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Genetical Analysis of Some Agronomic Traits in Durum Wheat

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ABSTRACT

The present study was carried out at Al-Azhar Uni. Assiut branch, Exp. Farm. during 2013/2014 and 2014/2015 seasons 15 F1`s obtained from a half diallel crossing system of 6 durum wheat (*Triticum durum.* Desf.) cultivars namely Beni-Soweif 1(P1), Beni-Soweif 5,(P2), Beni-Soweif 6 (P3), Local 39 (P4), Sohag 4 (P5) and Sohag 5 (P6).Parents and their fifteen hybrids were evaluated in RCBD design with three replications. Results showed that both general (G.C.A) and specific (S.C.A) combining abilities were significant for all studied characters and revealed that number of spikes/plant, number of spikelets/spike, number of kernels/spikelet,100-kernels weight, grain yield/plant were mainly affected by additive genes more than non-additive genes (dominance and epistasis).The GCA effects were high significant for studied traits and may considered the best combiners as P5 which was best combiner for no. spikes/plant, P4 and P3 were best combiner for 100-kerneles weight and P4 and P5 were best combiner for grain yield/plant. The most desirable SCA effects were detected by the crosses combination P1×P2, P1×P4, P1×P5, P2×P6, P3×P5 and P4×P5 for number of spikes/plant, P1×P4 and P3×P5 for no. of spikelets/spike, P1×P3, P1×P4, P1×P6, P2×P3, P2×P4, P2×P5, P3×P5, P3×P6 and P4×P5 for 100- kernels weight, P1×P2, P1×P3, P1×P5, P2×P6, P3×P5, P3×P6 and P4×P5 for grain yield/plant trait. Heterobeltiosis percentage values were significant for all studied traits. The best crosses for that traits recorded by the crosses P1 x P2 (205.88), P1 × P4 (13.46), P1×P2 and P2×P4 (16.67), P2×P3 (22.24), P5 × P6 (255.41), respectively. The result cleared positive significant correlation between 100-kernel weight with no. of spikes/plant and no. of spikes/plant with grain yield/plant trait. The previous results are useful for breeding processes and indicated that high heterosis of hybrids for that traits which suggested the possible exploration of durum wheat hybrids to raise grain yield potential within the existing genetic variation. Also, some hybrids can be successfully designed to capitalize on contrasting heterotic groups present in less adapted parents carrying alien substitution and translocations, for example, or in genotypes with a more extreme expression of yield components.

Key words: Durum wheat, combining ability, diallel, additive, dominance, heterosis, correlation.

Introduction

Wheat plays a significant role in critical areas of food security and economic stability of most countries of the world. The types and varieties of wheat are exceedingly diverse in crop traits. Durum wheat or macaroni wheat is the only tetraploid species of wheat of commercial importance that is widely cultivated today and in many countries. Durum wheat is an important crop for making pasta, bulgur, couscous and the other products. It differs from other durum wheat in that the starch swelling capacity is greater and the gluten has different characteristics which results in touhg, elastic doughs. Addition to this, high yield and high protein concentration with desirable milling and baking qualities have been the main criteria in wheat breeding. Among others, plant height, spike lenght, spikelet number/spike, number of grains/spike and thousand grains weight etc. (Topal *et al.* (2004).

Farooq *et al* (2010) stated that diallel cross technique is widely used for the evaluation of combining ability. Estimation of G.C.A and S.C.A are indicators on the nature of gene action. G.C.A is due to genes which are additive in nature, while S.C.A is due to genes with non-additive effect (dominance or epistatic effects). Akram *et al* (2009) reported that the different related yield traits estimated were number of spikelets/spike, number of grains/spike, 1000 grain weight and grain yield/plant. Some varieties are good parents when crossed in a series of crosses according to good combining ability or by their ability to transmit good characters to their progeny. When tests for general combining ability are significantly important, selected varieties or inbreds having higher combining ability values should prove to be superior parents in crosses. The results indicated that the differences among parents and hybrid progenies were highly significant for all characters. Therefore, it becomes possible to proceed in conducting the different comparisons between parents and their F_1 hybrids. Partitioning of the genetic variance indicated that both G.C.A and S.C.A were highly significant in all the studied traits. This result indicates that there is an importance of both additive and non-additive genetic effects in controlling the inheritance of all the studied characters.(Peng *et al.* (2009); Sener, (2009); Subhashchandra *et al.* (2009); Kumar and Gupta, 2010 and Padhar *et al.* (2010)).

