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General and Specitic Combining Abilities of Some Crosses in Bread Wheat at Normal Watering and Moisture Stress Conditions

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ABSTRACT

In order to determined of 6 bread wheat varieties representing different traits were crossed in a half-diallel in 2013/2014 season. The 6 parents and its15 F_1 crosses were evaluated under normal watering and water stress conditions in 2014/2015 season the objective of this investigation was aimed to study the combining ability and mode of gene action for some wheat traits under normal and stress conditions. Mean squares of genotypes were highly significant for all the studied traits. Both GCA and SCA variances were found to be highly significant for most traits under investigation at both conditions, indicating the importance of additive and non-additive effect in determining the performance of these characters. The ratio of GCA/SCA at the two conditions were more than unity for all studied traits, except heading date and flag leaf area under normal condition, and biomass yield per plant at water stress condition. This indicates that these traits are predominantly controlled by additive gene action, and it could be concluded that selection based on the accumulation of additive effects would be more effective in the early generations. P5 (Sids 14) at normal, P6 (Misr 2) under stress and combined data showed the highest biomass yield /plant. Among crosses, cross No. 12 (P3 x P6) under normal and combined data and cross No. 14 (P4 x P6) under stress showed the highest biomass yield /plant. P1 (Giza 168) and P2 (Sakha 93), at both normal and stress conditions were the best combiners for days to heading (earliness). P6 (Misr 2) was the best combiners for biomass yield per plant under both conditions. The best cross combinations for heading date (earliness) were crosses No. 1 (P1xP2), No. 6 (P2xP3) No. 10 (P3xP4) and No. 15 (P5xP6) at normal condition, crosses No. 5 (P1xP6) and No. 9 (P2XP6) under stress condition, and cross No. 2 (P1xP3) under both conditions. Also, the best cross combinations for biomass yield per plant were crosses No. 3 (P1xP4), No.8 (P2xP5) and No.15 (P5xP6) at both conditions, No. 10 (P3xP4) at normal watering condition, and No. 4 (P1xP5) and No. 14 (P4xP6) at water stress condition.

Keywords: Wheat, Crosses, GCA, SCA, Gene Action, water stress

INTRODUCTION

Wheat is one of the most essential nutritional crops of grain in Egypt and around the world. Wheat plants rarely attain their full genetic potential for yield because of the limitation imposed by biotic and abiotic environmental stresses. A biotic stress is defined as any change in environmental conditions that might reduce or adversely affect plant growth or development. This abiotic or environmental stress occurs in many forms, such as drought, salt, cold or low and high temperatures. Among the abiotic environmental stresses, drought remains one of the most important factors threatening the food security of people throughout the world (Farshedfar *et .al*., 1995). Information on the relative importance of GCA and SCA are important in the development of efficient wheat breeding programs. It is very important that the breeder evaluated the available germplasm and in crosses. In this regard, several studies have been reported in wheat, Mohamed (2004) reported that mean squares due to general and specific combining abilities were highly significant for plant height and grain yield/plant at normal and drought stress conditions. El-Danasory (2005) reported that GCA/SCA ratio was more than unity for days to heading at normal and water stress conditions, number of kernels/spike and days to maturity at normal and water stress conditions, respectively. Salem, Nagwa and Abdel-Dayem (2006) showed that the parents Sahel 1, Gemmeiza-9 and Sakha-61 expressed the highest GCA for kernels spike-1, as Sahel 1 and Gemmeiza-9 for spikes plant-1 , while Giza 164 was the highest for 100-kernel weight and grain yield plant-1, also, Sahel 1 had good potential for grain yield plant-1. And, they added that the highest SCA values, under drought conditions, were detected for the cross Sahel 1 x Sakha 94 for kernels number spike-1 and 100-kernel weight, Giza 164 x Sakha-61 for spikes number plant-1 and kernels number spike-1 , and Sahel 1 x Gemmeiza 9 for spikes plant-1 and grain yield plant-1. Also, Sultan *et al.* (2006) found that GCA and SCA variance were significant for most studied characters at both normal and drought environments. In addition, Salama (2007) showed that the mean squares of GCA and SCA were significant for all characters (days to heading, flag leaf area, spikes/plant, grains/spike, 1000-grain weight and grain yield/plant) under various number of irrigations, and added that, the some wheat cultivars, proved to be good general combiners, and some of wheat crosses; could be considered promising crosses and the best crosses combinations displayed for amount of heterotic effects for grain yield/plant.

Drought is recurring condition of abnormally dry weather leading to moisture stress for plants. Severity depends on a number of factors including degree of moisture deficiency, its duration and spatial spread drought tolerance refers to the ability of variety to remain relatively more productive than the others under limited condition. Plants usually adapted to drought stress through three major mechanisms, namely, escape, avoidance and resistance. Although the genetic and physiological bases of these mechanisms have not been established precisely, they have been indirectly exploited by plant breeders in developing drought tolerance cultivars. One of the mechanisms that helps drought resistance in wheat is early maturity i.e., ability of crop to ripe before the period of drought (Poehlman, 1987). Many studies on different wheat genotypes under drought conditions were conducted by several investigators such as, Abdel- Moneam (2008), Abdel- Moneam and Sultan (2009), and Sultan *et al* ., (2010 & 2011).

