Inheritance of Yield and Some Physiological Traits Related to Drought Tolerance in Wheat Crosses (*Triticum aestivum l.*)

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Abstract: In a study to determine the nature of gene action for yield and some physiological traits in wheat. Six diverse parents were used in a diallel cross without reciprocals in 2005/2006, 2006/2007 and 2007/2008 seasons. The experiments were conducted at the Ismailia Agriculture Research Station under three water regimes. The first water regime was non-stress (I_1) 2000 m^3 water/fad, the second water regime was 1500 m^3 (I_2) and the third water regime was severe water condition 1000 m^3 (I_3) water/fad. The results showed that water stress reduced the flag leaf area, relative water content (RWC), photosynthetic pigments, 1000-kernel weight and grain yield/plant. The crosses P1xP2 and P2xP6 were considered as the best hybrids for grain yield and other traits, revealing their importance in improving wheat in breeding programs for drought tolerance. The magnitude of dominance components (H_1 and H_2) was higher than the corresponding additive one (D) for all studied traits, indicating the important role of over dominance effect in the genetic control of these traits. Moreover, the heritability values in narrow sense were relatively low for all traits and ranged from 15.7% for relative water content to 55.5% for grain yield/plant due to subjected wheat plant to water stress.

Keywords: Genetic parameters, water stress, diallel and wheat hybrids

INTRODUCTION

Drought is generally accepted to be the most widespread abiotic stress experienced by crop plants. It is a serious problem in many parts of the world where wheat and other small-grained cereals form the staple diets. Future wheat breeding for drought tolerance must be even more efficient than in the past few decades to meet the requirements from an ever growing population. Approximately 32% of wheat growing regions in developing countries experience some type of drought stress during the growing season (Van Ginkel *et al.*, 1998).

A feasible strategy to achieve a quantum jump in yield of wheat under drought stress is the commercial production on hybrid varieties. Information on the prepotency of the parents helps in making suitable choice for initiating a hybridization program. To evolve an effective hybridization program, genetic parameters analysis is used to test the performance of parents in different cross combinations and characterize the nature and magnitude of gene effects in the expression of various drought tolerant parameters.

Criteria for assessment mechanisms of drought tolerance are critically needed and breeder must identify such criteria for their own crops to help in selection for drought tolerance. The ideal trait to be used as an additional or alternative selection criterion to yield in breeding for drought tolerance should satisfy the following requirements; (1) be causally related or genetically linked to yield under stress condition; (2) exhibit genetic variation; (3) be highly heritable; (4) be easy, inexpensive and quick to screen (Ceccarelli *et al.*, 1998). Plant ecophysiology may help us to identify trait or set of traits that maximize yield and its stability in either non stressed or stressed conditions. Several lists of physiological traits expected to lead to improve yield under drought have been presented by several authors. For example, leaf area, relative water content, heading and maturity date, leaf osmotic adjustment and drought susceptibility index (Steven *et al.*, 1990; Morgan, 1991 and Weyhrich *et al.*, 1995).

The objectives of this study were (1) to estimate the relative importance of gene action for the physiological traits and yield (2) to genetically evaluate parents which help wheat breeders for producing new genotypes of high yielding ability under drought stress and normal irrigation.

MATERIALS AND METHODS

The field work of this study was carried out at the Ismailia Agriculture Research Station during the three successive winter seasons i.e., 2005/2006, 2006/2007 and 2007/2008 to study the effect of water stress on six parents from bread wheat and their hybrids. To achieve this target, six genetically diverse wheat genotypes were used for this study, all possible crosses among parents, without reciprocals, were done to make a half diallel crosses to obtain fifteen hybrids. The parents were selected on the basis of the presence of wide differences between them with respect to certain economic and drought tolerance traits. The general pedigrees of these genotypes are given in the Table (1) for origin and pedigree of six wheat genotypes.

In seasons (2005/2006, 2006/2007) the experiment at work was carried out to gain enough seeds. The female spikes were hands emasculated and bagged to avoid contamination with foreign pollen. The emasculated spikes were pollinated by applying fresh pollen from the required male plant to obtain F1 seeds. At maturity, seeds of F1 from each cross were separately harvested.

