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INHERITANCE OF EARLINESS, YIELD AND YIELD COMPONENTS IN WHEAT (*T. aestivum* L. em. Thell)

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Abstract: The F_1-hybrids of an 8-parent diallel cross (excluding reciprocals) of spring wheat (*T. aestivum* L. em. Thell) were analyzed for combining ability for days to heading, spike length, number of spikes/plant, number of grains/plant, 100-kernel weight and grain yield/plant .The results indicated significant differences among the parents for general combining ability and crosses for specific combining ability for all the studied traits .The ratio $\Sigma g^2_i/\Sigma s^2_{ij}$ ranged from 0.02 for number of grains/plant to 0.15 for spike length indicating that non-additive gene effects were more important than additive in the inheritance of all the studied traits The best general combiners were Sakha 69 and Gemmiza 3 cultivars for days to heading; Sakha 69 for spike length; Giza 155 and Gemmeiza 3 for number of spikes/plant; Sakha 69, Giza 155, Giza 164 and Sakha 8 for number of grains/plant; Sids 1, Gemmiza 1 and Gemmiza 3 for 100-kernel weight and Sakha 69 for grain yield/plant .The best combination for a trait cannot simply be produced by crossing the two parents of the highest GCA alone .The useful or better-parent heterosis was observed in 2 crosses for days to heading, 11 crosses for spike length, 8 crosses for number of grains/plant, 5 crosses for each of 100 kernel weight and grain yield /plant.

Key words: inheritance, earliness, yield, yield components, wheat.

Introduction

Further knowledge of the inheritance of quantitative traits, would be of course useful to the plant breeder. Diallel cross analysis provides a systematic approach for the detection of parents and crosses superior for the traits of interest .Cockerham (1961) stated that the relative merits of current methods of selection with regard to epistatic gene action are not known .Mahdy (1988) found epistatic gene effects in the inheritance of grain yield/plant, spikes/plant and 1000 kernel weight, and the magnitude of the dominance components were larger and more important than the additive one for number of spikes/ plant, 1000-kernel weight and grain yield/plant .El-Sherbeny *et al*. (2000) stated that epistasis should not be ignored in the inheritance of yield and yield components of wheat .Non-additive gene action was more important than additive for earliness (El-Hennawy, 1991; El-Sherbeny, 1999 and Bayoumi, 2004) and yield components (Saad *et al*., 1997 and Hamada *et al*., 1997). Otherwise, the additive gene effects were more important in the inheritance of yield and yield components (Przulj, 1999; Ismail *et al*., 2001b; El-Sherbeny, 2004; Joshi *et al*., 2004 and Nazeer, 2004).Heterotic effects over the mid-parent for earliness , yield and yield components were found in many crosses (Alkoddoussi and Hassan, 1991; El-Hennawy, 1996 and Esmail and Kattab, 2002).The present article was conducted to study heterosis and types of gene action controlling earliness, yield and yield components in 8-parents diallel cross of bread wheat.

Materials and Methods

The present study was carried out at the Exper. Farm of Sohag Fac. Agric., South Valley Univ. during the two successive seasons of 1999/2000 and 2000/2001.Eight bread wheat cultivars (*T. aestivum* L. em. Thell) were chosen for this diallel study.A half diallel excluding reciprocals was made during the season of 1999/2000 .A randomized complete block design with three replications was used .Each replication included 36 genotypes .Seeds were sown on Nov. 20th, 2000 in rows, 3 m long, 20 cm apart and 10 cm between seeds within a row.The plot size was single row. The recommended cultural practices were adopted throughout the growing season.

Days to heading was measured as the number of days from planting to the day when 50 of the heads were extruded from the flag leaf. At harvest, data was recorded on 10 guarded plants from each row .Spike length, cm of the main culm, number of spikes/plant, and grain yield/plant, g. were recorded for each plant .The bulk grains of the ten plants were used to determine 100 seed weight, g and number of grains/plant. Statistical analysis was conducted on plot mean basis .The genetic analysis of Griffing (1956) model 1, method 2 was followed. Revised LSD was used to test the differences among genotypes according to El-Rawi and Kalafalla (1980).