Therefore, the present investigation was designed to estimate the combining ability effects and the mode of gene action in the inheritance of some traits of wheat, under normal watering and water stress conditions.

MATERIALS AND METHODS

The genetic materials were used in this investigation as parents included 6 bread wheat varieties (*Triticum aestivum* L.), instead of a wide range of diversity for several characters. The names and pedigree of these parental varieties are presented in Table 1.

Table 1. Parents names and pedigree of the studied wheat varieties.

No	Variety	Pedigree
P1	Giza-168	MRL/BUE/SERI CM93046-8M-0Y-0M-2Y-0B
P2	Sakha 93	Sakha 92/TR 810328 S.8871-1S-2S-1S-0S
P3	Shandweel1	SITE//MO/4/NAC/TH.AC//3*PVN/3/MIRLO/BUC.
P4	Gemmeiza 12	OTUS/3/SARA/THB//VEECM SS97YOO227S-5Y-010M-010Y- 010M-2Y – 1M-0Y- OGM
P5	Sids 14	SW8488*2/ KUKUNA CGSS01Y00081T-099M-099Y-099M-099B-9Y-0B-0SD.
P6	Misr 2	SKAUZ / BAV92 CMSS96M03611S-1M-010SY-010M-010SY-8M-0Y-0S

In 2013/2014 season, the parental varieties were sown at three various dates in order to overcome the differences in flowering time. All possible parental combinations, excluding reciprocals, were made among the six genotypes, giving 15 F_1 crosses.

In 2014/2015 season, the 21 entries (6 parents and 15 F1) were evaluated in 2 separated irrigation regimes experiments. The first experiment (normal watering) was irrigated four times after planting irrigation i.e. five irrigations were given through the whole season. The second experiment (water stress) was given one surface-irrigation 41 days after the sowing date i.e. 2 irrigations were given through the whole season.

Each of the two experiments was fertilized with 15 kg P_2O_5/fad, in one dose during soil preparing and nitrogen fertilizer at rate of 75kg N/fad was added in two doses. The first dose was 30% with sowing and the second dose was 70% with the first irrigation after. The two experiments were designed in a randomized complete block design with three replications in the Experimental Farm of Agron. Dept, Fac. of Agric., Mansoura Univ., Dakahlia Governorate, Egypt.

Each replicate consisted of 21 genotypes; each genotype was planted in one row as well as two borders, rows 4 m long and 25 cm apart with 20 cm between plants. Twenty grains were manually drilled in the rows on 18 th November 2014, in each year. All the other cultural practices, except irrigation, were applied as recommended for wheat cultivation. The two outside plants from each row and the two external rows of each plot were excluded to avoid the border effect.

Studied characters:

The studied characters were days to heading(day), number of tillers/plant, plant height(cm), total chlorophyll content (usinga portable chlorophyll meter (SPAD) according to Castelli *et al*. (1996)., flag leaf area (cm2) (length (cm) × maximum width (cm) × 0.75 (Gardner *et. al*. 1985), and biological yield/plant (g)

The data obtained for each trait were analyzed on plot mean basis in both parents and F_1 generation. A normal analysis using Griffing (1956) method-2 model-1 (fixed model) was applied to determine both general (GCA) and specific (SCA) combining abilities effects, as shown in Table 2.

Table 2. Mean squares from method-2 model-1 and expected mean squares for combining ability analysis.

S.O.V	df	M.S.	E.M.S.
Genotypes			
GCA	P-1	M_g	$\sigma^2_e + (P+2)(1/P-1)\sum g^2_i$
SCA	P (P-1)/2	M_s	$\sigma^2_e + 2/P(P-1) \sum_i \sum_j S^2_{ii}$
Error	(r-1)(c-1)	M_e	σ^2_e

Where: Me = Error mean squares of the randomized complete block design divided by replicates numbers (Me = Me/r), P= parents numbers.

The relative magnitude of GCA: SCA was expressed as follows:

$$K^2\ GCA/\ K^2\ SCA = [(MS_{GCA} - MS_e)/(P+2)]/(MS_{SCA} - MSe),$$

where: MS= mean squares, P= No. of parents and K^2= is the average squares of the effects.

RESULTS AND DISCUSSION

1- Analysis of variance:

The results indicated clearly that mean squares of genotypes were highly significant for all the studied traits. Under both normal and stress conditions Mean squares of GCA and SCA were significant or highly significant for all studied traits at both normal and stress conditions, except GCA for chlorophyll content under stress, flag leaf area under normal condition and SCA for chlorophyll content under normal condition. The significance of GCA and SCA indicate the presence of both additive and non-additive types of genes in the genetic system controlling these traits.

The obtained results in Table (3) revealed that the ratio of GCA/SCA under the two conditions were more than unity for all the studied traits, except heading date and flag leaf area under normal condition, and biomass yield per plant at water stress condition . This means that these traits are predominantly controlled by additive gene action. It therefore could be concluded that selection procedures based on the accumulation of additive effect would be more effective in the early segregating generation. These results are in general agreement with those reported by Mohamed, (2004); Abdel- Moneam (2008), Sultan *et al* . (2010 & 2011), Anwar, *et al*.(2011); Khodadadi, *et al*. (2012); El-Seidy, *et al*. (2013); Desale and Mehta (2013); Adel and Ali (2013); Nazir*et al*. (2014) and Shahid, *et al*.(2015).

