003
Available Phosphorus (ppm)	8.30

Table (3): Average of temperature through the growing seasons 2009/2010

Season		2009/2010		
Month	**Day**	**Maximum**	**Minimum**	**Average**
	1-10	23.70	5.40	14.55
	11-20	24.90	7.70	16.30
January	21-31	23.36	4.70	14.03
Average		23.99	5.93	14.96
	1-10	19.40	5.00	12.20
	11-20	27.25	10.20	18.73
February	21-28	24.00	9.37	16.69
Average		23.55	8.19	15.87
	1-10	29.00	9.80	19.40
March	11-20	27.20	14.60	20.90
	21-31	24.63	8.36	16.50
Average		26.94	10.92	18.93
	1-10	31.00	11.60	21.30
April	11-20	33.80	13.00	23.40
	21-30	28.10	13.50	20.80
Average		30.97	12.70	21.83
	1-10	35.08	18.46	26.77
	11-20	35.40	16.12	25.76
May	21.31	38.10	19.06	28.58
Average		36.19	17.88	27.04

In 2007/2008 season, a half diallel cross were made among the eight parents to produce 28 crosses. In 2008/2009 season, ten seeds from each cross were grown to produce seeds of F_2 population. The eight parents were also grown for crossing to obtain more F_1's hybrid seeds. In 2009 /2010 season the eight parents, 28 hybrids and 28 F_2 populations were grown in a randomized completely block design (RCBD) with three replicates at two planting dates 25th of Nov (normal planting date) and 25th of Dec (late planting date). Each of the parental materials were represented by six rows per replicate, while for F_1's crosses represented by one row of plants per replicate.

Each population was represented by six rows per bloke. The seeds were grown in 3 meter long rows spaced 30 cm apart and plant spaced 10 cm, within each row. The cultural practices were applied as recommended and weeds were controlled by hand.

Data collected

The data were recorded on ten guarded plants of each parent and F1 hybrid and 50 plants of each F2 population from each replicate to measure the following characters:1- days to heading (days) 2- days to maturity (days) 3- number of spikes/plant,4- biological yield/plant (g), 5- Grain yield/plant (g), 6- 100-kernel weight (g) and 7- number of kernels/spike

Heterosis

Heterosis was calculated as the percentage of deviation of F_1's mean from the mean of mid-parents and better parent according to following formula computed by Bhatt (1971):
Heterosis relative to mid-parents

$H = [(\bar{F}_1\text{'s} - \overline{M.P.})/\overline{M.P.}] x\ 100$

Heterosis relative to better-parent

$H = [(\bar{F}_1\text{'s} - \overline{B.P.})/\overline{B.P.}] x\ 100$

Where;

$\bar{F}_1$'s = Mean of a F_1's cross.

$\overline{B.P.}$ = Mean of the better parent.

$\overline{M.P.}$ = mean of mid-parents

To detect the significance of heterosis, the least significance differences (L.S.D) value from zero can be calculated as follows:

L.S.D of mid- parent heterosis = S.E. x tα/MP

L.S.D of better parent heterosis = S.E. x tα /B.P

Where: S.E. for better parent = $[3MSE/2r]^{1/2}$

S.E. for better parent = $[2MSE/r]^{1/2}$

Tα = tabulated value at the degree of freedom for the error.

MSE = mean squares for error.

r = number of replications

Combining ability analysis

Estimates of general (G.C.A.) and specific combining ability (S.C.A.) variances and their effects were calculated using ordinary method for analysis of variance in randomized complete block design. If the differences between genotypes were significant, further analysis for general and specific combining ability was made according to Griffing (1956), method 2 model 1.

Results and Discussion:

The analysis of variance for all the studied traits of the eight parents and their 28 F_1's and 28 F_2 populations grown at of the two planting dates are presented in (Table 4). The analysis of variance revealed that mean squares due to genotypes, parents and crosses were highly significant for all the studied traits for F_1's & F_2 under both planting dates i.e. days to heading and maturity, No. of spike/plant biological yield/plant, grain yield, No. of kernel/spike and 100-kernels weight, except No. of spike/plant under late planting date. This indicts the wide genetic diversity among the parental materials used in the present study. Also, mean squares due to P. vs. C were highly significant for days to heading and maturity, grain yield/plant and number of kernel/spike. Mean squares due to No. of spike/plant were highly significant, except for F_1's under normal planting date. The significant trend found to be with grain yield, except for F_1's under late planting date. Similar results were obtained by Al-Koddoussi and Hassan (1991), Tawfelis (1997), Tammam and Abd El-Gawad (1999), Ashoush *et al.* (2001), Moustafa (2002) and Abdel -kader (2006).

Mean squares due to GCA and SCA were highly significant for all studied traits under F_1's & F_2 generations at both planting dates. Except grain yield/plant, biological yield/plant and no. of kernel/spike for F_1's under late planting date (table 4). GCA/SCA ratios in F_1's & F_2 were high values for biological yield/plant, grain yield/plant and number of kernel/spike under both planting dates (table 4). This indicates that additive genetic effect played the major rate in the inheritance for these traits- On the other hand, GCA/SCA ratios were very small for some studied traits in both generations (F_1's & F_2), reflecting that the non- additive effects contributes more important role than additive effects. The present finding were partially in harmony with those obtained by Mosaad *et al.* (1990), Al-Koddoussi and Hassan (1991), Tawfelis (1997), Uma and Sharma (1997), Ashoush *et al.* (2001), Ismail *et al.* (2001)), Tawfelis *et al.* (2006) , El-Karamity *et al.* (2007) and Akicnci (2009).

Heterosis

Heterosis values over mid and better parent for the studied traits are given in Table (5).

Day to healing estimates of heterosis for days to heading over the mid-parents (MP) and better parent (BP) under the two environments are presented in (Table 5).

Under normal planting date: there are thirteen and two crosses significantly earliar than its MP and BP respectively. The earlist crosses were (P_6×P_8) and (P_3×P_6) from MP and BP respectively its gave – 9. 615 and -2.273% of heterosis, respectively

Under late planting date: there are thirteen and three crosses significantly ear liar than its MP and BP respectively. the ear list crosses were(P_4×P_8) and (P_6×P_7) from MP and BP respectively its gave -13.648 and -5.333% of heterosis, respectively. Early flowering crosses can be used in breeding program for getting early flowering lines by different selection methods. These results agree with those reported by Zaied (1995), El-Sayed (1997), Twfelis (1997), Tammam and Abdel- Gawad (1999), Ashoush *et al.* (2001), Abdel-Hameed (2002), Mohamed (2007) and Akicnci (2009)

Day to maturity estimates of heterosis for days to maturity over the mid-parents and better parent under the two environments are presented in (Table 5).

Under normal planting date: there are nine and five crosses significantly earliar than its MP and BP respectively, the earliest crosses were (P_4×P_6) from MP and BP respectively, its gave -6.227 and -5.185% of heterosis respectively.

Table (4): Mean squares of combining ability analysis in of wheat genotypes under recommended (N) and late (L) planting dates.