During the evaluation season (2007/2008), the crosses and their parents were conducted under three water regimes. The first water regime was non-stress (I_1) 2000 m^3 water/fad, the second water regime was moderate water stress (I_2) 1500 m^3 water/fad and the third water regime was severe water stress condition (I_3) 1000 m^3 water/fad. The experimental plot consisted of two rows for parents and their crosses. Plant to plant and row to row distances were 20 and 30 cm, respectively. All cultural practices were carried out at the recommended doses to give the requirements to the plants.

Table (1): pedigrees of six wheat genotypes and origin.

No.	Parents	Pedigree	Origin
P1	SAHEL 1	NS 732 / PIMA // VEERY "S"	Egypt
P2	Line 11	ACSAD881 /3/Mon "S"/Cndr"S"//Prl"S"ACS-W-9136-0GZ-3GZ-9GZ	ACSAD
P3	Line 20	CHIL/FINK CP3295-14CF-0Y-0C-4C-0C-0SY-0AP	CIMMYT/ICARDA
P4	Sakha 93	SAKHA92/TR8103285 8871-1S-2S-1S-OS	Egypt
P5	Giza 168	MRL/BUC//Seri CM 93046-8M-OY-OM-2Y-OB	Egypt
P6	Gemmieza 9	AL D"S" / HUAC "S" //CM74 A. 630/SX	Egypt

Samples of ten guarded plants were taken randomly from each plot for parents and their crosses to estimate, the following characters:-

1. **Flag leaf area (cm^2):** Flag leaves were collected from ten randomly selected plants to determine flag leaf area using the following formulae proposed by Muller (1991), i.e., maximum length x maximum width x 0.74 to represent the area of individual leaf.
2. **Chlorophyll content (SPAD value):** Leaf chlorophyll content was estimated by using chlorophyll meter [SPAD 502, Minolta Camera Co., Osaka, Japan] according to Castelli *et al.* (1996).
3. **Relative water content (RWC %):** Relative water content (RWC) was estimated using the following formula given by Barres (1968):

$$RWC\,\% = [(FW-DW) / (TW-DW)] \times 100$$

where:

(FW) Fresh weight, (TW) Turgid weight and (DW) Dry weight.

4. **1000 kernel weight (g).**
5. **Grain weight per plant (g).**
6. **Drought susceptibility index (S) for grain yield:** It was calculated using the formula presented by Fisher and Maurer (1978):

$$S = (1-Yd/Yp)/D$$

Where:

Yd = mean grain yield under stress.

Yp = mean grain yield potential without stress

D = stress intensity, = 1- (mean Yd of all cultivars) under stress/ (mean Yp of all cultivars) under non-stress.

The genotypes having susceptibility index more than unity means that these cultivars are sensitive to drought tolerance. However, the genotypes that exhibited (S) less than unity mean that these cultivars are more tolerant to drought condition.

Statistical analysis:

Data were statistically analyzed using the analysis of variance (ANOVA) in a randomized complete block design (RCBD) where, each water regime was considered as a separate experiment. After that combined analysis was used to determine the effect of water regime among genotypes. The least significant difference (LSD) at 5% was used to evaluate the differences between genotypes at each experiment (Steel and Torrie 1981).

The data were further subjected to the diallel analysis proposed by Hayman (1954) tc separate out the components of genetic variance and their ratios. The genetic parameters were estimated from combined analysis data.

RESULTS AND DISCUSSION

Mean performance

Flag leaf area (cm^2):

To utilize any introduced genotypes effectively in breeding for drought tolerance, it is necessary to characterize and evaluate these genotypes for desirable traits. Flag leaf area plays a great role and contributes with adequate amount of yield in the plant especially under water stress. Wheat genotypes which having broader flag leaves and maintain their performances under different irrigation treatments are considered from the requirements for developing high yielding and drought tolerant genotypes. The results presented in Table (2) revealed that wheat genotypes differed significantly for flag leaf area and indicated that there were sufficient variability existed in the population.

A wide range of variation among the parental genotypes was observed. It worth to mention that the largest flag leaf area was recorded for P5 followed by P2 under all water regimes which recorded 39.23 cm^2 and 38.63 cm^3 under non-stress. Where these values were 31.42 cm^2 and 26.99 cm^3 for water stress. Moreover the largest flag leaf area were resulted from P2xP5 and P2xP6 under both non-stress and stress which were 42.99 $cm^3$and 40.16 cm^2 under non-stress and values 35.27 cm^2 and 30.36 cm^2 under stress conditions. Generally, water stress decreased the flag leaf area significant and this reduction in flag leaf area may be attributed to reduction in number of cells through cell division and/or reduction in cell size through cell enlargement. Consequently, maintaining flag leaf area is seen as a trait contributing to yield, but at the same time as a potential threat to survival under drought.