Table 3. Mean squares of wheat genotypes, general (GCA) and specific (SCA) combining abilities, and GCA/SCA ratio for all studied traits under normal watering and water stress conditions.

S.V	D.F	Heading date (day)		Tillers number $plant^{-1}$		Plant height (cm)	
		Normal	Stress	Normal	Stress	Normal	Stress
Genotypes	20	77.74**	66.68**	6.75**	4.00**	80.13**	103.32**
GCA	5	12.09**	32.53**	3.67**	2.02**	56.59**	95.69**
SCA	15	30.52**	18.79**	1.78**	1.11*	16.75**	14.03**
Error	40	0.042	0.24	0.69	0.45	3.34	3.52
GCA/SCA		0.40	1.75	3.29	2.98	4.19	9.06

S.V	D.F	Total chlorophyll content		Flag leaf area (cm^2)		Biomass yield $plant^{-1}$ (g)	
		Normal	Stress	Normal	Stress	Normal	Stress
Genotypes	20	11.18*	9.18*	99.95**	85.19**	3321.82**	1391.42**
GCA	5	8.66*	2.98	14.98	29.24*	1113.32**	322.69**
SCA	15	2.08	3.09*	39.43**	28.11*	1105.26**	510.85**

Error	40	1.98	1.49	7k2.83	11.55	124.08	62.27
GCA/SCA	-	84.13	1.75	0.44	1.68	1.12	0.70

2-Mean performance of wheat genotypes:

The water stress treatment decreased the mean of days to heading for parents and their hybrids (Table 4). The parents P5 under normal, P1 (Giza 168) and P2 (Sakha 93) under stress and P4 (Gemmiza 12) under combined data, and crosses; No.7 (P2xP4) under normal and cross No. 1 (P1xP2) under stress were the earliest parents and crosses for days to heading.

The water stress decreased the means of tillers No. plant^{-1} for parents and its crosses (Table 4). The parental P5 (Sids 14) and P6 (Misr 2), and crosses No. 4 (P1 x P5) and 11 (P3 x P5) under both conditions and their combined data were the best genotypes for tillers number per plant, were they recorded the highest values of tillers per plant under both conditions and combined data.

Table 4. Means of heading date (day) , tillers no/p and Plant height (cm) for wheat genotypes under normal and stress irrigation conditions and their combined data.

Genotypes	Heading date (day)			Tellers No./P			Plant height (cm)		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
P1-Giza 168	٨٤.٦٦	٨٠.٦٦	٨٢.٦٦	١١.٦٦	٧.٦٧	٩.٦٦٧	١٠٧.٣	١٠٤.٠	١٠٥.٦
P2-Sakha 93	٨٤.٦٦	٨٠.٦٦	٨٢.٦٦	٩.٦٦٧	٧.٦٧	٨.٦٦٧	١١٣.٣	٩٦.٦٦	١٠٥.٠
P3-Shandweel 1	٨٧.٣٣	٨٢.٠٠	٨٤.٦٦	١١.٦٦	٨.٦٧	١٠.١٦	١١٣.٣	١٠٨.٣	١١٠.٨
P4-Gemmiza 12	٨٣.٦٦	٨١.٣٣	٨٢.٥٠	١١.٠٠	٩.٦٧	١٠.٣٣	١٠٥.٠	١٠١.٠	١٠٣.٠
P5-Sids 14	٨٣.٣٣	٨٣.٠٠	٨٣.١٦	١٤.٣٣	١١.٠٠	١٢.٦٦	١١٩.٠	١١٣.٠	١١٦.٠
P6-Misr 2	٨٧.٣٣	٨٣.٠٠	٨٥.١٦	١٥.٣٣	١١.٠٠	١٣.١٦	١١٨.٠	١١١.٠	١١٤.٥
1. P1XP2	٨٤.٦٦	٨٢.٠٠	٨٣.٣٣	١٢.٦٦	١٠.٦٦	١١.٦٦	١٠٥.٠	٩٢.٣٣	٩٨.٦٦
2. P1XP3	٨٧.٣٣	٨١.٠٠	٨٤.١٦	١٢.٦٦	١٠.٣٣	١١.٥٠	١١٣.٣	١٠٤.٠	١٠٨.٦
3. P1XP4	٨٧.٠٠	٨٤.٠٠	٨٥.٥٠	١٣.٦٦	٩.٦٧	١١.٦٦	١١٣.٣	١٠٣.٣	١٠٨.٣
4. P1XP5	٩٣.٠٠	٨٦.٠٠	٨٩.٥٠	١٥.٠٠	١٢.٠٠	١٣.٥٠	١١٩.٠	١١٠.٦	١١٤.٨
5. P1XP6	٩٥.٦٦	٨٤.٠٠	٨٩.٨٣	١٣.٦٦	١٠.٣٣	١٢.٠٠	١٢٣.٠	١١٣.٣	١١٨.١
6. P2XP3	٨٨.٣٣	٨٤.٠٠	٨٦.١٦	١٢.٠٠	٩.٦٧	١٠.٨٣	١١٥.٦	١٠٩.٣	١١٢.٥
7. P2XP4	٨٨.٠٠	٨٤.٠٠	٨٦.٠٠	١٣.٣٣	٩.٦٧	١١.٥٠	١١٠.٦	١٠٢.٠	١٠٦.٣
8. P2XP5	٩٥.٦٦	٨٨.٠٠	٩١.٨٣	١٢.٦٦	٩.٦٧	١١.١٦	١٢٠.٦	١١٢.٦	١١٦.٦
9. P2XP6	٩٣.٠٠	٨٤.٠٠	٨٨.٥٠	١٢.٠٠	١٠.٣٣	١١.١٦	١١٧.٣	١٠٧.٦	١١٢.٥
10. P3XP4	٨٣.٣٣	٨٨.٠٠	٨٥.٦٦	١٣.٦٦	٩.٦٧	١١.٦٦	١١٩.٣	١٠٩.٣	١١٤.٣
11. P3XP5	٩٥.٦٦	٨٧.٠٠	٩١.٣٣	١٥.٦٦	١١.٦٦	١٣.٦٦	١٢٠.٠	١١٤.٦	١١٧.٣
12. P3XP6	٩٨.٠٠	٩٤.٠٠	٩٦.٠٠	١٢.٠٠	٩.٦٧	١٠.٨٣	١١٨.٣	١١٢.٦	١١٥.٥
13. P4XP5	٩٦.٠٠	٨٩.٠٠	٩٢.٥٠	١٤.٣٣	١١.٣٣	١٢.٨٣	١١٨.٣	١٠٩.٦	١١٤.٠
14. P4XP6	٩٥.٦٦	٩٣.٠٠	٩٤.٣٣	١٣.٦٦	٨.٦٧	١١.١٦	١٢٠.٠	١١٠.٠	١١٥.٠
15. P5XP6	٨٤.٦٦	٩٨.٠٠	٩١.٣٣	١٢.٠٠	١٠.٣٣	١١.١٦	١١٩.٦	١١١.٦	١١٥.٦
Means	٨٩.٣٨	٨٥.٥٥	87.47	١٢.٩٨	٩.٩٧	11.48	115.7	107.5	111.5
LSD 1%	2.11		1.77	3.00		2.52	4.71		3.97
LSD 5%	1.71		1.44	2.44		2.05	3.83		3.22

