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# HETEROSIS AND GENE ACTION IN SOME EGYPTIAN COTTON CROSSES UNDER DIFFERENT LOCATIONS

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## ABSTRACT

**A half diallel set among five parents of Egyptian cotton was taken to evaluate general and specific combining abilities and their interactions with environments in three different locations. The five parents, $F_1$ and $F_2$ generations were evaluated using Randomized Complete Blocks Design at the three different locations.**

**Analysis of variance showed highly significant differences among genotypes for all studied characters .Seed cotton yield, lint cotton yield, bolls/plant and boll weight were the most affected characters by the environmental variables. GCA/SCA ratio of variance components indicated that the non-additive genetic variance was the most important in the inheritance of these characters, suggesting utilizing of heterosis to improve these characters. The additive genetic variance was greater importance for seed and lint indices, fiber fineness and uniformity ratio. Significant GCA and SCA by locations interactions were observed for all agronomic studied characters indicating that a range of environment are needed to better evaluate hybrid combinations. The best general combiners were; Giza 83 for most agronomic characters, Dandara for seed and lint indices, Giza 85 for fiber fineness and Giza 91 for fiber length and the best combinations and for all traits.**

## INTRODUCTION

Egyptian cotton (*Gossypium barbadense*, L.) is one of the most important fiber crops in the world and Egypt. The ultimate goal of cotton breeding program is to increase yielding capacity and improve fiber properties of commercial cotton varieties. Exploitation of hybrid vigor and the understanding of nature of gene action in cotton are considered the most important application of the science of genetics in cotton breeding programs. The two genetic parameters; GCA and SCA suggested by Griffing (1956) are mainly used for this purpose. Although, these two parameters have been studied in cotton by several investigators, (Rahouma and El-Shaarawy, 1992 and Abd El-Bary *et al.* 2008, the scope of these tests was limited as to establish a general trend and results of this kind of research are scant in Egyptian cotton. Therefore, further studies were needed for better understanding of the nature of gene action and its interactions with environment El-Disouqi *et al.* (1992); El-Debaby *et al.* (1997) and Al-Mostafa *et al.* (2005) calculated significant GCA by environment interactions for several agronomic and fiber properties.

The present study was carried out to evaluate the performance of five parental lines and their progeny in both $F_1$ and $F_2$ generations over three different environments located at different growing areas of cotton. Studying the genotype by environment interactions as well as general and specific combining abilities and above all, studying the effect of location on general and specific combining abilities with the aim to appreciate the influence of environment on both parameters and studying the effect of heterosis for yield and its components as well as fiber properties.

## MATERIALS AND METHODS

Five divergent cotton genotypes Dandara (Giza 31), Giza 85, Giza 90, Giza 83 and Giza 91 were used in this investigation.. All used genotypes belong to *Gossypium barbadense*, L. In 2004 growing season, the five parents were crossed in all possible combinations, excluding reciprocals, to obtain a total of 10 $F_1$ hybrids. In 2005 season, the ten $F_1$ hybrids seeds were planted in order to obtain the $F_2$

generation through self fertilization. The parental varieties were also crossed to obtain additional $F_1$ hybrid seeds. Both $F_1$'s and $F_2$'s seeds were produced at Sids Agric. Res. Exper. Sta., Beni-Suef Governorate, ARC, Egypt in 2004 and 2005 seasons.

In 2006 season, the five parents and 10 $F_1$ hybrids and their corresponding $F_2$ were grown at three experimental sites at three different locations of Sids, Tella and Dar El-Salam which located in three governorates of Beni-Suef, Minia (Middle Egypt) and Sohag (Upper Egypt), respectively. The three locations were taken as representatives of cotton growing areas in Egypt. A randomized complete blocks design (RCBD) was used for each location with three replications. Each plot included 2 rows, 4 m long and 60 cm apart. Hills were spaced at 20 cm within rows and seedlings were later thinned to two plants per hill. All cultural practices were followed as the recommendations for cotton growing in Egypt and applied properly in all experiments in the present study. Data were collected for these traits.

1- Boll weight (gm).
2- Number of open bolls per plant.
3- Seed cotton yield/plant (gm).
4- Lint cotton yield/plant.
5- Lint percentage (L%).
6- Seed index (gm).
7- Lint index (gm).
8- Fiber fineness and maturity (Mic).
9- Fiber strength (PI).
10- 2.5% span length (2.5% S.L.).
11- Uniformity ratio % (UR%).
12- 50% span length (50% S.L.).

Combined analysis over locations was carried out to test the genotypes by location interactions. Statistical genetic procedure for the analysis of diallel cross pooled over locations for combining ability was done according to Singh(1973 a and b)using method II, model I. Estimates of variance components for general and specific combining ability effects and interactinos with locations were calculated according to Singh and Chaudhary (1985). Estimates of gerneal and specific combining ability effect for each parent and crosses were calculated according to Griffing (1956).

Correlation coefficient (r) between GCA effects and mean performances of parental varieties were calculated according to Steel and Torri (1960). Heterosis percentage (H%) was expressed as the percentage increase of $F_1$ mean over the mid-parents (M.P) and better parent (B.P) values.

