GENETIC STUDIES ON THE EFFECTS OF DROUGHT TOLERANCE AND EARLINESS ON GRAIN YIELD IN DURUM WHEAT HAVING DIFFERENT THERMAL RESPONSES

ABDEL NOUR, NADYA A. R.[1] and HAYAM S.A. FATEH [2]

1. *Wheat Research Dep., Field Crops Research Institute, ARC, Giza, Egypt.*
2. *Lab. for Design and Statistical Analysis Research, ARC.*

(Manuscript received 22 August 2011)

Abstract

A diallel cross involving six durum wheat genotypes was evaluated to determine the genetic behavior of earliness components as well as yield and its components in durum wheat under irrigation and drought conditions. In addition, to drought susceptibility index, thermal unit and reduction percentage were calculated. The resultant hybrids along with their parents were evaluated in two experiments. The first experiment (stress) was irrigated once (70 days after planting while the second one (normal) was irrigated four times at Sids the experiment Station, Agriculture Research Centre.

Genotypes mean squares were significant for most studied characters in the two experiments except for heading under normal experiment. GCA variance values were higher two or more times than the SCA variance one for most studied characters in both experiments, suggesting the predominant of additive and additive x additive gene action in controlling these characters. Parent P_1 (Sohage1) could be considered as a good combiner for early heading and maturity under stress for days and thermal units; P_2 (Sohage3) could be considered as a good combiner for early maturity under stress and normal of days and only under stress of thermal unit, while P_3 (Beni Swief 6) could be considered as a good combiner for (early maturity under normal irrigation). Mareover, Parent P_4(Portoroco) could be considered as a good combiner for grain yield /plant and kernel weight under stress and normal irrigation and susceptibility index for No. of spikes/ plant meanwhile, parent P_5 (Quadrato) is a good combiner for grain yield/ plant, grain filling rate and No. of spikes/ plant of the two experiments and susceptibility index for both No. of kernels/ spike and kernel weight but parent P_6 (Beni Swief1) considered a good combiner for grain yield/ plant and grain filling rate under two stress and normal irrigation and also early maturing of No. of days under only irrigation only. The best SCA values were detected for cross P_1 x P_4 for the earliness of maturity (No. of days and thermal units) under stress water and the reduction percentage for number of days and thermal units of normal to stress conditions, grain filling rate, susceptibility index for No. of spikes/ plant, No. of kernels/ spike and kernel weight, and grain yield/ plant under both stress and normal conditions, crosses P_1 x P_6, P_2 x P_6, P_3 x P_4 and P_3 x P_5 gave the best SCA effects for grain yield/ plant under both stress and normal conditions.

Key words: Wheat, Drought, Combining ability, Susceptibility index, early maturing, Earliness characters.

INTRODUCTION

The new Egyptian policy for wheat production is to increase the area cultivated to durum wheat (*Triticum turigidum L.* var. durum*)* in Upper Egypt because of its high tolerance to the prevalent hot weat and the need for macaroni industry.

The Egyptian wheat cultivars have relatively narrow genetic background. Selection among these cultivars for increasing grain yield and its components would not be very effective. Hybridization between the Egyptian wheat cultivars and exotic materials was carried out to increase the genetic variability.

The ultimate goal of wheat breeder is to develop new genotypes characterized by high yield potentiality and tolerance to stress conditions such as drought. To achieve this target some important genetic information are required about drought susceptibility indices for yield and yield components. Such genetic information directs the breeding program towards the use of selection if the additive gene action is predominant or to exploit heterosis if non additive gene action was prevailed in controlling the traits of interest.

Heading time is affected by complex interactions of temperature and photoperiod (Masle *et. al.* 1989). The three components of heading time are vernalization requirement, photoperiod response, and intrinsic- earliness. These components may act individually or in combination to achieve different adaptation strategies according to Kato and Yokoyama (1992)

Developing early – maturing wheat is important for increasing cultivated area of wheat through planting in the areas designated for growing cotton in summer season. Early maturing cultivars are also preferable to escape diseases, pests, drought, heat and other stress injuries that occur at the end of the growing season Clarke *et. al.* 1984.Therefore,. Breeding early- maturing cultivars is an important objective in most wheat breeding programs.

Losses in grain yield and its components of wheat due to water stress were recorded by many investigates (Abul- Naas *et. al.* 2000, Abdel- Nour, Nadya 2005 and Abdel – Nour, Nadya and Manal A. Hassam 2009). They reported that water stress can be considered as major a biotic stress affecting wheat yield. Yield lasses due to certain stresses may be minimized in early – maturing cultivars, since they would escape such stresses that might occur late in season ((larke *et. al.* 1984). However, Fischer and Maurer (1978) reported that early – maturing cultivars were more drought tolerant than late ones. A better understanding of the inheritance and type of gene action for earliness and grain filling traits would help wheat breeders to incrand stabilize grain yield.

Regarding drought susceptibility index, Abul- Naas *et. al.* (2000) and Abdel Nour (2005) reported that additive gene action was predominant in the inheritance of total plant weight and straw yield, while non additive gene action was important in controlling number of spikes/ plant, kernel weight and grain yield.

The aim of the present work was to:

1- study water stress effects on earliness and grain filling traits as well as grain yield and its components for some durum wheat genotypes. 2- Determine some early maturing and high yielding genotypes under drought stress conditions.

3- Study general and specific combining ability for yield and its components and earliness components under normal and drought conditions as well as drought susceptibility index and thermal units in durum wheat. It is hoped that this study may help wheat breeders in developing new genotypes with high yield potentiality and tolerant to drought stress.

MATERIALS AND METHODS

This study was conducted during the two successive seasons 2008/2009 and 2009/2010. Six widely diversed durum wheat genotypes were used. Four local cultivars; Sohage 1, Sohage 3, Beni Swef 6 and Beni Swef 1 and two exotic cultivars (Portoroco and Quadrato) introduced from Italy, representing a wide range of diversity for several agronomic characters and drought tolerance as well as thermal units for heading and maturity were used for this study.

The pedigree and origin of these parental materials are presented in Table (1).

Table 1. Name, pedigree and origin of Six parental durum wheat cultivars.