The water stress treatment decreased the means of plant height for parents and their hybrids (Table 4). It is clear from the results that genotypes under stress were shorter than those at normal irrigation condition with highly significant. The reducing in plant height of stressed plants may be due to the reduction in internodes length and/or due to the reduction in water absorption, nutrients uptake and photosynthesis process under drought stress conditions Mahgoub (1996). These results are in agreement with those obtained by Mohamed (2004) and Farhat (2005) who indicated that, moisture stress throughout vegetative growth and heading stages decreased plant height significantly. The results indicated highly significant different between genotypes. Among parents, the tallest parents were P5 (Sids 14) and P6 (Misr 2) under both conditions, while the shortest were P4 (Gemmiza 12) under normal and combined, and P2 (Sakha 93) under stress condition. Among crosses, the tallest were cross No. 5 (P1XP6) under normal and combined, and cross No. 11 (P3XP5) underneath stress condition. While,the shortest was cross No. 1 (P1XP2) under both conditions and their combined data. The results revealed that P5 (Sids 14) and P6 (Misr 2) possessed genes controlling tallness, while Sakha 93 and Gemmiza 12 carry genes for shortness.

Results presented in Table (5) indicate clearly that total chlorophyll content is highly significantly affected by irrigation treatment. The total chlorophyll content means were decreased significantly as affected by water stress .The results indicated highly significant different between genotypes. Among parents, P3 (Shandweel 1) under both conditions and combined data, and crosses No 4 (P1XP5) under both conditions and combined data and No. 10 (P3XP4) under moisture stress were the best parents and crosses for this character. On the other side, P6 (Misr 2) under normal watering and combined data, P4 (Gemmiza 12) under stress condition, and cross No. 15 (P5XP6) under both conditions and their combined were the lowest parents and crosses for total chlorophyll content. Similar conclusion was reported by El-Danasory (2005), Farhat (2005), Abdel- Moneam (2008), Abdel- Moneam and Sultan (2009), and Sultan *et al* ., (2010 & 2011) in their wheat genotypes.

The means of flag leaf area were decrease significantly by moisture stress (Table 5). For parents, P1 (Giza 168) and cross No.11 (P3x P5) under both conditions in addition to their combined were the highest parents and crosses for flag leaf area. On the other hand, the parent P2 (Sakha 93) under normal and combined; P4 (Gemmiza 12) under stress and cross No. 15 (P5xP6) under both conditions and their combined were the lowly parents and crosses for flag leaf area.