Source of variance	Df	Days to heading				Days to maturity			
		F_1		F_2		F_1		F_2	
		N	L	N	L	N	L	N	L
Reps (R)	2	2.62	6.95	8.62	6.86	2.25	1.18	2.26	1.95
Genotypes(G)	35	91.71**	119.50**	121.40**	119.70**	43.15**	66.78**	73.96**	96.35**
Parents (P)	7	349.70**	422.50**	349.70**	422.50**	70.93**	138.80**	70.93**	138.80**
Crosses (C)	27	27.30**	40.50**	55.52**	40.78**	36.59**	49.57**	69.24**	87.65**
PxC	1	24.85**	131.50**	302.06**	130.94**	25.81**	27.31**	222.61**	34.10**
Error	70	1.239	0.87	0.9	1.75	1.12	1.3	1.107	1.28
GCA	7	309.22**	415.30**	429.50**	408.60**	147.20**	183.40**	234.30**	312.40**
SCA	28	37.33**	45.51**	44.37**	47.51**	17.14**	46.60**	24.89**	42.33**
Error	70	1.239	0.87	0.9	1.75	1.12	1.3	1.11	1.28
GCA/SCA		0.85	0.93	0.99	0.89	0.91	0.40	0.98	0.76

Source of variance	df	No. of spike / plant		No. of spike / plant	
		F_1		F_2	
		N	L	N	L
Reps (R)	**2**	2.84	0.039	2.25	1.02
Genotypes(G)	**35**	5.94**	1.31**	5.88**	1.15*
Parents (P)	**7**	9.77**	3.21**	9.77**	3.21*
Crosses (C)	**27**	5.16**	0.32	4.25**	0.33
PxC	**1**	0.19	14.39**	22.26**	9.14**
Error	**70**	0.69	0.44	1.21	2.93
GCA	**7**	21.41**	2.05**	19.69**	1.58**
SCA	**28**	2.07**	1.11**	2.43**	1.04**
Error	**70**	0.69	0.44	1.21	2.93
GCA/SCA		1.5	0.24	1.51	0.17

Count. Table (4): Mean squares of combining ability analysis of wheat genotypes under recommended (N) and late (L) planting dates.

Source of variance	Df	Grain yield / plant (g)				Biological yield / plant(g)			
		F_1		F_2		F_1		F_2	
		N	L	N	L	N	L	N	L
Reps (R)	2	9.71	3.11	2.11	0.14	41.76	11.98	8.16	14.12
Genotypes (G)	35	39.37**	22.02**	30.66**	16.34**	355.36**	180.30**	299.40**	158.00**
Parents (P)	7	62.63**	34.14**	62.63**	34.14**	525.40**	238.10**	525.40**	238.10**
Crosses (C)	27	33.39**	19.69**	8.10**	10.36**	322.40**	170.10**	51.59**	117.70**
PxC	1	38.01**	0.09	416.00**	53.20**	55.00	51.10	5408.00**	685.40**
Error	70	4.73	3.62	2.86	3.37	37.84	41.46	18.92	24.75
GCA	7	139.30**	94.32**	52.14**	54.70**	1178.20**	729.00**	360.70**	484.70**
SCA	28	14.40**	3.95	25.29**	6.75**	149.70*	43.15	284.06**	76.29**
Error	70	4.73	3.62	2.86	3.37	37.84	41.46	18.92	24.75
GCA/SCA		1.39	27.99	0.22	1.52	1.02	40.68	0.016	0.89

Source of variance	df	Number kernel/spike				100 – kernel weight			
		F_1		F_2		F_1		F_2	
		N	L	N	L	N	L	N	L
Reps (R)	2	69.5	33.81	59.76	4.92	0.126	0.148	0.527	0.092
Genotypes (G)	35	169.80**	130.00**	149.40**	125.50**	0.607**	0.730**	0.764**	0.513**
Parents (P)	7	339.80**	277.20**	339.80**	277.20**	1.796**	0.919**	1.796**	0.919**
Crosses (C)	27	132.00**	92.95**	89.21**	81.25**	0.286**	0.482**	0.515*	0.342**
PxC	1	0.4	99.95**	441.73**	258.35**	0.957**	6.106**	0.253*	0.747**
Error	70	16.25	18.38	12.28	13.95	0.145	0.122	0.203	0.102
GCA	7	686.80**	465.70**	479.00**	480.40**	1.579**	1.457**	2.328**	2.307**
SCA	28	40.59**	46.04	67.05**	36.74**	0.364**	0.548**	0.373*	0.254**
Error	70	16.25	18.38	12.28	13.95	0.145	0.122	0.203	0.102
GCA/SCA		2.76	1.62	0.85	2.05	0.65	0.314	1.25	0.95

Table (5): Heterosis percentages from mid-parent (MP) and better parent (BP) heterosis for days to heading and days to maturity of 28 F_1's crosses under recommended (N) and late (L) planting dates.

F_1 crosses	Days to heading				Days to maturity			
	N		L		N		L	
	MP	BP	MP	BP	MP	BP	MP	BP
P_1xP_2	4.762**	6.024**	-0.662	1.351	1.946*	3.150**	3.670**	4.630**
P_1xP_3	2.890**	4.706**	1.333*	4.110**	0.608	1.769*	1.991*	4.352**
P_1xP_4	-3.371**	1.176	-7.595**	-5.195**	1.887*	3.846**	6.250**	10.185**
P_1xP_5	0.770	3.141**	1.316*	2.667**	-0.375	2.308*	-0.441	4.630**
P_1xP_6	0.375	3.918**	-5.128**	-3.896**	2.239**	5.385**	2.655**	7.407**
P_1xP_7	5.649**	6.271**	4.829**	6.227**	3.475**	3.876**	5.505**	6.481**
P_1xP_8	-6.931**	10.588**	-11.828**	6.494**	1.845*	6.154**	1.266	11.111**
P_2xP_3	7.602**	10.843**	3.401**	4.110**	-0.769	1.575	2.242	3.636**
P_2xP_4	-2.648**	3.217**	-5.806**	-1.351	-0.763	2.362**	0.000	2.727**
P_2xP_5	2.709**	6.422**	1.114	1.797*	-2.500**	1.339	-3.057**	0.909
P_2xP_6	3.069**	8.036**	-4.144**	-0.905	-0.377	3.937**	-3.509**	0.000
P_2xP_7	6.509**	8.434**	6.040**	6.757**	-0.781	0.000	-1.182	-1.182
P_2xP_8	-8.000**	10.843**	-10.383**	10.811**	0.746	6.299**	-0.418	8.182**
P_3xP_4	4.972**	7.955**	5.195**	10.959**	0.000	0.752	-1.921*	-0.619
P_3xP_5	1.695**	2.273*	2.703**	4.110**	-3.481**	-2.030*	-5.172**	-2.655**
P_3xP_6	-3.911**	-2.273*	-3.947**	0.000	-2.804**	-0.977	-3.030**	-0.885
P_3xP_7	2.299**	3.488**	1.351*	2.740**	-0.992	0.543	-2.511**	-1.182
P_3xP_8	-8.293**	6.818**	-8.791**	13.699**	-2.190**	0.752**	-3.306**	3.540**
P_4xP_5	0.736	3.000**	1.282	5.333**	-3.676**	-2.963**	-2.979**	-1.724
P_4xP_6	-3.261**	-2.198*	1.250	2.532**	-6.227**	-5.185**	-3.419**	-2.586**
P_4xP_7	-0.559**	3.488**	-1.282	2.667**	-4.545**	-2.326*	-6.195**	-3.636**
P_4xP_8	-9.524**	2.151*	-13.684**	1.235	0.725	2.963**	-2.041*	3.448**
P_5xP_6	1.856*	3.000**	2.597**	5.333**	-2.764**	-2.409**	2.700**	3.136**
P_5xP_7	4.000**	5.814**	1.773**	1.773*	0.000	3.101**	-2.445**	1.545
P_5xP_8	-6.796**	7.865**	-9.783**	10.667**	-1.439	0.000	-4.032**	0.000
P_6xP_7	-3.955**	-1.163	-13.415**	-5.333**	-3.371**	0.000	-2.895**	0.636
P_6xP_8	-9.615**	3.297**	-12.766**	3.797**	-1.290	-0.217	-3.644**	0.847
P_7xP_8	-9.034**	7.360**	-9.783**	10.667**	0.741	5.426	-1.841*	6.636**
LSD 5%	1.569	1.812	1.314	1.517	1.490	1.721	1.608	1.856
LSD 1%	2.084	2.407	1.744	2.014	1.979	2.285	2.135	2.465
Average heterosis	-0.929	4.803	-3.029	3.684	-0.862	1.408	-0.991	2.485

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

Under late planting date : there are sixteen and three crosses significantly earliar than its MP and BP respectively the earliest crosses were ($P_4 \times P_7$) from MP and BP respectively, its gave -6.195 and -3.636% of heterosis, respectively. Early maturity crosses can be used in breeding program for getting early maturity lines by different selection methods. These results agree with those reported by Zaied (1995), Abdel -kader (2006), and Mohamed (2007).