Results and Discussion

The analysis of variance of genotypes (parents + crosses) and combining ability analysis (Table 1) indicated highly significant differences among genotypes for the six studied traits. Furthermore, mean squares of both of general (GCA) and specific (SCA) combining was highly significant .Highly significant GCA mean squares indicates that there were differences in performance of genotypes as parents in hybrid combinations .Highly significant SCA mean squares suggests the importance of non-additive gene effects .Joshi *et al*. (2004) found significant GCA and SCA variances, and GCA:SCA ratio tilted normally in favour of GCA for grain yield and grains/spike, however, this ratio was in favour of SCA for 1000-grain weight .Baker (1978) and Cisar *et* *al*. (1982) suggested that the progeny performances could be

predicted by the use of the ratio of general to specific combining ability variance components .The ratio less than unity indicating the importance of non-additive (dominance and epistasis) gene effects rather than additive in the inheritance of a trait .This ratio was small and less than one for all traits (Table 1) and ranged from 0.02 for number of grains/plant to 0.15 for spike length indicating that non-additive gene effects were more important than additive in controlling the inheritance of all studied traits.

Days to heading:

Days to heading (Table 2) of the parents ranged from 81.0 for Sakha 69 to 85.33 for Giza 164, and ranged for crosses from 79.0 (P_7xP_8) to 86.33 (P_4xP_6 and P_4xP_7) .The ratio of $\Sigma g^2i/\Sigma s^2ij$ for days to heading was very low (0.08)(Table1).Therefore, the earliest cross cannot simply be produced by crossing the two parents with the lowest GCA effects alone .Theoretically GCA effects depends on the group of parents to which this particular parent was crossed in a diallel cross system .If the parents is exactly has average GCA, the expected estimate would be zero .Significant departure from zero either positive or negative would indicate that the parent is much better or much poorer than the average of the group involved with it in the diallel crossing system (Griffing , 1956).The lowest negative highly significant GCA effect was recorded for P_1 (-1.00) and P_8 (-0.67), whereas the highest highly significant positive GCA was found for P_4 (1.10) and P_5 (0.77) (Table 2).The other parents showed insignificant GCA effects .A parent with a significant negative GCA value contributed a high level of earliness, whereas a parent with a positive value contributed relatively high level of lateness .The earliest hybrid array means (arrays 1, 2, 7 and 8) showed negative GCA effects of the associated common parents .Otherwise, the parents of positive GCA effects (P_4 and P_5) gave the latest hybrid combinations .The best combiners for earliness were Sakha 69 followed by Gemmiza 3 and Gemmiza 1.

Significant SCA effects were detected in 4 of the 28 possible combinations, indicating the presence of non-additive effects. Significant negative SCA effects were observed for the combinations P_7/P_8, P_6/P_7 and P_4/P_5. These results indicate that earliness of these progenies was higher than would be expected from the average earliness of their respective inbred parents, suggesting the importance of non-additive gene effects in the inheritance of days to heading in this population.The largest positive SCA effect corresponded especially to the hybrid P_4/P_7. This combination was more late in heading than predicted from average parental performance .These results are in contrary with

those reported by Abd El-Aty (2004) in which he found that the magnitude of GCA was larger than SCA for earliness, and in a harmony with those reported by El-Hennawy (1991), El-Sherbeny(1999) and Bayoumi(2004). Przulj (1999) found partial dominance for days to heading.

Significant mid-parent heterosis (Table 8) towards earliness was observed in only three crosses; P_6xP_7 (-5.14%), P_6xP_8 (-3.57%) and P_7xP_8 (-5.20%). Significant better-parent heterosis was also observed for P_6xP_7 (-4.39%) and P_7xP_8 (-4.82%).