Results presented in Table (5) showed that, water stress condition decreased the means of biomass yield/plant for the parents and its hybrids. With regard to parents, the highest biomass yield/plant belonged P5 (Sids 14) under normal, P6 (Misr 2) under stress and combined while, P4 (Gemmiza 12), under both conditions and its combined data produced the lowest biomass yield /plant. These results showed the different of genetic background of these parents. Among crosses, cross No. 12 (P3xP6) under normal and combined data, and cross No. 14 (P4xP6) under stress showed the highest biomass yield /plant. However, the lowest biomass yield plant^{-1} belong to cross No. 1 (P1xP2) at both conditions and their; combined data.

Table 5. Means of chlorophyll content, flag leaf area (cm^2) and Biomass yield/plant (g) for wheat genotypes under normal and stress irrigation conditions and their combined.

Genotypes	Total chlorophyll content			Flag leaf area (cm^2)			Biomass yield plant^{-1} (g)		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
P1-Giza 168	٢٦.١٧	٢٤.٣٧	٢٥.٢٧	٦٧.٩١	٦٢.٤٨	٦٥.١٩	٢١٨.٩	١٧٤.٠	١٩٦.٤
P2-Sakha 93	٢٣.٣٧	٢١.٣٠	٢٢.٣٣	٥٨.٠٨	٥٣.٤١	٥٥.٧٤	٢٠١.٠	١٦٣.٣	١٨٢.١
P3-Shandweel 1	٢٦.٤٠	٢٥.٢٠	٢٥.٨٠	٦٣.٤٦	٥٩.١٨	٦١.٣٢	٢٣٠.٥	١٧٨.٨	٢٠٤.٦
P4-Gemmiza 12	٢٤.٣٠	٢٠.٤٠	٢٢.٣٥	٦٢.٣٩	٥١.٣٣	٥٦.٨٦	١٩٢.٢	١٥٠.١	١٧١.١
P5-Sids 14	٢٥.٣٣	٢٠.٨٣	٢٣.٠٨	٦١.٧٥	٥٧.٣٣	٥٩.٥٤	٢٣٨.٤	١٥٩.٢	١٩٨.٨
P6-Misr 2	٢٢.٥٣	٢١.٢٧	٢١.٩٠	٦٢.٢٥	٥٦.١٦	٥٩.٢٠	٢٣٧.٠	١٩٧.٣	٢١٧.١
1. P1XP2	٢٧.١٣	٢١.٩٣	٢٤.٥٣	٦٩.٩١	٥٧.٥١	٦٣.٧١	١٩٨.٦	١٦٨.٣	١٨٣.٥
2. P1XP3	٢٦.٥٠	١٩.٧٠	٢٣.١٠	٧٠.٠٠	٦١.٩٨	٦٥.٩٩	٢٦٦.٠	٢٠٩.٩	٢٣٧.٩
3. P1XP4	٢٥.٣٧	٢٢.٢٠	٢٣.٧٨	٧٠.٤٠	٦٢.٨٤	٦٦.٦٢	٢٧٦.٠	٢١٢.٠	٢٤٤.٠
4. P1XP5	٢٩.٢٧	٢٢.٧٠	٢٥.٩٨	٧٨.٧١	٦٩.٦٦	٧٤.١٨	٢٥٣.٤	٢١٤.٠	٢٣٣.٧
5. P1XP6	٢٣.٩٧	٢٠.٨٧	٢٢.٤٢	٧٠.٧٥	٦٥.٢٣	٦٧.٩٩	٢٦٣.٦	٢٠٢.٣	٢٣٣.٠
6. P2XP3	٢٣.٨٣	٢١.١٧	٢٢.٥٠	٧٢.٩٨	٦٧.٩٢	٧٠.٤٥	٢٣٩.٠	٢٠٠.٠	٢١٩.٥
7. P2XP4	٢٥.٦٠	٢١.٧٣	٢٣.٦٧	٦٨.٤٥	٦٢.٠٤	٦٥.٢٤	٢٣٩.٣	١٨٧.٠	٢١٣.١
8. P2XP5	٢٤.٤٠	٢١.٨٣	٢٣.١٢	٧٥.٦١	٦٦.٤١	٧١.٠١	٢٧٣.٣	٢٢٢.٣	٢٤٧.٨
9. P2XP6	٢٢.٢٣	٢١.٥٠	٢١.٨٧	٦٧.١٩	٥٩.٠٠	٦٣.٠٩	٢١٥.٤	١٨٩.٣	٢٠٢.٣
10. P3XP4	٢٨.٠٠	٢٢.٧٠	٢٥.٣٥	٧١.٦١	٦٧.٣٢	٦٩.٤٦	٢٦٩.٢	٢٠١.٨	٢٣٥.٥
11. P3XP5	٢٥.٠٠	٢٢.٠٧	٢٣.٥٣	٧٩.٨٣	٧٢.١٤	٧٥.٩٩	٢٢٣.٢	١٩٧.٦	٢١٠.٤
12. P3XP6	٢٣.٥٣	١٩.٨٣	٢١.٦٨	٧٢.٩٩	٦٣.١١	٦٨.٠٥	٣٢٥.٤	٢٠٩.٣	٢٦٧.٤
13. P4XP5	٢٣.٩٠	٢١.٤٧	٢٢.٦٨	٧٣.٢٥	٦٢.١٦	٦٧.٧٠	٢١٤.٧	١٩٥.١	٢٠٤.٩
14. P4XP6	٢٣.٧٠	٢٢.٤٠	٢٣.٠٥	٧٦.١٥	٥٩.٩١	٦٨.٠٣	٢٧٢.٩	٢٢٤.٠	٢٤٨.٤
15. P5XP6	٢٠.٧٣	١٦.٩٠	١٨.٨٢	٦٦.٧٧	٥٦.٦١	٦١.٦٩	٢٨٢.٥	٢٢١.٣	٢٥١.٩
Means	٢٤.٨٢	٢١.٥٤	23.18	٦٩.٥٥	٦١.٦١	65.58	244.3	194.1	219.2
LSD 1%	3.98		3.34	6.11		5.14	10.75		9.04
LSD 5%	3.23		2.71	4.96		4.17	8.73		7.34