Photosynthetic pigments:-

Data in Table (2) showed that the values of chlorophyll content in flag leaf area differed significantly among wheat genotypes at vegetative growth for all studied water regimes.

Chlorophyll content varied from 41.08 (P3) to 46.69 (P6) *Spad value* and from 40.57 (P3) to 45.46 (P5) *Spad value* and from 40.13 (P5) to 45.56 (P6) *Spad value* under non-stress, moderate and stress conditions, respectively. It is evident to note that, genotypes P6, P1 and P4 were appeared to be the highest chlorophyll content which recorded 45.56, 41.85 and 40.85 *Spad values* under stress condition. These results revealed that these genotypes had maintained high concentration of leaf chlorophyll and the biochemical factors controlling this trait appear to be affected less by water stress than others. While, the mean values of the crosses ranged from 40.87 for P1xP3 to 47.27 for P2xP6 *Spad value* under stress condition. It might be concluded that, subjected wheat crosses to water stress decreased leaf chlorophyll content significantly. The chlorophyll pigments may be used as a useful tool for screening wheat genotypes for drought tolerance, and helpful criteria to stress conditions.

Relative water content (RWC %):

Relative water content (RWC) was measured to determine the water status of leaf tissues. The high values of relative water content indicate that, plants are tolerant, while the low values revealed that plants are sensitive to drought. The obtained data in Table (2) revealed that wheat genotypes differed significantly in relative water content for the three water regimes. The mean performance of parents for relative water content showed that the highest genotype was P1 under all water regimes which gave 86.19, 82.21 and 82.03 % under non-stress, moderate and stress conditions, respectively. The results of RWC% for crosses ranged from 76.47 to 85.75 % for P1xP5 and P2xP3 under non-stress. While, it ranged from 55.73 for P1xP3 to 81.16% for P2xP6 under stress condition.

It could be concluded from the results that the cross P2xP6 which maintained higher RWC under stress condition believed to be more drought tolerant than others. Moreover, it can be concluded that this genotype which tend to arise their RWC, it a quire its tolerance from great solute accumulation and metabolites, hence, osmotic adjustment occurred with higher RWC. In this respect, Bajji *et al.* (2001); Rane *et al.* (2001) and Yadav *et al.* (2001) reported that, relative water content RWC decreased significantly under stress conditions compared to normally irrigated control conditions.

1000-Kernel weight (g):

Water regime was one of the environmental parameter considered in this experiment which effected significantly on 1000-kernel weight. Genetic variation was found among wheat genotypes under three water regimes for 1000-kernel weight. The data in Table (2) showed that the mean performance of parents under non stress ranged from 31.22 for P1 to 47.28 g for P2 and ranged from 27.10 for P6 to 35.77 g for P2 under stress. The crosses ranged from 31.97 for P2xP5 to 55.74 g for P2xP3 for non stress and ranged from 31.16 for P2xP5 to 40.62 g for P2xP4 under stress conditions. Generally, the results revealed that wheat genotype P2xP4 was superior for 1000-kernel weight than other genotypes under water stress. So, this genotype can be taken into consideration for breeding for high yielding and drought tolerance.

Grain yield/plant (g):

Almost all biochemical and physiological processes in plants are relevant to physiological component of yield. These processes which are associated with crop growth and development are influenced by water deficits. Subjecting wheat genotypes to water stress decreased remarkably grain yield as shown in Table (2). The relative reduction due to water stress in grain yield amounted to 39.6%. The results indicated that, wheat genotypes differed significantly for grain yield/plant under the three water regimes. It varied from 4.15 for P4 to 4.77 g for P1 under non-stress and ranged from 2.04 for P6 to 3.30 g for P1 under stress. The data revealed that the highest values of grain yield/plant were shown in P1, P2 and P5 under both non-stress and stress conditions. The crosses ranged from 3.29 g for (P2xP6) to 5.48 g for (P3xP5) and from 2.15 g for (P3xP6) to 4.11 g for (P3xP5) and from 1.59 g for (P3xP6) to 3.25 g for (P1xP2) hybrids under non-stress, moderate and stress conditions, respectively.

