Egyptian J. Desert Res., 54, No.2, 327-347 (2004)

GENETIC PARAMETERS AND GRAPHICAL ANALYSIS OF BREAD WHEAT DIALLEL CROSSES UNDER DROUGHT STRESS CONDITIONS

Farag, H.I.A.; K.A. El-Shouny*, A.A. Mohamed* and S.A.N. Afiah
Plant Genetic Resources Dept., Desert Research Center, El-Matareya, Cairo, Egypt.
*Agron. Dept., Fac. of Agric., Ain Shams Univ., Cairo, Egypt.

The objective of the present investigation was to study the genetic system controlling heading date, maturity date, number of spikes/plant, number of grains / spike, 1000-grain weight, straw and grain yield/plant in seven spring wheat genotypes (*Triticum aestivum* L.) under well-watered condition (irrigation every 7 days interval) and drought stress (irrigation every 13 days interval) at Ras Sudr Agricultural Experiment Station of Desert Research Center at South Sinai Governorate. The seven parents were crossed in diallel system excluding reciprocals and evaluated with its F_1's in the two seasons 2001/2002 and 2002/2003.

The estimated values of additive component (*D*) for most traits under the two irrigation intervals in the 1st and 2nd seasons and straw yield under severe stress condition in both seasons were significant. Presence of dominance effects (H_1 and H_2) were substantiated by significant estimates of H_1 for all traits recorded except heading date under the two irrigation treatments in the first season and number of spikes /plant under the two irrigation treatments in the second season. Also, H_2 estimated values which represent dominance variance adjusted for asymmetric gene distribution, were highly significant for all cases except heading date under the two irrigation intervals in both seasons, maturity date under control treatment in the first season and number of spikes/plant under the control in the 1st season and two irrigation treatments in the 2nd season, and were higher than those of *D* in most cases.

$(H_1/D)^{0.5}$ derivative values which measure the average degree of dominance overall loci were greater than unity for all traits recorded indicating that these traits are controlled mainly by over dominance genetic effects. The ratio of additive genetic portion to the phenotypic variance computed as narrow sense heritability [H(n.s.)] was relatively high for 1000-grain weight and heading date under the two water treatments in both seasons. These results confirm that additive gene effects play major role in the genetic variation of these traits under tested conditions and that selection in early segregating generations could be effective for isolating good new recombinants suitable to the aimed environments.

Data of graphical analysis showed variation in the dominance or recessive positions for parents where W_r (covariance between the parents and their offspring in the rth array),V_r (variance of the rht array) graph showed that Sakha8 (P_4) and Line-2 (P_7) contained the highest frequency of recessive alleles for heading and maturity dates, grain yield/plant, number of grains/spike and straw yield / plant under the two water treatments in both seasons.

Keywords: bread wheat, gene action, genetic parameters, graphical analysis, drought stress.

Increasing grain yield of cereal crops is an important national goal to face the increasing food needs of Egyptian population. Wheat production in Egypt increased from 2.08 million ton in 1982/1983 to 7.18 million ton in 2003/2004 season, 245% increase (Statistical year book, 2004). This increase was achieved both by increasing wheat area (from 554,400 to 1085617.9hectares) and the continuous rise in grain yield ha^{-1} as a result of cultivating high yield genotypes (from 3.595 to 6.61 ton ha^{-1}) and improved cultural practices at newly reclaimed areas. It has become necessary to develop wheat lines adapted to salt affected soils and rainfed areas The diallel mating design has been used and abused more extensively than any other cross technique (Hallauer and Miranda, 1981). Crossing of wheat genotypes possessing desired characteristics has, so far, been the most effective way to achieve progress. Diallel cross technique is a good tool for identification of hybrid combinations that have the potentiality of producing maximum improvement and identifying superior lines among the progenies in early segregating generations. In this regared, several studies have been reported in wheat (EL-Marakby *et al.*, 1993; Mann and Sharma, 1995; Afiah and Abdel-Sattar, 1998; Afiah and Khattab, 1999; Afiah *et al.*, 2000 and Afiah, 2002 a and b).

It is emphasized that the proper interpretation of genotypic effects depends on the particular diallel method. Jinks (1956) procedure was practiced for partitioning the genetic variance into its components and utilizing graphical analysis to understand the genetic nature of polygentic traits and to investigate the breeding potential of parental wheat genotypes in respect to transmit or accumulate genes controlling their yielding capacity in the following generations.

Therefore, the main objectives of this investigation are: 1) to partition phenotypic variation into genotypic and environmental components as well as subdivide genetic parameters as outlined by Hayman (1954 b), 2) to detect non-allelic interactions and gene distribution in the parental genotypes through graphical analysis and 3) to determine whether the increasing or decreasing genes are the dominant one's under well-watered and drought stressed conditions.

MATERIALS AND METHODS

Seven divergent parents used in this study were crossed in 2000/2001 season to form a non-reciprocal diallel set of 21 F_1 hybrids. Names, source, pedigree and/or history of the parental varieties or lines are presented in table (1). Crosses were repeated in 2001/2002 season to obtain grains of the 21 F_1 hybrids again. In both seasons, crosses were made at the Experimental Farm of the Faculty of Agriculture, Ain Shams University at Shoubra El-Kheima, Kalubia Governorate. In 2001/2002 season, a field trial included the 21 F_1 hybrids and their respective parents were conducted at Ras Sudr Agricultural Experiment Station of Desert Research Center at South Sinai, This experiment was fairly repeated during 2002/2003 season. Sowing date was on November 27th and 23th in the 1st and 2nd season, respectively. The physical and chemical properties of composite soil samples taken from the experimental site to depths of 0-15 and 15-30 cm were analyzed mechanically (Piper, 1950) and chemically (Black *et al.,* 1965), as well as analysis of artesian irrigation water (average over five irrigations) during each growing season was made. The results of analysis are presented in table (2) which showed that soil is characterized as highly calcareous (45.62, 48.34 $CaCO_3$), saline (ECe 8.54 and 7.84 dSm^{-1}) and has sandy loam texture with 7.39 and 7.71 pH in the two depths, respectively. The artesian irrigation water had EC value of 7.94 dSm^{-1} and pH 7.65. Each field trial was subjected to three irrigation regimes applied in a form of irrigation intervals. The irrigation treatments began when wheat plants were 30 days old after sowing in the two seasons where plants were established and constant amount of water per irrigation was given for all irrigation treatments. The irrigation treatments were as follows:

a) Irrigation every 7 days (a well-watered control or treatment).
b) Irrigation every 10 days (a moderate moisture stress or moderate water deficit treatment)
c) Irrigation every 13 days (a severe moisture stress or severe water deficit stress).

TABLE (1). Names, source, pedigree and/or selection history of the parental genotypes.

