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PERFORMANCE OF SOME BREAD WHEAT GENOTYPES AND THEIR HYBRIDS UNDER WATER STRESS CONDITIONS

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ABSTRACT

Six bread wheat genotypes: 3 susceptible genotypes for water stress (Giza 168, Giza 170 and Gemmiza 9) and 3 drought tolerant genotypes (Prl x Toni, Rabi x Weaver and Pastor) were crossed at Giza (ARC), during 2002/2003 and 2003/2004. Parental genotypes and 15 F_1 hybrids were grown under irrigation (6-times per season) and water stress (irrigated only once) during 2004/2005. Results showed highly significant differences among genotypes for all traits except number of spikes/plant under water stress. Grain yield /plant recorded the highest mean square followed by number of grains/spike under irrigation and water stress. 100-grain weight recorded the lowest mean square. General combing ability (GCA) variances of traits under stress conditions were larger than the specific combining ability (SCA) except grain yield/plant. The ratios of GCA and SCA for measured traits were less than unity, indicating that the main genetic variation for these traits was due to non-additive gene action. The drought tolerant parental genotypes (Rabi x Weaver) recorded the best results for number of grains/spike and 100-grain weight followed by Pastor for number of spikes/plant and grain yield/plant under irrigation and water stress. Susceptible parental genotype Gemmiza 9 exhibited the highest number of spikes/plant and grain yield under water stress. Giza 170 recorded the highest 100-grain weight/plant under irrigation. According to the heterotic effects on the studied traits, F_1 hybrids were classified into three groups, the first included the combination of drought tolerant parental genotypes which exhibited highly significant positive heterosis % (favourable) for all traits under water stress except number of grains/spike. The second one (susceptible x tolerant) recorded highly significant positive heterosis% (favourable) for number of spikes/plant and grain yield/plant under irrigation and 100-grain weight and grain yield under water stress. The third included the hybrids of susceptible x susceptible genotypes. Pastor recorded highly significant positive (favourable) GCA effects for number of spikes/plant and grain yield/plant under irrigation and for 100-grain weight under water stress. Rabi x Weaver exhibited favourable GCA effects for number of grains/plant and 100-grain weight under irrigation. Prl x Toni showed highly significant positive GCA effects for number of grains/plant under water stress.

It could be concluded that crossing of different parental genotypes having variable reaction to water stress enriches the variability of resultant combinations. Results revealed that drought tolerance of bread wheat was strengthened by crossing and the superior combinations may be enrolled in the breeding programs for drought tolerance

Key words: ***Wheat, Water stress, Heterosis, Combining ability***

INTRODUCTION

Wheat is the world's most important strategic cereal crop in Egypt. It's the main winter cereal crop as it occupies approximately 2.7 million fed. producing 7 million tons by 2006. Wheat is the primary stable food source of the most Egyptian population. Moreover, it's straw is an important feed.

The long term strategic plan of wheat research in Egypt is aiming to select among introductions and regionally collected germplasm that possess good adaptation to the unfavorable conditions. Water stress is one of the most important problem facing researchers. Besides, high yielding potentiality, drought tolerant cultivars are required for more crop intensification as the cultivated land and irrigation water are limited. The recommended quantity of water for wheat is about 2000 m^3/feddan (6-irrigations) and decreasing this amount may help in increasing the area to reclaim and this target can be reached by one or two ways of breeding. The first one is evaluating many genotypes under different water stress conditions. The other one is breeding program, which depend on stretching the genetic base to develop the variation as the best tool for breeders. Hybridization offers good possibilities for widening the genetic base and studying the nature of genetic systems controlling the inheritance of traits and/or transfer of characters/genes from one genotype to another.

The estimates of general (GCA) and specific (SCA) combining abilities, presented by Ikram and Tanah (1991), Eissa (1993), El-Bially and El-Sayed (2002), El-Sayed (2004) and El-Sayed and Moshref (2005) indicated that both of them played an important role in the inheritance of grain yield, number of spikes/plant, number of kernel/spike, 100-kernel weight. However, Sharma and Smith (1986), Darwish (1992) and Mohammed (1999) reported that non-additive gene effects were found for grain yield/plant, number of kernel/spike and 100-kernel weight. Moreover, El-Hennawy (1991) and Abd El-Majeid *et al* (2004) found that mean squares of GCA were higher than those of SCA for yield and its components.