The crosses P1xP2, P2xP4 and P4xP5 were considered as the best hybrids for grain yield and the other traits, revealing their importance in wheat improving programs for drought tolerance

Drought susceptibility index (S):

Drought susceptibility index has been used to characterize relative drought tolerance of durum wheat. Low drought susceptibility index (S<1) is synonymous with higher stress tolerance. Results of drought susceptibility index are presented in Table (2). It ranged from 0.7 to 1. 3 for parents and from 0.26 to 1.50 for hybrids. Hybrids No. 2 x 6, 4 x 5, 2 x 4, 1 x 5, 1 x 4 and 1 x 2 were relatively stress tolerant, where S values were 0.26, 0.55, 0.74, 0.74, 0.87, and 0.89 (i.e less than one), respectively. While the other genotypes were relatively stress susceptible where, (S) values were greater than unity. These results are in agreement with (Winter *et al.*, 1988) who reported linear relationship between genotypes yield and drought susceptibility index.

Genetic parameters:

Understanding the genetic bases of yield and its components is essential for choosing efficient breeding method leading to rapid genetic improvement. The breeding procedure which be followed should be based on a good understanding the mode of inheritance of the desired characters. Therefore, successful breeding program need continues information on gene action and system controlling the studied characters.

Separating the total genetic variance to its parts, additive and dominance gene effects for the studied traits are given in Table (3, 4). The estimated value of the additive (D) and dominance (H_1 and H_2) genetic variance were significant for all the studied traits, except for flag leaf area under three water regimes, chlorophyll content under non-stress and stress conditions and relative water content under non-stress. Where the additive components were non significant. The magnitude of dominance components (H_1 and H_2) was higher than the corresponding additive one (D) except for flag leaf area under moderate (I_2) suggesting that the genetic variation for the studied traits was mainly attributable to dominance genetic portion.

Table (2): Mean performance of Flag leaf area, Chlorophyll content, Relative water content, 1000-kernel weight grain yield/plant and drought Susceptibility index (S) for six Genotypes and their crosses of wheat under three water regimes.

parents & F1 crosses	Flag leaf area (cm^2)			Chlorophyll Content (SPAD value)			RWC %			1000-kernel weight (g)			Grain yield/plant (g)			(S) value
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	
P1 Sahel 1	32.87	22.36	19.76	45.07	43.77	41.85	86.19	82.21	82.03	31.22	29.03	28.72	4.77	3.10	3.30	0.70
P2 Line 11	38.63	33.13	26.99	44.11	43.66	39.93	82.09	80.04	76.33	47.28	35.89	35.77	4.30	4.14	2.89	0.83
P3 Line 20	38.07	33.12	24.56	41.08	40.57	39.56	83.91	80.37	70.16	35.78	31.35	30.17	4.43	2.84	2.28	1.22
P4 Sakha 93	29.55	28.81	20.00	44.46	42.36	40.85	78.46	72.49	66.46	37.89	33.62	27.44	4.15	3.40	2.53	0.98
P5 Giza 168	39.23	33.17	31.42	44.77	45.46	40.13	79.36	78.68	70.66	33.22	30.65	30.64	4.28	3.91	2.59	0.99
P6 Gemmieza 9	34.08	28.19	24.23	46.69	43.55	45.56	83.17	80.77	71.14	33.99	29.16	27.10	4.22	3.17	2.04	1.30
P1xP2	31.51	30.69	29.73	46.63	42.45	42.13	79.68	79.51	78.16	53.46	46.39	31.40	4.95	3.29	3.25	0.89
P1xP3	33.42	28.74	21.69	40.87	41.60	41.44	82.21	68.06	55.73	36.28	35.51	30.78	4.24	2.61	2.57	1.01
P1xP4	35.80	31.20	24.15	44.04	40.40	40.64	79.18	78.31	69.20	50.23	48.54	37.74	4.39	2.90	2.79	0.87
P1xP5	38.45	28.15	24.07	44.11	40.95	41.02	76.47	75.99	70.96	33.63	32.66	31.90	3.87	3.04	2.75	0.74
P1xP6	38.17	26.17	24.93	45.36	45.09	42.63	84.09	81.59	79.32	40.03	34.60	33.64	3.91	2.79	1.86	1.35
P2xP3	37.00	32.48	24.39	46.88	37.98	37.47	85.75	82.49	77.12	55.74	37.29	36.27	4.13	3.89	2.61	0.94
P2xP4	33.50	33.13	30.50	46.89	46.63	38.87	81.09	76.68	62.99	53.67	49.79	40.62	4.31	3.52	3.06	0.74
P2xP5	42.99	35.40	35.27	43.81	40.27	42.06	81.19	80.95	70.39	31.97	31.65	31.16	4.33	3.65	2.49	1.09
P2xP6	40.16	36.05	30.36	47.27	46.64	43.51	85.42	85.36	81.16	42.62	36.32	33.86	3.29	2.95	2.74	0.26
P3xP4	29.87	29.24	22.65	45.32	44.99	43.03	78.80	77.41	74.42	36.58	35.13	35.10	4.23	3.59	2.49	1.06
P3xP5	36.43	36.03	22.44	45.79	43.79	43.07	80.16	76.28	69.45	46.34	36.95	31.77	5.48	4.11	2.76	1.28
P3xP6	35.71	27.23	25.36	44.32	41.56	40.05	84.49	79.79	55.89	47.08	41.43	35.73	3.81	2.15	1.59	1.50
P4xP5	31.85	27.87	26.23	45.10	41.89	40.46	81.55	79.31	76.13	51.83	38.47	31.56	3.68	2.59	2.90	0.55
P4xP6	37.78	28.61	21.53	45.81	42.62	40.29	77.14	74.24	57.93	40.40	35.94	33.79	4.28	3.85	2.08	1.32
P5xP6	38.81	30.55	27.63	47.17	46.20	45.16	81.22	81.18	77.76	35.32	33.49	32.37	4.00	3.04	2.18	1.17
LSD 0.5	7.87	7.58	8.64	5.52	4.51	5.84	6.54	7.67	6.96	6.39	5.88	8.48	0.564	0.525	0.648	

