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INHERITANCE OF SOME AGRONOMIC TRAITS IN WHEAT UNDER DROUGHT CONDITIONS

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ABSTRACT

A diallel cross involving five bread wheat genotypes were evaluated to determine the genetic behavior of yield and its components in wheat under drought conditions. The resultant hybrids along with their parents were evaluated in two experiments. The first experiment was irrigated once (stress), while the second one was irrigated four times (normal).

The parents, P_1 (Sahel 1) , P_2 (Gemmeiza 9) and P_5 (Sakha 61) expressed the highest GCA for number of kernels/ spike, as P_1 (Sahel 1) and P_2 (Gemmeiza 9) for number of spikes / plant, while P_3 (Giza 164) was the highest for 100 kernels weight and grain yield / plant. Also, P_1(Sahel 1) had good potential for grain yield/plant.

The highest SCA values were detected for the cross Sahel 1 / Sakha 94 for number of kernels/ spike and 100 kernel weight, Giza 164 / Sakha 61 for number of spikes / plant and number of kernels/ spike, and Sahel 1 / Gemmeiza 9 for number of spikes/plant and grain yield / plant.

INTRODUCTION

Improving wheat grain yield is one of the most important national goals in Egypt to face the increasing population demands. Thus, it is important to extend wheat area around Nile valley, in marginal areas which suffer either biotic or abiotic stress conditions, even those suffering drought conditions or shortage to water in critical stages.

In this case, the ultimate goal of wheat breeder is to develop new genotypes characterized by high yield potentiality and tolerance to such stress conditions. To achieve this target some important genetic information, about drought for yield and its components of wheat, are required. Such genetic information would direct the breeding program towards the route of selection. If the additive gene action was responsible, it is easy to apply successfully pedigree method of selection. If non additive gene action was prevailed in controlling the traits of interest, other methods should be applied, e.g. recurrent selection, back crosses, heterotic hybrids. Additive gene action was responsible for the inheritance of the number of spikes /plant, (Mahmmoud,1999 and Abdel-Wahed, 2001),1000 kernel weight,(Alkaddousi *et al.*, 1994 and Hassan, 2002), grain yield, (khalifa, 1999, Ghanem, 2001; Abdel Hameed, 2002 and Muhammad and Muhammed, 2003). On the other hand, non additive gene action played an important role in the inheritance of the number of spikes / plant (Nassar, 1992 and Abdel Hameed, 2002), and grain yield (Hassan, 2002 and Ammar, 2003). Also, non additive gene action was important in controlling the number of spikes / plant, 1000 kernel weight and grain yield (Abul–Naas *et al.*, 2000). Also, Dawam and Hendawy (1990), and Darwish (1992) found that dominance genetic effects were significant for grain yield / plant, number of kernels / spike and kernel weight.

The aim of the present work was to study general and specific combining ability for yield and yield components under drought conditions.

MATERIALS AND METHODS

The present work was carried out at Etay El-Baroud Agricullural Research Station, El-Behera Governorate, during the two seasons 2002/2003 and 2003/2004. Five common wheat genotypes (*Triticum aestivm L.*), representing a wide range of diversity for several agronomic characters and drought tolerance were selected for this study. The pedigrees and origins of these parental materials were presented in Table (1).

Table (1): Names, pedigrees and origins of the parental common wheat cultivars.

Number	Cultivar	Pedigree	Origin
P_1	Sahel 1	NS732/ PIMAXVEERY"S"#5.	Egypt
P_2	Gemmeiza 9	Ald"S"/ Huac"S"//CMH74A.630/SX CGM4583-5GM-1GM-0GM.	Egypt
P_3	Giza 164	KVZ/ BUHO "S" //KAI/ BB.	Egypt
P_4	Sakha 94	OPATA/RAYON//KAUZ CMBW 90Y3180 – OTOPM – 3Y – 010M-- 010M – 010Y -10M – 015Y – OY – OAP – OS.	Egypt
P_5	Sakha 61	INIA/RL4220//7C/YR"S".	Egypt