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Heterosis effect has been used in breeding of open pollinated plants such as maize or rye. At present, hybrid breeding also being focused on self-pollinated plants, including wheat (Krystkowiak *et al.,* 2009). Development of hybrid durum wheat rests on the premise that there is heterosis in this crop (Elfadl *et al*., (2006).

Knowledge on the expression levels of heterosis are useful to help breeders to choose the best hybrid combinations which will serve as the basis for the selection of superior genotypes. (Abdel-Moneam, 2009 and Subhashchandra *et al*., 2009).

In the present work, Griffing,s (1956) method II model I mating system was used for analysis and partition the total genetic variance among six durum wheat cultivars and their F_1 hybrids in order to evaluate these parents. The aim of this work was determine the best parents and the best crosses according to the agronomic traits and study results of G.C.A, S.C.A, heterosis and correlation coefficient.

Materials and Methods

The present investigation was carried out at Faculty of Agriculture, Al-Azhar University, Assiut Branch, Experimental Farm during 2013/2014 and 2014/2015 growing seasons. The present work aimed to study the general and specific combining ability, heterosis and correlation coefficient using half diallel analysis including six cultivars of durum wheat cultivars.

The used cultivars namely Beni-Soweif 1(P1), Beni-Soweif 5,(P2), Beni-Soweif 6 (P3), Local 39 (P4), Sohag 4 (P5) and Sohag 5 (P6) and which chosen with regard to the genetic and local variance. The seeds of parents were planted in the farm on 15 th and 30 th of November 2013 in plots 7×10 m^2 on parallel lines, 20 cm apart. The plans spaced 10 cm within the line. At blooming stage, crossing were done between the six parents in one way (half diallel according to Griffing,s(1956) method II model I mating system). On 15 th of November 2014, the six parents and their fifteen hybrids were grown in a randomized complete block design with three replications. All agricultural practices were carried out as recommended for wheat production. At the end of this season, ten graded plants from each replicate were randomized taken as a sample to record agronomic characters were as follow:

1- Number of spikes/plant:Tiller with fertile spike.
2- Number of spikelets/spike.
3- Number of kernels/spikelet.
4- 100- kernels weight (g).
5- Grain yield/plant (g).

Statistical analysis:

Data of the 2014/2015 growing season were subjected to statistical analysis as outlined by Snedecor and Cochran (1967) for the RCBD experiments.

The genetic analysis for the data of the 21 genotypes was made according to Griffing, (1956) fixed model method 2.

General (GCA) and specific (SCA) combining ability effects were estimated. Higher or better parent (BP) heterosis (heterobeltiosis) was made according to Fonseca and Patterson (1968) through the formulas: H=(F1-BP)/BP.

L.S.D for better parent heterosis = t × $(2M.S.E/r)^{1/2}$

Where: t is the value of tabulated t at a stated level of probability for the experimental error degrees of freedom; r is the number of replications.

Correlation coefficient (r) : were computed according Johnson *et al.* (1955)

$$r = \frac{\sum xy - (\frac{\sum x . \sum y}{n}}{\sqrt{(\sum x^2 - \frac{(\sum x)^2}{n}).(\sum y^2 - \frac{(\sum y)^2}{n})}}$$

Results and Discussion

The analysis of variance indicated significant differences among all genotypes (parents and their F1 hybrids) for all characters except no. of kernels/spikelet (Table 1) and same results for examined general combining ability (GCA) and specific combining ability (SCA) which were highly significant different for all traits except no. kernels/spikelet trait was controlled additive genes only. Thus, both types of gene action were present in controlling the inheritance of all the studied traits but variance of GCA was higher for all traits except no. kernels/spikelet in accordance with the high values of MSGCA/MSSCA ratios. MSGCA/MSSCA ratio favored GCA for all traits, which showed that additive gene action was prominent in controlling all the studied traits.

These results are in harmony with those of Ali and Shakor(2012), Lohithaswa *et al*. (2013), Ali and Sulaiman(2014) Brahim and Mohamed (2014) and Ismail(2015).

Table 1: Analysis of variance among genotypes for all the studied traits

S.O.V.	M.S.					
	D.F	No. of spikes/plant	No. of spikelets /spike	No. of kernels/ spikelet	100- kernels weight	Grain yield/plant
Replications	2	1.25	1.76	0.14	0.01	0.03
Genotypes	20	54.05**	5.30*	0.47	1.68**	458.29**
Error	40	5.15	2.55	0.29	0.01	0.25

*,** *Significant at 0.05 and 0.01 probability levels, respectively.*

Table 2: Partioning of genetic variance for all the studied traits.