The component of variation due to dominance portion associated with gene distribution (H_2) values were smaller than (H_1) values for all traits under the three water regimes which agreed with the theoretical assumption of Hayman (1954) and could be a further proof for the unequal proportion of positive and negative alleles in the parent at all loci for these traits, indicated unequal allele frequency.

The estimator (E), which refers to the environmental variance was highly significant for all studied traits under the three water regimes, indicated the large effect of the environmental factor on these traits. The environmental variance played a great role and contributed to the total phenotypic variance. These findings might favor the hybridization procedure as the most effective way to improve these traits. Thus, increasing years and locations are a must for obtaining reliable estimation.

The average degrees of dominance $(H_1/D)^{0.5}$ were more than unity except for flag leaf area under moderate water stress and chlorophyll content under non-stress conditions, confirming the important role of over dominance in the genetic control of these traits. These results suggest that reciprocal recurrent selection is considered effective for improving the studied traits. The importance of over dominance in the genetic control of wheat traits was reported by El-Sayed (2007).

The relative frequency of dominance and recessive alleles (F) coupled with the ratio of dominance (KD) to recessive (KR) ratios less than unity, indicated an excess of recessive alleles for these traits. Showing that the relative frequencies of dominant and recessive alleles were not equal in the parents of these traits.

These results are in harmony with those obtained by Bayoumi (2005), Koumber *et al.* (2005), Sahin Dere, *et al.* (2006), and El-Sayed (2007).

Estimates of broad sense heritability were found to be high while narrow sense heritability values were less than 50% for all traits under three water regimes, except for grain yield/plant under stress condition indicating that selection should be delayed to latter generations. These results are in harmony with those obtained by Vitkare and Atale (1996).

It could be concluded that the best performance parents of all studied traits were P1, P2, P5 and P6 while, the best performance for F1 crosses were P1xP2, P2xP4, P2xP6 and P4xP5. The estimated of the additive (D) and dominance (H_1 and H_2) were significant for most studied traits, the environmental variance (E) was highly significant for all studied traits under the three water regimes indicated the large effect of the environmental factor on these traits The average degrees of dominance $(H_1/D)^{0.5}$ were more than unity. The sign KD/KR were less than unity, indicated an excess of recessive alleles for all studied traits.