Spike length, cm:

Spike length of the parents (Table 3) ranged from 10.77 for Giza 155 (P_3) to 13.90 cm for Sids 6 (P_6), and ranged for the crosses from 11.17 (P_3xP_4) to 18.03 cm (P_1xP_8) .Twenty of the 28 crosses showed over-dominance towards the longest spike .Sakha 69 and Sids 1 showed highly significant positive GCA and were the best combiners, however Giza 155 and Sakha 8 showed highly significant negative GCA. The combinations in which Sakha 69 Gemmeza1 and Sids 1 (high and low GCA) were the common parent showed the longest spikes. However, the longest spike (18.03 cm) was recorded for the combination of Sakha 69 (high GCA) with Gemmiza 3 (negative GCA). Furthermore, some combinations which include Giza 155 or Sakha 8 (negative highly significant GCA) showed over-dominance towards long spike .Therefore, the longest spike cannot simply be produced by crossing the two parents with the highest GCA in these materials .

Highly significant SCA effects (Table 3) were detected in 9 of the 28 combinations, 3 were negative and 6 were positive indicating the presence of non-additive effects .The largest positive SCA effects corresponded especially to the hybrid Sakha 69/Gemmiza 3.This combination showed the longest spike than predicted from average parental performance, indicating the importance of non-additive gene effects .These results are in contrary to those obtained by Ismail *et al*. (2001a).

Significant positive mid-parent heterosis was observed in 17 crosses and ranged from 7.18% for P_2xP_8 to 36.28% for P_1xP_8 .All the crosses of Sakha 69 showed significant heterosis (Table 8).Furthermore, 11 of the 20 crosses which showed over-dominance, gave significant better-parent heterosis which ranged from 13.44% for P_5xP_7 to 31.32% for P_1xP_8.

Number of spikes/plant:

Number of spikes/plant (Table 4) ranged from 10.17 for Sids 1 to 18 for Gemmiza 1 and ranged from 8.33 for the cross Gemmiza 1/Sids 6 to 16.30 for Giza 155/Giza 164 .The

ratio $\Sigma g^2 i/\Sigma s^2 ij$ was very low (0.04) indicating preponderance of dominance and epistatic effects in the inheritance of number of spikes/plant .Giza 155 showed positive and highly significant GCA effects (1.474) and was the best combiner in these materials. Gemmiza 3 showed positive significant GCA (0.384) .Comparing the array means with GCA effects indicated that except for Giza 155, the high number of spikes/plant cannot simple be produced by crossing two parents of positive GCA .The lowest array mean was recorded for Gemmiza 1 (11.65), however, Sakha 69 and Sids 1 which showed negative highly significant GCA, gave array means larger than Gemmiza 1 (GCA=0.178) .These results suggest the importance of non-additive gene effects in the inheritance of number of spikes/plant .Fourteen SCA effects were significant or highly significant, 8 of them were negative indicating the importance of non-additive effects .Abd El-Aty (2004), Bayoumi (2004) and Nazeer (2004) stated that both additive and non-additive gene actions were involved in the inheritance of most yield components.These results are in accordance to those reported by Mahdy (1988).

Mid-parent heterosis (Table 8) was significant only in three crosses, i.e., Sakha 69/Sids 1 (14.04%), Sids 1/Gemmiza 3 (24.34%) and Giza 155/Giza 164 (16.01%). However, no significant better-parent heterosis was obtained.

Number of grains/plant:

Mean performance of the parents and crosses, GCA and SCA effects for number of grains/plant are presented in Table 5.

Number of grains/plant varied significantly among genotypes, and ranged among the parents from 556 for Gemmiza 1 to 951 for Sakha 8, and ranged for the crosses from 438 for sakha 8/Gemmiza 3 to 1015 for Sakha 69/Giza 164. The GCA effects were significant or highly significant for seven parents. The best combiner was Sakha 69 which showed GCA effects of 48.92 followed by Giza 155 (32.12), Giza 164 (26.46) and Sakha 8 (16.56). A parent with a significant positive GCA value would contribute a high number of grains/plant. But, this was not always true, in which Sids 1 which had negative significant GCA (-13.48) produced array mean for number of grains (708) more than Sakha 8 (653 grain/plant) which had positive significant GCA (16.56). This could be due to that non-additive effects were more important than the additive, and some combinations gave more or less number of grains/plant than would be expected from their GCA of the respective parents .Significant SCA effects were detected in 18 of the 28 possible combinations .Joshi *et al*. (2004) indicated that the additive

predominated the non-additive gene effect for grains/spike.