Estimates of heterosis for number of n. spikes/plant over mid-parents and better parent under the two environments are presented in (Table 6).

Under normal planting date: there are twenty eight and twenty one crosses significantly no. of spike / plant at MP and BP respectively. The tillering crosses were (P_1×P_6) from MP and BP, respectively, its gave 23.544 and 17.984% of heterosis, respectively.

Under late planting date: there are ten and eight crosses significantly no. of spike / plant at MP and BP respectively. The n. of spike / plant crosses were (P_6×P_7) from MP and BP, respectively its gave 16.972 and 16.555% of heterosis, respectively.

Eight hybrids reflected that showed highly significant positive heterosis under late planting date. It can be used in breeding program from tolerant to heat under late planting date by different selection methods. These results agree with those reported by Hamada and Twfelis (2001), Sharma *et al*. (2002) and Abdel -kader (2006).

Estimates of heterosis for grain yield/plant (Table 7) indicated that 19 and 7 crosses under normal planting date and 11and 3 crosses under late planting date were significantly positive over the MP and BP, respectively. This indicted that two crosses (P_2×P_7) and (P_4×P_7) gives positive significant heterosis over MP and BP under both planting date. Variable amount of heterosis were found from planting date to another which could be highly significant interaction and parent vs. crosses. Furthermore, the sensitivity of the parent to heat stress which was one of the major causes of heterosis fluctuation. Heterosis for grain yield/plant (Table 5) ranged from 3.829 (P_3×P_7) to 55.491% (P_1×P_6) at MP and from 8.798 (P_4×P_7) to 41.122% (P_1×P_6) at BP under normal planting date. While, under late planting date it ranged from 5.704 (P_5×P_6) to 17.980% (P_2×P_4) and from 4.297 (P_2×P_7) to 11.532% (P_2×P_4) at MP and BP respectively. These results in agreement with those reported by Al-Kodoussi and Hassan (1995), Hamada and Twfelis (2001), Abdel-kader (2006) and Akicnci (2009).

With respect to the biological yield/plant (Table 7) indicated that six and one crosses under normal planting date 5 and one crosses under late planting date significantly positive over MP respectively. It is clear results that many of crosses possessed negative heterosis value over MP and BP even under normal or late planting date. Heterosis for biological yield/plant (Table 5) ranged from 9.587(P_1×P_8) to 30.965% (P_1×P_6) at MP under normal planting. While, under late planting ranged from 9.932 (P_3×P_6) to 22.718% (P_7×P_8) at MP respectively. These results are in agreement with those reported by Zaied (1995) and Abd-Elkader (2006).

With regard to the number of kernel/spike (Table 8) indication that two crosses and normal planting at Mp and 13 and 3 crosses under late planting date were significantly positive over the MP and BP, respectively. Heterosis for number kernel/spike (Table 6) ranged from 11.445 (P_1×P_3) to 17.488% (P_3×P_4) at MP under normal planting. Otherwise, there is no crosses had positive value over better parent. While, under late planting it ranged from 6.861(P_3×P_8) to 24.147% (P_6×P_8) and from 7.273 (P_6×P_8) to 10.803% (P_2×P_6) at MP and BP, respectively table 6. These results are in line with those reported by Al-Kodoussi and Hassan (1995), Hamada and Twfelis (2001), Ashoush (2002) and Nagwa (2007).

Table (6): Heterosis percentages from mid-parent (MP) and better parent (BP) heterosis for No. of spike/plant of 28 F_1's crosses under recommended (N) and late (L) planting dates.

F1 crosses	No. of spike / plant		No. of spike / plant	
	N		L	
	MP	BP	MP	BP
P_1xP_2	14.038**	12.424**	-2.830**	-3.507**
P_1xP_3	11.909**	6.873**	-22.404**	-27.038**
P_1xP_4	13.044**	6.123**	6.040**	0.000
P_1xP_5	11.106**	4.051**	-21.140**	-21.427**
P_1xP_6	23.544**	17.984**	11.118**	10.714**
P_1xP_7	11.776**	3.475**	-9.356**	-10.006**
P_1xP_8	10.589**	-0.474	-0.708*	-2.083**
P_2xP_3	8.738**	5.286**	-5.651**	-10.698**
P_2xP_4	11.526**	6.123**	11.340**	5.696**
P_2xP_5	2.142**	-3.046**	3.203**	2.113**
P_2xP_6	3.820**	0.524	-18.151**	-19.015**
P_2xP_7	15.570**	8.421**	9.290**	7.754**
P_2xP_8	6.115**	-3.265**	-3.493**	-4.167**
P_3xP_4	11.167**	9.184**	-4.098**	-4.396**
P_3xP_5	3.629**	1.523**	-3.352**	-9.434**
P_3xP_6	5.286**	5.286**	-14.769**	-20.132**
P_3xP_7	2.816**	-0.490	-2.364**	-8.811**
P_3xP_8	5.933**	-0.474	-21.446**	-25.151**
P_4xP_5	5.847**	5.573**	-7.071**	-12.664**
P_4xP_6	11.696**	9.705**	2.364**	-3.797**
P_4xP_7	7.041**	5.451**	-2.037**	-8.240**
P_4xP_8	6.569**	1.856**	-10.599**	-14.562**
P_5xP_6	10.873**	8.619**	6.475**	6.475**
P_5xP_7	11.278**	9.906**	9.022**	8.634**
P_5xP_8	19.412**	14.413**	-6.710**	-8.333**
P_6xP_7	17.133**	13.367**	16.972**	16.555**
P_6xP_8	7.418**	0.921*	-10.251**	-11.813**
P_7xP_8	3.597**	0.460	11.340**	9.021**
LSD 5%	0.742	0.857	0.613	0.708
LSD 1%	0.985	1.138	0.814	0.940
Average heterosis	9.772	5.350	-2.831	-5.654

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

Table (7): Heterosis percentages from mid-parent (MP) and better parent (BP) heterosis for grain yield/ plant and biological yield/plant of 28 F_1's crosses, under recommended (N) and late (L) planting dates.