Genotype	Source	Pedigree and/or selection history
Line-1	CIMMYT	Kvz / / Cno / / Pj 62
Line-2	ICARDA	Tsi / Vee'S' CM64335-3AP-1AP-4AP-0AP
Line-3	ACSAD	Cno'S' – Pj62 x Eullo / Pie's' x TZPP X 7C/TOZIM73-Paran'S' CM35044-04-1AP-0AP
Line-606#	Egypt	Atlas 66 / Nap Hall / / (NE70117) Skores Pelka35 / 3 / 2* RCB-61 Su606-13Su-2Su-5Su-0Su
Sakha-8	Egypt	Indus 66 / Norteno'S' PK 3418-6S-1SW-0S
Sakha-93	Egypt	S92 / TR 810328 S 8871-1S-2S-1S-0S
Giza-164	Egypt	Kvz / Buha'S' // Kal/Bb CM33029-F-15M-500Y

CIMMYT; Centro International de Mejoramiento de Maize Y Trigo (Mexico) = International maize and wheat improvement center.
ICARDA ; International Center of Agricultural Research in the Dry Areas
ACSAD ; Arab Center for the Studies of Arid Zones and Dry Lands
Newly bred line released through Desert Research Center crop breeding program

Randomized complete blocks design with four replications was used in each experiment. Wide borders (3m in width) were kept among the different water regimes to minimize the underground water permeability. Each experimental unit consisted of one row for each genotype. Row was 3.5m in length and row spacing and distance among seedlings on rows were 30 cm and 10 cm, respectively. Heading date of 50% plants/plot was recorded for each genotype. Maturity date was also recorded at harvest; number of spikes/plant, number of grains/spike, 1000-grain weight, straw and grain yield/plant were recorded and statistically analyzed.

The components of variation for diallel crosses are estimated according to Hayman(1954 a) and Jinks (1956). In this model, the genetic parameters are; D (the variation due to additive effects), H_1 (the variation due to dominance effects), F (the covariance of dominance and additive effects involving a particular parent), and H_2 (a dominance measure indicating asymmetry of positive and negative effects of genes). The previous components were used for computation of the other derived ratios. The genetic interpretation of this diallel approach is based on statistical models with fixed genotypic effects. The significance of various statistics is tested by t. test at n -2 d.f. as t = parameter/SE of parameter. The variance, covariance (V_r, W_r) graphical analysis was used to illustrate gene action and other genetic properties of parents for different traits recorded, as outlined by Mather and Jinks (1982).

To test the validity of diallel cross assumptions, two main tests were employed; 1) The uniformity of Wr, Vr by using Hayman's (1954 a and b) formula (as shown in table (3), r^2 value is not significant), 2) The regression coefficient of Wr/Vr is expected to differ significantly from zero but not from unity (absence of non-allelic interaction with independent distribution of the genes among the parents) if all assumptions are valid (Jinks and Hayman, 1953). Simple correlation coefficient between (Y_r) and (Wr + Vr) was computed to determine whether the increasing or decreasing genes are the dominant one's.

TABLE (2). Soil and irrigation water analysis for the experimental site at Ras Sudr region over two seasons.

A) Soil mechanical analysis of the experimental site					
Depth (cm)	Coarse sand %	Fine sand %	Silt %	Clay %	Texture
0-15	22.61	45.49	16.48	15.33	Sandy loam
15-30	35.20	28.40	18.96	17.10	Sandy loam

B) Soil chemical analysis at 0-15 and 15-30 cm depth											
Depth (cm)	pH	EC_e dSm^{-1}	$CaCo_3$	Soluble cations (mg/100g)				Soluble anions (mg/100g)			
				Na^+	Ca^{++}	Mg^{++}	K^+	CO_3^-	HCO_3^-	Cl^-	SO_4^{--}
0-15	7.39	8.54	45.62	48.04	21.21	10.86	5.62	-----	10.85	43.8	25.2
15-30	7.71	7.84	48.34	43.24	15.19	10.80	6.23	-----	11.6	44.95	19.8

C) Irrigation water chemical analysis									
pH	EC dSm^{-1}	Soluble cations (mg/100g)				Soluble anions (mg/100g)			
		Na^+	Ca^{++}	Mg^{++}	K^+	CO_3^-	HCO_3^-	Cl^-	SO_4^{--}
7.65	7.94	46.38	24.73	15.17	0.41	-----	2.65	62.75	21.29

RESULTS AND DISCUSSION

F_1 diallel crosses must meet the following six assumptions for estimating the variance components; 1) Diploid segregation; 2) Parental homozygosity, which assured from the history of self pollination in the parents and from numerous reports that *Triticum aestivum* wheat regularly forms 21 bivalents in meiosis so that its inheritance is uniformly disomic; 3) The absence of reciprocal differences which could be assumed from various numerous reviews, although a few workers reported it for distinct characters and in a limited range; 4) Absence of non-allelic gene interactions, 5) No multiple allels and 6) Independent gene distribution among the parents. The regression of Wr on Vr which have a linear unit slope and the uniformity of Wr, Vr as detected by not significant t^2 values for most of the traits recorded led to validate the three later assumptions.

Significant genotypic difference is the base requirement for half diallel analysis in Hyman's approach. Mean squares due to genotypes were highly significant for all traits recorded at the two extreme water intervals tested (control and severe stress) and the two seasons shown in table (3). Variances (V_r) and covariances (W_r) were estimated and the uniformity of W_r, V_r were detected for all studied cases except heading date, in both seasons and maturity date under severe stress in the first season by insignificant t^2 values indicating the validity of assumptions made by Hayman (1954a) as clearly shown in table (3). The components of variations D, H_1, H_2, F, h^2 and E as expected values using least square technique were calculated and given in table (4). The estimated values of additive component (D) for most traits except heading date, grain yield/plant under the two irrigation intervals in the 1st and 2nd season and straw yield under severe stress in both seasons were significant, suggesting the possibility of improving such traits by selection in the following generations under similar conditions. Presence of dominance effects were substantiated by significant estimates of H_1 for all traits recorded except heading date under the two irrigation treatments in the first season and number of spikes/plant under the two irrigation treatments in the second season. Moreover, H_1 values were higher than D estimates in all cases regardless its sign. Also, H_2 estimated values which represent dominance variance adjusted for asymmetric gene distribution, were highly significant for all cases except heading date under the two irrigation intervals and in both seasons, maturity date under control treatment in the first season and number of spikes/plant under control treatment in the 1st season and under the two irrigation treatments in 2nd season, respectively, and were higher than those of D in most cases. H_2 values were smaller than those of H_1 in all traits studied except grain yield/plant indicating unequal proportion of positive and negative alleles for each trait in the parental genotypes. This would indicate the importance of non-additive genetic variance in the inheritance of these traits. Hence, it could be concluded that the selection procedures would be effective when additive, dominance and epistatic effects are involved in the genetic control of such traits especially, when they acted at the same direction. The relative frequency of dominant to recessive alleles in parental genotypes (gene symmetry) as indicated by F values which showed unequal gene frequencies was negative and significant in heading date, maturity date, 1000-grain weight under two water treatments in both seasons and No. of spikes/plant under two stress treatments in the 1st season (Table 4) suggesting that the dominant alleles were more frequent than the recessive ones. This finding was confirmed by the ratio of K_D/K_R that was more than unity in heading date under severe stress, maturity date under the two water treatments in both seasons and grain yield/plant under well-watered in the 2nd season. It is worthy mentioned that, F value was significant and exceeded unity for 1000-grain weight under the two water reatments in two seasons indicating that dominant alleles have increasing effects (Mather and Jinks, 1982) .The overall dominance effects of heterozygous loci (h^2) were found to be positive and highly significant for all traits recorded except heading date, maturity date and number of spikes/plant. This means that the dominant effect was mainly attributed to heterozygous phase in all crosses. The environmental effects indicated by E values reached the significant level in all traits except number of grains/spike, 1000-grain weight and straw yield/plant revealing their sensitivity to the environmental changes.