## RESULTS AND DISCUSSION

Combined analysis of variance over the three locations for genotypes showed highly significant differences for all studied traits which indicated that detailed analysis for most gene action could be pursued for these characters (Table 1).

**Combining ability:**

Since a fixed set of lines was studied in this investigation, it was not possible to obtain completely valid estimates of the GCA (additive) and SCA (non-additive) components of variance (Griffing, 1956). However, on the assumption that an approximate estimate was better than none. Variance components for general and specific combining effects and their interactions with locations in $F_1$ and $F_2$ generations are presented in Table 2. The magnitude of specific combining ability variances were exceeded general combining ability variances for all studied characters in $F_1$ generation with the exception of seed index and micronaire reading, while general combining ability for most studied characters in $F_2$ generation. It is interesting to mention that the GCA was higher than SCA for some characters, it's up to suggest that the major portion of genetic variance may be due to the additive gene effects, although dominance genetic variance also was important for other characters which showed SCA more than GCA, (Table3). Our results are in harmony with those obtained by El-Disouqi *et al.* (1992) and El-Debaby *et al.* (1997).

The parental mean performances, the mean estimates of GCA effects and the correlation coefficient between these two parameters are shown in Table 4. The GCA effects agree closely in rank with parental means for all studied characters. This indicates that selection of parents in breeding program to improve these traits may be based largely on the phenotypic performance of the parents. This indicates

**Table 1: Combined mean squares for the analysis of variance for twelve cotton characters across three locations in $F_1$ and $F_2$ generations.**

| SOV | d.f | Generation | BW | B/P | SCY/P | LCY/P | L% | S.I | L.I | Mic | P.I | 2.5% SL | UR% | 50% SL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Locations (L) | 2 | $F_1$ | 3.61** | 665.21** | 769.07** | 111.33** | 3.07** | 57.14** | 26.43** | 4.63** | 0.96** | 2.34* | 4.23* | 2.80* |
| | | $F_2$ | 3.69** | 567.63** | 592.64** | 70.14** | 7.36** | 41.57** | 21.31** | 3.43** | 0.12 | 0.29 | 2.87 | 0.51 |
| R/L | 6 | $F_1$ | 0.02 | 2.66 | 6.41 | 1.04 | 1.30* | 0.24* | 0.29** | 0.07 | 0.24* | 0.58 | 0.70 | 0.58 |
| | | $F_2$ | 0.03 | 2.48 | 11.78 | 0.82 | 1.17 | 1.16** | 0.61** | 0.06 | 0.12 | 0.86 | 1.26 | 0.80 |
| G | 14 | $F_1$ | 0.17** | 20.14** | 161.22** | 37.03** | 14.98** | 0.71** | 1.57** | 0.46** | 0.35** | 4.39** | 5.17** | 5.49** |
| | | $F_2$ | 0.15* | 23.77** | 94.19** | 17.11** | 5.05** | 0.96** | 1.02** | 0.42** | 0.48** | 2.82** | 4.60** | 4.20** |
| Par. | 4 | $F_1$ | 0.14* | 19.99** | 73.71** | 13.92** | 6.82** | 1.81** | 2.45** | 0.89** | 0.44** | 4.32** | 6.91** | 6.21** |
| | | $F_2$ | 0.14 | 19.99** | 73.71** | 13.74** | 6.82** | 1.73** | 2.45** | 0.89** | 0.44* | 4.32** | 6.91** | 6.21** |
| Crosses | 9 | $F_1$ | 0.12* | 18.21** | 80.21** | 19.18** | 11.27** | 0.28* | 0.83** | 0.32** | 0.28** | 3.00** | 0.96 | 2.49** |
| | | $F_2$ | 0.15* | 21.38** | 111.32** | 20.42** | 4.82** | 0.70** | 0.49** | 0.26** | 0.53** | 1.72 | 2.92* | 2.61* |
| Par. Vr. C | 1 | $F_1$ | 0.74** | 38.08** | 1240.35** | 290.00** | 81.02** | 0.23 | 4.78** | 0.01 | 0.58* | 17.23** | 36.15** | 29.60** |
| | | $F_2$ | 0.25* | 60.40** | 21.92 | 0.83 | 0.05 | 0.17 | 0.03 | 0.00 | 0.21 | 6.75** | 10.56** | 10.56** |
| GL | 28 | $F_1$ | 0.18** | 7.97** | 33.83** | 5.60** | 5.68** | 0.64** | 0.93** | 0.07* | 0.22** | 1.35* | 1.75* | 1.13 |
| | | $F_2$ | 0.19** | 8.74** | 43.20** | 5.08** | 4.24** | 0.32* | 0.53** | 0.07 | 0.17 | 1.14 | 2.40** | 0.98 |
| Par. X L | 8 | $F_1$ | 0.14** | 12.89** | 13.81** | 2.02** | 6.03** | 0.29** | 0.64** | 0.03 | 0.16 | 0.35 | 1.90 | 0.32 |
| | | $F_2$ | 0.14* | 12.89** | 13.81 | 2.03** | 6.03** | 0.28 | 0.64** | 0.03 | 0.16 | 0.35 | 1.90 | 0.32 |
| Crosses X L | 18 | $F_1$ | 0.17** | 5.91** | 29.65** | 4.14** | 3.60** | 0.61** | 0.68** | 0.08** | 0.25** | 1.49** | 1.85* | 1.26* |
| | | $F_2$ | 0.18** | 7.24** | 50.35** | 5.18** | 2.76** | 0.23 | 0.26 | 0.06 | 0.17 | 1.33 | 2.88** | 1.22 |
| Par. Vr. C X L | 2 | $F_1$ | 0.44** | 6.80** | 151.57** | 33.10** | 22.92** | 2.33** | 4.41** | 0.13* | 0.16 | 4.06** | 0.26 | 3.16* |
| | | $F_2$ | 0.54** | 5.67* | 96.38** | 16.43** | 10.42** | 1.19** | 2.52** | 0.29** | 0.13 | 2.66* | 0.10 | 1.45 |
| ERROR | 84 | $F_1$ | 0.04 | 1.31 | 2.86 | 0.49 | 0.48 | 0.09 | 0.08 | 0.03 | 0.09 | 0.62 | 0.91 | 0.70 |
| | | $F_2$ | 0.05 | 1.69 | 11.19 | 0.68 | 1.04 | 0.17 | 0.15 | 0.05 | 0.16 | 0.83 | 0.99 | 0.93 |