S.O.V	D.F	M.S				
		No. of spikes /plant	No. of spikelets /spike	No. of kernels/ spikelet	100- kernels weight	Grain yield /plant
Genotypes	20	54.05**	5.30*	0.47	1.68*	458.29**
GCA	5	15.75**	2.03**	0.26**	0.96**	148**
SCA	15	18.76**	1.68*	0.12	0.43**	154.17**
Error	40	1.72	0.85	0.098	0.005	0.08
GCA/SCA		0.84	1.21	2.17	2.23	0.96

*,** *Significant at 0.05 and 0.01 probability levels, respectively.*

Mean performance for the parent and their hybrids (F1) are presented in Table 3.

The cross ($P_3 \times P_{5)}$ expressed the highest mean value for the number of spikes/plant (22.33|), also parent P6 and cross $P_3 \times P_5$ had the best mean value for no. of spikelets/spike (21.00), while the cross $P_2 \times P_6$ had the high number of kernels/spike (5.00). Meanwhile $P_1 \times P_4$ had highest value for 100- kernels weight (6.97). The best cross for grain yield/plant was $P_4 \times P_5$ which gave (55.45).

These results in common agreement with Topal *et al*., (2004), Ali and Shakor, (2012), Brahim and Mohamed, (2014) and Ismail, (2015).

Table 3: Means performance of six parents and their 15 F1 hybrids for studied traits of twenty one genotypes.

Characters / Genotypes		No. of spikes /plant	No. of spikelets /spike	No. of kernels/spikelet	100- kernels weight	Grain yield /plant
P_1		5.67	17.33	4.00	5.00	11.76
P_2		5.33	18.67	4.00	4.73	13.28
P_3		7.67	20.00	4.00	5.50	14.98
P_4		13.00	17.33	3.67	6.50	27.93
P_5		11.67	18.33	3.33	4.75	29.40
P_6		7.00	21.00	4.33	4.74	11.55
$P_1 \times P_2$		17.33	18.00	4.67	5.03	47.19
$P_1 \times P_3$		11.00	17.00	4.00	6.00	24.44
$P_1 \times P_4$		14.33	19.67	3.67	6.97	30.63
$P_1 \times P_5$		17.00	17.00	4.00	5.07	36.47
$P_1 \times P_6$		10.33	18.00	4.33	5.10	11.53
$P_2 \times P_3$		13.33	19.00	3.67	6.72	10.27
$P_2 \times P_4$		13.33	19.67	4.67	6.40	30.63
$P_2 \times P_5$		13.33	20.33	4.33	5.50	18.22
$P_2 \times P_6$		15.33	20.33	5.00	4.76	36.50
$P_3 \times P_4$		9.67	19.33	4.00	5.07	27.50
$P_3 \times P_5$		22.33	21.00	4.00	6.55	28.24
$P_3 \times P_6$		12.33	17.00	4.33	5.49	27.39
$P_4 \times P_5$		18.67	17.67	4.00	6.07	55.45
$P_4 \times P_6$		11.67	18.00	4.33	5.03	25.00
$P_5 \times P_6$		13.00	19.33	3.67	4.74	10.17
L.S.D	5%	3.74	2.64	0.89	0.17	0.83
	1%	5.01	3.53	1.19	0.22	1.10

Beni -Soweif 1(P1), Beni-Soweif 5,(P2), Beni-Soweif 6 (P3), Local 39 (P4), Sohag 4 (P5) and Sohag 5 (P6).

General combining ability GCA effects:

The results showed that many of the parents had significant or highly significant of GCA effect and may be good combination for this traits, hence, estimates of GCA effect (Table 4) revealed that the P4 was best general combiner for 100- kernels weight and grain yield/plant. P5 was the next best for no.of spikes/plant and grain yield/plant. Similarly, P3 was an excellent general combiner for 100- kernels weight, while P2 and P6 was good combiners for no. of kernels/spikelet. Therefore, the best yielding parents for quantitative and that parents reflecting attractive qualitative performance, and which might be exploited separately for varietal improvement for different cross combinations**.** In this respect Peng *et al.* (2009) reported that some parents had high value of general combining ability for certain specific traits and can be used as parents in hybrid wheat breeding. These results are in harmony with those obtained by Topal *et al*. (2004), Ali and Shakor (2012), Brahim and Mohamed (2014) and Ismail, (2015).