Heterosis and combining ability as well as the nature of genetic behavior were studied through the different methods of mating designs by many authors, i.e. diallel, line x tester, six populations method and straight hybridization. On the other hand, heterosis in wheat has not been exploited yet, although several authors detected significant heterosis on most crosses of wheat as reported by Walia *et al* (1993) El-Beially and El-Sayed (2002), Abd El-Majeid *et al* (2004) and El-Sayed and Moshref (2005)

This work was conducted to study the performance of six bread wheat genotypes and their hybrids under water stress by using diallel crossing technique without reciprocals.

MATERIALS AND METHODS

This study was carried out at the Agricultural Research Center, ARC Giza Research Station, Wheat Research Department during three successive seasons starting from 2002/2003. Six bread wheat genotypes (*Triticum aestivum* L.) were used as parental lines, their commercial names, and origin are presented in Table (1).

Table 1. Commercial names, pedigree and origin of the parental lines.

Parents	Pedigree	Water stress	Origin
Giza 168 (P_1)	MRL/BUC//SERI	Susceptible	ARC
Giza 170 (P_2)	Kauz/Altar 84//AS0		
Gemmiza 9 (P_3)	ALD (S)/HUAC(S)//CMH 74 A.630/SX		
Prl X Toni (P_4)	PRL/TONI//CHIL/3/PRL	Tolerant	CIMMYT
Rabi x Weaver (P_5)	RABE*2/WEAVER//RABE		
Pastor (P_6)	PFAU/SERI//BOW - SERI=VEERY		

During 2002/03 and 2003/04 seasons, all possible combinations excluding reciprocals were made among the six parents to produce 15 F_1 hybrids. During 2004/05 season, the parental genotypes and resultant 15 F_1 hybrids were grown under two irrigation treatments: I=6-irrigations and Ws=one irrigation. Each treatment was conducted as a separate experiment using randomized complete block design (RCBD) replicated four times. Each plot consisted of one row 4 m long and 30 cm between rows. Grains of each genotype were spaced 20 cm apart within rows. The studied traits were number of spikes/plant, number of grains/spike, 100-grain weight and grain yield/plant.

The heterotic effect of F_1 crosses were estimated over mid parents. Combining ability effects and variances were calculated according to Method 2, Model 1 of Griffing (1956) including parents and F_1's without reciprocals.

RESULTS AND DISCUSSION

Results of statistical analysis are presented in Table (2) showed highly significant differences among tested genotypes for all studied traits except number of spikes/plant under water stress, indicating genetic variability for all variables. Grain yield /plant recorded the highest mean square followed by number of grains/spike under irrigation and water stress conditions. However, 100-grain weight recorded the lowest mean square.

Table 2. Significance of mean square due to genotypes, general (GCA), specific (SCA) combining ability and ratio of additive (σ^2_g) to non-additive (σ^2_s) gene effects for yield and some of its components under irrigation and water stress

Source of variation	df	No. of spikes/plant		No. of grains /spike		100- grain weight		Grain yield/plant (g)	
		I	Ws	I	Ws	I	Ws	I	Ws
Genotypes	20	22.19**	4.73ns	163.34**	125.02**	1.13**	1.14**	282.68**	73.36**
GCA	5	2.18**	1.30ns	36.95**	48.53**	0.58**	0.46**	54.16**	15.96ns
SCA	15	6.67**	1.15ns	42.13**	25.50**	0.18**	0.23**	76.18**	19.14**
Error	60	0.43	1.11	11.12	13.81	0.05	0.08	3.64	10.12
σ^2g/σ^2s		0.09	0.47	0.02	0.25	0.38	0.21	0.04	0.04

*&**indicate significance at 5% and 1% levels, respectively. I=Irrigation Ws=Water stress

These finding could be mainly attributed to the wide genetic diversity between parental genotypes along with F_1 hybrids. Results given in Table (2) revealed highly significant general and specific combining ability variances for all tabulated traits except number of spikes under stress condition. On the other hand, general combining ability variances of tabulated traits under stress condition were larger than those of specific combining ability except grain yield/plant, indicating that GCA effects appeared to be more important than SCA effects for these traits. Due to the presence of significant GCA and SCA variances, the additive and non-additive gene action might be controlling the inheritance of various studied traits.