No.	Name	Pedigree	Origin
1	Sohage1	GDOVZ46913/JO"S"// 61.130-LDS	Egypt
2	Sohage3	MEXI"S"/ MGHA/ 51792// DURUM6	Egypt
3	Beni Swief 6	BOOMER-21/ BUSCA-3	Egypt
4	Portoroco		Italy
5	Quadrato		Italy
6	Beni Swief 1	Jo "S" / AA "S" // Fg "s"	Egypt

This study was carried out at El- Giza Research Station during 2008/ 2009 season. The parental genotypes were sown at various dates to overcome the differences in time of heading and secure enough time for making crosses and hence getting more hybrid seeds for evaluation. Parents were crossed in all possible combinations excluding reciprocals to obtain total of 15 F1 hybrids.

In 2009/2010 season, the six parents along with their single crosses (15 crosses) were sown at Sids Research Station, Beni Swef Governorate ARC, in two adjacent experiments. The first experiment (Stress) was irrigated once (70 days after planting irrigation).Meanwhile, the second experiment (non stress or normal) was irrigated four times after planting irrigation. A border of fifteen meter was set between the two experiments. Each experiment was arranged in a randomized complete block design with three replications. Each experimental unit consisted of one row of three meter long, with single plants spaced 20 cm and 30 cm between rows. The proper cultural practices were applied as recommended for wheat production in both experiments. The amount of total rainfall during the second growing season was recorded in Table (2). Water table was estimated (150 cm.).

Table 2. Monthly average of total rainfall at Beni Swef governorate during 2009/2010 winter season.

Month	Nov.2009	Dec.2009	Jon.2010	Feb. 2010	Mor.2010	Apr.2010	May.2010
Rainfall mm/month	0.15	0.30	0.20	0.24	0.04	0.00	0.00

Observation and measurements were recorded in both experiments as mean value of ten individual guarded plants from each row. The studied characters were earliness components', number of days to heading, number of days to maturity, grain filling period (that is number of days from heading to maturity) and grain filling rate (the grain yield divided by grain filling period).In addition, number of days to heading and number of days to maturity also were expressed as thermal unit time (TTi). Thermal time was calculated as the accumulation of degree- days, (TTi) considering that temperature changed linearly during the day between maximum and minimum temperature fallowing a triangular function:

$$TTi = ((T\ max\ i + Tmin\ i)/2) - Tb$$

$$Tb = O^{o}C$$

Where T max i and T min i are the maximum and minimum daily air temperature on the i^{th} day and Tb is the base temperature below which the rate of development is assumed to be zero (Gomez- Macpherson and Richard, 1997).

Table 3. Average of monthly temperature at Bani Suef governorate during 2009/2010 wheat growing season.

Month	Period	Average temperature
November	21-30	18.5
December	1-10	19.2
	11.20	17.5
	21-31	15.1
January	1-10	13.8
	11.20	15.9
	21-31	16.4
February	1-10	17.4
	11-20	16.7
	21-28	14.9
March	1-10	16.7
	11.20	17.0
	21-31	16.9
April	1-10	21.4
	11.20	22.9
	21-30	22.6
May	1-10	23.3
	11.20	26.3
	21-31	26.4

Average = (Maximum + Minimum)/2

Measurements were recorded under stress and normal experments for number of spikes/ plant, number of kernels/ spike, 100-kernel weight and grain yield/ plant.

The susceptibility index (S.I) was used as a measure for drought tolerance in terms of minimization of the reduction in grain yield or yield components caused by unfavorable versus favorable environments. (S.I) was calculated for each genotype according to the formula of Fischer and Maurer (1978).

$S.I = (1- Y_S / Y_N) / D$

Where:

S.I = an index of drought susceptibility

Y_S = yield or yield components from stress experiments of a genotype

Y_N = yield or yield components from normal irrigation experiment of a genotype.

D = drought intensity =1-(mean Y_S of all genotypes/ mean Y_N of all genotypes)

Analysis of variance was performed for all studied characters in stress and normal irrigation experiments as well as susceptibility index according to Steel and Torrie (1980). General and specific combining abilities were estimated according to Griffin (1956) as method 2 model 1.

RESULTS AND DISCUSSION

Analysis of variance and mean performance:

Analysis of variance for all the studied characters in stress and non stress experiments as well as drought susceptibility index and thermal unit is presented in Table (4a and b). Results indicated that mean squares due to genotypes were significant for all characters except for number of days and thermal units of heading in normal experiment, indicating a wide range of diversity for the studied materials. Mean squares due to both parents and crosses were significant for most characters in both experiments including reduction percentage, thermal units and susceptibility index.

Mean performance for parents and their hybrids are presented in Table (5). Under stress condition, parent P_1 expressed the lowest mean for number of days and thermal units of maturity, while, parent P_5 had the highest mean value for grain filling rate, and parent P_5 exhibited the most desirable values for the number of spikes/ plant, number of kernels/ spike and grain yield / plant. On the other hands normal irrigation experiment, P_1 and P_2 expressed the lowest mean value favorable for number of days and thermal units of maturity while parent (P_6) recorded the highest reduction. For the thermal unit of maturity, the highest desirable mean values were recorded by parent P_5 for number of spike/plant, number of kernels / spike and grain yield / plant and P_4 for grain weight. For drought susceptibility index, the most desirable mean value were detected by parent P_2 for number of spikes/ plant and P_5 for number of kernels / spike, grain weight and grain yield / plant. Regarding hybrid mean performance, lowest desirable values in stress experiment were recorded by cross combination P_1 x P_2 for maturity (days and thermal units), Meanwhil P_1 x P_4

had the highest value for grain filling rate, P_3 x P_5 for the number of spikes / plant and grain yield / plant, P_1x P_6 for number of kernels / spikes and P_5 x P_6 for grain weight. Such results indicate that these cross combinations are promising and prospective in drought condition. Under normal irrigation, the best hybrids were P_1x P_5, P_1 x P_6, P_3 x P_4 and P_4 x P_6 which had the lowest values (favorable) for the maturity (days and thermal units). Moreover, P_1 x p_6 had the highest value for grain filling rate; P_3 x P_5 for the number of spikes / plant, P_1 x P_2 for number of kernels / spike, P_4 x P_6 for the 100 – grain weight and P_1x P_6 for the grain yield / plant. The most desirable hybrids for reduction were recorded for by the cresses (P_1 x P_4 for number of days and P_1 x P_5 for thermal units) for maturity, while P_1 x P_4 had less reduction (favorable) for grain filling rate. The most desirable hybrids for drought susceptibility index were by the cross P_3 x P_5 for number of spikes / plant, P_2 x P_6 for number of kernels / spike, and P_2 x P_5 for 100 – grain weight and grain yield / plant.