Table 4: Estimates of GCA effects for the studied traits

Parents \ Characters		No. of spikes /plant	No. of spikelets /spike	No. of kernels /spikelet	100- kernels weight	Grain yield /plant
P_1		-0.8054	-0.8750**	0.0004	-0.050*	-0.2771**
P_2		-0.5579	0.4175	0.2092*	-0.088**	-0.8283**
P_3		-0.4717	0.2500	-0.0833	0.282**	-3.5246**
P_4		0.7371*	-0.2912	-0.0821	0.496**	5.9992**
P_5		2.4871**	0.0825	-0.2508*	-0.143**	3.9192**
P_6		-1.3892**	0.4163	0.2067*	-0.497**	-5.2883**
S.E×t	5%	0.855	0.601	0.204	0.046	0.184
	1%	1.145	0.805	0.273	0.062	0.247

, Significant at 0.05 and 0.01 probability levels, respectively.*

Specific combining ability SCA effects:

The most desirable and significant values of SCA effects were detected by the crosses combinations P1×P2, P1×P5, P2×P6, P3×P5 and P4×P5 for number of spikes/plant, P3×P5 for no.of spikelets/spike, On the other hand no significance SCA effects for no. of kernels/spikelet, P1×P3, P1×P4, P1×P6, P2×P3, P2×P4, P2×P5, P3×P5, P3×P6 and P4×P5 for 100- kernels weight, P1×P2, P1×P3, P1×P5, P2×P6, P3×P5, P3×P6 and P4×P5 for grain yield/plant trait. (Table 5)

It could be concluded that from the present results the hybrids P1×P2, P1×P3, P1×P5, P2×P6, P3×P6 and P4×P5 seem to be the best among studied crosses as it expressed the most desirable SCA effects for most traits accordance with heterosis better parent values. This result coincide with those of Topal *et al.*(2004), Ali and Shakor (2012), Brahim and Mohamed (2014) and Ismail (2015).

Table 5: Specific combining ability effects for studied traits.

Crosses \ Characters		No. of spikes /plant	No. of spikelets /spike	No. of kernels /spikelet	100-kernels weight	Grain yield /plant
P1×P2		6.158**	-0.982	0.362	-0.339**	23.150**
P1×P3		-0.262	-7.148**	-0.012	0.258**	3.103**
P1×P4		1.863	-3.274**	-0.347	1.011**	-0.231
P1×P5		2.779*	-0.939	0.155	-0.250**	7.682**
P1×P6		-0.011	-7.940**	0.031	0.137*	-8.044**
P2×P3		1.824	-6.107**	-0.554	1.019**	-10.523**
P2×P4		0.615	-5.566**	0.444	0.482**	0.320
P2×P5		-1.135	-5.899**	0.280	0.220**	-10.013**
P2×P6		4.741**	-4.232**	0.489	-0.166*	17.474**
P3×P4		-3.138*	-9.065**	0.070	-1.222**	-0.117
P3×P5		7.779**	3.269**	0.239	0.900**	2.706**
P3×P6		1.655	-7.065**	0.115	0.197**	11.057**
P4×P5		2.903*	0.143	0.238	0.203**	20.393**
P4×P6		-0.220	-7.190**	0.114	-0.480**	-0.853**
P5×P6		-0.637	-6.189**	-0.384	-0.134*	-13.600**
S.E×t	5%	2.349	1.652	0.561	0.127	0.507
	1%	3.143	2.210	0.750	0.169	0.678

, Significant at 0.05 and 0.01 probability levels, respectively.*

Heterosis:

Heterosis values calculated as percentage of better parent which were listed in Table 6.

The results showed positive and negative significant heterobeltiosis values in all the hybrids studied. The results denoted that of 15 crosses, 12 crosses of them were high number of spikes/plant, 4 crosses of them had high significant and positive heterosis values for number of spikelets/ spike, 5 crosses had high for no. of kernels/spikelet, 9 crosses high 100- grains weight and finaly 8 crosses high grain yield/plant trait.

The Maximum heterosis values over better parent recorded by the crosses P1 x P2 (205.88), P1 × P4 (13.46), P1×P2 and P2×P4 (16.67), P2×P3 (22.24), P5 × P6 (255.41) for number of spikes/plant, number of spikelets/ spike, number of grains/ spikelet, 100-grain weight and grain yield/plant traits, respectively.