In comparing the magnitudes of GCA and SCA, all the ratios for all measured traits were less than unity, indicating that the main genetic variation for these traits was due to non-additive gene action. However, such conclusion doesn't entirely eliminate the presence of a considerable portion of additive genetic variance in the studied traits under two conditions of water treatments.

The mean performance of parental genotypes and F_1 hybrids for different studied traits are presented in Table (3). The drought tolerant parental genotype Prl x Toni recorded the best results for number of grains/spike, Rabi x Weaver for 100-grain weight and Pastor for number of spikes/plant and grain yield/plant under irrigation and water stress. On the

Table 3. Mean performance of parental genotypes and their crosses for yield and its components under irrigation and water stress.

Entries	No. of spikes/plant		No. of grains /spike		100- grain weight		Grain yield/plant (g)	
	I	Ws	I	Ws	I	Ws	I	Ws
Giza 168 (P_1)	20.72	13.85	67.83	56.85	3.64	3.28	39.83	23.88
Giza 170 (P_2)	17.01	13.27	67.72	53.62	4.97	4.04	40.39	21.91
Gemmeiza 9 (P_3)	19.46	16.35	59.93	57.72	4.94	4.01	41.37	28.08
Prl X Toni (P_4)	16.34	13.83	59.89	64.01	4.34	3.48	37.51	24.07
Rabi x Weaver (P_5)	16.12	14.44	72.09	60.65	3.71	4.19	38.59	25.41
Pastor (P_6)	21.26	14.48	57.24	57.99	4.06	3.90	44.24	25.25
(P_1) x (P_2)	19.47	14.40	69.30	62.71	3.72	3.86	43.21	25.41
(P_1) x (P_3)	19.66	13.15	65.31	56.29	4.45	3.97	42.99	24.64
(P_1) x (P_4)	25.37	14.94	63.03	56.96	4.70	3.97	42.16	25.21
(P_1) x (P_5)	21.62	13.98	70.13	56.99	4.14	3.66	37.54	30.28
(P_1) x (P_6)	19.59	13.77	70.75	50.46	4.46	4.51	44.90	27.67
(P_2) x (P_3)	24.77	14.26	77.06	49.14	4.63	4.93	71.56	26.15
(P_2) x (P_4)	18.73	13.94	66.61	53.27	4.59	4.28	39.53	27.89
(P_2) x (P_5)	21.27	13.49	66.43	45.30	4.24	4.71	46.37	20.66
(P_2) x (P_6)	21.92	13.96	65.32	48.41	3.99	4.64	51.20	30.31
(P_3) x (P_4)	20.71	12.96	59.20	56.42	5.48	4.52	49.16	29.62
(P_3) x (P_5)	21.13	14.05	61.63	49.87	5.60	4.34	49.63	25.01
(P_3) x (P_6)	21.65	15.41	68.94	49.99	4.43	4.75	46.54	26.97
(P_4) x (P_5)	21.99	16.07	65.51	67.39	4.75	4.92	52.82	35.85
(P_4) x (P_6)	22.73	16.05	73.85	59.97	4.12	5.12	55.87	27.38
(P_5) x (P_6)	21.07	16.75	84.33	57.79	3.98	5.21	60.24	39.33
$LSD_{0.05}$	1.86	2.98	9.43	10.51	0.61	0.78	5.39	9.00

other hand, the susceptible and high yield potential parental genotype Gemmiza 9 exhibited the highest number of spikes/plant and grain yield under water stress, while, Giza 170 recorded the highest 100-grain weight/plant under irrigation.

Comparing the performance of crosses under normal irrigation to corresponding highest parents, all combinations of tolerant and susceptible parental genotypes had higher number of spikes/plant except P_1 x P_2 and P_1 x P_3 . However, under water stress, the combinations of tolerant parents (P_4 x P_5, P_4 x P_6 and P_5 x P_6) exhibited the highest number of spikes/plant. On the other hand, hybrids P_4 x P_5 and P_5 x P_6 behaved the greatest number and heaviest grains under drought treatment, respectively. Moreover, hybrids P_2 x P_3 and P_5 x P_6 recorded the highest grain yield under irrigation and water stress, respectively. It could be concluded that the above mentioned hybrids may be valuable in bread wheat breeding for improving grain yield and its components under low water requirements or breeding for drought tolerance.