In 2002/2003 growing season, parents were crossed in all possible combinations, excluding reciprocals, to obtain hybrid seeds of 10 crosses. In 2003/2004 season, the five parents along with their crosses were grown in two adjacent experiments. The first experiment (stress experiment) was irrigated once at 70 days after sowing irrigation. The second experiment (non stress or normal experiment) was irrigated four times after planting irrigation. A border of fifteen meters was left between the two experiments. Each experiment was arranged in randomized complete block design, according to (Steel and Torrie 1980), with three replications. Each plot consisted of one row of three meters long, with 20 cm spaces between seeds and 30 cm between rows. The proper culture practices were applied as recommended for wheat production in both experiments.

Analysis of variance for combining ability effects followed Griffing (1956), Method 2, Model 1. Mean square under both treatments, were compared by F-test, i.e. MSN at normal / MSS at stress of the same respective source of variation and degrees of freedom.

RESULTS AND DISCUSSION

Analysis of variance:

Analysis of variance for all studied traits (Number of spikes/plant, Number of kernels/spike, 100 kernels weight and grain yield/plant), among F_1 hybrids are given in Table (2). Genotypic mean squares associated with general and specific were hardly significant ($P \leq 0.10$) for 100 kernels weight and grain yield / plant only in stress and normal experiment. Very slight significant difference; at ($P \leq 0.15$), could be detected for Number of kernels/spike, at both conditions and grain yield / plant at normal condition . However, Mean squares test (F-test) for normal against stress treatments showed significant difference for 100 kernels weight and grain yield, among genotypes for general and specific effects, only . Table (2), showing the effect of drought condition on both characters. Average performance of parents and their hybrids for the four characters are given in Table (3). It reflects significant differences among all genotypes in all traits which are also reflected in their hybrids.

Differences among genotypes for Number of kernels/spike and grain yield were reflected significantly in specific combining ability effects for both traits, beside general effects for Number of kernels/spike. Furthermore, trivial specific effects were detected for Number of spikes/plant at stress treatment.

Table (2): Observed mean squares from diallel cross analysis under stress and normal conditions .

Source of variation	d.f.	Number of spikes/plant			Number of kernels/ spike			100-kernel weight			Grain yield /plant		
		Stress	Normal	MSN/ MSS	Stress	Normal	MSN/ MSS	Stress	Normal	MSN/ MSS	Stress	Normal	MSN/ MSS
Genotypes	14	2.498	2.756	-	48.36+	30.92++	_	0.385	0.609	+	11.24	142.9+	**
G.C.A	4	1.1555	3.581	_	33.88++	21.39++	_	0.521	0.771	_	10.91	40.64	_
S.C.A	10	3.035+	2.425	_	54.16+	34.73	_	0.331	0.544	+	11.38	183.7+	**
Error	28	2.6599	5.688	*	32.92	27.78	_	0.605	0.873	_	20.88	118.296	**
GCA/SCA		0.380	1.47		0.62	0.62		1.57	1.42		0.96	0.22	
C.V.%		27.89	11.52		15.11	9.51		16.69	20.39		25.93	25.32	

MSN /MSS = Mean square under normal condition,
MSS = Mean square under stress condition .
++, +, *, & ** significant at probability levels . P ≤0.15 , 0.10 , 0.05 & 0.01 , respectively .

Table (3): Mean performance of parents and their hybrids under stress and normal conditions .