General combining ability (GCA) effects:

Estimates of general combining ability effects of all the parental varieties for all traits under study at normal watering and moisture stress conditions are shown in Tables (6 and 7).

Table 6. General combining ability effects of the six parental wheat varieties for heading date (day), tillers No./ plant and plant height (cm)traits under normal and water stress conditions.

Prarents	Heading date (day)		Tillers No. / plant		Plant height (cm)	
	Normal	Stress	Normal	Stress	Normal	Stress
P1 (Giza 168)	-1.08**	-2.75**	0.014	-0.18	-2.69**	-2.60**
P2 (Sakha 93)	-0.83**	-0.94**	-1.11	-0.56**	-1.74**	-4.39**
P3 (Shandweel 1)	0.21	-0.11	-0.19	-0.18	0.43	1.77**
P4 (Gemmeiza 12)	-1.04**	0.22	-0.028	-0.18	-2.28**	-2.01**
P5 (Sids 14)	0.75**	1.89**	0.93**	0.90**	3.22**	4.11**
P6 (Misr 2)	2.00**	2.51**	0.39	0.19	3.06**	3.11**
LSD 5% Gi	0.14	0.32	0.55	0.44	1.19	1.23
LSD 1% Gi	0.15	0.33	0.56	0.46	1.23	1.27
LSD 5% Gi-GJ	0.90	1.40	1.83	1.67	2.73	2.77
LSD 1% Gi-GJ	0.93	1.45	1.89	1.72	2.82	2.87

Significant negative GCA values would be the best combiners for heading date (earliness). Based on general combining ability estimates, it could be concluded that the best general combiners for days to heading (earliness) were P1 (Giza 168) and P2 (Sakha 93) at both normal and stress conditions, and P4 (Gemmeiza 12) at normal condition, where they recorded highly significant and negative GCA effects for this trait, as shown in Table (6).

Significant positive GCA values would be the best combiners for tillers No./plant. The best general combiners for increasing tillers No. plant^{-1} was P5 (Sids 14), where it exhibited positive and significant GCA effects for this character at both normal and water stress conditions, as shown in Table (6).

Table 7. General combining ability effects of the six parental wheat varieties for chlorophyll content, flag leaf area (cm^2) and biomass yield per plant (g) traits under normal and water stress conditions.

Prarents	Chlorophyll content		FLA (cm^2)		Biomass yield/plant (g)	
	Normal	Stress	Normal	Stress	Normal	Stress
P1 (Giza 168)	1.31**	0.74	1.09	1.36	-1.85	-0.56
P2 (Sakha 93)	-0.44	0.028	-2.07**	-1. 44	-17.85**	-8.22**
P3 (Shandweel 1)	0.68	0.61	0.94	2.44**	9.24**	2.19
P4(Gemmeiza 12)	0.18	-0.056	-0.27	-1.78	-6.76	-4.85
P5 (Sids 14)	0.014	-0.47	1.36	1.30	1.74	1.24
P6 (Misr 2)	-1.74**	-0.85**	-1.05	-1.88	15.49**	10.19**
LSD 5% Gi	0.91	0.79	1.82	2.22	7.27	5.15
LSD 1% Gi	0.94	0.81	1.88	2.30	7.52	5.33
LSD 5% Gi-GJ	2.39	2.23	3.38	3.72	6.74	5.68
LSD 1% Gi-GJ	2.47	2.31	3.50	3.85	6.98	5.87

Significant negative GCA values would be the best general combiners for plant height (shortness). Based on general combining ability estimates, it could be concluded that the best general combiners for plant height were P1 (Giza 168), P2 (Sakha 93) and P4 (Gemmeiza 12) at both conditions, where they exhibited highly significant and negative GCA effects for this trait (Table 6).

It could be concluded general that the best combiner for increasing total chlorophyll content was P1 (Giza 168) under normal condition, where it recorded highly significant and positive GCA effects for chlorophyll content.

P3 (Shandweel 1) showed positive and significant GCA effects for flag leaf area under stress condition, therefore it could be considered as the best general combiners for increasing flag leaf area.

Significant positive GCA values would be the best combiners for biomass yield per plant. The best general combiner for biomass yield plant^{-1} was P6 (Misr 2), as it exhibited positive and significant GCA effects for this character at both conditions.