F1 crosses	Grain yield / plant (g)				Biological yield / plant(g)			
	N		L		N		L	
	MP	BP	MP	BP	MP	BP	MP	BP
P_1xP_2	17.690**	1.582	-7.446**	-10.317**	-11.517*	-19.378**	-11.322*	-15.392**
P_1xP_3	10.025**	3.234	-11.632**	-25.449**	-4.318	-15.476**	-16.054**	-31.640**
P_1xP_4	24.289**	1.033	-1.113	-9.249**	26.546**	3.647	-6.201	-14.626**
P_1xP_5	9.241**	1.825	-13.248**	-17.613**	-11.429**	-13.936**	-23.374**	-29.619**
P_1xP_6	55.491**	41.122**	1.024	-25.521**	30.965**	17.938**	-9.743*	-29.904**
P_1xP_7	20.139**	0.989	-3.109	-7.682**	2.630	-10.165*	-0.151	-2.774
P_1xP_8	21.195**	13.795**	10.106**	-2.876	9.587*	3.649	10.616*	4.898
P_2xP_3	13.650**	-6.999**	-14.883**	-30.007**	2.550	-16.396**	-21.618**	-38.433**
P_2xP_4	9.341**	1.776	17.980**	11.532**	-0.340	-11.500**	15.380**	9.800
P_2xP_5	-11.123**	-18.217**	-12.070**	-18.948**	-25.942**	-30.694**	-13.865**	-24.194**
P_2xP_6	-4.547**	-24.017**	6.393**	-23.129**	-11.966**	-26.988**	-9.492*	-32.008**
P_2xP_7	15.684**	12.095**	6.128**	4.297**	12.405**	7.508	0.697	-1.389
P_2xP_8	9.485**	-10.355**	-1.571	-15.509**	-5.215	-17.860**	-12.103**	-20.264**
P_3xP_4	-8.136**	-28.872**	13.773**	-10.450**	-14.477**	-36.316**	17.840**	-10.693*
P_3xP_5	6.069**	-6.788**	-14.273**	-24.380**	-6.450	-19.390**	-10.325*	-21.486**
P_3xP_6	23.917**	19.578**	6.807**	-9.728**	-1.655	-3.760	9.932*	3.339
P_3xP_7	3.829*	-17.086**	13.724**	-7.747**	-10.599*	-29.571**	7.740	-14.044**
P_3xP_8	10.534**	10.451**	-0.248	-5.268**	-1.670	-8.555	-5.607	-19.711**
P_4xP_5	-20.364**	-31.351**	-17.078**	-27.387**	-24.994**	-37.130**	-18.730**	-31.463**
P_4xP_6	-8.589**	-30.979**	-8.559**	-36.156**	-25.072**	-43.386**	-15.485**	-38.563**
P_4xP_7	13.412**	8.798**	11.903**	7.568**	11.836**	3.451	8.192	0.935
P_4xP_8	-9.677**	-30.029**	-6.378**	-23.303**	-22.450**	-39.164**	-12.812**	-24.341**
P_5xP_6	4.284**	-11.124**	5.704**	-19.265**	-9.922*	-20.925**	-7.847	-23.467**
P_5xP_7	7.569**	-3.822	-0.466	-9.701**	-16.541**	-25.066**	3.026	-7.636
P_5xP_8	-2.108	-13.919**	-10.890**	-17.586**	-10.993*	-18.063**	-21.196**	-23.815**
P_6xP_7	-5.753**	-26.709**	3.279	-26.172**	-9.522*	-27.558**	2.255	-22.072**
P_6xP_8	35.283**	30.451**	8.996**	-11.665**	14.468**	8.654	-12.958**	-29.624**
P_7xP_8	15.644**	-7.599**	14.121**	-3.451*	-6.801	-22.211**	22.718**	21.723**
LSD 5%	3.067	3.541	2.683	3.098	8.673	10.015	9.079	10.483
LSD 1%	4.073	4.703	3.563	4.114	11.518	13.300	12.057	13.922
Average heterosis	9.160	-4.326	-0.108	-14.113	-4.317	-16.023	-4.66	-16.659

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

Estimates of heterosis for 100-kerenal weight over the mid parent and better parent (Table 8) indicated that 10 and 4 under normal planting date and 15 and 9 crosses under late planting date were significantly positive over MP and BP, respectively it is clear to notice that the (P_1×P_8) and(P_2×P_8) possessed positive and significant heterosis over MP and BP under both planting dates. This that these crosses could be used source for tolerant heat stress in wheat program. Heterosis for 100- kernel weight (Table 8) ranged from 8.228 ($P_1 \times P_7$) to 25.765 ($P_1 \times P_8$) at Mp and from 9.456 ($P_7 \times P_8$) to 10.621% ($P_1 \times P_8$) at BP under normal planting. While, under late planting it ranged from 7.816 ($P_2 \times P_3$) to 24.77% ($P_1 \times P_8$) and from 7.675($P_1 \times P_6$) to 19.946% ($P_1 \times P_8$) at MP and BP, respectively (Table 8). These results in agreement with those obtained by, Al-Kodoussi and Hassan (1995), Hassan (1997), Hamada and Twfelis (2001), Nagwa (2007) and Akicnci (2009).

Table (8): Heterosis percentages from mid-parent (MP) and better parent (BP) heterosis for number of kernel/ spike and 100- kernel weight of 28 F_1's crosses, under recommended (N) and late (L) planting date.

F1 crosses	Number of kernel / spike				100 – kernel weight (g)			
	N		L		N		L	
	MP	BP	MP	BP	MP	BP	MP	BP
P_1xP_2	4.123	-2.730	5.930	0.950	11.982**	9.651**	15.057**	6.470
P_1xP_3	11.445**	6.431	11.158**	3.661	4.375	-3.198	14.543**	13.342**
P_1xP_4	-8.330**	-19.586**	-7.847*	-15.353**	3.208	-2.211	5.151	0.201
P_1xP_5	1.258	-3.670	-4.216	-6.522	3.679	-2.824	12.905**	5.659
P_1xP_6	5.250	0.582	8.431**	8.067*	4.525	4.516	8.194*	7.675*
P_1xP_7	-0.665	-10.766**	1.331	-8.987*	8.228**	3.387	19.481**	12.594**
P_1xP_8	-2.157	-8.090*	-5.230	-17.878**	25.765**	10.621**	24.777**	19.946**
P_2xP_3	4.907	-6.097	11.237**	-0.789	5.687*	-3.861	7.816*	0.752
P_2xP_4	1.005	-5.622	-1.570	-5.311	6.349*	-1.216	7.964*	4.680
P_2xP_5	2.688	-8.411*	12.371**	4.637	4.172	-4.259	-1.217	-13.983**
P_2xP_6	5.676	3.187	15.898**	10.803**	-0.333	-2.417	3.054	-4.213
P_2xP_7	1.339	-2.847	1.951	-4.217	-0.878	-3.351	4.268	-8.626**
P_2xP_8	0.236	-11.639**	10.101**	-8.388*	23.328**	10.512**	12.708**	8.319*
P_3xP_4	17.488**	-0.927	17.170**	1.012	-6.148*	-8.250**	16.193**	11.851**
P_3xP_5	1.989	1.578	6.984*	2.110	-9.084**	-10.106**	8.143*	0.214
P_3xP_6	-4.452	-12.607**	7.852*	0.265	-0.854	-8.039*	9.437**	8.808*
P_3xP_7	-5.203	-18.241**	2.162	-13.728**	-6.200*	-16.591**	-11.889**	-17.785**
P_3xP_8	1.820	0.07	6.861*	-1.294	11.808**	-7.813*	16.532**	13.172**
P_4xP_5	-8.092**	-22.752**	-1.441	-11.455**	-10.239**	-11.264**	-1.826	-12.155**
P_4xP_6	-11.262**	-18.900**	-7.887*	-15.129**	-5.016	-9.995**	6.201	1.667
P_4xP_7	-3.796	-6.344	-11.111**	-13.275**	-1.496	-10.611**	-9.489**	-18.476**
P_4xP_8	-6.472**	-22.234**	2.296	-17.465**	8.650**	-8.764**	15.900**	14.849**
P_5xP_6	4.835	-4.464	5.490	2.613	2.321	-4.089	-5.354	-11.824**
P_5xP_7	0.961	-13.220**	-2.705	-14.478**	-6.030*	-15.599**	-5.212	-5.912
P_5xP_8	3.780	2.404	6.930*	-5.358	11.703**	-7.067*	9.324**	-1.381
P_6xP_7	-0.339	-6.610*	-1.218	-11.010**	4.229	-0.441	-0.621	-6.771
P_6xP_8	1.793	-8.347*	24.147**	7.273*	14.962**	1.111	5.832	2.208
P_7xP_8	-0.897	-15.762**	9.499**	-13.289**	19.379**	9.456**	-8.771**	-17.154**
LSD 5%	5.684	6.563	6.045	6.980	5.366	6.196	6.205	7.165
LSD 1%	7.548	8.715	8.028	9.270	7.126	8.229	8.240	9.515
Average heterosis	0.676	-7.701	4.449	-5.091	4.574	-3.311	6.396	0.505