*, ** Significant at the 5% and 1% level of probability, respectively.

**Table 2: Mean squares for gca, sca and their interactions by locations for twelve cotton characters in $F_1$ and $F_2$ generations**

| S.O.V. | d.f | Generation | Boll weight | No. of bolls/ plant | Seed cotton yield | Lint cotton yield | Lint percentage | Seed index | Lint index | Micronaire reading | Pressely index | 2.5% SL | Uniformity ratio | 50% SL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| gca | 4 | $F_1$ | 0.014 | 6.167** | 47.265** | 10.642** | 2.666** | 0.511** | 0.555** | 0.459** | 0.071 | 0.727* | 2.162** | 1.083** |
| | | $F_2$ | 0.022 | 12.803** | 65.565** | 13.784** | 3.206** | 0.875** | 0.922** | 0.390** | 0.098 | 1.885** | 2.912** | 2.774** |
| sca | 10 | $F_1$ | 0.072** | 6.930** | 56.329** | 13.022** | 5.926** | 0.127** | 0.513** | 0.031** | 0.134** | 1.759** | 1.549** | 2.128** |
| | | $F_2$ | 0.063** | 5.972** | 17.728** | 2.473** | 1.074** | 0.097 | 0.106* | 0.041** | 0.184** | 0.563* | 0.984** | 0.852** |
| gca X L. | 8 | $F_1$ | 0.040* | 3.806** | 8.012** | 1.447** | 1.810** | 0.174** | 0.371** | 0.021 | 0.034 | 0.392 | 0.506 | 0.324 |
| | | $F_2$ | 0.049* | 2.222** | 14.751** | 1.505** | 1.460** | 0.088 | 0.172** | 0.023 | 0.029 | 0.171 | 1.191** | 0.184 |
| sca X L. | 20 | $F_1$ | 0.068** | 2.197** | 12.584** | 2.034** | 1.925** | 0.230** | 0.288** | 0.023* | 0.090** | 0.473** | 0.616* | 0.396 |
| | | $F_2$ | 0.070** | 3.191** | 14.258** | 1.770** | 1.395** | 0.112* | 0.177** | 0.022 | 0.066 | 0.466 | 0.646* | 0.384 |
| error | 84 | $F_1$ | 0.014 | 0.438 | 0.954 | 0.163 | 0.160 | 0.032 | 0.028 | 0.011 | 0.029 | 0.205 | 0.304 | 0.234 |
| | | $F_2$ | 0.018 | 0.562 | 3.728 | 0.228 | 0.345 | 0.055 | 0.051 | 0.015 | 0.053 | 0.277 | 0.329 | 0.308 |

*, ** Significant at the 5% and 1% level of probability, respectively.