TABLE (3). Mean squares of analysis of variance component for two irrigation intervals and two years for the studied characters of wheat genotypes

Season	First season (2001/2002)						Second season (2002/2003)					
Irrigation intervals	7 days			13 days			7 days			13 days		
Source	Genotypes	Error	t^2	Genotypes	Error	t^2	Genotypes	Error	t^2	Genotypes	Error	t^2
d.f.	27	81		27	81		27	81		27	81	
1-Heading date	87.93**	1.701	4.759**	96.93**	1.10	6.180**	82.10**	1.459	7.175**	91.29**	2.637	8.351**
2-Maturity date	64.52**	1.504	2.470	52.94**	1.080	2.920*	69.67**	0.833	0.277	55.45**	1.290	2.340
3-Grain yield/plant (g)	11.31**	0.072	0.0004	7.456**	0.116	2.420	12.414**	0.083	0.270	8.064**	0.111	2.484
4-No. of spikes/plant	0.80**	0.125	0.795	0.523**	0.05	0.029	0.76**	0.060	1.362	0.622**	0.044	0.160
5-1000-grain weight (g)	152.07**	0.009	0.030	144.94**	0.012	0.001	117.93**	0.048	0.121	140.26**	0.0170	0.009
6-No. of grains/spike	218.98**	0.692	0.244	150.74**	0.475	0.537	164.39**	0.410	0.511	169.84**	0.264	1.537
7-Straw yield/plant (g)	11.80**	0.326	0.177	7.180**	0.342	0.251	22.51**	0.471	1.141	9.359**	0.237	2.072

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

$(H_1/D)^{0.5}$ derivative values which measure the average degree of dominance overall loci were greater than unity for all traits recorded indicating that these traits controlled mainly by over dominance genetic effects. H_2 / $4H_1$ value was used to estimate the average frequency of negative (v) versus positive (u) alleles in the parental genotypes. This ratio theoretically equals 0.25 when the distribution of positive equal negative genes among the genetic make up of parents. As shown in table (4), this ratio seemed to be smaller than 0.25 for all traits studied except grain yield/plant under two water treatments in both seasons revealing that positive and negative alleles were not equally distributed in the parental genotypes. The fraction h^2 / H_2 was calculated to determine the number of effective gene groups that control the character and exhibit dominance. Data showed that about four and three effective gene groups controlled grain yield/plant under two water treatments in both seasons, respectively. Very low h^2 / H_2 ratios were obtained for maturity date under severe stress in the 1st and 2nd season, respectively. Also, relative low estimate was computed for heading date under well watered in the 2nd season and straw yield/plant under severe stress in the 1st season suggesting that among the genes governing each of these traits, one or more of high dominance effect led to disportionate h^2/H_2 fraction as previously stated by Crumpacker and Allard (1962) especially when such gene groups distributed independently. The prediction for measurement of completely dominant and recessive parents (r^2) exhibited the highest value (0.898) for grain yield/plant (Table 4). Afiah and Abdel-Sattar (1998), Ismail *et al.* (2000) Awaad (2001) and Afiah (2002 a and b) studied the genetic parameters in wheat diallel crosses under stress conditions and obtained results more or less in harmony with these findings.

The ratio of additive genetic portion to the phenotypic variance computed as narrow sense heritability [Hn.s.] was relatively high for 1000-grain weight and heading date under two water treatments in both seasons (Table 3). These results confirm that additive gene effects play major role in the genetic variation of these traits under tested conditions and that selection in early segregating generations could be effective for isolating good new recombinants suitable to the aimed environments. Similar conclusion was previously obtained by Kheiralla and Sherif (1992) and Afiah *et al.* (2000).

Graphical Analysis

Mather and Jinks (1982) concluded that Hayman's (1954 a and b) analysis is the most useful for determining significance of principal genetic components. This procedure suggests that the diallel set of data could be graphically analyzed. The graph of W_r on V_r prospectively provides information on three points: 1) it supplies a test of adequacy of the model in the absence of non-allelic interaction and with independent distribution of the genes among the parents. W_r is related to V_r by a straight regression line of unit slope; 2) a measure of the average level of dominance is provided by the departure from the origin of the point where the regression line cuts the W_r axis, and 3) the relative order of the points along the regression line indicates the distribution of dominant and recessive genes among the parent arrays. Figures (1 to 7) illustrate variance (V_r) and covariance (W_r) graphs for all traits recorded under the two water treatments in both seasons.

The values of regression coefficient (b) of parent-offspring covariance (W_r) on parental array variance (V_r) are illustrated in Figures (1-7 a and b). Values were significantly differed from zero indicating real relationship between W_r and V_r for all traits under two water treatments in both seasons except maturity date under well watered in the 1st and 2nd seasons. The slope of regression line "b" deviated significantly from unity for grain yield/plant and straw yield/plant under well-watered, 1000-grain weight under the two water treatments in the 1st and 2nd seasons indicating the presence of additive and dominance effects without any complications by the epistatic effects.

TABLE (4). Estimates of genetic parameters and some of its derived ratios in F_1 diallel cross analysis for all traits recorded in bread wheat

Characters	Heading date				Maturity date			
Seasons	2001/2002		2002/2003		2001/2002		2002/2003	
Genetic Parameters	Irrigation intervals (days)		Irrigation intervals (days)		Irrigation intervals (days)		Irrigation intervals (days)	
	7	13	7	13	7	13	7	13
E	19.89**	22.44**	22.89**	23.39**	23.95**	24.95**	26.57**	29.83**
D	1.865	-3.150	0.172	-5.752	-13.94*	-16.91*	-8.414*	-20.29**
F	-34.41*	-33.54*	-36.41*	-37.41*	-37.92*	-34.75*	-36.91*	-46.04**
H_1	-12.45	-1.000	-26.48*	-9.639*	-19.61*	-29.34*	-29.72*	-46.98**
H_2	-1.722	2.970	-12.68	-2.881	-6.69	-22.32*	-13.03*	-31.55**
h^2	-9.044	-10.15	-6.792	-9.908	-10.33	-12.18	-10.91	-14.39*
$(H_1/D)^{0.5}$	2.585	0.565	12.41	1.294	1.186	1.320	1.879	1.522
$H_2/4H_1$	0.035	-0.740	0.120	0.075	0.085	0.190	0.110	0.168
h^2/H_2	5.252	-3.411	0.536	3.439	1.544	0.546	0.838	0.456
K_D/K_R	-1.780	25.10	-1.264	35.89	37.78	34.97	36.74	46.29
Hn.s.	39.62	36.29	36.62	35.44	19.89	21.83	20.20	19.04
r^2	0.15	0.001	0.05	0.009	0.051	0.033	0.094	0.012
Characters	Grain yield/plant (g)				No. of spikes/plant			
E	0.800**	0.986**	0.951**	0.910*	0.385**	0.346**	0.427**	0.312**
D	0.810	-0.250	0.320	-0.201	-0.26*	-0.20**	-0.18*	-0.12*
F	0.110	-0.560	-0.450	-0.453	-0.51*	-0.430*	-0.23	-0.25
H_1	6.173**	4.040*	7.292**	4.792*	-0.22	-0.510*	-0.24	-0.16
H_2	6.222**	4.270*	7.505**	4.898*	0.01	-0.310*	-0.20	-0.05
h^2	27.33**	14.49**	28.14**	16.25**	-0.03	-0.130	-0.14	-0.12
$(H_1/D)^{0.5}$	2.761	4.050	4.776	4.882	0.935	1.600	1.171	1.161
$H_2/4H_1$	0.252	0.260	0.257	0.256	-0.009	0.150	0.208	0.073
h^2/H_2	4.392	3.393	3.750	3.317	-3.318	0.412	0.720	2.743
K_D/K_R	0.915	-1.772	1.303	-1.597	0.437	0.790	0.690	0.326
Hn.s.	12.13	2.072	8.962	3.295	3.410	4.732	2.044	3.277
r^2	0.689	0.780	0.898	0.712	0.015	0.134	0.214	0.640