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

General and specific combining ability effects

General and specific combining ability effects of the parent, the 28 F_1-hybrid and 28 F_2-populations for days to heading under the two planting dates are presented in (Table 9). Highly significant negative GCA effects were detected for P_1,P_2, P_3,$P_6$and P_7 across environments, indicating that these parents may possess favorable genes which could be utilized in breeding for earliness in wheat. However P_8 showed positive and highly significant GCA effects under the tow planting dates, this parent could be considered as a good combiner for lateness.

With regarded to SCA, Eight F_1's and F_2 crosses showed highly significant negative SCA effects under the two planting date. They could be considered for breeding program for improvement of earliness in wheat. These results are in agreement with those reported by Hendawy (1994), El-Hennawy (1996), El-Sayed (1997), El-Sayed *et al*. (2000) and Akinci (2009).

Concerning the days to maturity, highly significant negative GCA effects for three parents; P_2, P_3 and P_7 over the two planting dates under F_1's and F_2 (table 10). This indicts that these parents could decrease days to maturity in their hybrids. These parents may possess favorable genes which be utilized in breeding for earliness in wheat. Two parents; P_6 and P_8 had positive and highly significant over environments for days to maturity, indicating that these parents were considered good combiners to increase for days to maturity under both environments.

With regarded to SCA, three crosses; ($P_3 \times P_5$), ($P_3 \times P_6$) and ($P_4 \times P_6$) had highly significant negative for days to maturity under different environments at F_1's and F_2 (Table 10).

These results are in agreement with those reported by Mann and Sharma (1995) and Zaied (1995).

General and specific combining ability of the parents and SCA effects of the F_1's hybrids and F_2 populations for number of spikes/plant are shown in Table (11). Regarding to GCA for F_1-crosses and F_2 population, highly significant and positive GCA effects were detected for two parental genotypes; P_4 and P_7 under normal planting date and late planting date. Concerning SCA effects for no. of spike/plant proved that $P_6 \times P_8$ had highly significant SCA effects in F_1's and F_2 under normal planting date. Meanwhile, most of crosses showed no significant and positive SCA in F_1's and F_2 under the two planting dates; indicating the predominance of non-additive gene effects. These results are in line with those reported by Al-Kodooussi and Hassan (1995), Abdel -kader (2006) and Nagwa (2007).

Table (9): General (GCA) and specific (SCA) combining ability effects of days to heading.

Genotypes	F_1		F_2		Genotypes	F_1		F_2	
	N	L	N	L		N	L	N	L
P_1	-2.208**	-1.425**	-2.467**	-1.475**	P_2xP_8	-3.819**	-3.007**	-1.170*	-3.856**
P_2	-2.375**	-2.325**	-2.133**	-2.175**	P_3xP_4	4.648**	4.259**	0.796	0.044
P_3	-0.442*	-1.892**	-1.133**	-2.875**	P_3xP_5	-0.052	0.493	-3.704**	-3.089**
P_4	0.192	0.308	0.967**	0.858**	P_3xP_6	-3.185**	-2.074**	-4.004**	-2.422**
P_5	-0.108	-0.925**	-0.533**	-1.342**	P_3xP_7	0.515	-0.041	1.163**	1.944**
P_6	-0.975**	-1.358**	-1.233**	-1.008**	P_3xP_8	-3.752**	-2.441**	-3.504**	-2.156**
P_7	-1.675**	-1.392**	-2.400**	-0.708**	P_4xP_5	0.981	1.293**	2.196**	2.178**
P_8	7.592**	9.008**	8.933**	8.725**	P_4xP_6	-0.819	3.726**	-0.104	-0.156
P_1xP_2	1.981**	0.426	0.230	-0.656	P_4xP_7	-0.119	-0.241	-1.937**	2.878**
P_1xP_3	1.048	0.993*	-3.437**	-2.956**	P_4xP_8	-3.385**	-5.641**	-5.270**	-6.222**
P_1xP_4	-2.585**	-4.207**	3.130**	-0.689	P_5xP_6	2.148**	2.959**	-0.604	2.711**
P_1xP_5	-0.619	1.026*	1.630**	0.511	P_5xP_7	2.181**	0.326	0.563	0.411
P_1xP_6	0.915	-1.541**	-0.670**	-0.822	P_5xP_8	-2.085**	-3.407**	-3.770**	-2.689**
P_1xP_7	3.615**	4.159**	-1.170	3.878**	P_6xP_7	-2.952**	-4.574**	-0.737	1.744
$P1xP_8$	-1.985**	-3.907**	-2.837**	-2.556**	P_6xP_8	-3.219**	-3.974**	-4.070**	-4.356**
P_2xP_3	4.215**	1.893**	8.896**	7.744**	P_7xP_8	-4.185**	-2.941**	-0.904	-4.656**
P_2xP_4	-2.752**	-3.307**	-4.204**	0.011	S.E. gi	.0.190	0.159	0. 162	0.226
P_2xP_5	0.215	0.259	0.296	1.211	S.E. sij	0.583	0.488	0.496	0.692
P_2xP_6	2.415**	-1.307**	-0.004	-2.122**	S.E. (gi-gj)	0.288	0.241	0.245	0.341
P_2xP_7	3.148**	4.393**	-1.837**	-2.422**	S.E. (sij-sik)	0.863	0.722	0.734	1.024

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

Table (10): General (GCA) and specific (SCA) combining ability effects of Days to maturity.

Genotypes	F_1		F_2		Genotypes	F_1		F_2	
	N	L	N	L		N	L	N	L
P_1	0.483**	-0.525**	0.608**	-0.392*	P_2xP_8	0.733	0.748	2.252**	-4.041**
P_2	-2.883**	-2.125**	-1.358**	-2.758**	P_3xP_4	2.267**	-0.319	-2.381**	-2.707**
P_3	-0.850**	-1.725**	-1.525**	-3.258**	P_3xP_5	-2.167**	-3.552**	-6.415**	-4.141**
P_4	-0.250**	-0.058	-1.158**	0.308	P_3xP_6	-1.267*	-1.552**	-2.415**	-5.807**
P_5	0.517**	0.842**	-0.125	1.075**	P_3xP_7	-0.033	-0.852	-3.848**	-4.874**
P_6	0.950**	0.842**	0.875**	0.742**	P_3xP_8	-2.300**	-1.652**	4.085**	2.126**
P_7	-2.283**	-3.192**	-2.692**	-2.525**	P_4xP_5	-2.100**	-1.219*	2.219**	-0.041
P_8	4.317**	5.942**	5.375**	6.808**	P_4xP_6	-5.533**	-2.219**	-1.781**	1.293*
P_1xP_2	0.567	1.215*	-0.981	-0.174	P_4xP_7	-4.300**	-5.185**	-4.215**	-0.107
P_1xP_3	-0.133	0.481	0.185	-3.674**	P_4xP_8	2.100**	-0.319	-7.281**	1.559**
P_1xP_4	1.933**	5.148**	0.485	0.759	P_5xP_6	-0.633	5.548**	-5.815**	-0.141
P_1xP_5	-0.833	-1.752**	-0.215	5.993**	P_5xP_7	1.933**	-0.419	-5.248**	0.459
P_1xP_6	2.733**	1.248*	1.452**	2.326**	P_5xP_8	-0.667	-2.219**	0.685	-0.541
P_1xP_7	2.967**	4.281**	4.685**	3.593**	P_6xP_7	-2.500**	-1.419*	-0.248	-0.874
$P1xP_8$	0.367	0.148	-1.048	2.259**	P_6xP_8	-0.433	-2.219**	-1.315*	-2.874**
P_2xP_3	-0.100	3.415**	0.819	8.693**	P_7xP_8	1.133*	0.148	4.252**	-0.607
P_2xP_4	0.300	0.748	0.452	-2.874**	S.E. gi	0.018	0.195	0.180	0.193
P_2xP_5	-1.800**	-2.152**	2.419**	-6.641**	S.E. sij	0.553	0.597	0.551	0.592
P_2xP_6	1.100*	-3.152**	-0.248	1.693**	S.E. (gi-gj)	0.562	0.491	0.272	0.292
P_2xP_7	-0.667	-0.452	-2.015**	0.959	S.E. (sij-sik)	0.818	0.884	0.816	0.876