From these results, it could be concluded that the three crosses P_1 x P_6, P_4 x P_6 and P_3 x P_5 were the best among the studied hybrids since they expressed the most desirable values for early maturing and most characters under stress and normal irrigation conditions. However,P_3 x P_4 have also desirable values under susceptibility index .In this connection several investigators reported that there was a wide range of response to drought resistance in wheat genotypes. Abul – Naas *et. al.* (2000), Ammar (2003), Abdel – Nour, Nadya (2005), Menshawy (2005), Menshawy (2007) and Abdel – Nour, Nadya and Hassan (2009).

Combining ability analysis

Analysis of variance for combining ability in stress and normal experiments as well as thermal units, reduction and drought susceptibility index are presented in Table (4 a and b). Mean squares associated with general (GCA) and specific (SCA) combining abilities were significant for most studied characters under both experiments and also thermal units, reduction and drought susceptibility index. High GCA / SCA ratios which largely exceeded the unity were detected for most of traits under study in both experiments. Such results indicated that the additive and additive x additive of gene actions are the two main types responsible for the inheritance of these characters. The importance of additive genetic variance for durum wheat grain yield susceptibility index and its components as well as drought resistance was previously reported by khalifa *et. al.* (1998), Abul -Naas *et. al.* (2000), Abdel – Nour, Nadya (2005) Menshawy (2005),and Abdel- Nour, Nadya and Hassan (2009).

Table 4a: Mean squares analysis for the earliness components under water stress and normal irrigated conditions.

S.O.V	d.f	Heading						Maturity		
		Days			Thermal units			Days		
		Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%
Rep	2	23.467	19.875	0.014	5284	5176	0.012	13.312	4.375	0.039
Genotypes	20	6.031*	5.319	5.785**	1415.2*	1392.8	5.437**	39.55**	28.738**	6.751**
Parent (P)	5	5.6*	6.134	5.766**	1314.4*	1586.4	5.147**	92.988**	70.319**	8.016**
Crosses (c)	14	6.313*	5.368	6.12**	1482.86*	1410.29	5.84**	14.589**	6.205*	6.781**
prsc	1	4.25	0.547	1.202**	972	180	1.25**	121.813**	136.281**	0.001
GCA	5	4.313*	1.163	3.084**	1027.2**	318.4	3.065**	28.25**	15.275**	5.733**
SCA	15	1.241	1.975	1.543**	286.93	512.53	1.395**	8.159**	7.685**	1.089**
Error	40	2.626	7.14	0.207	606.8	1852.4	0.031	2.003	2.684	0.04
GCA/SCA		3.475	0.589	1.999	3.58	0.621	2.197	3.462	1.988	5.264

Cont.Table 4a:

S.O.V	Maturity Thermal units			Grain filling period /day			Grain filling rate/ day(g)		
	Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%
Rep	4128	17440.0	0.046	1.477	2.777	0.124	0.006	0.006	0.077
Genotypes	14654.4**	29003.2	7.612**	24.267**	22.397*	98.187**	0.158**	0.238**	82.384**
Parent (P)	36099.2**	36321.6*	9.065**	60.189**	44.989**	74.778**	0.234**	0.325**	23.823**
Crosses (c)	4546.3**	20009.1	7.591**	6.365*	8.555	119.575**	0.095**	0.163**	109.172**
prsc	48944**	118328**	0.635**	95.287**	103.219**	50.796**	0.656**	0.854**	0.154
GCA	10236.8**	8012.8	5.957**	13.677**	13.683**	24.359**	0.056**	0.102**	25.638**
SCA	3100.8**	10217.6	1.397**	6.226**	5.393	35.519**	0.051**	0.072**	28.069**
Error	636	17178	0.033	2.792	11.228	0.159	0.016	0.023	0.096
GCA/SCA	3.301	0.784	4.264	2.197	2.537	0.686	1.098	1.417	0.913

Table 4b: Mean squares analysis for yield and its components under water stress and normal irrigated conditions

S.O.V	d.f	No. of spikes/ plant			No. of kernels / spike			100-kernel weight (g.)			Grain yield./plant (g.)		
		Stress	Normal	SI	Stress	Normal	SI	Stress	Normal	SI	Stress	Normal	SI
Rep	2	16.01	17.88	0.00	79.33	142.89	0.006	0.606	0.472	0.136	17.813	25.88	0.001
Genotypes	20	24.22*	23.67*	0.245**	86.35*	91.42*	7.58**	0.56**	0.51**	55.18**	245.57**	302.24**	0.056**
Parents (P)	5	51.3**	59.13	0.172**	104.78*	85.62*	7.857**	0.556**	0.472**	87.53**	650.57**	756.33**	0.114**
Crosses (c)	14	15.88	12.26	0.289**	84.86*	93.84*	6.457**	0.531**	0.505**	46.109**	103.247**	143.258**	0.036**
prsc	1	5.46	5.99	0.002	15.03	86.59*	21.986**	0.983**	0.763**	20.439**	213.063**	257.6**	0.043**
GCA	5	20.09**	12.72**	0.109**	37.813*	43.02*	0.769**	0.115**	0.119*	19.097**	161.788**	190.789**	0.059**
SCA	15	4.07	3.28	0.073**	25.77	26.29	3.114**	0.211*	0.187**	18.159**	55.212**	70.733**	0.005**
Error	40	10.18	11.84	0.003	42.88	42.82	0.008	0.165	0.158	0.04	13.986	15.263	0.002
GCA/SCA		4.936	3.878	1.493	1.467	1.636	0.247	0.545	0.636	1.052	2.93	2.697	11.8

SI = susceptibility index

Table 5. Mean performance(x) for the earlines components and yield and its components under water stress and normal irrigated condition