Percent heterosis of crosses over mid parents are presented in Table (4). According to the obtained results, crosses could be classified into three groups. The first group included the combinations of drought tolerant parental genotypes (P_4, P_5 and P_6), which exhibited highly significant positive heterosis % (favourable) for all tabulated traits under water stress except number of grains/spike.

Table 4. Significant heterosis% of F_1 crosses over mid-parents for studied traits under irrigation and water stress.

Hybrids	No. of spikes/plant		No. of grains /spike		100- grain weight		Grain yield/plant (g)	
	I	Ws	I	Ws	I	Ws	I	Ws
$(P_1) \times (P_2)$		6.19**		13.53**	-13.59**	5.46**	7.73**	10.98**
$(P_1) \times (P_3)$		-12.91**			3.73**	8.92**	5.89**	
$(P_1) \times (P_4)$	36.91**	7.95**			17.79**	17.46**	9.03**	
$(P_1) \times (P_5)$	17.37**				12.65**	-2.01**		22.86**
$(P_1) \times (P_6)$		-2.79**	13.14**	-12.12**	15.84**	25.63**	6.82**	12.64**
$(P_2) \times (P_3)$	35.84**	-3.71**	20.74**	-11.73*	-6.56**	22.48**	75.05**	
$(P_2) \times (P_4)$	12.32**	2.88*		-9.43*	-1.40**	13.83**		21.31**
$(P_2) \times (P_5)$	28.40**	-2.63*		-20.71**	-2.30**	14.46**	17.42**	-12.68**
$(P_2) \times (P_6)$	14.55**			-13.25**	-11.63**	16.88**	21.00**	28.54**
$(P_3) \times (P_4)$	15.70**	-14.12**			18.10**	20.69**	24.65**	13.60**
$(P_3) \times (P_5)$	18.77**	-8.74**		-15.74**	29.48**	5.85**	24.14**	-6.49**
$(P_3) \times (P_6)$			17.68**	-13.59**	-1.56**	20.10**	8.73**	
$(P_4) \times (P_5)$	35.49**	13.69**			18.01**	28.29**	38.82**	44.91**
$(P_4) \times (P_6)$	20.90**	13.39**	26.10**		-1.90**	38.75**	36.69**	11.03**
$(P_5) \times (P_6)$	12.73**	15.84**	30.41**		2.45**	28.80**	45.45**	55.27**

***&**indicate significance at 5% and 1% levels, respectively.**

On the other hand, the same group recorded highly significant positive heterotic effects under irrigation except P_4 x P_5 and P_4 x P_6 for number of grains/spike and 100-grain weight, respectively. The second group comprised the crosses of susceptible x tolerant genotypes. Those hybrids (P_1 x P_4 and P_1 x P_5) recorded highly significant positive heterosis% (favourable) for number of spikes/plant and 100-grain weight and P_2 x P_5, P_2 x P_6, P_3 x P_4, and P_3 x P_5 for number of spikes/plant and grain yield/plant under irrigation. Whereas, the hybrid, P_2 x P_4 was highly significant (favourable) for number of spikes/plant only. On the other hand, the same group was highly significant positive heterosis% (favourable) for 100-grain weight and grain yield/plant except P_1 x P_5 for 100-grain weight and P_1 x P_4, P_1 x P_6, P_2 x P_5, P_3 x P_5 and P_3 x P_6 for grain yield/plant. The last group included the hybrids of susceptible x susceptible genotypes, which showed favourable heterotic effects for 100-grain weight and grain yield under both conditions except the hybrid P_1 x P_2 for 100-grain weight under irrigation and P_1 x P_3 for grain yield/plant under water stress. These results are in agreement with Attia (1972), El-Rassas and Mitkees (1985), Shamarka (1980), Hassan *et al* (1991), Seleem (1993), , Abd El-Mejeid, *et al* (2004), Abd El-Mejeid (2005) and El-Sayed and Moshref (2005)

General combining ability (GCA) effects of susceptible and tolerant parental genotypes under irrigation and water stress are presented in Table (5).

Table 5. General combining ability effects (g_i) estimated for various parents and studied traits.