**Table 3: Estimates of variance components for twelve cotton characters in $F_1$ and $F_2$ generations.**

| SOV | Generation | Boll weight | No. of bolls /plant | Seed cotton yield | Lint cotton yield | Lint percentage | Seed index | Lint index | Micronaire reading | Pressely index | 2.5% SL | Uniformity ratio | 50% SL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mg | $F_1$ | -0.0014 | -0.1130 | -0.2139 | -0.0854 | -0.1497 | 0.0209 | -0.0019 | 0.0205 | -0.0003 | -0.0453 | 0.0344 | -0.0463 |
| | $F_2$ | -0.0010 | 0.3714 | 2.2545 | 0.5513 | 0.0984 | 0.0382 | 0.0391 | 0.0166 | -0.0024 | 0.0770 | 0.0658 | 0.1010 |
| Ms | $F_1$ | 0.0013 | 1.5778 | 14.5816 | 3.6625 | 1.3336 | -0.0342 | 0.0750 | 0.0025 | 0.0148 | 0.4289 | 0.3110 | 0.5773 |
| | $F_2$ | -0.0022 | 0.9270 | 1.1568 | 0.2341 | -0.1069 | -0.0050 | -0.0239 | 0.0061 | 0.0395 | 0.0326 | 0.1127 | 0.1559 |
| Mg x L | $F_1$ | -0.0040 | 0.2299 | -0.6531 | -0.0839 | -0.0164 | -0.0079 | 0.0118 | -0.0003 | -0.0080 | -0.0115 | -0.0157 | -0.0104 |
| | $F_2$ | -0.0030 | -0.1385 | 0.0704 | -0.0380 | 0.0093 | -0.0035 | -0.0007 | 0.0001 | -0.0052 | -0.0421 | 0.0779 | -0.0285 |
| MS x L | $F_1$ | 0.0536 | 1.7589 | 11.6302 | 1.8713 | 1.7647 | 0.1983 | 0.2601 | 0.0118 | 0.0602 | 0.2674 | 0.3128 | 0.1626 |
| | $F_2$ | 0.0524 | 2.6289 | 10.5293 | 1.5423 | 1.0493 | 0.0571 | 0.1267 | 0.0070 | 0.0132 | 0.1885 | 0.3165 | 0.0757 |
| Me | $F_1$ | 0.0144 | 0.4382 | 0.9538 | 0.1631 | 0.1601 | 0.0316 | 0.0278 | 0.0111 | 0.0294 | 0.2051 | 0.3035 | 0.2339 |
| | $F_2$ | 0.0175 | 0.5619 | 3.7284 | 0.2279 | 0.3455 | 0.0551 | 0.0506 | 0.0154 | 0.0525 | 0.2770 | 0.3292 | 0.3083 |
| GCA/SCA | $F_1$ | 0.198 | 0.890 | 0.839 | 0.817 | 0.450 | 4.011 | 1.082 | 15.053 | 0.529 | 0.414 | 1.396 | 0.509 |
| | $F_2$ | 0.341 | 2.144 | 3.698 | 5.575 | 2.985 | 8.999 | 8.732 | 9.596 | 0.532 | 3.347 | 2.960 | 3.256 |

**Table 4: Parental mean performances and mean estimates of GCA effects (g^i) of five parents over locations for twelve cotton characters in $F_1$ and $F_2$ generations and correlation coefficient (r) between parental mean and their (g^i).**

| Parents | Mean | B.W | B/P | SCY/P | LCY/P | Lint % | S.I | L.I | Mic | P.I | 2.5%SL | UR % | 50%SL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2.07 | 16.14 | 31.98 | 12.34 | 38.94 | 11.23 | 7.26 | 4.30 | 10.06 | 31.79 | 87.96 | 28.08 |
| $P_1$ | $F_1$ | -0.043** | -0.099 | -0.576** | -0.240** | 0.148** | 0.249** | 0.225** | -0.104** | 0.017 | 0.005 | -0.272** | -0.057 |
| | $F_2$ | -0.049** | -0.519** | -1.332** | -0.543** | 0.194** | 0.362** | 0.302** | -0.067** | 0.093** | 0.048 | -0.331** | -0.035 |
| | Mean | 2.36 | 14.29 | 31.30 | 11.45 | 36.57 | 10.33 | 5.86 | 4.00 | 10.21 | 31.07 | 87.94 | 27.31 |
| $P_2$ | $F_1$ | 0.016 | -0.666** | -1.730** | -0.769** | -0.360** | 0.008 | -0.119** | -0.190** | 0.063** | -0.030 | -0.335** | -0.141** |
| | $F_2$ | 0.027 | -0.763** | -1.660** | -0.752** | -0.582** | -0.133** | -0.263** | -0.175** | 0.023 | -0.110 | -0.193** | -0.163* |
| | Mean | 2.09 | 17.21 | 34.67 | 13.13 | 37.88 | 10.17 | 6.21 | 4.52 | 9.93 | 30.92 | 88.83 | 27.48 |
| $P_3$ | $F_1$ | 0.000 | -0.337** | -0.817** | -0.482** | -0.406** | -0.111** | -0.186** | 0.010 | 0.040* | -0.234** | 0.135* | -0.170** |
| | $F_2$ | -0.005 | -0.335** | -0.807** | -0.439** | -0.173* | -0.089** | -0.102** | -0.032* | -0.093** | -0.312** | -0.201** | -0.351** |
| | Mean | 2.27 | 16.88 | 36.22 | 13.96 | 38.21 | 10.14 | 6.30 | 4.76 | 9.72 | 31.54 | 88.73 | 28.01 |
| $P_4$ | $F_1$ | 0.025 | 0.572** | 1.819** | 0.873** | 0.324** | -0.151** | 0.002 | 0.123** | -0.048* | -0.028 | 0.017 | -0.024 |
| | $F_2$ | 0.031* | 0.521** | 2.106** | 0.679** | 0.127 | -0.073** | -0.007 | 0.113** | -0.030 | -0.110 | 0.134* | -0.062 |
| | Mean | 2.21 | 18.30 | 38.13 | 14.57 | 38.19 | 10.53 | 6.50 | 4.72 | 9.69 | 32.67 | 90.09 | 29.42 |
| $P_5$ | $F_1$ | 0.002 | 0.530** | 1.304** | 0.619** | 0.294** | 0.006 | 0.078** | 0.160** | -0.073** | 0.286** | 0.455** | 0.392** |
| | $F_2$ | -0.005 | 1.097** | 1.694** | 1.054** | 0.434** | -0.068* | 0.070** | 0.160** | 0.007 | 0.485** | 0.591** | 0.611** |
| (r) | $F_1$ | 0.774** | 0.755** | 0857** | 0.877** | 0.688** | 0.998** | 0.889** | 0.956** | 0.728** | 0.876** | 0.983** | 0.979** |
| | $F_2$ | 0.847** | 0.818** | 0.907** | 0.932** | 0.844** | 0.904** | 0.983** | 0.931** | 0.320 | 0.998** | 0.912** | 0.962** |
| LSD 1% | $F_1$ | 0.261 | 1.438 | 2.121 | 0.877 | 0.869 | 0.386 | 0.362 | 0.229 | 0.372 | 0.984 | 1.197 | 1.050 |
| LSD 5% | $F_1$ | 0.196 | 1.081 | 1.595 | 0.660 | 0.654 | 0.290 | 0.272 | 0.172 | 0.280 | 0.740 | 0.900 | 0.790 |
| LSD 1% | $F_2$ | 0.2874 | 1.6280 | 4.1937 | 1.0369 | 1.2766 | 0.5100 | 0.4887 | 0.2698 | 0.4979 | 1.1431 | 1.2462 | 1.2060 |
| LSD 5% | $F_2$ | 0.2161 | 1.2241 | 3.1532 | 0.7796 | 0.9599 | 0.3835 | 0.3675 | 0.2029 | 0.3743 | 0.8595 | 0.9370 | 0.9068 |
| $g_i$ 1% | $F_1$ | 0.036 | 0.198 | 0.293 | 0.121 | 0.120 | 0.053 | 0.050 | 0.032 | 0.051 | 0.136 | 0.165 | 0.145 |
| $g_i$ 5% | $F_1$ | 0.027 | 0.149 | 0.220 | 0.091 | 0.090 | 0.040 | 0.038 | 0.024 | 0.039 | 0.102 | 0.124 | 0.109 |
| $g_i$ 1% | $F_2$ | 0.040 | 0.225 | 0.579 | 0.143 | 0.176 | 0.070 | 0.067 | 0.037 | 0.069 | 0.158 | 0.172 | 0.166 |
| $g_i$ 5% | $F_2$ | 0.030 | 0.169 | 0.435 | 0.108 | 0.132 | 0.053 | 0.051 | 0.028 | 0.052 | 0.119 | 0.129 | 0.125 |