Genotypes	Number of spikes/plant		Number of kernels/ spike		100-kernel weight		Grain yield/ plant	
	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal
P1,Sahel 1	6.33	18.4	35.2	52.0	4.50	4.61	20.1	32.28
P2, Gem. 9	5.22	22.2	46.2	59.0	3.40	4.40	16.2	33.8
P3,Giza164	6.11	19.2	31.2	64.2	4.87	5.00	20.0	37.4
P4, Sakha 94	7.23	20.2	28.2	61.2	3.30	4.22	16.5	38.5
P5, Sakha 61	5.12	23.2	36.2	54.3	4.75	4.40	15.7	42.3
P1xP2	8.00	20.2	41.2	46.0	3.77	4.30	20.4	37.7
P1xP3	6.00	23.0	44.3	57.2	4.32	4.70	17.5	38.3
P1xP4	6.23	19.2	48.0	52.3	4.45	4.10	16.5	37.8
P1xP5	5.23	20.3	45.0	61.5	4.75	4.30	16.8	24.1
P2xP3	6.95	20.0	36.0	62.3	5.13	5.20	17.6	60.3
P2xP4	7.00	22.0	38.5	57.3	4.12	4.20	18.3	43.3
P2xP5	6.00	20.0	43.2	49.3	4.60	4.35	15.4	37.6
P3xP4	5.00	23.2	33.2	61.2	4.11	5.30	16.9	45.18
P3x P5	6.88	25.0	41.2	52.3	4.18	4.10	13.2	44.3
P4xP5	4.98	19.0	36.2	49.2	4.65	4.22	16.9	36.5
LSD at 0.05%	2.11	3.98	11.2	13.4	0.58	0.71	4.66	6.23

Combining ability Effects:

Estimates of general combining ability effects for each parent under stress and normal conditions were presented in (Table 4). Parents P_1 , P_2 , and P_5 showed positively significant GCA for Number of kernels/spike at stress condition. These parents actually gave the highest number of kernels/spike under stress condition, where P_2 was the highest (Table 3). Fortunately, number of kernels/spike may be the most important yield component, which may be utilized to decrease the negative effect of drought. Also, the comparison between normal versus stress conditions mean squares showed no significant difference, for any variance components reflect insignificant effects for irrigation on this trait. However, the best combiners under stress conditions were not as so under normal conditions.

For other yield components, though insignificant GCA under both conditions, P_1 was the best combiner for number of spikes/plant, number of kernels/spike and grain yield/plant under stress condition . The parents P_2 and P_5 were superior for number of kernels/spike, as P3 was a good combiner for 100 Kernel weight and grain yield / plant under stress and normal conditions . These results reflect valuable additing gene action in these parents, to be successfully used to obtain genotypes less affected by drought.

Table (4): Estimates of general combining ability effects under stress and normal conditions .

Parents	Number of spikes/plant		Number of kernels/ spike		100-kernel weight		Grain yield /plant	
	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal
P_1	0.250*	0.800*	0.524*	-0.171	0.108	-0.059	0.906*	-1.665
P_2	0.164*	-1.147*	1.429*	-1.029	-0.072	-0.109	-0.223	0.585
P_3	-0.027	-1.019*	-1.143	1.495*	0.217*	0.251*	0.487*	1.817*
P_4	-0.027	1.00	-1.524*	0.448*	-0.0 83	-0.222	-0.205	0.358
P_5	-0.360*	0.308*	0.714*	-0.743	-0.169*	0.140*	-0.964	-1.094
S_g	0.034	0.072	0.418	0.352	0.111	0.007	0.265	1.521
S_{gi-gj}	0.084	0.614	1.049	0.882	0.028	0.019	0.663	3.755

Specific combining ability effects for all the studied traits under stress and normal conditions were presented in (Table 5).Significant positive SCA was detected for number of kernels/spike in the three crosses $P_1 \times P_3$, $P_1 \times P_4$, and $P_3 \times P_5$ under drought stress. Each of these crosses utilized one of the best combiners mentioned before, i.e. good × poor combiner.

Similar results were obtaind by Ikram and Tanach (1991), El-Hennawy (1992) and Mostafa (2002) for number of kernels/spike.

For other yield components, the following crosses exhibited significantly valuable specific combining ability effects (SCA) under drought conditions, i.e. $P_1 \times P_2$, $P_2 \times P_3$, $P_2 \times P_5$ and $P_3 \times P_5$ for number of spikes/plant; $P_1 \times P_4$, $P_2 \times P_3$, and $P_4 \times P_5$ for 100 kernels weight and $P_1 \times P_4$ and $P_3 \times P_4$ for grain yield.