TABLE (4) Continued.

Characters	No. of grains/spike				1000-grain weight (g)			
Seasons	2001/2002		2002/2003		2001/2002		2002/2003	
Genetic Parameters	Irrigation intervals (days)		Irrigation intervals (days)		Irrigation intervals (days)		Irrigation intervals (days)	
	7	13	7	13	7	13	7	13
E	19.89**	22.44**	22.89**	23.39**	23.95**	24.95**	26.57**	29.83**
D	1.865	-3.150	0.172	-5.752	-13.94*	-16.91*	-8.414*	-20.29**
F	-34.41*	-33.54*	-36.41*	-37.41*	-37.92*	-34.75*	-36.91*	-46.04**
H_1	-12.45	-1.000	-26.48*	-9.639*	-19.61*	-29.34*	-29.72*	-46.98**
H_2	-1.722	2.970	-12.68	-2.881	-6.69	-22.32*	-13.03*	-31.55**
h^2	-9.044	-10.15	-6.792	-9.908	-10.33	-12.18	-10.91	-14.39*
$(H_1/D)^{0.5}$	2.585	0.565	12.41	1.294	1.186	1.320	1.879	1.522
$H_2/4H_1$	0.035	-0.740	0.120	0.075	0.085	0.190	0.110	0.168
h^2/H_2	5.252	-3.411	0.536	3.439	1.544	0.546	0.838	0.456
K_D/K_R	-1.780	25.10	-1.264	35.89	37.78	34.97	36.74	46.29
Hn.s.	39.62	36.29	36.62	35.44	19.89	21.83	20.20	19.04
r^2	0.15	0.001	0.05	0.009	0.051	0.033	0.094	0.012

Characters	Straw yield/plant			
E	0.093	0.198	0.132	0.162
D	2.163*	0.983	4.119*	1.288
F	3.313	0.913	5.311	1.435
H_1	11.87**	6.717*	21.24**	8.391*
H_2	9.734**	6.066*	18.65**	7.047*
h^2	13.21**	3.608*	32.32**	9.158**
$(H_1/D)^{0.5}$	2.343	2.614	2.271	2.552
$H_2/4H_1$	0.205	0.226	0.220	0.210
h^2/H_2	1.357	0.595	1.733	1.299
K_D/K_R	-1.986	0.265	-4.03	-0.22
Hn.s.	16.39	17.39	12.72	23.72
r^2	0.382	0.089	0.798	0.073

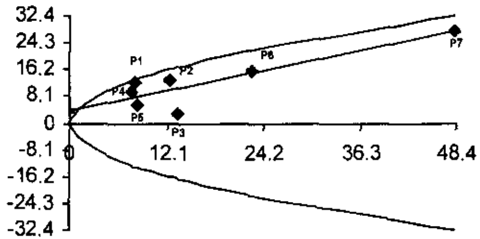
* and ** : Denote significance differences at 0.05 and 0.01 probability levels, respectively.
E = the expected environmental component of variation.
D = additive effects of genes.
F = covariation of additive and dominance effects.
H_1 = dominance effects of genes.
H_2 = dominance indicating symmetry of positive and negative effects of genes.
h^2 = dominance effect as the algebraic sum over all loci in heterozygous phases in all crosses.
$(H_1/D)^{0.5}$ = the mean degree of dominance over all loci.
$H_2/4H_1$ = the ratio of genes with positive and negative effects in the parents.
h^2/H_2 = number of groups of genes which control the character and exhibited dominance .
K_D/K_R = the ratio of dominance and recessive genes in the
Hn.s. =heritability in n arrow sense.
r^2 = prediction for measurement of completely dominant and recessive parents.

For 1000-grain weight under two water treatments, grain yield/plant, number of spikes/plant and straw yield/plant under well water treatment in the 1^{st} and 2^{nd} season, the regression lines intercept W_r below the origin suggesting the major role of over-dominance and confirmed again $(H_1/D)^{0.5}$ derived ratios. Regarding the other cases, partial dominance had an important role in controlling grain yield / plant under severe stress treatment in the 1^{st} and 2^{nd} seasons as the regression line intercept W_r axe above the origin. The scattered parental array points along the regression line for all studied cases indicate the presence of different genetic systems (types of alleles) among parents for each trait.

The relative position of array points and W_r/V_r graph showed that Sakha 8 (P_4) and Line-2 (P_7) contained the highest frequency of recessive alleles for heading date, maturity date, grain yield / plant, number of grains/spike and straw yield / plant under two water treatments in the 1^{st} and 2^{nd} season. Such recessiveness resulted in a negative effect (low parental measurement "Y_r") in grain yield/plant and number of grains/spike and straw yield/plant under two water treatments in the 1^{st} and 2^{nd} season, respectively (Figures 2,6 and 7 a and b).

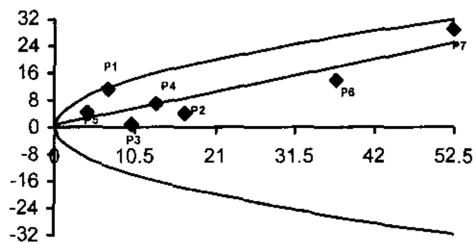
Figures (1and 3) under well-watered treatment and figures (2,6 and 7) under water stress treatment, clearly showed the fact of significantly negative $r_{(Vr+Wr),Yr}$ values means that parents containing most dominant alleles have the lowest V_r+W_r estimates and "r" will be positive if the case is reversed. The relative order of parental points along regression line designated P_1, P_4 and P_7 at the upper end and so it possessed more recessive genes contributed to the lowest estimate of 1000-grain weight, number of grains/spike, and heading date under two water treatments and maturity date under well-watered in both seasons. However both dominant and recessive alleles were approximately of equal portion in the genetic makeup of P_2 and P_6 which had a moderate Y_r values (Figure 3b). It could be concluded that the parental genotypes exhibited high level of genetic diversity, thus considered valuable to be included in crosses for developing new high yielding recombinants of bread wheat suitable for similar stress conditions. These findings confirm more or less those previously obtained by Kheiralla and El-Defrawy (1994), Afiah and Khattab (1999), Afiah *et al.* (2000) and Afiah *et al.* (2002).