$P_1$, $P_2$, $P_3$, $P_4$ and $P_5$ are Dandara, Giza 85, Giza 90, Giza 83 and Giza 91, respectively.
*, ** Significant at the 5% and 1% level of probability, respectively.

that the breeder can estimate GCA effects from the mean performance of the genotypes in concern and depend on this performance in the direction of his crosses in the breeding program, in other words the breeder can select the genotype performances. However, the best general combiners were; Giza 83 for most agronomic characters, Dandara for seed and lint indices, Giza 85 for fiber fineness and Giza 91 for most yield components and fiber length. The same conclusion was adapted by El-Debaby *et al.* (1997) and Al-Moustafa *et al.* (2005).

Mean estimates of specific combining ability effects ($\hat{S}_{ij}$) of the parental combinations in both $F_1$ and $F_2$ generations for number of bolls/plant, seed cotton yield and lint cotton yield characters at combined analysis are presented in Table 5. Moderate levels of SCA effects were observed for Giza 85 x Giza 83, which had the best SCA effects for number of bolls/plant, seed cotton yield and lint cotton yield. It could be also noted that Giza 83 x Giza 91 had high estimates of SCA effects for lint cotton yield.

**Heterosis (H %):**

The significant of parents vs. crosses by location interaction for all studies characters expect pressley index and uniformity ratio (Table 1) showed that the level of heterosis also varied from location to other. However, heterosis over mid-parents (MP) and better parent were significant with a pronounced magnitude at different locations and their combined analysis for most of studied characters in this study (Table 6). Also, the promising crosses showed the highest values of heterosis relative to MP over the three location were ($P_3$ x $P_5$) for boll weight (16.53), ($P_2$ x $P_4$) for bolls/plant (24.14), ($P_1$ x $P_2$) for seed cotton yield/plant (30.16), ($P_2$ x $P_4$) for lint yield/plant (37.26), ($P_2$ x $P_3$) for lint % (3.09), ($P_2$ x $P_4$) for seed index (11.29), ($P_2$ x $P_4$) for lint index (22.29), ($P_2$ x $P_5$) for fiber maturity, (6.75), ($P_3$ x $P_4$) for fiber strength (5.03), ($P_2$ x $P_4$) for 2.5 % SL (6.94), ($P_1$ x $P_2$) for uniformity ratio and ($P_2$ x $P_4$) for 50 % SL (8.17). On the other hand, the promising crosses which exhibited the highest values of heterosis relative to their B.P at the three locations were ($P_3$ x $P_5$) for boll weight (13.31), ($P_2$ x $P_4$) for bolls/plant (14.61), ($P_1$ x $P_2$) for both seed cotton (28.77) and lint (32.26) yields/plant, ($P_2$ x $P_4$) also for both seed