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

Table (11): General (GCA) and specific (SCA) combining ability effects of no. of spike / plant .

Genotypes	F1		F2		Genotypes	F1		F2	
	N	L	N	L		N	L	N	L
P_1	-0318*	-0.187	-0.269	-0.077	P_2xP_8	0.265	0.026	-0.140	-0.070
P_2	0.676**	-0.032	0.393*	-0.235*	P_3xP_4	0.551	0.256	0.541	0.032
P_3	-0684**	-0.265*	-0.649**	-0.208*	P_3xP_5	0.535	0.386	0.503	0.554
P_4	1.039**	0.452**	1.123**	0.353**	P_3xP_6	0.658	0.716*	0.334	0.671*
P_5	-0.344*	-0.045	-0.513**	0.018	P_3xP_7	-0.709	0.246	-0.384	0.058
P_6	-1.268**	-0.308**	-0.977**	-0.239**	P_3xP_8	-0.009	0.159	-0.718	0.222
P_7	1.066**	0.228*	1.177**	0.247**	P_4xP_5	-2.155**	-0.064	-2.176**	0.100
P_8	-0.168	0.184	-0.285	0.143	P_4xP_6	-2.299**	0.066	-2.139**	0.110
P_1xP_2	0.081	-0.047	-0.889	-0.024	P_4xP_7	0.268	-0.171	0.207	-0.116
P_1xP_3	-0.625	0.619	-0.780	0.556*	P_4xP_8	0.035	-0.257	-0.297	-0.292
P_1xP_4	0.418	-0.097	0.294	0.035	P_5xP_6	0.185	0.496	0.024	0.478
P_1xP_5	0.268	0.433	0.076	0.383	P_5xP_7	0.185	-0.007	-0.940	-0.034
P_1xP_6	0.125	0.463	0.333	0.667*	P_5xP_8	0.018	0.806*	0.039	0.756
P_1xP_7	0.225	-0.107	0.199	-0.152	P_6xP_7	0.808	0.889*	0.900	0.930
$P1xP_8$	-0.175	-0.261	-0.045	-0.355	P_6xP_8	1.275**	0.269	1.149**	0.100
P_2xP_3	-0.552	-0.194	-0.829	0.027	P_7xP_8	-0.092	-0.367	-0.465	-0.306
P_2xP_4	1.525**	0.589	0.925	-0.240	S.E. gi	0.142	113.000	0.019	0.093
P_2xP_5	0.175	0.086	-0.312	-0.146	S.E. sij	0.434	0.347	0.575	0.284
P_2xP_6	-0.569	0.583	-0.575	0.505	S.E. (gi-gj)	0.214	0.171	0.284	0.140
P_2xP_7	-0.035	-0.054	0.257	-0.174	S.E. (sij-sik)	0.647	0.347	0.851	0.396

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

General combining ability effects for grain yield/plant were positive and highly significant for P_4 and P_7 under normal and late planting date in F_1's and F_2 (Table 12). It could be concluded that P_4 and P_7 were considered good combiners for grain yield under both planting dates. With respect to SCA, some crosses showed positive and no significant for grain yield/plant under normal planting and late date.

These results were in line with those reported by Bakheit *et al.* (1989), Al-Kodooussi and Hassan (1991), Abdel -kader (2006), Mohamed (2007) and Akinci (2009).

General combining ability effects of F_1's and F_2 were positive and highly significant for P_4 and P_7 under both normal and late planting date (Table13). Therefore, they could be considered good combiners for biological yield. The best hybrids displayed positive and significant or highly significant SCA effects of F_1's for biological yield were $P_1×P_4$, $P_1×P_6$, $P_2×P_7$, $P_4×P_7$ and $P_6×P_8$, under normal planting date. While, the hybrid $P_2×P_4$ showed significant and positive SCA affects under late planting date. SCA effects of F_2 population showed that $P_2×P_6$ and $P_4×P_8$ had positive and significant SCA effects under late planting date. Most population has negative effects under normal planting date. These results were agree with those reported by Zaied (1995), Tawfelis *et al.* (2006).and Barhim and Mohamed (2014).

General and specific combining ability effects of the parents of the F_1-hybrid and F_2-populations for number of Kernel/spike are presented in Table (14). General combining ability effects of F_1's and F_2 parents had positive significantly for P_2, P_4 and P_7 under normal and late planting date. Therefore, they could be considered good combiners for number of kernel/spike. The best hybrid was $P_3×P_4$ had positive and highly significant SCA effects of both F_1's and F_2 populations for number of Kernel/spike under both planting dates. These results are in line with those obtained by El-Borhamy (1995), Zaied (1995), El-Henawy (1996), Abdel -kader (2006), El-Sayed (1997), El-Sayed *et al*. (2000) and El-Karamity *et al*. (2007).

General combining ability effects of both F_1's and F_2 generations were positive and highly significant for P_3 and P_5 under normal and late planting date (table 15). These could be consider good combiner, for number of 100-Kernel weight across environments. Regarding F_1's and F_2 SCA, only one hybrid; showed ($P_3×P_8$) significantly positive under normal and late planting dates, for 100 -Kernel weight (Table 13).

Similar results obtained by Zubair *et al.* (1987), El-Shami *et al.* (1996), El-Sayed (1997), El-Sayed *et al*. (2000) and Nagwa (2007).

Table (12): General (GCA) and specific (SCA) combining ability effects of Grain yield / plant (g).