First season (2001/2002)



P	$\bar{Y}_r$
P_1	72.50
P_2	84.50
P_3	74.50
P_4	82.25
P_5	77.50
P_6	83.50
P_7	81.50

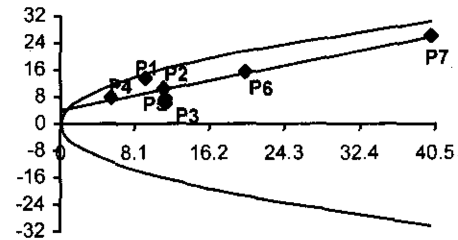
Irrigation every 7 days (a)



P	$\bar{Y}_r$
P_1	65.00
P_2	75.50
P_3	67.50
P_4	75.25
P_5	69.50
P_6	75.25
P_7	68.00

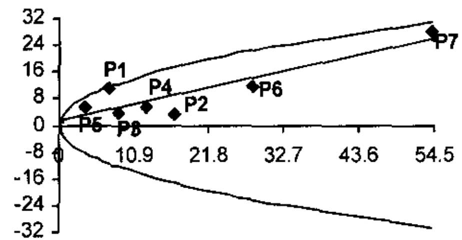
Irrigation every 13 days (b)

Second season (2002/2003)



P	$\bar{Y}_r$
P_1	71.50
P_2	83.50
P_3	73.75
P_4	83.00
P_5	77.25
P_6	82.50
P_7	80.75

Irrigation every 7 days (a)

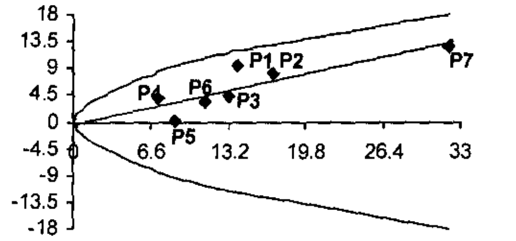


P	$\bar{Y}_r$
P_1	64.00
P_2	74.75
P_3	67.25
P_4	74.50
P_5	69.00
P_6	73.50
P_7	67.50

Irrigation every 13 days (b)

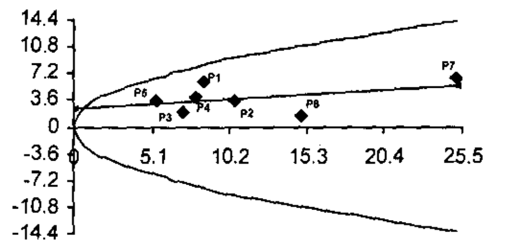
Fig (1). W_r/ V_r graphs for heading date under two water treatments in both seasons.

First season (2001/2002)



P	$\bar{Y}_r$
P_1	107.3
P_2	114.8
P_3	109.8
P_4	113.5
P_5	113.3
P_6	116.8
P_7	112.0

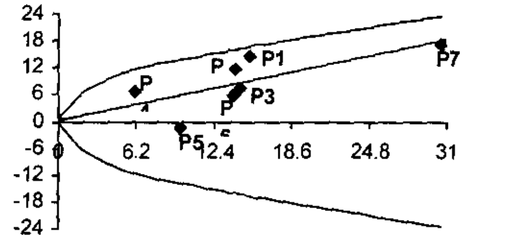
Irrigation every 7 days (a)



P	$\bar{Y}_r$
P_1	99.0
P_2	106.8
P_3	104.3
P_4	105.8
P_5	104.8
P_6	107.5
P_7	103.0

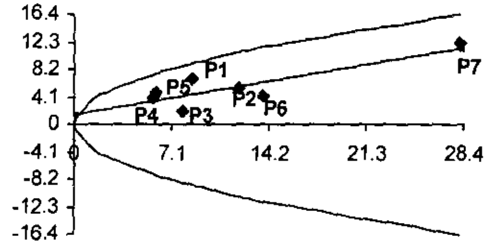
Irrigation every 13 days (b)

Second season (2002/2003)



P	$\bar{Y}_r$
P_1	106.3
P_2	116.3
P_3	108.5
P_4	115.5
P_5	115.0
P_6	117.8
P_7	113.3

Irrigation every 7 days (a)

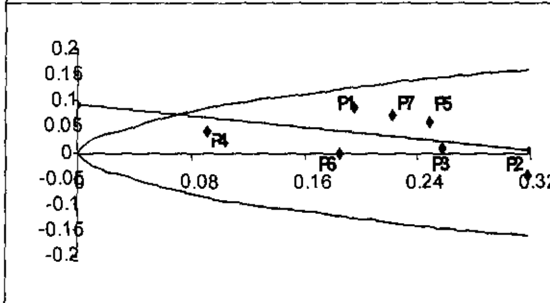


P	$\bar{Y}_r$
P_1	100.5
P_2	109.0
P_3	102.8
P_4	106.5
P_5	104.8
P_6	108.3
P_7	103.3

Irrigation every 13 days (b)

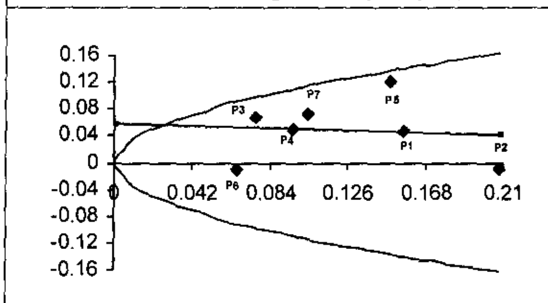
Fig (2). W_r/ V_r graphs for maturity date under two water treatments in both seasons.

First season (2001/2002)



P	$\bar{Y}_r$
P_1	3.79
P_2	3.70
P_3	3.94
P_4	4.13
P_5	3.97
P_6	3.33
P_7	3.46

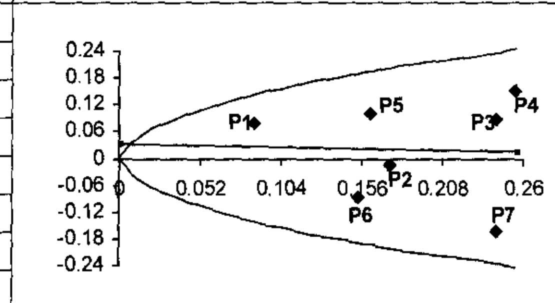
Irrigation every 7 days (a)



P	$\bar{Y}_r$
P_1	2.43
P_2	2.10
P_3	2.95
P_4	2.72
P_5	2.77
P_6	2.01
P_7	2.34

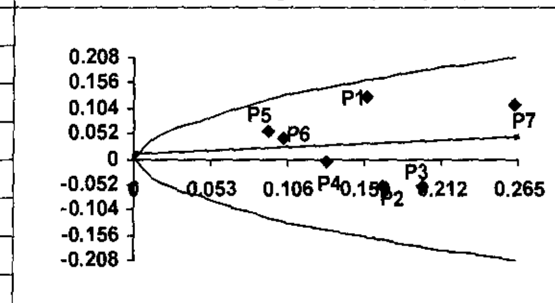
Irrigation every 13 days (b)