Parental genotypes	No. of spikes/plant		No. of grains /spike		100- grain weight		Grain yield/plant (g)	
	I	Ws	I	Ws	I	Ws	I	Ws
Giza 168 (P_1)	0.37	-0.40	0.43	0.82	-0.28**	-0.45**	-4.34**	-1.17
Giza 170 (P_2)	-0.50*	-0.57	1.18	-3.07*	0.02	0.05	0.93	-2.01
Gemmeiza 9 (P_3)	0.33	0.18	-2.34*	-1.68	0.44**	0.05	2.18**	-0.22
Prl X Toni (P_4)	-0.25	0.06	-2.84**	3.93**	0.17*	-0.04	-1.33*	0.47
Rabi x Weaver (P_5)	-0.61**	0.26	2.69*	1.01	-0.11	0.14	-0.18	1.45
Pastor (P_6)	0.66**	0.47	0.87	-1.00	-0.23**	0.24**	2.75**	1.48
S.E. $\hat{g}i$	0.21	0.34	1.08	1.20	0.07	0.09	0.62	1.03
S.E. $\hat{g}I - \hat{g}j$	0.54	0.53	2.96	1.85	0.11	0.14	0.95	1.60

*&**indicate significance at 5% and 1% levels, respectively.

Results indicated that, the tolerant genotype Pastor recorded highly significant positive (favourable) general combining ability effects for number of spikes/plant and grain yield/plant under irrigation and for 100-grain weight under water stress. Moreover, Rabi x Weaver (P_5) exhibited favourable GCA effects for number of grains and 100-grain weight under irrigation. On the other hand, the tolerant genotype Prl x Toni (P_4) showed highly significant positive GCA effects for number of grains under water stress. Whereas, the GCA effects of susceptible parent Gemmiza 9 had significant positive GCA effect (favourable) for 100-grain weight and grain yield/plant under irrigation.

The specific combining ability (SCA) effects of F_1 cross combinations are presented in Table (6). For number of spikes/plant under irrigation, seven F_1 combinations (P_1 x P_4, P_1 x P_5, P_2 x P_3, P_2 x P_5, P_2 x P_6, P_4 x P_5 and P_4 x P_6) showed significant positively SCA effects. However, two combinations (P_1 x P_3 and P_1 x P_6) had significant unfavourable SCA effects for the same trait. On the other hand, for number of grains/spike, 100-grain weight and grain yield/plant, three (P_2 x P_3, P_4 x P_6 and P_5 x P_6), four (P_1 x P_4, P_1 x P_6, P_3 x P_4, and P_3 x P_5)) and four (P_2 x P_3, P_4 x P_5, P_4 x P_6 and P_5 x P_6) cross combinations exhibited significant positive effects (favourable SCA effects) under irrigation, respectively.

Table 6. Estimates of specific combining ability effects (S_{ij}) of F_1 hybrids for studied traits.

Hybrids	No. of spikes/plant		No. of grains /spike		100- grain weight		Grain yield/plant (g)	
	I	Ws	I	Ws	I	Ws	I	Ws
$(P_1) \times (P_2)$	-0.99	0.92	0.44	9.61**	-0.44*	-0.05	0.17	1.41
$(P_1) \times (P_3)$	-1.64**	-1.08	-0.03	1.36	-0.13	0.07	-1.30	-1.16
$(P_1) \times (P_4)$	4.65**	0.83	-1.81	-3.59	0.38*	0.16	1.38	-1.28
$(P_1) \times (P_5)$	1.26*	-0.33	-0.24	-0.63	0.10	-0.33	-4.39**	2.81
$(P_1) \times (P_6)$	-2.04**	-0.75	2.21	-5.15	0.54**	0.41	0.03	0.17
$(P_2) \times (P_3)$	4.34**	0.21	10.97**	-1.91	-0.25	0.52*	21.99**	1.20
$(P_2) \times (P_4)$	-1.11	-0.00	1.03	-3.39	-0.02	-0.02	-6.52**	2.24
$(P_2) \times (P_5)$	1.78**	-0.65	-4.68	-8.44**	-0.09	0.22	0.84	-5.97*
$(P_2) \times (P_6)$	1.16*	-0.39	-3.97	-3.33	-0.21	0.05	1.06	3.65
$(P_3) \times (P_4)$	0.03	-1.73	-2.87	-1.63	0.45*	0.21	1.86	2.19
$(P_3) \times (P_5)$	0.81	-0.84	-5.97*	-5.26	0.85**	-0.16	1.17	-3.41
$(P_3) \times (P_6)$	0.06	0.32	3.16	-3.13	-0.20	0.15	-4.85**	-1.48
$(P_4) \times (P_5)$	2.24**	1.30	-1.58	6.66*	0.26	0.52*	7.88**	6.74*
$(P_4) \times (P_6)$	1.72**	1.07	8.57**	1.24	-0.23	0.62**	7.99**	-1.76
$(P_5) \times (P_6)$	0.42	1.57	13.53**	1.98	-0.11	0.53*	11.21**	9.21**
S.E. (Sij)	0.58	0.94	2.96	3.29	0.19	0.24	1.69	2.82
S.E. (Sij-Ski)	0.81	1.29	4.08	4.55	0.27	0.33	2.34	3.90