Mid-parent heterosis (Table8) was positive and significant for 9 crosses, 7 of them showed significant better-parent heteosis .Mid-parent heterosis ranged from 13.82 for P_4/P_7 to 52.58% for P_1/P_4, and better-parent heterosis ranged from 16.21 for P_1/P_7 to 39.82% for P_1/P_4.

100-kernel weight, g:

The parents ranged for 100-kernel weight (Table 6) from 3.5 for Sakha 8 to 5.23 g for Gemmiza 3 (Table 6), and the crosses ranged from 3.37 for Giza 155/Sids 6 to 6.30 g for sakha 69/Sids 1.The best combiner was Gemmiza 1 which showed highly significant GCA (0.378) associated with the highest array mean (4.88 g) followed by Gemmiza 3 which associated with array mean of 4.74 g .Otherwise, Sakha 8 and Sids 1 showed negative significant and positive highly significant GCA, respectively, and showed fairly the same array mean (Table 6).Therefore, the best combination in kernel weight cannot simply be produced by crossing the two parents with the highest GCA effects alone.

Significant SCA effects were detected in 12 of the 28 possible combinations, indicating the presence of non-additive effects .Highly significant positive SCA effects were observed for the combinations Sakha 69/Sids 1 (low kernel weight and high kernel weight), Sakha 69/Sids 6 (low kernel weight and moderate kernel weight), Sakha 8/Gemmiza 1, Sakha 8/ Gemmiza 3 (low kernel and high kernel weight), and Gemmiza 1/Gemmiza 3 (high kernel with high kernel weight).These results indicate that the high kernel weight of these progenies was higher than would be expected from the average kernel weight of their respective parents, and this possibly due to transgressive or inter- and intra-locus gene interactions .Otherwise, highly significant negative SCA effects were detected for the combination of the two parents of the highest kernel weight, Sids 1/Gemmiza 3.These results confirm the major role of non-additive gene effects in the inheritance of kernel weight.

Mid-parent heterosis was positive and significant for 11 crosses, 5 of them showed positive significant better parent heterosis (Table 8).The useful or better parent heterosis ranged from 12.24 for Gemmiza 1/Gemmiza 3 to 21.86% for Sakha 69/Sids 1.These results are in agreement with those reported by Mahdy (1988).

Grain yield/plant, g:

Grain yield/plant ranged from 22.83 for Giza 164 to 35.33 g for Gemmiza 3, and ranged from 22.50 for the cross Sakha 8/Gemmiza 1 to 45.40 g for the cross Sakha 69/Giza

164 (Table 7).The ratio of $\Sigma g^2 i/\Sigma s^2 ij$ was 0.03 (Table 1) indicating that non-additive gene effects were more important than additive in controlling the inheritance of grain yield/plant. The best combiner was Sakha 69 which showed highly significant positive GCA (Table 7) associated with the highest array mean (35.65 g).The lowest array mean (27.48 g) was observed for Sids 6 which showed negative and highly significant GCA effects, indicating that a parent with a significant positive GCA value would contribute a high grain yield/plant .However, the array means of the other parents were not associated with their GCA effects, suggesting the importance of non-additive gene effects in the inheritance of grain yield/plant, and the bet combination in grain yield/plant cannot simply be produced by crossing the two parents with the highest GCA effects alone.

Significant SCA effects were detected in 14 of the 28 combinations indicating the presence of non-additive effects .Highly significant positive SCA effects were detected for Sakha 69/Giza 164 (moderate and very low grain yield/plant), Giza 155/Giza 164 (moderate and very low grain yield) .These results indicate that these progenies were higher in grain yield than would be expected from their parents and possibly due to transgressive or inter- and intra-locus gene combinations .However, negative highly significant SCA effects were observed for Sakha 8/Gemmiza 3 (the two high yielding parents).This combination was lower in grain yield than predicted from average parental performance, indicating the importance of non-additive gene effects in this particular cross. These results are in agreement with those reported by Mahdy (1988).