Second season (2002/2003)



P	$\bar{Y}_r$
P_1	3.87
P_2	3.55
P_3	4.05
P_4	4.82
P_5	4.24
P_6	3.68
P_7	3.41

Irrigation every 7 days (a)

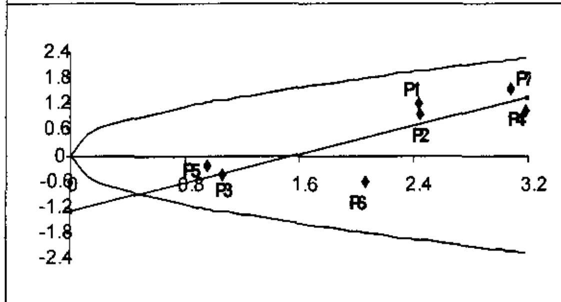


P	$\bar{Y}_r$
P_1	2.09
P_2	2.57
P_3	2.48
P_4	2.93
P_5	2.85
P_6	2.19
P_7	1.84

Irrigation every 13 days (b)

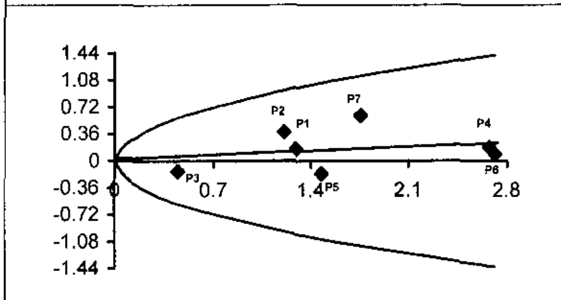
Fig (3). W_r/ V_r graphs for number of spikes/plant under two water treatments in both seasons.

First season (2001/2002)



P	$\bar{Y_r}$
P_1	7.87
P_2	8.70
P_3	11.57
P_4	8.27
P_5	10.23
P_6	9.68
P_7	9.12

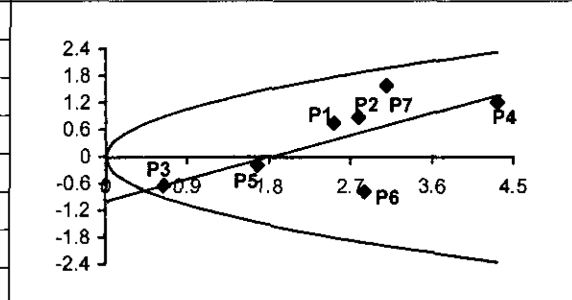
Irrigation every 7 days (a)



P	$\bar{Yr}$
P_1	4.61
P_2	5.08
P_3	6.15
P_4	3.72
P_5	4.68
P_6	4.35
P_7	3.62

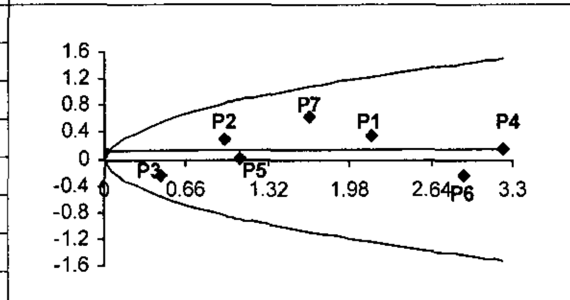
Irrigation every 13 days (b)

Second season (2002/2003)



P	$\bar{Y_r}$
P_1	8.50
P_2	8.85
P_3	11.33
P_4	8.07
P_5	10.10
P_6	9.42
P_7	8.59

Irrigation every 7 days (a)

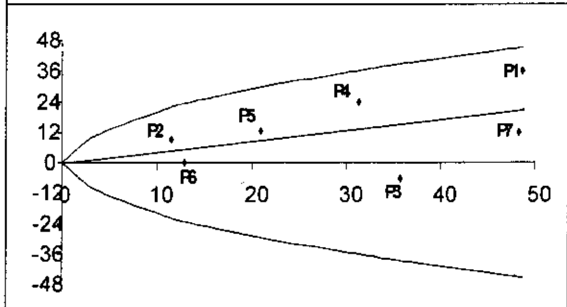


P	$\bar{Yr}$
P_1	3.71
P_2	4.99
P_3	5.59
P_4	3.47
P_5	4.47
P_6	4.40
P_7	3.28

Irrigation every 13 days (b)

Fig (4). W_r/ V_r graphs for grain yield/plant under two water treatments in both seasons.

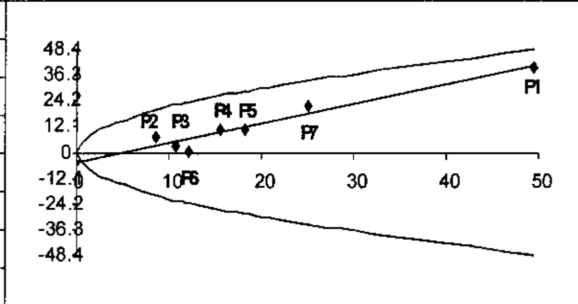
First season (2001/2002)



P	$\bar{Y}_r$
P_1	41.44
P_2	52.31
P_3	49.13
P_4	47.27
P_5	45.49
P_6	61.19
P_7	44.39

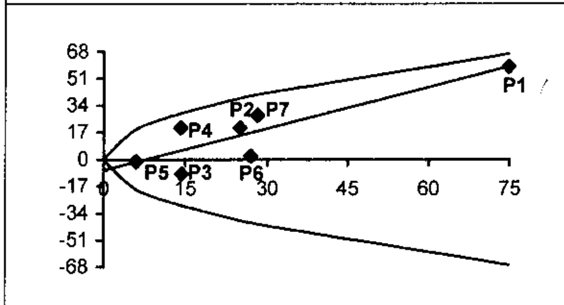
Irrigation every 7 days (a)

Second season (2002/2003)



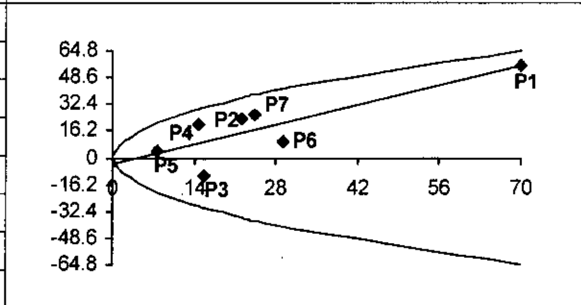
P	$\bar{Y}_r$
P_1	42.49
P_2	52.99
P_3	49.72
P_4	48.55
P_5	46.48
P_6	63.33
P_7	45.27

Irrigation every 7 days (a)



P	$\bar{Y}_r$
P_1	30.22
P_2	39.41
P_3	38.11
P_4	38.66
P_5	39.49
P_6	54.29
P_7	32.39

Irrigation every 13 days (b)