Thus $P_1 \times P_4$ has good specific combining ability effects (SCA) for number of kernels / spike, 100 kernel weight, as $P_3 \times P_5$ for number of spikes/plant and number of kernels / spike and $P_1 \times P_2$ for number of spikes/plant and grain yield / plant.

Abul-Naas *et al.,* (2000) came to a conclusion that non-additive gene action was important in controlling number of spikes/plant, 100 kernel weight and grain yield.

Therefore, these results indicated that it is possible to use these parents (Sahel 1, Gemmeiza 9 and Sakha 94) in crossing programs to select line more drought resistant and to make use of the denoted crosses by applying special breeding program utilizing non additive gene action like using hybrid vigour or practice back crosses or recurrent selection.

Table (5): Estimates of specific combining ability effects under stress and normal conditions .

Genotypes	Number of spikes/plant		Number of kernels/ spike		100-kernel weight		Grain yield/ plant	
	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal
P1xP2	1.611**	0.270	-2.063	-4.556	-0.823	0.072	2.293*	0.920
P1xP3	-0.198	0.508	3.841*	0.587	-0.276	-0.083	-1.910	5.947*
P1xP4	0.135	-0.63	7.889*	-1.698	0.326*	0.050	-1.705	1.676
P1xP5	-0.532	0.175	-0.683	6.492**	0.245	0.103	-0.020	-5.952
P2xP3	0.554**	-0.778	0.603	1.778	0.687*	0.230	0.136	16.95*
P2xP4	0.887	-0.016	1.651	0.825	-0.111	-0.370	-1.606	1.69
P2xP5	0.221*	-0.778	1.746	-3.984	-0.012	0.149	1.779	-3.33
P3xP4	-0.922	-0.111	0.556	1.968	-0.480	0.575	2.077*	1.69
P3x P5	1.078**	2.127	3.317*	-2.841	-0.212	-0.673	-3.314	-3.33
P4xP5	-0.922	-0.444	1.365	-2.460	0.134*	0.127	0.495	5.91
S_{ij}	0.224	1.080	2.787	2.351	0.0512	0.074	1.767	10.015
$S_{ij} - S_{ik}$	0.507	1.084	6.270	5.291	0.115	0.166	3.976	22.532
$S_{ij} - S_{ki}$	0.422	0.903	5.225	4.409	0.096	0.139	3.313	18.777

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وراثة بعض الصفات المحصولية في القمح تحت ظروف الجفاف

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أجرى تقيم الهجن الدائرية و ذلك في إتجاه واحد من خمسة أباء من قمح الخبز (ساحل ١ ، جميزة ٩ ، جيزة ١٦٤ ، سخا ٩٤ ، سخا ٦١) تحت ظروف الجفاف بمحطة البحوث الزراعية بايتاى البارود لموسم ٢٠٠٣/٢٠٠٤ لتقدير القدرة العامة والخاصة على الائتلاف فى الجيل الأول لهذه الهجن الدائرية للتعرف على السلوك الوراثى لصفات المحصول و مكوناته تحت ظروف الجفاف و تحديد أفضل الأباء و الهجن التي يمكن الإنتخاب فيها تحت هذه الظروف.

أظهرت الدراسة تفوق القدرة العامة على الائتلاف للأصناف (ساحل ١ ، جميزة ٩ ، سخا٦١) لصفة عدد الحبوب بالسنبلة ، و الصنفين (ساحل ١ ، جميزة ٩) لعدد السنابل بالنبات ، بينما تفوق الصنف (جيزة ١٦٤) في وزن المائة حبة و محصول النبات وكذلك تفوق الصنف (ساحل ١) فى محصول النبات ، و كانت أفضل الهجن في القدرة الخاصة على الائتلاف تحت ظروف الجفاف هى :

- (ساحل١ / سخا ٩٤) لعدد الحبوب بالسنبلة و وزن المائة حبة.
- (جيزة١٦٤/ سخا ٦١) لعدد السنابل بالنبات و عدد الحبوب بالسنبلة.
- (ساحل ١ / جميزة ٩) لعدد السنابل فى النبات و محصول النبات.