4- Specific combining ability (SCA):

The estimates of SCA effects of F_1 hybrids were determined for all the studied characters at normal and moisture stress conditions are illustrated in Tables (8 and 9)

Significant negative SCA values would be the best cross combinations for heading date, and would be useful from the breeder point of view. It could be concluded that the best cross combinations for heading date (earliness) were (P1Xp2), (P2XP3), (P3Xp4) and (P5XP6) at normal condition, (P1XP6) and (P2XP6) under stress condition, and (P1xP3) under both conditions, where they showed highly significant and negative SCA effects, (Table 8).

Table 8. Estimates of specific combining ability (SCA) effects for F1 crosses for heading date (day), tillers No./ plant and plant height (cm) traits under normal irrigation and water stress conditions.

Crosses	Heading date		Tillers no/p		Plant height (cm)	
	Normal	Stress	Normal	Stress	Normal	Stress
1-P1xp2	-2.80**	0.96**	0.78	1.44**	-6.27**	-8.17**
2-P1xP3	-1.17**	-1.88**	-0.14	0.73	-0.10	-2.67
3-P1xP4	-0.26	0.79	0.70	0.06	2.61	0.45
4-P1xP5	3.95**	1.13**	1.07	1.31**	2.77	1.66
5-P1xP6	5.37**	-1.50**	0.28	0.35	6.94**	5.33**
6-P2xP3	-0.42**	0.50	0.32	0.44	1.27	4.45**
7-P2xP4	0.49**	0.17	1.49	0.44	-1.02	0.91
8-P2xP5	6.37**	2.50**	-0.14	-0.65	3.48**	5.45**
9-P2xP6	2.45**	-2.13**	-0.26	0.73	0.32	1.45
10-P3xP4	-5.21**	2.33**	0.91	0.06	5.48**	2.08
11-P3xP5	5.33**	-0.33	1.95**	0.98	0.65	1.29
12-P3xP6	6.41**	6.04**	-1.18	-0.32	-0.85	0.29
13-P4xP5	6.91**	1.33**	0.45	0.64	1.69	0.08
14-P4xP6	5.33**	4.71**	0.32	-1.32**	3.52**	1.41
15-P5xP6	-7.46**	8.04**	-2.30**	-0.73	-2.31	-3.05
LSD 5% (SIJ)	0.36	0.87	1.47	1.21	3.27	3.35
LSD 1% (SIJ)	0.38	0.90	1.53	1.25	3.39	3.47
5% (SIJ-SIK)	1.48	2.29	2.98	2.70	4.44	4.50
1% (SIJ – SIK)	1.54	2.36	3.09	2.79	4.60	4.65
5% (SIJ- SKI)	1.43	2.19	2.87	2.59	4.28	4.33
1% (SIJ – SKI)	1.48	2.27	2.97	2.68	4.42	4.48

Significant positive SCA values would be the best crosses for ./plant and would be useful from the breeder point of view. The best cross combinations for tillers No./plant were P3XP5 at normal condition and P1XP2 and P1xP5 at stress condition, where they showed significant or highly significant positive SCA effects for this trait, (Table 8).

Significant negative SCA values would be the best crosses for plant height (shortness) and would be useful from the breeder point of view. The best cross for plant height was (P1Xp2) at both normal and stress condition, where it recorded highly significant and negative SCA effects for this trait, (Table 8).

Significant positive SCA values would be the best crosses for total chlorophyll content and would be useful from the breeder point of view. The best cross combinations for chlorophyll content was (P1XP5) at normal condition, where it recorded highly significant and positive SCA effects for this trait. On the other hand, there were not any crosses showed significant and positive SCA effects at stress condition, as shown in Table (9).

Table 9. Estimates of specific combining ability (SCA) effects for F_1 crosses for chlorophyll content, flag leaf area (cm^2) and biomass yield per plant (g) traits under normal and water stress conditions.

Crosses	Chlorophyll content		FLA (cm)^2		Biomass yield per plant (g)	
	Normal	Stress	Normal	Stress	Normal	Stress
1-P1xp2	1.25	-0.30	1.32	-4.03	-25.99**	-17.10**
2-P1xP3	-0.54	-3.22**	-1.58	-3.44	14.26	14.15
3-P1xP4	-1.04	-0.22	0.03	1.65	40.26**	23.20**
4-P1xP5	3.13**	0.86	6.73**	5.40	9.10	19.45**
5-P1xP6	-0.46	-0.43	1.17	4.14	5.68	-1.51
6-P2xP3	-1.13	-1.18	4.58	5.32	3.26	11.82
7-P2xP4	1.04	0.16	1.25	3.68	19.60	5.86
8-P2xP5	-0.13	0.90	6.79**	4.94	45.10**	35.11**
9-P2xP6	-0.38	0.95	0.76	0.74	-26.65**	-6.85
10-P3xP4	2.25	0.24	1.38	5.06	22.51**	10.45
11-P3xP5	-0.58	0.66	7.99**	6.79**	-32.32**	0.03
12-P3xP6	-0.17	-1.64	3.56	0.93	-56.60**	2.74
13-P4xP5	-1.08	0.32	2.63	1.04	-24.65**	4.40
14-P4xP6	0.67	1.70	7.94**	1.99	19.93	24.45**
15-P5xP6	-2.17	-3.55**	-3.06	-4.43	21.10**	15.70**
LSD 5% (SIJ)	2.53	2.18	5.01	6.08	19.94	14.12
LSD 1% (SIJ)	2.61	2.26	5.18	6.29	20.63	14.61
5% (SIJ-SIK)	3.90	3.63	5.49	6.06	10.97	9.23
1% (SIJ – SIK)	4.03	3.76	5.69	6.27	11.35	9.55
5% (SIJ- SKI)	3.75	3.50	5.29	5.83	10.55	8.88
1% (SIJ – SKI)	3.88	3.62	5.47	6.03	10.92	9.19