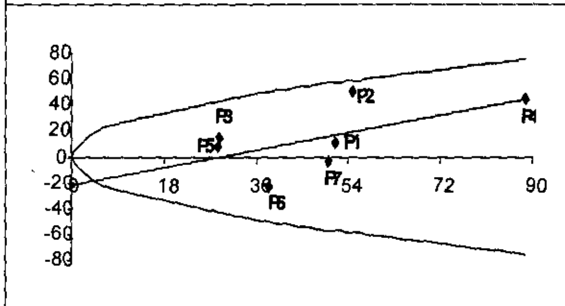


P	$\bar{Y}_r$
P_1	31.54
P_2	39.70
P_3	37.77
P_4	38.48
P_5	39.70
P_6	55.49
P_7	33.53

Irrigation every 13 days (b)

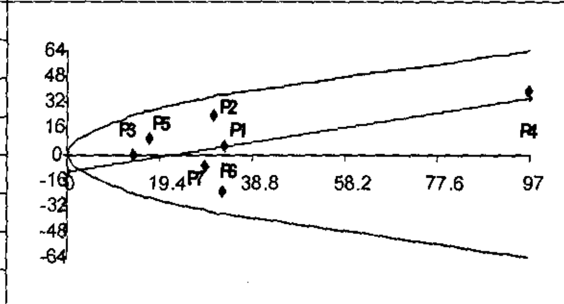
Fig (5). W_r/V_r graphs for 1000-grain weight under two water treatments in both seasons.

First season (2001/2002) — Irrigation every 7 days (a)



P	$\bar{Y_r}$
P_1	53.25
P_2	61.00
P_3	72.00
P_4	47.00
P_5	65.00
P_6	60.00
P_7	59.75

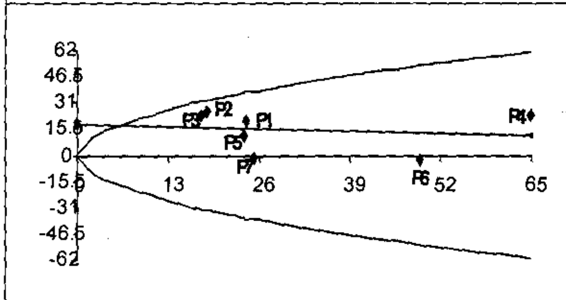
Second season (2002/2003) — Irrigation every 7 days (a)



P	$\bar{Y_r}$
P_1	57.33
P_2	63.95
P_3	67.76
P_4	48.74
P_5	66.32
P_6	62.99
P_7	60.41

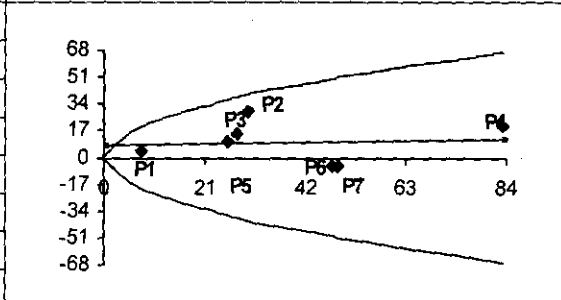
Irrigation every 7 days (a)

First season (2001/2002) — Irrigation every 13 days (b)



P	$\bar{Y_r}$
P_1	30.75
P_2	39.25
P_3	47.50
P_4	26.75
P_5	46.25
P_6	34.75
P_7	36.75

Second season (2002/2003) — Irrigation every 13 days (b)

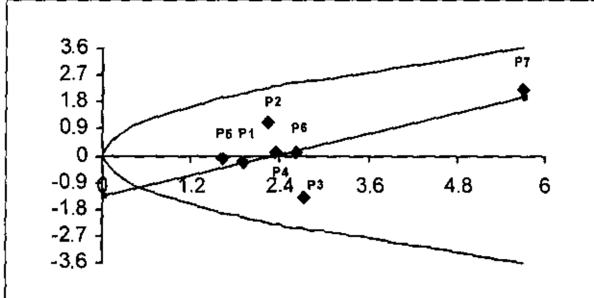


P	$\bar{Y_r}$
P_1	38.03
P_2	38.51
P_3	47.80
P_4	28.27
P_5	49.43
P_6	36.02
P_7	36.34

Irrigation every 13 days (b)

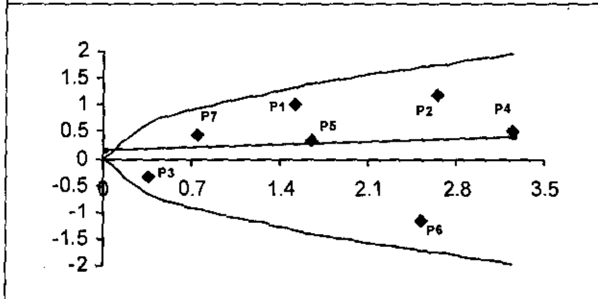
Fig (6). W_r/ V_r graphs for number of grains/spike under two water treatments in both seasons.

First season (2001/2002)



P	$\bar{Y}_r$
P_1	17.80
P_2	17.31
P_3	19.01
P_4	16.97
P_5	20.82
P_6	17.19
P_7	16.46

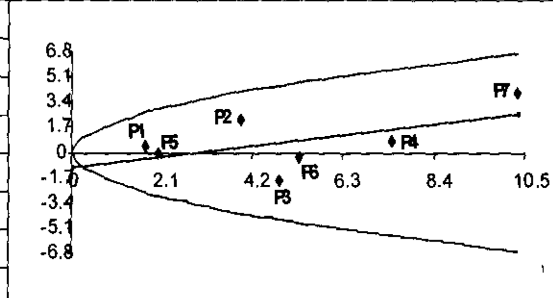
Irrigation every 7 days (a)



P	$\bar{Y}_r$
P_1	14.06
P_2	14.03
P_3	14.34
P_4	12.99
P_5	16.56
P_6	14.25
P_7	13.93

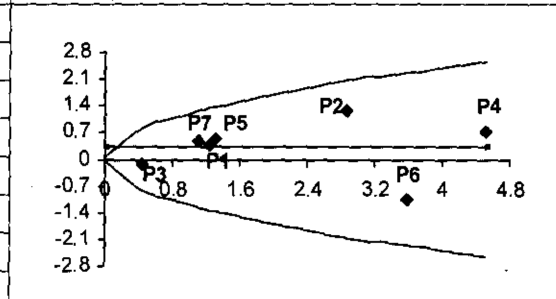
Irrigation every 13 days (b)

Second season (2002/2003)



P	$\bar{Y}_r$
P_1	17.51
P_2	16.01
P_3	16.98
P_4	15.47
P_5	20.15
P_6	16.97
P_7	13.41

Irrigation every 7 days (a)



P	$\bar{Y}_r$
P_1	13.00
P_2	14.18
P_3	13.62
P_4	11.91
P_5	15.44
P_6	14.05
P_7	12.32

Irrigation every 13 days (b)

Fig (7). W_r/ V_r graphs for straw yield/plant under two water treatments in both seasons.

REFERENCES

Afiah, S.A.N. (2002a). Comparative study on combining ability, degrees of dominance and heterotic effects in bread wheat under saline stress and rainfed conditions. *Proceedings. 2nd Conf. Sustainable Agric. Develop., Egypt,* p.75-94.