These crosses could be extensively used in breeding programme to develop superior segregants and or better pure lines specially the best one P1xP2.

These results are in harmony with those obtained by Akinci (2009), Ali and Shakor (2012), Brahim and Mohamed (2014) and Ismail (2015).

Table 6: Heterosis percentages for all the studied traits to relative of the better parents.

Characters / Crosses	No. of spikes /plant	No. of spikelets /spike	No. of kernels /spikelet	100- kernels weight	grain yield /plant
	$H_{B.P.}$%	$H_{B.P.}$%	$H_{B.P.}$%	$H_{B.P.}$%	$H_{B.P.}$%
P1×P2	205.88**	-3.57**	16.67**	0.67**	255.41**
P1×P3	43.48**	-15.00**	0.00	9.09**	63.17**
P1×P4	10.26**	13.46**	-8.33**	7.18**	9.67**
P1×P5	45.71**	-1.92	0.00	1.33**	24.04**
P1×P6	47.62**	-14.29**	0.00	2.00**	-1.90**
P2×P3	73.91**	-5.00**	-8.33**	22.24**	-31.46**
P2×P4	2.56	5.36**	16.67**	-1.54**	9.67**
P2×P5	14.29**	8.93**	8.33**	15.71**	-38.03**
P2×P6	119.05**	-3.17*	15.38**	0.42**	174.92**
P3×P4	-25.64**	-3.33*	0.00	-22.05**	-1.55**
P3×P5	91.43**	5.00**	0.00	19.09**	-3.93**
P3×P6	60.87**	-19.05**	0.00	-0.12	82.82**
P4×P5	43.59**	-3.64**	9.09**	-6.67**	88.62**
P4×P6	-10.26**	-14.29**	0.00	-22.62**	-10.50**
P5×P6	11.43**	-7.94**	-15.38**	-0.35**	-65.40**
L.S.D 5%	3.745	2.635	0.889	0.165	0.825
L.S.D 1%	5.010	3.526	1.189	0.221	1.104

, Significant at 0.05 and 0.01 probability levels, respectively.*

Correlation:

The results showed positive significant correlation between 100-kernel weight with no.of spikes/plant (0.43) and no.of spikes/plant with grain yield/plant (0.68) only. On the other hand, the correlation coefficient (Table 7) was low positive and /or negative between other traits. This results of correlation could be useful in selection program.

These results agreed with those obtained by Soylu and Akgun (2003), Yagdi (2009), Ali and Shakor (2012) and Cifci. (2012).

Table 7: Correlation among studied characters for genotypes.

Characters	No. of spikes /plant	No. of spikelet s/spike	No. of kernels /spikelet	100- kernels weight	Grain yield /plant
No. of spikes/plant	1				
No. of spikelets/spike	0.07	1			
No. of kernels/spikelet	0.10	0.19	1		
100-kernels weight	0.43*	0.06	-0.25	1	
Grain yield/plant	0.68**	-0.24	0.24	0.18	1

Conclusion:

In the present study, both additive and non- additive gene effects were important, but a large part of the total genetic variation observed in all characteristics as associated with genes that are additive in nature, since the variance in GCA was higher than that in SCA. The variance ratio GCA/ SCA suggested that additive genetic component is preponderant in the inheritance of all the characters.

Most significant desirable SCA effects were detected by the crosses combination P1×P2, P1×P4, P1×P5, P2×P6, P3×P5 and P4×P5 for number of spikes/plant, P1×P4 and P3×P5 for no. of spikelets/spike, P1×P3, P1×P4, P1×P6, P2×P3, P2×P4, P2×P5, P3×P5, P3×P6 and P4×P5 for 100- kernels weight, P1×P2, P1×P3, P1×P5, P2×P6, P3×P5, P3×P6 and P4×P5 for grain yield/plant.

Heterosis over better parent values were significant for all studied characters. The highest crosses for these traits in same ranking recorded by the crosses P1 x P2 (205.88), P1 × P4 (13.46), P1×P2 and P2×P4 (16.67), P2×P3 (22.24), P5 × P6 (255.41), respectively.

Also, the result showed positive significant correlation between 100-kernel weight with no.of spikes/plant and high positive significant correlation between no.of spikes/plant with grain yield/plant.

It can be conclude that possibility of use the superior crosses for improving durum wheat traits by breeding processes and selection in sequent generations.

The selection is effective in early segregating generations particularly when additive genes supported by dominance genes.

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