*&**indicate significance at 5% and 1% levels, respectively.

The results of SCA effects of hybrids under water stress showed that the combination of drought tolerant parental genotypes (P_4, P_5 and P_6) exhibited highly significant positive effects (favourable) for 100- grain weight and grain yield/plant except $P_4 \times P_6$ for grain yield/plant.

From the previously obtained results, it could be concluded that crossing of different parental genotypes that having variable reaction to drought widens variability of resultant combinations. Generally, the drought tolerance of bread wheat was strengthened by crossing and the superior combinations will be enrolled in the breeding programs for drought tolerance.

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أداء بعض التراكيب الوراثية من قمح الخبز وهجنها تحت ظروف الإجهاد المائي

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أجريت التجارب الحقلية لهذه الدراسة بقسم بحوث القمح – مركز البحوث الزراعية بالجيزة حيث استخدمت ستة أباء متباينة في تحملها للإجهاد المائي في التهجين الدائري بدون الهجن العكسية في الموسمين ٢٠٠٢/٢٠٠٣، ٢٠٠٣/٢٠٠٤ وفي الموسم ٢٠٠٤/٢٠٠٥ تم تقييم الأباء والهجن الناتجة تحت ظروف الإجهاد المائي (ريه واحدة خلاف ريه الزراعة) والري الطبيعي (٦ ريات) حيث نفذت كل معاملة كتجربة مستقلة باستخدام تصميم القطاعات الكاملة العشوائية في أربع مكررات.

أظهرت نتائج التحليل الإحصائي تباينات عالية المعنوية لجميع الصفات التي درست ماعدا عدد السنابل/نبات تحت الإجهاد المائي.كما سجل محصول النبات أعلى متوسط لمجموع مربعات الانحرافات تحت ظروف الإجهاد المائي في حين كان وزن الـ-١٠٠ حبة هو الأقل. كما أوضحت نتائج القدرة العامة على التآلف قيما أعلى من القدرة الخاصة على التآلف لكل الصفات التي تم دراستها فيما عدا محصول النبات في الإجهاد المائي. وكانت قيم نسبة القدرة العامة إلي القدرة الخاصة على التآلف اقل من الواحد للصفات المدروسة مما يدل على أن التباين الوراثي لهذه الصفات يرجع إلي تأثير الجين الغير مضيف.

أمكن تقسيم نتائج قوة الهجين الناتجة إلى ثلاث مجموعات كالأتي:

المجموعة الأولى: وتشمل الهجن الناتجة من الأباء المتحملة للجفاف والتي أظهرت قوة هجين موجبة ومرغوبة لجميع الصفات فيما عدا عدد الحبوب/سنبله

المجموعة الثانية: الهجن الناتجة من الأباء الحساسة للجفاف x الأباء المتحملة للجفاف والتي أظهرت معنوية موجبة ومرغوبة لصفات عدد السنابل/نبات، محصول النبات في الإجهاد المائي.

المجموعة الثالثة: وتضمنت الهجن الناتجة من الأباء الحساسة للجفاف والتي تباينت على مستوى الصفات ومعاملات الري والإجهاد المائي.

ومما سبق يتضح أن التهجين بيت الأباء المتباينة في تحملها للإجهاد المائي يؤدي إلي توسيع القاعدة الوراثية للتحمل كما يمكن تحسين الأداء لمحصول القمح تحت ظروف الإجهاد المائي بواسطة التهجين وإدخال الهجن المتفوقة في برامج التربية المستقبلية كما يمكن عزلها وتهجينها معا لزيادة حجم الوعاء الوراثي المتميز لتحمل الإجهاد المائي.

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