Afiah, S.A.N. (2002b). Genetic parameters and graphical analysis of F_2 wheat diallel cross under saline stress. *Egypt. J. Genet. Cytol.,* 31 (2): 267-278.

Afiah. S.A.N. and A.A. Abdel-Sattar (1998). Diallel cross analysis for some quantitative characters in bread wheat (*Triticum aestivum* L.) under saline and normal environments. *Annals Agric. Sci., Moshtohor, Egypt,* 36 (4): 2039- 2061.

Afiah, S.A.N. and S.A.M. Khattab (1999). Graphical analysis of F_1 diallel crosses in bread wheat under normal and saline environments. *J. Agric. Sci., Mansoura Univ., Egypt,* 24 (10): 5509-5518.

Afiah, S.A.N. ; N.A. Mohamed and Manal, M. Salem (2000). Statistical genetic parameters, heritability and graphical analysis in 8x8 wheat diallel crosses under saline conditions. *Annals Agric. Sci., Ain-Shams Univ., Cairo, Egypt,* 45(1): 257-280.

Afiah, S.A.N. ; N.A. Mohamed ; S.A. Omar and H.Kh. Hassan(2002). Performance of stability of newly bred wheat genotypes under rainfed and saline environments. *Desert Inst. Bull., Egypt,* 52(2): 105-122

Awaad, H.A. (2001). The relative importance and inheritance of grain filling rate and period and some related characters to grain yield of bread wheat (*Triticum aestivum* L.). *Proceedings. 2nd Plant Breed. Conf., Assiut University, Egypt,* p. 181-198.

Black, C.A.; D.D. Evan; L.E. Ensminger; J.L. White and F.E. Clark (1965). Methods of soil analysis (chemical and microbiology properties, part2). *Amer. Soc. Agron.,* p. 142.

Crumpacker, D.W. and R.W. Allard (1962). A diallel cross analysis of heading date in wheat. *Hilgardia,* 32: 275-318.

El-Marakby, A.M., A.A. Mohamed and M.F. Abd El-Rahman (1993). Studies on general and specific combining ability in bread wheat (*Triticum aestivum* L.). *Proceedings. 4th conf. Agric. Dev. Res., Ain Shams Univ., Cairo, Egypt. Annals Agric. Sci. Special. Issue,* 1: 135-149.

Hallauer, A.R. and J.B. Miranda Fo. (1981). In "*Quantitative Genetic in Maize Breeding*". Iowa State Univ. Press, Ames., p. 104-106.

Hayman, B.L. (1954a). The analysis of variance of diallel crosses. *Biometrics,* 10: 235-244.

Hayman, B.L. (1954b). The theory and analysis of diallel crosses. *Genetics,* 39: 789-809.

Ismail, T.A; A.H. Fayed and R.M.E. Khalaf (2000). Diallel analysis for partitioning genetic variance for some yield characters and chlorophyll content in wheat. *Zagazig J. Agric. Res.,* 27: 487-500.

Jinks, J.L. (1956). The F_2 and backcross generations from a set of diallel crosses. *Heredity,* 10: 1-30.

Jinks, J.L. and B.I. Hayman (1953). The analysis of diallel crosses. *Maize Genetics Coop. Newsletter,* 27: 48-54.

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

Kheiralla, K.A. and M.M. El-Defrawy (1994). Inheritance and selection for early heading in wheat under water stress and non-stress conditions. *Assiut J. Agric. Sci. Egypt,* 25(5): 1-17.

Mann, M.S. and S.N. Sharma (1995). Combining ability in the F_1 and F_2 generations of diallel cross in macaroni wheat (*Triticum durum* Desf.). *Indian J. Genet.and Plant Breed.,* 55 (2): 160-165.

Mather, K. and J.L. Jinks (1982). In "*Biometrical Genetics*" 3rd Ed., Chapman and Hall Ltd., London, 396 pp.

Piper, C.S. (1950). In "*Soil and plant analysis*". Interscience Publishers Inc., New York, p. 151-172.

Statistical year book (2004). Ministry of Agriculture, Giza, Egypt.

Received: 31/10/2004
Accepted: 04/03/2005

المعايير الوراثية و التحليل البياني للتهجينات الدائرية في قمح الخبز تحت ظروف الإجهاد الجفافى

حسام إبراهيم على فرج ، كمال عبد العزيز الشونى* ، احمــد عبــد الصــادق محمــد* وسامي عبد العزيز نصر عافيه
قسم الأصول الوراثية النباتية – مركز بحوث الصحراء – المطرية – القاهرة – مصر.
*قسم المحاصيل – كلية الزراعة – جامعة عين شمس– القاهرة – مصر.

أجرى هذا البحث بهدف دراسة النظام الوراثي الذي يحكم صفات تاريخ طــرد ٥٠% من النباتات ، تاريخ النضج، عدد السنابل/نبــات، عــدد الحبــوب بالســنبلة، وزن ١٠٠٠ حبــة ومحصول القش والحبوب/نبات من خلال التهجينات الدائرية لسبعة آباء مختلفة ومتباينة وراثيا من قمح الخبز مع استبعاد الهجن العكسية خلال موســمين زراعيــين ٢٠٠١/٢٠٠٢، ٢٠٠٢/٢٠٠٣ بمحطة بحوث راس سدر التابعة لمركز بحوث الصحراء تحت ظروف الإجهاد الجفافى (الري كل ١٣ يوم) مقارنة بالمعاملة القياسية (الري كل ٧ أيام) ويمكن تلخيص أهم النتائج المتحصل عليهــا فيما يلي:

- الجينات ذات التأثير الإضافي وغير الإضافي ساهمت في النظام الوراثي لكل الصــفات تحــت الدراسة كما لعب المكون الوراثي المضيف دورا في وراثة معظم الصفات تحت فترتي الــري في كلا السنتين ما عدا صفتي طرد ٥٠% من النباتات تحت فترتي الري ومحصول القش تحت ظروف الإجهاد في كلا السنتين.
- المكون السيادى كان له دور اكبر لكل الصفات تحت الدراسة ما عدا صفة تاريخ طــرد ٥٠% من النباتات تحت فترتي الري في السنة الأولى وعدد السنابل بالنبات تحت فترتي الــري فــي السنة الثانية.
- أظهرت الآباء عدم تساوى التكرار الجينى بالنسبة للجينات السائدة والمتنحية لكل الصفات تحت الدراسة تحت فترتي الري في كلا السنتين.
- قيم معامل التوريث بمعناها الضيق كانت منخفضة لكل الصفات المدروسة عدا صفتي تــاريخ طرد ٥٠% من النباتات ووزن ١٠٠٠–حبة تحت معاملتي الري في كلا السنتين.
- اظهر التحليل البياني اختلافات في مناطق السيادة و التنحي بالنسبة للآباء حيث وجــد أن الأب الرابع (الصنف المنزرع سخا ٨) والأب السابع (Line-2) يحتويان على اكبــر تكــرار مــن الاليلات المتنحية لصفات تاريخ طــرد ٥٠% مــن النباتــات ، ميعــاد النضــج، محصــول الحبوب/نبات، عدد الحبوب/سنبلة ومحصول القش/نبات تحت فترتي الري في كلا السنتين.