Mid-parent heterosis (Table 8) was found for 11 crosses and 5 of them showed significant better-parent heterosis .Mid-parent heterosis ranged from 12.12 for Gemmiza 1/Gemmiza 3 to 75.29% for Sakha 69/Giza 164, and better-parent heterosis ranged from 15.13 for Sakha 69/Sids 1 to 56.71% for Sakha 69 (Giza 164).

Our results indicate that the best crosses for a trait could involve good x good and/or good x average, average x average, good x poor and poor x poor general combiners .This indicates the major role of non-additive effects of genes in controlling the aforementioned traits in these materials, and the best combination for any trait cannot simply be produced by crossing the two parents of the highest GCA effects alone .The useful or better-parent heterosis was observed in only two crosses for days to heading, 11 crosses for spike length, 8 crosses for number of grains/plant,

5 crosses for each of 100 kernel weight and grain yield/plant.

Finally, it could be concluded that non-additive effects of genes were more important than additive in the inheritance of days to heading, yield and yield components .Sakha 69 variety was the best general combiner for days to heading, spike length, number of grains/plant and grain yield/plant .Gemmiza 3 was a good combiner for days to heading, number of spikes/plant and 100 kernel weight .The best combiners for 100 kernel weight were Sids 1, Gemmiza 1 and Gemmiza 3.Whereas, Sakha 69, Giza 155, Giza 164 and Sakha 8 were the best combiners for number of grains/plant .These results indicate that pedigree method is a must to improve earliness, yield and yield components in these materials.

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وراثة التبكير والمحصول ومكوناته فى القمح

(*T. aestivum* L. em. Thell)

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أجريت هذه الدراسه بمزرعه كليه الزراعه بسوهاج – جامعه جنوب الوادى ، وفيها أجرى تحليل الهجن الدائرية لثمانية آباء من القمح(*T. aestivum* L. em. Thell)) لدراسة القدرة على الائتلاف لعدد الأيام حتى طرد السنابل ، طول السنبلة ، عدد السنابل للنبات ، عدد الحبوب للنبات ، وزن 100 حبة ووزن محصول الحبوب للنبات . أشارت النتائج إلى وجود فروق معنوية بين القدرة العامة وكذلك القدرة الخاصة على الائتلاف. وتراوحت نسبة مكون التباين للقدرة العامة إلى مكون التباين للقدرة الخاصة $\Sigma g^2 i/\Sigma s^2 ij$ من 0.02 لعدد الحبوب للنبات إلى 0.15 لطول السنبلة ، ويشير ذلك إلى أن الفعل الغير مضيف للجينات أهم من الفعل المضيف فى وراثة كل الصفات المذكورة . وكانت أفضل الآباء فى القدرة العامة على الائتلاف هى سخا 69 وجميزه (3) بالنسبة للتبكير ، سخا 69 بالنسبة لطول السنبلة ، جيزه 155 بالإضافة إلى جميزه (3) لعدد السنابل للنبات ، والآباء سخا 69 ، جيزه 155 ، جيزه 164 ، سخا 8 بالنسبة لعدد الحبوب للنبات ، والآباء سدس1، جميزه (1) ، جميزه (3) لوزن 100 حبة وسخا 69 بالنسبة لمحصول الحبوب للنبات . كما أوضحت الدراسة أن أفضل الهجن بالنسبة لأى من الصفات المدروسة ليس بالضرورة ينتج من التهجين بين أفضل الآباء للقدرة العامة على الائتلاف.

عدد الهجن التى أظهرت قوة هجين معنوية من الأب الأكبر كان إثنان لصفة عدد الأيام حتى طرد السنابل ، 11 لطول السنبلة ، 8 لعدد الحبوب للنبات ، 5 لكل من محصول الحبوب للنبات ووزن 100 حبة .