**Table 5: Mean performance and estimates of SCA effects for Bolls number/plant, Seed cotton yield and lint yield in $F_1$ and $F_2$ generations over three locations.**

| Crosses | Bolls number/plant | | | | Seed cotton yield/plant | | | | Lint cotton yield/plant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $F_1$ | | $F_2$ | | $F_1$ | | $F_2$ | | $F_1$ | | $F_2$ | |
| | Mean | $\hat{S}_{ij}$ | Mean | $\hat{S}_{ij}$ | Mean | $\hat{S}_{ij}$ | Mean | $\hat{S}_{ij}$ | Mean | $\hat{S}_{ij}$ | Mean | $\hat{S}_{ij}$ |
| $(P_1 \times P_2)$ | 18.16 | 1.605$^{**}$ | 14.39 | 0.053 | 41.18 | 4.741$^{**}$ | 31.26 | 0.363 | 16.32 | 2.164$^{**}$ | 11.76 | 0.063 |
| $(P_1 \times P_3)$ | 17.63 | 0.754$^{*}$ | 13.31 | -1.453$^{**}$ | 40.40 | 3.042$^{**}$ | 29.68 | -2.073$^{*}$ | 15.73 | 1.291$^{**}$ | 11.09 | -0.913$^{**}$ |
| $(P_1 \times P_4)$ | 17.56 | -0.233 | 14.13 | -1.487$^{**}$ | 43.38 | 3.392$^{**}$ | 33.78 | -0.883 | 16.71 | 0.918$^{**}$ | 12.60 | -0.525$^{*}$ |
| $(P_1 \times P_5)$ | 17.57 | -0.18 | 15.96 | -0.241 | 39.53 | 0.050 | 35.34 | 1.083 | 15.85 | 0.31 | 13.90 | 0.399 |
| $(P_2 \times P_3)$ | 14.47 | -1.846$^{**}$ | 12.32 | -2.198$^{**}$ | 33.58 | -2.624$^{**}$ | 30.14 | -1.283 | 12.58 | -1.334$^{**}$ | 11.18 | -0.620$^{*}$ |
| $(P_2 \times P_4)$ | 19.34 | 2.122$^{**}$ | 16.76 | 1.380$^{**}$ | 41.94 | 3.103$^{**}$ | 38.24 | 3.899$^{**}$ | 17.44 | 2.175$^{**}$ | 14.33 | 1.419$^{**}$ |
| $(P_2 \times P_5)$ | 18.69 | 1.510$^{**}$ | 16.32 | 0.370 | 41.08 | 2.758$^{**}$ | 29.49 | -4.436$^{**}$ | 16.35 | 1.337$^{**}$ | 12.49 | -0.797$^{**}$ |
| $(P_3 \times P_4)$ | 18.76 | 1.205$^{**}$ | 15.76 | -0.049 | 43.08 | 3.328$^{**}$ | 34.02 | -1.170 | 17.03 | 1.481$^{**}$ | 12.19 | -1.042$^{**}$ |
| $(P_3 \times P_5)$ | 16.26 | -1.252$^{**}$ | 15.56 | -0.825 | 40.37 | 1.138$^{*}$ | 34.52 | -0.263 | 15.99 | 0.697$^{**}$ | 14.14 | 0.538$^{*}$ |
| $(P_4 \times P_5)$ | 18.49 | 0.071 | 16.96 | -0.280 | 44.37 | 2.502$^{**}$ | 39.61 | 1.913 | 17.97 | 1.320$^{**}$ | 15.64 | 0.923$^{**}$ |
| LS D 5% | 1.0809 | | 1.2241 | | 1.5949 | | 3.1532 | | 0.6595 | | 0.7796 | |
| LS D 1% | 1.4377 | | 1.6280 | | 2.1212 | | 4.1937 | | 0.8772 | | 1.0369 | |
| $(S_{ij}-S_{kl})$ 5% | | 0.6672 | | 0.7555 | | 0.9844 | | 1.9462 | | 0.4071 | | 0.4812 |
| $(S_{ij}-S_{kl})$ 1% | | 0.8873 | | 1.0048 | | 1.3092 | | 2.5884 | | 0.5414 | | 0.6400 |

$P_1$, $P_2$, $P_3$, $P_4$ and $P_5$ are Dandara, Giza 85, Giza 90, Giza 83 and Giza 91, respectively

*, ** Significant at the 5% and 1% level of probability, respectively.

**Table 6: Heterosis relative to mid parent (M.P) and better parent (B.P) for twelve cotton characters from combined data over three locations.**