Genotypes		Heading					
		Days			Thermal units		
		Stress	Normal	Red%	Stress	Normal	Red%
P_1		90.00	98.67	87.90	1506.70	1638.00	8.02
P_2		92.00	100.33	8.30	1538.00	1666.80	7.73
P_3		93.00	100.00	7.00	1553.00	1661.80	6.55
P_4		94.00	101.00	6.93	1568.00	1674.90	6.38
P_5		92.00	103.00	10.68	1538.00	1708.70	9.99
P_6		93.00	101.00	7.92	1553.00	1674.90	7.28
P_1xP_2		90.00	100.00	9.00	1506.70	1659.30	9.20
P_1xP_3		91.67	100.33	8.63	1532.40	1663.60	7.89
P_1xP_4		92.00	99.00	7.07	1538.00	1643.00	6.39
P_1xP_5		89.00	101.00	11.80	1491.10	1676.20	11.04
P_1xP_6		92.00	101.67	9.51	1538.00	1687.40	8.85
P_2xP_3		92.00	101.00	8.91	1538.00	1674.90	8.17
P_2xP_4		91.00	101.00	9.90	1523.00	1675.50	9.10
P_2xP_5		90.00	99.00	9.09	1506.70	1644.30	8.37
P_2xP_6		93.00	101.67	8.53	1553.00	1688.1	8.00
P_3xP_4		92.00	98.00	6.12	1538.00	1628	5.53
P_3xP_5		91.00	100.00	9.00	15 23.00	1659.9	6.25
P_3xP_6		93.00	102.00	8.82	1553.00	1693.10	8.27
P_4xP_5		95.00	102.67	7.47	1583.00	1703.10	7.05
P_4xP_6		92.33	100.67	8.28	1543.00	1669.30	7.57
P_5xP_6		92.33	89.67	6.43	1543.00	1639.30	5.87
L.S.D	5%	2.59	4.28	0.73	39.42	68.88	0.28
	1%	3.55	5.85	1.00	53.90	94.18	0.38

Table 5. Cont

Maturity					
Days			Thermal unites		
Stress	Normal	Red%	Stress	Normal	Red%
124.00	136.00	8.82	2064.2	2292.2	9.95
127.00	136.00	6.62	2114.6	2292.2	7.75
129.00	137.00	5.84	2148.2	2313.4	7.14
139.33	145.67	4.35	2362.9	2515.8	5.74
135.00	146.00	7.53	2271.0	2514.4	9.68
130.00	137.00	5.11	2167.9	2313.4	10.14
126.00	138.00	8.70	2097.8	2334.6	9.04
126.00	136.67	7.81	2097.8	2306.3	10.05
125.00	137.00	8.76	2081.0	2313.4	9.11
124.00	135.00	8.15	2064.2	2271.0	5.26
128.00	135.00	4.48	2131.4	2249.8	7.02
128.00	136.00	5.88	2131.4	2292.2	7.94
129.00	138.00	6.52	2149.7	2001.8	9.21
125.00	136.00	8.09	2081.0	2292.2	6.44
128.00	135.33	5.42	213.4	2278.1	6.89
127.00	135.00	5.93	2114.6	2271.0	5.73
129.67	136.00	4.65	2160.9	2292.2	6.92
130.00	137.67	5.57	2166.5	2327.5	6.32
132.33	139.33	5.02	2214.5	2364.0	6.15
128.00	135.00	5.19	2131.40	2271.0	6.82
128.67	136.33	5.62	2142.6	2299.3	
2.26	2.62	0.32	40.35	209.7	0.29
3.1	3.59	0.44	55.18	286.8	0.41

Table 5. cont

Grain filling period			Grain filling rate		
Stress	Normal	Red%	Stress	Normal	Red%
34.00	37.33	8.92	0.759	0.823	7.78
36.33	35.67	-1.85	1.150	1.315	12.55
36.00	37.00	2.70	1.107	1.277	13.31
45.33	44.67	-1.48	1.197	1.384	13.51
43.00	43.00	0.00	1.611	1.802	10.60
37.00	36.00	2.70	1.326	1.579	16.02
36.00	38.00	5.26	1.416	1.519	6.78
34.33	36.33	5.51	1.190	1.290	7.75
33.00	38.00	13.16	1.681	1.699	1.06
35.00	34.00	-2.94	1.436	1.712	16.12
36.00	32.33	-11.35	1.580	2.057	23.19
36.00	35.00	-2.86	1.177	1.357	13.26
38.00	37.00	-2.70	1.083	1.259	13.98
35.00	37.00	5.41	1.469	1.523	3.55
35.00	33.67	-3.95	1.611	1.890	14.76
35.00	37.00	5.41	1.520	1.639	7.26
38.67	36.00	-7.42	1.497	1.831	18.24
37.00	35.67	-3.73	1.231	1.480	16.82
37.33	36.67	-1.80	1.390	1.639	15.19
35.67	37.33	-3.90	1.598	1.898	15.81
36.33	37.67	3.56	1.383	1.520	9.01
2.67	5.36	0.64	0.204	0.245	0.496
3.66	7.33	0.87	0.278	0.335	0.678

Table 5. cont

No. of spike / plant			No. of kernels / spike		
Stress	Normal	S.I	Stress	Normal	S.I
14.42	16.89	1.367	69.00	68.94	-0.054
14.92	16.22	0.756	61.33	62.11	0.785
17.45	19.25	0.882	61.47	60.64	-0.855
20.39	22.60	0.922	68.39	67.75	-0.590
25.20	28.00	0.943	77.33	75.17	-1.796
15.70	18.14	1.269	66.69	69.89	2.862
17.78	20.22	1.138	77.00	77.78	0.627
16.00	18.22	1.149	69.11	71.61	2.182
18.83	20.72	0.861	72.72	73.35	0.537
19.32	21.92	1.119	66.27	66.12	-0.142
19.14	20.83	0.765	67.25	78.75	1.984
17.55	19.41	0.904	69.73	70.49	0.674
17.42	18.75	0.669	59.58	62.09	2.527
17.63	20.44	1.297	61.38	64.11	2.661
17.08	19.58	1.205	66.50	64.01	-2.431
21.78	23.84	0.815	65.08	67.6	2.330
23.75	25.03	0.482	65.47	66.33	0.810
18.67	20.86	0.990	63.41	64.17	0.740
22.11	24.00	0.743	68.42	72.00	3.108
17.42	20.25	1.318	75.99	78.33	1.867
15.47	18.89	1.708	69.89	73.44	3.021
5.107	2.508	0.093	10.48	10.47	0.139
6.982	7.531	0.127	14.33	14.32	0.190