Genotypes	F_1		F_2		Genotypes	F_1		F_2	
	N	L	N	L		N	L	N	L
P_1	0.424	0.367	-1.501**	0.183	P_2xP_8	0.416	-0.331	-1.144	-1.891*
P_2	1.720**	1.145**	1.080**	0.417	P_3xP_4	-1.551	1.665	-3.383**	-0.192
P_3	-2.211**	-1.532**	-1.295**	-1.046**	P_3xP_5	1.207	-0.690	-0.327	0.542
P_4	2.505**	2.285**	1.701**	1.889**	P_3xP_6	1.867	0.410	0.711	1.516
P_5	-1.130**	-0.810*	-0.039	-0.372	P_3xP_7	-0.686	1.150	-3.191**	-0.783
P_6	-2.254**	-2.737**	-0.753**	-1.739**	P_3xP_8	0.337	-0.114	2.361*	-0.314
P_7	2.859**	2.059**	1.685**	1.834**	P_4xP_5	-3.229*	-1.880	-3.172**	-1.760
P_8	-1.913**	-0.777*	-0.877**	-1.168**	P_4xP_6	-2.018	-1.406	-1.305	-2.089*
P_1xP_2	0.572	-0.704	-3.216**	-0.833	P_4xP_7	2.499*	1.074	-0.243	0.631
P_1xP_3	-1.047	-0.961	0.822	-0.676	P_4xP_8	-2.125	-1.234	-1.955*	1.501
P_1xP_4	3.051**	-0.037	-2.277**	-0.988	P_5xP_6	0.490	1.156	-0.005	0.725
P_1xP_5	0.076	-0.585	-2.017*	0.033	P_5xP_7	1.187	0.126	-2.963**	-1.008
P_1xP_6	4.736**	0.242	1.077	0.567	P_5xP_8	-0.341	-0.592	1.292	-0.022
P_1xP_7	0.700	-0.742	-1.691	-0.173	P_6xP_7	-2.786*	-0.477	0.281	0.395
$P1xP_8$	0.256	1.428	-1.623	-2.633**	P_6xP_8	3.043**	0.409	-0.217	-0.071
P_2xP_3	1.417	-1.722	-1.349	-1.020	P_7xP_8	1.123	1.052	-1.426	-0.127
P_2xP_4	1.934	2.651**	-1.888	-0.462	S.E. gi	0.371	0.325	0.289	0.313
P_2xP_5	-2.008	-0.804	-0.631	-2.634**	S.E. sij	1.139	0.996	0.885	0.960
P_2xP_6	-2.091	0.497	-0.667	1.170	S.E. (gi-gj)	0.562	0.491	0.436	0.474
P_2xP_7	1.870	0.327	-1.123	0.063	S.E. (sij-sik)	1.685	1.474	1.309	1.421

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

Table (13): General (GCA) and specific (SCA) combining ability effects of biological yield / plant(g).

Genotypes	F_1		F_2		Genotypes	F_1		F_2	
	N	L	N	L		N	L	N	L
P_1	0.643	0.899	-2.735**	-0.507	P_2xP_8	-1.791	-2.621	-2.661	-7.987**
P_2	4.095**	3.066**	2.143**	1.142	P_3xP_4	-4.883	6.276	-8.069**	2.610
P_3	-6.890**	-4.868**	-4.719**	-4.077**	P_3xP_5	4.485	-0.190	-1.872	2.584
P_4	10.697**	6.712**	5.377**	6.109**	P_3xP_6	0.859	3.203	0.196	999.000
P_5	-5.198**	-3.469**	-0.937	-2.202**	P_3xP_7	-2.272	0.729	-9.299**	-3.057
P_6	-5.372**	-7.155**	-2.348**	-5.270**	P_3xP_8	0.847	-0.784	4.194	-1.068
P_7	5.365**	5.265**	3.770**	4.993**	P_4xP_5	-7.152*	-4.893	-9.618**	-7.252**
P_8	-3.340**	-0.451	-0.550	-0.186	P_4xP_6	-11.44**	-4.547	-6.890**	-7.947*
P_1xP_2	-6.618*	-1.898	-9.196**	-4.963	P_4xP_7	11.208**	1.616	0.722	3.133
P_1xP_3	-1.776	-3.538	0.533	-2.104	P_4xP_8	-10.46**	-4.554	-7.608**	5.602*
P_1xP_4	16.077**	-1.341	-8.833**	-3.774	P_5xP_6	2.221	1.461	-1.606	1.494
P_1xP_5	-0.425	-4.153	-4.406	0.048	P_5xP_7	-1.234	1.937	-8.661**	-2.709
P_1xP_6	11.899**	-0.577	0.039	0.089	P_5xP_8	1.569	-3.603	0.929	-0.740
P_1xP_7	1.955	-0.447	-7.179**	-0.597	P_6xP_7	-2.566	-0.256	-3.333	-0.661
$P1xP_8$	3.367	6.149	-1.983	-6.978**	P_6xP_8	6.310*	-1.930	0.157	-2.032
P_2xP_3	2.565	-5.921	-3.415	-3.876	P_7xP_8	-1.361	4.106	-5.438*	4.175
P_2xP_4	1.822	7.986*	-9.868**	-1.090	S.E. gi	1.051	1.100	0.743	0.850
P_2xP_5	-7.030*	-1.270	-4.054	-5.915*	S.E. sij	3.220	3.371	2.277	2.605
P_2xP_6	-4.806	-0.903	0.058	5.200*	S.E. (gi-gj)	1.588	1.663	1.123	1.285
P_2xP_7	9.217**	-0.317	-2.031	-0.856	S.E. (sij-sik)	4.765	4.988	3.369	3.854

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

Table (14): General (GCA) and specific (SCA) combining ability effects of number kernel / plant.

Genotypes	F_1		F_2		Genotypes	F_1		F_2	
	N	**L**	**N**	**L**		**N**	**L**	**N**	**L**
P_1	-1.670*	-1.475*	-1.122	-0.298	P_2xP_8	-0.814	0.723	-1.806	3.093
P_2	3.839**	4.102**	3.616**	3.992**	P_3xP_4	12.12**	8.778**	6.027**	0.579
P_3	-3.282**	-2.385**	-3.743**	-2.413**	P_3xP_5	-0.846	0.371	0.309	-4.387*
P_4	6.449**	2.667**	3.851**	1.407*	P_3xP_6	-4.403*	-0.600	-3.389	1.850
P_5	-4.948**	-2.139**	-3.531**	-2.487**	P_3xP_7	-4.508*	-0.552	-3.872*	-0.232
P_6	0.776	0.942	1.713*	0.990	P_3xP_8	-0.387	-1.633	-6.404**	0.315
P_7	5.101**	5.057**	4.750**	5.745**	P_4xP_5	-4.343	0.152	-2.475	-2.774
P_8	-6.267**	-6.769**	-5.535**	-6.935**	P_4xP_6	-6.867**	-5.396**	-10.05**	-1.544
P_1xP_2	1.023	1.237	2.181	0.413	P_4xP_7	-0.759	-5.288**	-7.519**	-7.072**
P_1xP_3	4.643*	3.350	3.973**	3.492	P_4xP_8	-2.591	0.742	-2.768	-4.712*
P_1xP_4	-4.987*	-3.128	-4.841**	-1.349	P_5xP_6	2.863	0.484	0.672	1.297
P_1xP_5	-0.024	-2.629	-2.286	-3.575	P_5xP_7	1.105	-1.328	0.549	-1.465
P_1xP_6	3.059	2.917	0.866	-1.072	P_5xP_8	2.139	0.761	0.634	2.828
P_1xP_7	-0.239	1.885	-0.307	-1.050	P_6xP_7	0.581	-1.956	-0.475	-0.855
$P1xP_8$	-1.471	-4.386	-3.649*	-2.253	P_6xP_8	1.515	7.753**	5.866**	-2.315
P_2xP_3	0.201	1.060	0.072	-0.305	P_7xP_8	0.424	4.138	1.610	1.130
P_2xP_4	1.103	-1.959	-3.345	-3.612	S.E. gi	0.688	0.732	0.598	0.638
P_2xP_5	0.200	4.184	-0.237	-0.665	S.E. sij	2.110	2.245	1.835	1.955
P_2xP_6	2.843	4.939*	1.586	1.625	S.E. (gi-gj)	1.041	1.107	0.905	0.964
P_2xP_7	0.485	-0.316	-2.564	-0.470	S.E. (sij-sik)	3.122	3.321	2.715	2.893

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

Table (15): General (GCA) and specific (SCA) combining ability effects of 100 – kernel weigh.