Significant positive SCA values would be the best crosses for flag leaf area would be useful from the breeder point of view. The best crosses for flag leaf area were three crosses namely; (P1XP5), (P2XP5) and (P4XP6) at normal condition, and only one cross namely; (P3XP5) at both normal conditions, as they exhibited highly significant and positive SCA effects for this trait.

The best cross combinations for biomass yield per plant were crosses No. 3 (P1xP4), No. 8 (P2XP5) and No. 15 (P5XP6) at both conditions, No. 10 (P3Xp4) at normal watering condition, and No.4 (P1XP5) and No. 14 (P4XP6) at water stress, as they recorded highly significant and positive SCA effects for this character.

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القدرة العامة والخاصة على التآلف لبعض هجن قمح الخبز تحت ظروف الرى والجفاف

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أجريت هذه الدراسة في المزرعة البحثية لقسم المحاصيل التابعة بمحطة التجارب والبحوث الزراعة - كلية الزراعة - جامعة المنصورة -محافظة الدقهلية خلال الموسمين الشتويين ٢٠١٤/٢٠١٣ و ٢٠١٥/٢٠١٤ و قد استخدمت ستة أصناف من قمح الخبز مختلفة في صفاتها الوراثية كآباء. أجريت كل التهجينات الممكنة بين الآباء للحصول علي١٥ هجينا فيما عدا الهجن العكسية في الموسم الأول ، وفي الموسم الثاني تم زراعة الستة آباء و ١٥ هجينا في تجربتين بنظام القطاعات الكاملة العشوائية تحت الظروف الطبيعية (٥ ريات بالموسم) وظروف الجفاف (منع الرى بعد رية المحاياه) ، وذلك لدراسة القدرة على التآلف والفعل الجينى وكفاءة التوريث لهذه الهجن تحت ظروف الرى العادى والجفاف ، وفيما يلي ملخص لأهم النتائج:١- أظهرت النتائج أن متوسطات مربعات التباين الراجعة للتراكيب الوراثية عالية المعنوية لكل الصفات المدروسة ، وكانت متوسطات مربعات القدرة العامة على التآلف وكذلك القدرة الخاصة على التآلف عالية المعنوية لكل الصفات المدروسة تحت كل من ظروف الرى العادية وتحت ظروف الجفاف ،وهذا يشير إلى أهمية كل من الفعل الجينى المضيف والسيادى في وراثة هذه الصفات وكانت النسبة بين تباين القدرة العامة والخاصة على التآلف أكبر من الوحدة لكل الصفات المدروسة تحت كل من ظروف الرى والجفاف ما عدا ميعاد وطرد السنابل ومساحة ورقة العلم تحت الظروف الطبيعية والمحصول البيولوجى للنبات تحت ظروف الإجهاد المائى ،وهذا يعنى أن هذه الصفات يتحكم في وراثتها أساسا الفعل الجينى المضيف ،كذلك إجراء الإنتخاب في الأجيال الإنعزاليةالمبكرة والذى سيكون أكثر فعالية .٢- أشارت النتائج إلى أن سجل الصنف سدس ١٤ تحت ظروف الرى الطبيعى والصنف مصر تحت ظروف الجفاف والذى أعطى أعلى محصول بيولوجى للنبات ومن بين الهجن رقم ١٢تحت الظروف العادية والهجين رقم ١٤ تحت ظروف الجفاف أعلى محصول بيولوجى للنبات .أظهر الصنف جيزة ١٦٨ والصنف سخا ٩٣ تحت كل من ظروف الرى والجفاف أفضل قدرة عامة على التآلف لصفات التبكير والصنف مصر٢ كان أكثر الأصناف قدرة عامة لصفة المحصول البيولوجى للنبات تحت كل من ظروف الرى والجفاف .٣-أوضحت النتائج أن أفضل الهجن قدرة خاصة على التآلف في صفات التبكير هى الهجن أرقام ٦,١ ،١٠، ١٥ تحت ظروف الرى ، والهجينان أرقام ٥ ،٩ تحت ظروف الجفاف ، والهجين رقم ٢ تحت كل من ظروف الرى والجفاف كذلك كانت أفضل الهجن قدرة خاصة على التالف لصفات المحصول البيولوجى للنبات هى أرقام ٣ ، ٨ ، ١٥ تحت كل من ظروف الرى والجفاف رقم ١٠ تحت ظروف الرى ورقم ٤,١٤ تحت ظروف الجفاف .