Table (3): Genetic components for wheat crosses under three water regimes according to (Haymen 1954)

Genetic parameters	Flag leaf area (cm^2)			Chlorophyll Content			Relative water content %		
	I1	I2	I3	I1	I2	I3	I1	I2	I3
D	7.5573	10.5115	9.2515	-1.5110	-1.8785	-1.5817	-2.1515	18.919	33.436*
H1	12.2467	2.2361	30.1710	-0.2290	17.6906	6.2823	3.0911	53.426*	229.43**
H2	11.9780	4.8788	23.9364	2.1140	18.8009*	5.7808	3.7637	36.937*	200.26**
F	-4.8731	-4.6071	-1.8035	-9.8061	-4.1033	-3.4068	-6.7928	29.628	11.119
E	7.3681**	8.1591**	10.1212**	4.9713**	3.7588**	3.5909**	8.4972**	6.312**	6.405**
$(H_1/D)^{0.5}$	1.273	0.461	1.806	0.389	1.8505	1.1197	2.150	1.680	2.620
KD/KR	0.3734	0.2624	0.4730	-3.6681	0.0596	0.864	0.6005	0.7330	0.468
h^2b	55.9%	47.8%	59.1%	41.3%	58.3%	42.1%	25.6%	65.8%	93.1%
h^2n	38.0%	39.9%	34.9%	35.1%	16.2%	18.8%	39.5%	15.7%	17.4%

Table (4): Genetic components for wheat crosses under three water regimes according to (Haymen 1954)

Genetic parameters	1000-kernel weight (g)			Grain yield/plant (g)		
	I1	I2	I3	I1	I2	I3
D	26.2495	-0.9711	-1.6163	-0.0117	0.2177*	0.1389
H1	217.445**	116.9**	40.8540	0.7918**	0.8613**	0.2428
H2	199.624**	101.5**	37.1092*	0.7499**	0.8051**	0.2214*
F	0.2710	-12.1212	-0.3064	-0.0639	0.0688	-0.1284
E	7.2206**	5.228**	7.7378**	0.0345**	0.0345**	0.061**
$(H_1/D)^{0.5}$	2.878	3.026	2.952	1.656	1.989	1.322
KD/KR	0.5009	0.552	0.526	0.424	0.5397	0.3253
h^2b	90.9%	88.1%	57.6%	87.2%	89.8%	76.8%
h^2n	27.7%	30.3%	16.7%	55.5%	30.3%	17.5%

D: additive variance. H_1: dominance variance effect of genes. H_2: dominance variance effect of genes for gene distribution.
F: relative frequency of dominance and recessive alleles. E: environmental variance. $(H1/D)^{0.5}$: average degree of dominance.
Kd/kr: proportion of dominance genes. h^2_b: heritability in broad sense. h^2n: heritability in narrow sense.

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وراثة المحصول وبعض الصفات الفسيولوجيه ذات العلاقه بالتحمل للجفاف فى هجن قمح الخبز

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اجريت دراسة لتقدير الفعل الجينى للمحصول وبعض الصفات الفسيولوجية فى القمح على ستة آباء من قمح الخبز باستخدام نظام التهجين الدائرى (الداى آليل) بدون استحدام الهجن العكسية فى مواسم ٢٠٠٥ \٢٠٠٦ ، ٢٠٠٦\٢٠٠٧، ٢٠٠٧\٢٠٠٨ وقد نفذت التجربة فى محطة البحوث الزراعية بالاسماعيلية تحت ثلاثه معدلات من الرى بالرش وكان المعدل الاول رى عادى (٢٠٠٠م٣ مياه/فدان) والمعدل الثانى متوسط (١٥٠٠م٣ مياه/فدان) والمعدل الثالث جفاف (١٠٠٠م ٣ مياه/فدان). اشارت النتائج الى ان المعدل الثالث (الجفاف) ادى الى نقص معنوى وملحوظ فى المحصول ومكوناته والصفات الفسيولوجيه تحت الدراسه مثل مساحه ورقه العلم ومحتوى الماء النسبى ومحتوى الكلوروفيل ووزن الالف حبه. وقد حققت الهجن P1xP2, P2xP6 اعلى انتاجيه لمحصول الحبوب والصفات الاخرى. مما يشير الى اهميه ادخال هذه الهجن فى برامج تربيه وتحسين القمح للتحمل للجفاف، وكانت القيم العاليه للمكونات السائده (H_1,H_2) لكل الصفات تحت الدارسه دليلا على اهميه دور السياده الفائقه فى التحكم الوراثى للصفات المدروسه. انخفضت قيم معامل التوريث على النطاق الضيق لكل الصفات المدروسه نتيجه تعرضها للجفاف وتراوح قيمها بين ١٥,٧ لصفه محتوى الماء النسبى الى ٥٥,٥% لمحصول الحبوب للنبات مما يدل على تاثر معظم الصفات بالعوامل البيئيه.