S.I. Susceptibility index

Table 5. cont

100-graim weight			Grain yield / plant		
Stress	Normal	S.I	Stress	Normal	S.I
4.78	4.88	3.82	25.85	30.63	1.264
4.97	4.99	0.746	41.4	46.24	0.848
5.34	5.66	10.528	39.72	47.07	1.265
5.89	5.89	0.00	54.55	61.81	0.951
5.76	5.58	-6.01	69.2	77.24	0.843
5.39	5.46	2.387	48.96	56.79	1.117
5.82	5.79	-0.965	50.91	57.61	0.942
5.7	5.68	-0.656	40.69	46.84	1.064
5.92	5.9	-0.631	55.11	64.62	1.192
5.93	5.9	-0.947	50.15	57.67	1.056
5.89	5.94	1.568	56.97	66.45	1.156
5.72	5.66	-1.974	42.25	47.45	0.888
5.42	5.46	1.364	41.1	46.22	0.897
5.58	5.33	-8.725	50.94	56.35	0.778
5.84	5.85	0.318	56.48	63.37	0.881
5.47	5.6	4.323	53.25	60.47	0.967
5.01	5.16	5.413	57.83	65.55	0.954
4.92	4.87	-1.912	45.48	52.45	1.075
5.05	5.19	5.023	51.88	59.31	1.015
6.56	6.56	0.00	56.98	65.16	1.017
5.66	5.9	7.575	50.24	57.1	0.973
0.65	0.64	0.322	5.99	6.252	0.066
0.889	0.87	0.439	8.18	8.549	0.090

Table 6. Estimate of general combining ability effects for the earliness components and yield and its components under water stress and normal irrigated conditions.

Genotype		Heading						Maturity						Grain felling period			Grain felling rate / day(g)		
		Daye			Thermal units			Daye			Thermal unites								
		Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%
g1		-1.097**	-0.528	0.531**	-16.989**	-8.893	0.531**	-2.833**	-1.042**	1.357**	-50.961**	-9.467	1.288**	-1.792**	-0.639	3.075**	-0.081**	-0.114**	-1.882**
g2		-0.431	-0.028	0.326**	-6.511	-0.127	0.392**	-1.208**	-0.708*	0.395**	-23.478**	-43.996	0.382**	-0.5	-0.806	-0.678**	-0.052*	-0.082**	-1.011**
g3		0.278	-0.278	-0.493**	4.351	-4.193	-0.495**	-0.125	-0.708*	-0.396**	-5.095	-2.4	-0.415**	-0.458	-0.556	-0.072	-0.08**	-0.085**	0.554**
g4		0.861*	-0.028	-0.84**	13.181**	-0.997	-0.846**	2.542**	1.833**	-0.571**	51.072**	14.687	-0.546**	1.625**	2.111**	0.541**	0.025	0.009	-0.65**
g5		-0.264	0.472	0.726**	-4.09	7.928	0.674**	1.25**	1.708**	0.238**	24.605**	51.525*	0.419**	1.458**	1.111	-0.759**	0.116**	0.125**	-0.276**
g6		0.653*	0.389	-0.251**	10.056*	6.282	-0.256**	0.375	-1.083**	-1.023**	3.855	10.35	-1.128	-0.333	-1.222*	-2.107**	0.073**	0.146**	3.254**
L.S.D g_i	5%	0.619	1.021	0.174	9.41	16.44	0.067	0.54	0.626	0.076	9.634	50.07	0.069	0.638	1.28	0.152	0.048	0.057	0.118
	1%	0.833	1.374	0.234	12.67	22.14	0.091	0.728	0.843	0.103	12.97	67.41	0.093	0.859	1.72	0.205	0.065	0.078	0.159
L.S.D $g_{i1}-g_i$	5%	0.959	1.25	0.269	14.578	25.47	0.104	0.838	0.97	0.118	14.524	77.56	0.108	0.989	1.98	0.235	0.075	0.09	0.183
	1%	1.291	2.13	0.362	19.626	34.29	0.14	1.128	1.305	0.159	20.093	104.4	0.145	1.331	2.66	0.318	0.101	0.121	0.247

Table 6. Cont.

No. of spikes / plant			No. of kernels / spike			100-Kernel Weight (g)			Grain yield /plant (g)		
Stress	Normal	S.I	Stress	Normal	S.I	Stress	Normal	S.I	Stress	Normal	S.I
-1.180	-1.126	0.081**	2.793*	2.575*	- 0.234**	- 0.006	- 0.014	-0.134**	-5.138**	-5.126**	0.111**
-1.506*	-1.729*	- 0.047**	-2.518*	-2.775*	- 0.165**	- 0.07	- 0.126	-1.947**	-2.772**	- 4.0**	-0.121**
0.413	0.147	- 0.125**	-2.658*	-2.926*	- 0.24**	- 0.171**	- 0.1	2.397**	-3.463**	-3. 57**	0.054**
1.126	1.009	- 0.106**	0.196	0.497	0.28**	0.165**	0.175*	0.375**	2.595**	2.992**	-0.007
2.417**	2.699*	0.017	1.135	0.93	- 0.135**	- 0.016	-0.056	-1.346**	6.6**	6.874**	-0.073**
-1.270	-0.999*	0.178**	1.052	1.699	0.495**	0.097	0.012	0.656**	2.177**	2.831**	0.036**
1.219	1.314	0.021	2.501	2.5	0.034	0.155	0.152	0.076	1.429	1.492	0.016
1.641	1.77	0.028	3.368	3.365	0.045	0.209	0.204	0.103	1.923	2.009	0.021
1.888	2.036	0.032	3.875	3.872	0.052	0.24	0.235	0.118	2.213	2.312	0.024
2.542	2.742	0.044	5.217	5.214	0.07	0.324	0.317	0.159	2.98	3.113	0.033

Estimates of GCA effects ($\hat{g}_i$) for individual parents to each trait in stress and non stress experiments as well as thermal units, reduction and drought susceptibility index are presented in Table (6). Highly significant negative ($\hat{g}_i$) values would be of interest for most traits of heading and maturity (days and thermal units) and susceptibility index, whereas highly significant and positive ($\hat{g}_i$) values are preferred for grain yield and its components and the reduction percentage under both experiments.

Under stress condition, parent P_1 ranked the best combiner for heading and maturity (days and thermal units), grain filling period and number of kernels / spike, while P_4 ranked the second best general combiner for grain yield / plant and the first combiner for kernel weight. Parent P_5 expressed the highest significant ($\hat{g}_i$) effects for grain yield / plant and number of spikes / plant, and P_6 ranked the third best general combiner for grain yield.

In normal experiments condition, parent P1 ranked the second best combiner for number of days of maturity (early) and the first best combiner of number kernels / spike, parents P_2 and P_3 the third best combiner for number of days of maturity, while parent P_4 ranked the best combiner for kernel weight and the second best general combiner. Parent p_5 expressed the most desirable ($\hat{g}_i$) effects for number of spikes / plant and grain yield / plant, wheals parent P 6 the best desirable ($\hat{g}_i$) effects for number of days for maturity (early), the best of grain filling rate and the third best combiner of grain yield / plant.