| Crosses | Heterosis | Boll weight | No. of bolls/ plant | Seed Cotton yield | Lint Cotton yield | Lint percentage | Seed index | Lint index | Micronaire reading | Pressely index | 2.5% SL | Uniformity ratio | 50%SL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $(P_1 \times P_2)$ | MP | 3.89 | 19.31** | 30.16** | 37.18** | -3.35** | 5.39** | 5.22** | 0.40 | -3.40** | 4.22** | 1.93** | 6.00** |
| | BP | -2.49 | 12.46** | 28.77** | 32.26** | -7.22** | 2.17* | -4.96* | 4.17 | -4.13** | 3.04** | 1.92** | 4.55** |
| $(P_1 \times P_3)$ | MP | 11.83** | 5.73* | 21.21** | 23.54** | -3.01* | 1.53* | -1.13 | 0.25 | 1.72 | 2.62* | 1.36** | 3.84** |
| | BP | 11.32* | 2.45 | 16.51** | 19.80** | -7.62** | 0.14 | -8.30** | 2.84 | 1.10 | 1.22 | 0.86 | 2.73 |
| $(P_1 \times P_4)$ | MP | 15.48** | 6.33* | 27.21** | 27.11** | -0.83 | -0.09 | -1.92 | -0.86 | 2.47* | 0.88 | 1.80** | 2.38 |
| | BP | 10.37* | 4.02 | 19.76** | 19.72** | -5.64** | -1.03 | -8.40** | 4.39* | 0.77 | 0.49 | 1.35** | 2.26 |
| $(P_1 \times P_5)$ | MP | 5.47 | 2.00 | 12.76** | 17.87** | -4.24** | 4.06** | 1.68 | -1.97 | 1.41 | -0.09 | 0.72 | 0.41 |
| | BP | 2.11 | -4.01 | 3.67 | 8.85** | -7.22** | 3.05** | -3.63 | 2.84 | -0.44 | -1.43 | -0.47 | -1.89 |
| $(P_2 \times P_3)$ | MP | 11.53** | -8.15** | 1.79 | 2.32 | 3.09* | 0.51 | 4.08* | -1.17 | 0.06 | 2.28* | 1.38** | 3.71** |
| | BP | 5.13 | -15.95** | -3.16 | -4.21 | 2.26 | -1.23 | 1.13 | 5.28* | -1.31 | 2.04 | 0.88 | 3.40* |
| $(P_2 \times P_4)$ | MP | -4.99 | 24.14** | 24.22** | 37.26** | 1.68 | 11.29** | 22.29** | 2.03 | -0.45 | 6.94** | 1.24** | 8.17** |
| | BP | -6.78 | 14.61** | 15.78** | 24.93** | 0.75 | 8.90** | 17.97** | 11.67** | -2.83* | 6.13** | 0.79 | 6.82** |
| $(P_2 \times P_5)$ | MP | -2.04 | 14.69** | 18.34** | 25.67** | 0.96 | 6.63** | 13.20** | 6.75** | 3.74** | 1.50 | 0.81 | 2.35 |
| | BP | -5.13 | 2.13 | 7.74** | 12.24** | 0.00 | 4.36** | 7.57** | 16.39** | 1.09 | -0.99 | -0.39 | -1.32 |
| $(P_3 \times P_4)$ | MP | 7.28 | 10.04** | 21.53** | 25.76** | -0.98 | 4.23** | 6.10** | -2.75 | 5.03** | 3.13** | 1.60** | 4.73** |
| | BP | 2.98 | 8.97* | 18.92** | 22.02** | -1.09 | 3.78** | 5.33* | -0.25 | 3.91** | 2.11 | 1.54** | 3.73* |
| $(P_3 \times P_5)$ | MP | 16.53** | -8.45** | 10.91** | 15.51** | 0.81 | 4.27** | 7.89** | 1.92 | 1.25 | 3.93** | 1.19** | 5.02** |
| | BP | 13.31** | -11.17** | 5.88** | 9.81** | -0.95 | 3.84** | 5.45* | 4.18* | 0.00 | 1.16 | 0.48 | 1.55 |
| $(P_4 \times P_5)$ | MP | 7.88* | 5.12 | 19.36** | 26.01** | -1.99 | 5.64** | 6.87** | -0.59 | 2.35 | -1.26 | 0.37 | -0.91 |
| | BP | 6.45 | 1.03 | 16.37** | 23.39** | -3.80** | 5.61** | 5.21* | -0.24 | 2.17 | -2.96* | -0.38 | -3.29 |
| LSD 5% | MP | 0.170 | 0.936 | 1.381 | 0.571 | 0.251 | 0.566 | 0.236 | 0.149 | 0.242 | 0.641 | 0.779 | 0.684 |
| | BP | 0.20 | 1.08 | 1.59 | 0.66 | 0.29 | 0.65 | 0.27 | 0.17 | 0.28 | 0.74 | 0.90 | 0.79 |
| LSD 1% | MP | 0.226 | 1.245 | 1.837 | 0.760 | 0.334 | 0.753 | 0.314 | 0.199 | 0.322 | 0.852 | 1.036 | 0.910 |
| | BP | 0.26 | 1.44 | 2.12 | 0.88 | 0.39 | 0.87 | 0.36 | 0.23 | 0.37 | 0.98 | 1.20 | 1.05 |

$P_1$, $P_2$, $P_3$, $P_4$ and $P_5$ are Dandara, Giza 85, Giza 90, Giza 83 and Giza 91, respectively.
*, ** Significant at the 5% and 1% level of probability, respectively.

(8.90) and lint (17.97) indices, ($P_2$ x $P_5$) for fiber maturity (16.39), ($P_3$x $P_4$) for fiber strength (3.91), ($P_2$ x $P_4$) for 2.5% SL (6.13), ($P_1$x$P_2$) for uniformity ratio (1.92) and ($P_2$ x $P_4$) for 50% SL (6.82), indicating that hybridization would improve cotton production and fiber quality.