Genotypes	F_1		F_2		Genotypes	F_1		F_2	
	N	L	N	L		N	L	N	L
P_1	0.155*	0.341**	0.049	0.237**	P_2xP_8	0.425**	0.263**	0.233	0.253
P_2	-0.027	-0.243**	-0.128	-0.272**	P_3xP_4	-0.201*	0.378**	-0.455	0.214
P_3	0.286**	0.101	0.280**	0.126*	P_3xP_5	-0.404**	0.165	-0.184	0.225
P_4	0.112	-0.161*	0.262**	-0.035	P_3xP_6	0.004	0.207*	0.070	-0.005
P_5	0.191**	0.298**	0.321**	0.357**	P_3xP_7	-0.284**	-0.388**	-0.352	0.009
P_6	-0.079	-0.068	-0.058	-0.001	P_3xP_8	0.220*	0.405**	0.832**	0.335*
P_7	-0.358**	-0.138*	-0.417**	-0.255**	P_4xP_5	-0.438**	-0.210*	-0.320	-0.285
P_8	-0.280**	-0.130*	-0.311**	-0.148	P_4xP_6	-0.219*	0.152	0.264	0.174
P_1xP_2	0.202*	0.086	0.203	-0.124	P_4xP_7	0.022	-0.161	0.017	0.119
P_1xP_3	0.091	0.048	-0.433	-0.194	P_4xP_8	0.060	0.450**	0.275	0.380*
P_1xP_4	0.041	-0.262**	-0.157	-0.054	P_5xP_6	0.218*	-0.286**	-0.089	-0.201
P_1xP_5	0.066	0.237**	-0.074	0.219	P_5xP_7	-0.249*	0.088	0.117	0.146
P_1xP_6	-0.036	-0.036	0.355	0.537**	P_5xP_8	0.225*	0.313**	0.347	0.046
P_1xP_7	0.179	0.911**	0.400	0.021	P_6xP_7	0.196*	0.341**	-0.179	-0.250
$P1xP_8$	0.510**	0.594**	0.166	0.414*	P_6xP_8	0.205*	0.145	0.051	0.044
P_2xP_3	0.229*	-0.005	-0.017	-0.020	P_7xP_8	0.402**	0.113	-0.155	0.171
P_2xP_4	0.286**	0.065	0.359	0.027	S.E. gi	0.056	0.060	0.077	0.055
P_2xP_5	0.155	-0.221*	0.124	-0.168	S.E. sij	0.099	0.090	0.236	0.168
P_2xP_6	-0.248*	-0.027	-0.441	0.083	S.E. (gi-gj)	0.098	0.183	0.016	0.083
P_2xP_7	-0.250*	0.420**	-0.239	0.070	S.E. (sij-sik)	0.295	0.256	0.349	0.248

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

Conclusion

The study of diallel crosses of durum wheat more favorable element for the selection of these genotypes under both planting date. The result that showed highly significant negative heterosis in the tow hybrids (P_3×P_5) and (P_4×P_6) under both tow planting date. Early maturity crosses can be used in breeding program for getting early maturity lines by different selection methods. While, eight hybrid showed highly significant positive heterosis under late planting date i.e. (P_1×P_6), (P_2×P_4), (P_2×P_5), (P_2×P_7), (P_5×P_6) ,(P_5×P_7) (P_6×P_7) and (P_7×P_8) for no. spike/plant, (P_2×P_7) and (P_4×P_7) for grain yield /plant, (P_1×P_8) and (P_2×P_8) for 100-kernel weight under both tow planting date ,addition these hybrid were tolerant heat stress.

P_4, P_7 showed highly significant positive GCA effects in four traits under both tow planting date. These parents could be consider as good combiner for tolerant heat stress, Also P_2 showed highly positive GCA effects in three traits under both planting date, which could be unlisted in beading for ear lines in wheat.

P_8 showed positive and highly significant GCA effect under two planting date. This parent could be as a good combiner for lateness. While, the cross (P_3×P_8) showed positive values for 100-krnel weight under both planting date

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دراسات وراثية علي محصول الحبوب ومكوناته في قمح الديورم تحت الإجهاد الحراري

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الملخص:

أجري تقييم الهجن الدائرية دون العكسية بين ثمانية تراكيب وراثية من قمح الديورم في محطة البحوث الزراعية بأسيوط موسم ٢٠٠٨/٢٠٠٧ ، ٢٠٠٩/٢٠٠٨ ، ٢٠١٠/٢٠٠٩ للتقدير القدرة العامة والخاصة وقوة الهجين في قمح الديورم تحت الإجهاد الحراري

ويمكن تلخيص أهم النتائج فيما يلي :-

- أوضحت النتائج وجود اختلافات معنوية بين كافة التراكيب الوراثية في كل من الصفات تحت الدراسة. وكان التباين الراجع إلي القدرة العامة والخاصة علي الائتلاف معنويا في كل من الجيل الأول والثاني ما عدا القدرة الخاصة لصفة المحصول والمحصول البيولوجي وعدد حبوب السنبلة في الميعاد المتأخر في الجيل الأول. وبتقدير القيم النسبية لتباين كل من القدرة العامة والخاصة علي الائتلاف وجد أنها تزيد عن الوحدة لصفات محصول الحبوب و المحصول البيولوجي و عدد حبوب السنبلة في الجيل الأول تحت ميعاد الزراعة الأمثل كذلك صفة عدد السنابل للنبات تحت ميعاد الزراعة المتأخر.

- كما أعطت نتائج مماثلة لصفات عدد السنابل – المحصول – وزن ال١٠٠ حبة تحت ميعاد الزراعة الأمثل في الجيل الثاني كذلك بالنسبة لصفة محصول الحبوب وعدد حبوب السنبلة تحت ميعاد الزراعة المتأخر. مما يدل علي أن الفعل الجيني المصنف أكثر أهمية في وراثة معظم الصفات المدروسة وكذلك كان التباين الراجع لقوة الهجين معنوي في كل الصفات ما عدا صفة عدد السنابل للنبات للجيل الأول في الميعاد المتأخر.

- كما أوضحت النتائج تفوق سبع هجن علي الأب الأفضل بنسبة تراوحت ما بين ٨,٧٩٨% للهجين (P4×P7) إلي ٤١,٢٢% للهجين P1×P6 تحت الميعاد الأمثل للزراعة .

هذه التأثيرات غير الإضافية لقوة الهجين مع التباين الواضح بين كافة التراكيب الوراثية تعطي الفرصة لعزل توليفات جديدة في الأجيال الانعزالية التالية مقاومة للحرارة.

- أوضحت نتائج القدرة العامة علي التآلف أن الأب P7،P4 وهما بني سويف و Altar 84 أفضل الآباء تآلف في أربع صفات تحت الدراسة في الجيلين الأول والثاني. ثلاث صفات منها مساهمة في المحصول بينما السلالة P2 أفضل الآباء تآلف في صفة التزهير والنضج الفسيولوجي وعدد حبوب السنبلة.

- أوضحت نتائج القدرة الخاصة علي الائتلاف في محصول الحبوب أن أربعة هجن أعطت قيما موجبة للقدرة الخاصة علي الائتلاف في الجيل الأول تحت ميعاد الزراعة الأمثل وهجين واحد أعطى قيمة موجبة تحت ميعاد الزراعة المتأخر بينما في الجيل الثاني أعطى هجين واحد قيمة موجبة تحت ميعاد الزراعة.

- أعطي الهجين P3×P8 (Edmor ×line #2) قيمة موجبة بالنسبة للقدرة الخاصة علي الائتلاف لصفة وزن إل ١٠٠حبة في الجيل الأول والثاني تحت ميعادي الزراعة.