For the reduction percentage, P_1 was the second best combiner for heading (days and thermal units), the first best for maturity (days and thermal units) and the best for grain filling pried and filling rate while P_2 was the second best general combiner for heading (days and thermal units) and the second for maturity. P_4 consider the second combiner for grain filling period. While P_5 ranked the first best combiner for heading (days and maturity)

For drought susceptibility index, parent P_1 was the best combiner for number of kernels / spike and kernel weight, parent P_2 considers a good combiner for grain yield and its components, while P_3 ranked the first best combiner for number of spikes / plant and number of kernels / spike. Parent P_4 ranked the second best combiner for number of spikes / plant, whears P_5 considered a good combiner for number of kernels / spike, kernel weight and grain yield / plant.

Specific combining ability effects for all the studied traits in stress and non stress conditions, thermal units, reduction and susceptibility index are presented in Table (7). In stress condition, the most desirable Sij effects were detected by the cross combinations P_1 x P_4 for early maturity (days and thermal units) and grain filling rate, P_1 x P_5 for early heading and maturity (days and thermal units), P_2 x P_5 and P_3 x P_4 for early maturity (days and thermal units), P_1 x P_2 for number of kernels / spike and grain yield , P_1 x P_4 for grain yield / plant , P_1 x P_6 for number of spikes / plant and grain yield, P_2 x P_6, P_3 x P_4 and P_3 x P_5 for grain yield, plant.

Under normal condition , specific combining ability effects were detected in the crosses; P_1 x P_5 and P_2 x P_5 for early maturity of number of day, P_3 x P_4, P_3 x P_5 and P_4 x P_5 for early maturity number of days and grain filling rate and P_5 x P_6 for early heading of number days, P_1 x P_2 for number of kernels / spike and grain yield / plant, P_1 x P_4, P_2 x P_6, P_3 x P_4 and P_3 x P_5 for grain yield / plant and P_1 x P_6 for number of spikes / plant and grain yield / plant.

Regarding reduction percentage, six, eight, eight, eight, six and nine crosses expressed significant and positive Sij effects for number of days for heading, thermal units for heading, number of days for maturity, thermal units for maturity, grain filling period and grain filling rate, respectively.

Table 7. Estimate of specific combining ability effects for the earliness components and yield and its components under water stress and normal irrigated conditions

Genotype		Heading						Maturity						Grain felling period			Grain felling rate / day(g)		
		Daye			Thermal units			Daye			Thermal units								
		Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%	Stress	Normal	Red%
P_1xP_2		-0.393	0.048	-0.346	-6.277	0.194	0.397**	1.518*	2.464**	0.564**	28.198*	83..0 25	0.871**	1.625*	2.524	2.451**	0.196**	0.166*	-2.544**
P_1xP_3		0.565	0.631	0.103	8.493	8.627	-0.027	0.435	1.131	0.465**	9.815	13.162	0.567**	-0.083	0.607	2.095**	-0.001	-0.059	-3.139**
P_1xP_4		0.315	-0.952	-1.11**	5.297	-15.202	-1.176**	-3.23**	-1.077	1.59**	-63.15**	3.141	1.708**	-3.5**	-0.393	9.133**	0.385**	0.257**	-8.625**
P_1xP_5		-1.26	0.548	2.134**	-24.332*	9.04	1.957**	-2.94**	-2.952**	0.172	-53.49**	-76.096	-0.197**	-1.333	-3.393*	-5.667**	0.049	0.153*	6.061**
P_1xP_6		0.524	1.298	0.741**	8.422	21.952	0.694**	1.935**	-1.161	-2.237**	34.46**	-35.421	-2.499**	1.458*	-2.726	-12.73**	0.235**	0.477**	9.591**
P_2xP_3		0.232	0.798	0.588**	3.652	11.128	0.394**	0.18	0.131	-0.503**	15.931	33.558	-0.547**	0.292	-0.56	-2.522**	-0.044	-0.023	1.5**
P_2xP_4		-1.351	0.548	1.925**	-20.177	8.565	1.673**	-0.857	-0.411	0.312**	-21.969*	-273.9**	0.505**	0.208	-1.226	-2.975**	-0.243**	-0.215**	3.424**
P_2xP_5		-1.226	-1.952	-0.451*	-19.173	-31.627	-0.577**	-3.57**	-2.286**	1.073**	-64.17**	-20.37	0.81**	-2.625**	-0.226	6.435**	0.052	-0.067	-7.38**
P_2xP_6		0.857	0.798	-0.034	12.948	13.819	-0.017	0.31	-0.161	-0.336**	6.981	27.38	-0.431**	-0.833	-1.226	-1.577**	0.237**	0.277**	0.29*
P_3xP_4		-1.06	-2.202	-1.036**	-16.04	-34.902	-1.01**	-3.94**	-3.411**	0.513**	-75.42**	-46.33	0.251**	-2.833**	-1.476	4.529**	0.223**	0.168*	-4.861**
P_3xP_5		-0.935	-0.702	0.278	-13.769	-11.927	0.189*	0.018	-2.286**	-1.576**	-2.686	-61.96	-1.874**	1.0	-1.476	-7.001**	0.108	0.244**	5.745**
P_3xP_6		0.149	1.381	1.075**	2.085	22.886	1. 14**	1.226**	2.173**	0.605**	23.664*	35.25	0.863**	1.125	0.524	-1.964**	-0.115**	-0.129	0.785**
P_4xPs		2.482**	1.714	-0.905**	37.402**	28.044	-0.66**	0.018	-1.494*	-1.031**	-5.252	-7.25	-1.153**	-2.417**	-3.476*	-1.994**	-1.104	-0.042	3.899**
P_4xP_6		-1.101	-0.202	0.883**	-16.744	-4.11	0.791**	-3.44**	-3.036**	0.4**	-67.57**	-38.38	0.225**	-2.292**	-0.476	-2.746**	0.147*	0.195**	0.979**
P_5xP_6		0.024	-2.702*	-2.534**	0.527	-43.035*	-2.43**	-1.482*	-1.577*	0.022	-29.90**	-46.95	-0.07	-1.458*	0.857	6.014**	-0.159**	-0.298**	-6.195**
L.S.D	5%	1.403	2.315	0.394	21.34	37.28	0.153	1.226	1.419	0.173	21.85	113.5	0.157	1.447	2.903	0.345	0.11	0.131	0.268
sij	1%	1.89	3.12	0.531	28.73	50.2	0.205	1.65	1.911	0.233	29.41	152.9	0.212	1.949	3.908	0.465	0.148	0.177	0.361
L.S.D	5%	2.54	4.18	0.712	38.57	67.39	0.277	2.22	2.57	0.313	39.49	205.2	0.28	2.616	5.25	0.624	0.198	0.237	0.485
sij-sik	1%	3.42	5.63	0.959	51.93	90.73	0.371	2.98	3.45	0.422	53.16	276.3	0.38	3.52	7.06	0.841	0.267	0.32	0.653
L.S.D	5%	2.35	3.87	0.66	35.7	62.39	0.255	2.05	2.37	0.29	36.56	190	0.263	2.422	4.86	0.5780	0.183	0.22	0.449
sij-skl	1%	3.16	5.21	0.888	48.07	83.99	0.343	2.76	3.2	0.39	49.22	255.8	0.354	3.261	6.45	0.778	0.247	0.296	0.605