**Breeding implication:**

The above results, generally demonstrated differences among crosses for yield and yield components ; number of bolls/plant seed cotton yield and lint cotton yield which showed high levels of heterosis and relatively high inbreeding depression. Therefore, it could be concluded that most of the genetic controlling these traits in this material is non-additive.

The GCA/SCA ratio for these traits confirmed that non-additive (dominance) variance component accounted for a sizable portion of the genetic variance. Hence, dominance should receive better attention in breeding programs utilizing heterosis in this material in future work. On the other hand, the results showed that GCA appeared to be more important than SCA for lint percentage, lint index and fiber properties (Table 3).

Besides, the data obtained on GCA effects and its relation to the means of parents, endorse the idea that selection of parents for crossing based on their *per se* performances would also be beneficial to improve these characters.

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# قوة الهجين وفعل الجين فى بعض هجن القطن المصرى تحت مناطق مختلفة

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أُستخدم نظام الهجن التبادلية بين خمسة آباء متباينة وراثياً وتتبع القطن الباربادنس وهى دندرة، جيزة ٨٥، جيزة ٩٠، جيزة ٨٣، بالإضافة إلى جيزة ٩١ وتم الحصول على عشرة هجن لكل من الجيل الأول والثانى. وقد أجريت هذه التهجينات بمحطة البحوث الزراعية بسدس خلال الموسمين ٢٠٠٤،٢٠٠٥ ثم أقيمت تجربة تقييم تلك التراكيب الوراثية (٢٥ تركيب وراثى) فى ثلاثة مناطق تمثل مدى واسع من الظروف البيئية لمنطقتى مصر الوسطى ومصر العليا وهذه المناطق هى: سدس (محافظة بنى سويف)، تله (محافظة المنيا)، ودار السلام (محافظة سوهاج)، وذلك خلال الموسم ٢٠٠٦. كان التصميم الأحصائى المستخدم لهذه التجارب الثلاثة هو قطاعات كاملة العشوائية فى ثلاث مكررات.

هذا وقد تم تقدير التباين الوراثى وتجزئته إلى القدرة العامة والخاصة للتآلف بإستخدام طريقة (Griffing, 1956) النموذج الأول الطريقة الثانية. كما قدرت قوة الهجين كنسبة مئوية من قيمة متوسط الأبوين والأب الأحسن بالإضافة لحساب معامل التربية الداخلية وتم حساب الارتباط الظاهرى بين متوسط الأباء والقدرة العامة للتآلف.

<u>وفيما يلى ملخص لأهم النتائج المتحصل عليها:</u>

* أظهر التحليل التجميعى للمناطق الثلاثة وجود اختلافات عالية المعنوية بين جميع التراكيب الوراثية لكل الصفات تحت الدراسة كما كان تأثير التفاعل بين التراكيب الوراثية والمناطق أكثر وضوحاً للصفات المحصولية مقارنة بالصفات التكنولوجية للألياف.

* أظهر التفاعل الثلاثي بين الآباء والهجن والمناطق (قوة الهجين والمناطق) معنوية لمعظم الصفات محل الدراسة فى كلا الجيلين الأول والثانى مما يؤكد استجابة قوة الهجين للتغيرات البيئية لتلك الصفات كما أظهرت النتائج أيضاً وجود تفاعل بين المناطق وكلاً من القدرة العامة والخاصة للتآلف فى معظم الصفات وخاصة المحصولية مما يستوجب تقييم هذه التراكيب الوراثية فى بيئات مختلفة للحصول على تقديرات أكثر دقة.
* كان تباين القدرة العامة للتآلف أكبر من تباين القدرة الخاصة للتآلف فى صفات معاملى البذرة والشعر وقراءة الميكرونير ومعامل الانتظام مما يشير إلى أن التأثير المضيف هو المتحكم فى توريث تلك الصفات بينما كان تباين القدرة العامة على التآلف أصغر من تباين القدرة الخاصة للتآلف فى باقى الصفات.
* كان الصنف دندرة جيداً لتحسين صفات معدل الحليج ومعاملى البذرة والشعر و الصنف جيزة ٨٥ للنعومة. الصنف جيزة ٨٣ لصفات عدد اللوز/نبات ومحصول النبات من القطن الزهر والشعر. ويعتبر الصنف جيزة ٩١ جيداً لتحسين صفات المحصول وطول التيله أيضا تم الحصول على أفضل التأثيرات المرغوبة للقدرة الخاصة على التآلف فى الهجن (دندرة X جيزة ٨٥)، (جيزة ٨٥ X جيزة ٩١)، (جيزة ٩٠ X جيزة ٨٣)، (جيزة ٩٠ X جيزة ٩١) مشيرا لإمكانية استخدامها فى برامج التربية لاستنباط أصناف جديدة متفوقة فى المحصول وجودة التيلة.
* كانت قوة الهجين معنوية فى هجين أو أكثر لجميع الصفات المدروسة، مما يدل على مدى أهمية استغلال ظاهرة قوة الهجين لتحسين إنتاجية وجودة ألياف القطن المصرى.