Table 7. Cont:

No. of spikes / plant			No. of kernels / spike			100-Kernel Weight (g)			Grain yield /plant (g.)		
Stress	Normal	S.I	Stress	Normal	S.I	Stress	Normal	S.I	Stress	Normal	S.I
1.989	2.409	0.087**	8.582**	8.706**	0.033	0.344	0.35*	0.105	9.302**	10.244**	-0.055**
-1.71	-1.471	0.176**	0.831	2.691	1.663**	0.325	0.207	-3.93**	-0.227	-0.956	-0.108**
0.411	0.164	- 0.13**	1.591	1.008	-0.502**	0.204	0.152	-1.884**	8.131**	10.262**	0.081**
- 0.398	-0.326	0.005*	-5.906*	-6.659*	-0.766**	0.396*	0.389*	-0.478**	-0.83	-0.577	0.011
3.109*	2.288	- 0.51**	4.261	5.206	0.73**	0.244	0.253	0.035	10.409**	12.253**	0.002
0.166	0.323	0.061*	6.765*	6.924*	0.087*	0.405*	0.306	-3.434**	-1.037	-1.475	-0.052**
- 0.68	-1.196	- 0.192**	-6.238*	-4.906	1.419**	- 0.226	-0.172	1.925**	-8.242**	-9.271**	0.018
-1.761	-1.196	0.313**	-5.381	-3.316	1.969**	0.113	-0.072	-6.453**	-2.41	-3.02	-0.035
1.382	1.642	0.06*	- 0.178	-4.185	-3.753**	0.257	0.276	0.599**	7.55**	8.04**	-0.041*
1.768	2.019	0.032	- 0.599	0.759	1.298**	- 0.078	-0.062	0.54**	4.593**	4.55*	-0.086**
2.493	1.512	- 0.425**	-1.156	-0.941	0.193**	-0.352*	-0.265	3.352**	5.175**	5.747**	-0.033
1.046	1.043	- 0.078**	-3.129	-3.876	-0.507**	-0.561**	-0.731**	-5.975**	-2.759	-3.303	-0.021
0.09	-0.377	- 0.182**	-1.052	1.302	1.971**	- 0.65**	-0.517**	4.983**	-6.834**	-7.048**	0.089**
- 0. 913	-0.429	0.232**	6.598*	6.867*	0.1*	0.741**	0.681**	-2.042**	2.682	2.838	-0.019
- 4.151**	-3.479**	0.499**	- 0.442	1.544	1.669**	0.023	0.248	7.259**	-8.056**	-9.101**	0.003
2.764	2.981	0.047	5.673	5.669	0.077	0.352	0.344	0.173	3.24	3.384	0.036
3.721	4.013	0.064	7.637	7.632	0.103	0.474	0.464	0.233	4.362	4.556	0.048
4.996	5.388	0.086	10.253	10.246	0.138	0.636	0.622	0.313	5.855	6.117	0.065
6.726	7.253	0.115	13.804	13.794	0.186	0.856	0.838	0.422	7.883	8.235	0.087
4.625	4.988	0.079	9.492	9.486	0.128	0.589	0.576	0.29	5.421	5.663	0.06
6.227	6.715	0.107	12.78	12.771	0.172	0.793	0.776	0.39	7.299	7.625	0.08

Whears draught susceptibility index, different crosses expressed significant and negative Sij effects for number of spikes / plant, (in six crosse) number kernels / spikes, kernel weight (in seven crosses) and grain yield / plant (in five crosses) respectively.

In conclusion, parents P_1 and P_2 are the best combiners for early maturing, parents P_4 and P_5 could be considered as good combiners for grain yield and most of its components and parent P_6 considered the best combiner for early mature and grain yield / plant under stress and non stress experiments.

It could be concluded that hybrid P_1 x P_4 and P_3 x P_4 seem to be the best combination among studied crosses as it expressed the most desirable Sij effects for early maturity (days and thermal units) and high grain yield / plant under stress condition and for drought susceptibility index while P_3 x P_4 and P_3 x P_5 expressed the most desirable Sij effects for early maturity (days and thermal units) under normal condition. Therefore, it may be prospective in wheat breeding programs towards the development of new genotypes characterized by higher yield potentiality, early maturity and resistance to drought condition.

REFERENCES

1. Abdel- Nour, Nadya A.R. 2005. Genetic Studies for yield and its components on drought and drought susceptibility index in wheat. Egypt. J.Agric.Res. 83 (4).
2. Abdel- Nour, Nadya A.R. and Manal A. Hassam. 2009. Determination of gene effects and variance in three bread wheat crosses for low water (drought). Egypt J. plant Breed 13:235-249.
3. Abul – Naas, A.A, Sh.A. El- Shamarka; A.A. El- Hosary and I. H. Darwish. 2000. Genetical studies on drought susceptibility index for yield and its components in wheat. J. Agric. Sci. Mansoura Univ., 25(12): 7457-7472.
4. Ammar, S.El.M.M. 2003. Estimates of genetic variance for yield and its components in wheat under normal and drought conditions. Egypt.J.plant Breed. 7(2):93-110.
5. Fischer, R.A. and R. Maurer. 1978. Drought resistance in spring wheat cultivars.I.Crain yield response. Aust. I.Agric.Res.29:897-912.
6. Clarke, J.M., T.F.C.Townle y, T.N.C.Mc and D.G.Green 1984. Growth analysis of spring wheatcultivars of varying drought resistene. Crop Sc.24:537-541.

7. Griffing J.B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. Australian J.Biol.,Sci., 9:463- 493.
8. Gomez- Macpherson, H. and R.A.Richards. 1997. Effect of early sowing on development in wheat isoclines differing in verbalization and photoperiod requirements. Field Crops Research 54:91-107.
9. Kato, K. and H. Yokoyama. 1992. Geographical variation in heading characters among wheat landraces Triticum L.and its implication for their adaptability. Theor. Appl. Genet.84:259-265.
10. halif, M. A. , A. A. Ismaiel,G.R. El- Nagar and I. M. Amin. 1998. Genetical studies of earliness, grain yield and its components of bread wheat. Assiut J.Agric.Sci., 29(5):59-69.
11. Masle, J, G. Doussinault and B. Sun. 1989. Response of wheat genotypes to temperature and photo period in natural condition. Crop. Sci., 29:712-721.
12. Menshawy, A.M.M. 2005. Genetic analysis for earliness components in some wheat genotypes of different photo thermal response. Fourth plant Breeding Conference (March 5). Egypt. J.plant Breed . 8(1):31-37. Special Issue.
13. Menshawy, A.M.M. 2007. Evaluation of some ealy bread wheat genotypes under different sowing dates: 1-Earliness characters, 2-Agronomic characters. Fifth plant Breeding Conference (May 27 Giza). Egypt.J.plant Breed. 11(1): 25-55.
14. Steel, R.G.D.and J. H. Torrie. 1980. Principles and procedures of statisties. A biometrical approach. Second Ed. McGraw-Hill PP. 167-173.

دراسات وراثية لتحمل المحصول للجفاف والتبكير فى النضج لأقماح الديورم المختلفة فى إستجابتها للحرارة والضوء

نادية عدلى رياض عبد النور[1] ، هيام سيد أحمد فاتح[2]

1. قسم بحوث القمح - معهد المحاصيل الحقلية - مركز البحوث الزراعية

2. معمل بحوث التصميم والتحليل الأحصائى – مركز البحوث الزراعية

أجريت هذة الدراسة بهدف تقييم السلوك الوراثى للمحصول ومكوناتة ومكونات التبكير تحت ظروف الرى العادى وظروف الجفاف وكذلك لدراسة معامل الحساسية للجفاف والوحدات الحرارية و عدد الأيام اللازمة حتى طردالسنابل والنضج الفسيولوجى والنسبة المئوية لاختزال الأيام والوحدات الحرارية نتيجة تأثر القمح بالجفاف , وكان ذلك من خلال اجراء جميع الهجن التبادلية بين ستة أصناف متباينة الصفات بالنسبة لتحمل الجفاف والتبكير فى النضج فى قمح الديورم فى الموسم 2008 / 2009 فى محطة البحوث الزراعية بالجيزة ., فى الموسم الثانى 2009 / 2010 تم تقييم الأباء هجن الجيل الأول F1 فى محطة البحوث الزراعية بسدس وذلك بزراعتها فى تجربتين، الأولى تم ريها مرة واحدة بعد 70 يوم من رية الزراعة (ظروف الجفاف) والثانية تم ريها أربع مرات (ظروف عادية) وذلك بأستخدام تصمييم قطاعات كاملة العشوائية فى ثلاث مكرارات. تم تقدير معامل الحساسية للجفاف بأستخدام معادلة (1978) Fischer and Maurer ،كما تم تقدير القدرة على التالف طبقا لمقترح (1956) Griffing الطريقة الثانية النموذج الأول وقد تم حساب عدد الايام والوحدات الحرارية حتى طرد السنابل والنضج الفسيولوجى وطول فترة امتلاء الحبوب وكذلك معدل امتلاء الحبوب وكذلك نسبة الفقد المئوية لمكونات التبكير نتيجة التأثير بالجفاف. كما درست أيضا الصفات عدد السنابل / نبات، عدد الحبوب / سنبلة وزن مائة حبة ووزن محصول الحبوب / نبات

وكانت أهم النتائج هى :

1- كان التباين الراجع الى القدرة العامة والخاصة على الائتلاف معنويا فى معظم الصفات تحت الدراسة مما يدل على أن الفعل الجينى المضيف لة أهمية فى وراثة هذة الصفات المدروسة

2 - كان التباين الراجع الى التراكيب الوراثية معنويا لجميع الصفات تحت الدراسة فى كلتا التجربتين وكذلك الوحدات الحرارية لمكونات التبكير واختزال الأيام بالنسبة لطرد ونضج السنابل نتيجة تأثرها بالجفاف وأيضا معامل الحساسية للجفاف للمحصول ومكوناتة فقد كان P_1(سوهاج 1) هو الأفضل لعدد الأيام حتى الطرد والنضج الفسيولوجى والوحدات الحرارية لة تحت ظروف الجفاف بينما P_2 الافضل بالنسبة للنضج تحت كل من ظروف الجفاف والرى العادى وفى نفس الوقت P_5, P_1هما الأفضل للتبكير فى النضج تحت ظروف الرى العادى.

قد كان P_5 هو الافضل بالنسبة لعدد السنابل / نبات ووزن محصول النبات بالنسبة لظروف الجفاف والرى العادى، P_4 يلية بالنسبة وزن محصول النبات ووزن مائة حبة لكل من ظروف الجفاف والرى العادى بينما P_6 كان الثا لث فى الترتيب لمحصول الحبوب/ نبات تحت ظروف كل من الجفاف والرى العادى.

3- الهجين P_3 x P_4 , P_1 x P_4 أعطيا تأثيرا مرغوبا لصفة التبكير فى النضج ومحصول النبات تحت ظروف الجفاف بينما P_3xP_5 , P_3xP_4 أعطيا تأ ثيرا مرغوبا لصفة التبكير فى النضج ومحصول الحبوب / نبات ومعظم مكوناتة.

4- قد كانت النسبة بين تباين القدرة العامة والقدرة الخاصة على التأ لف تفوق الوحدة لمعظم الصفات ويشير ذلك الى أهمية التأثير الوراثى المصنف additive والتفوق من النوع
المصنف x المصنف additive x additive فى توارث الصفات تحت الدراسة، وكان الأبوين P_6, P_5 الأفضل تحت ظروف الجفا ف ومعامل الحساسية للجفاف وظروف الرى العادى حيث أظهرا قدرة عامة مرغوبة لصفة محصول الحبوب النبات ومعظم مكوناتة.