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GENETIC ANALYSIS OF SOME MORPHOLOGICAL TRAITS OF EGYPTIAN COTTON (*Gossypium barbadense* L.) UNDER DIFFERENT ENVIRONMENTS

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Abstract: A half-diallel set of crosses was established among six local cultivars of cotton namely Giza-88, Giza-90, Giza-87, Giza-89, Giza-91 and Giza-83 in order to estimate the genetic parameters of agro-physiological traits under two contrasting environments of a clay-fertile soil and a sandy-calcareous infertile soil. The results revealed that the additive and non-additive gene effects were involved in the control of the studied traits in both environments. Most of the variation was attributed to the non –additive gene. Drought stress reverse the gene effects controlling the plant height and number of opened boll under favorable environment, whereas the additive gene effects were more important in favorable conditions but under stress the dominant effects of the genes were more important. The Wr/Vr analysis revealed that over-dominance was operating for the F_1 generation and partial dominance was detected for the F_2 generation under the two environments. The order of the dominance of the cultivars Giza-87 and Giza-89 were reversed under drought. The genetic parameters indicating non-equal distribution of dominant and recessive alleles among the six parents analyzed. Narrow-sense heritability values were much smaller relatively to broad-sense heritability in the two environments except for the plant height indicating that the additive component was smaller than the other components of variance.

Key words: Egyptian cotton – Diallel analysis – Drought .

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Introduction

The past decade has witnessed a remarkable improvement in cotton production and productivity in Egypt. Such improvement is the ultimate objective of many cotton breeding programs especially by cultivating cotton under adverse environmental conditions which prevail in the new land. Most of the newly reclaimed soils in Egypt are located in the desert where the availability of irrigation water is the most limiting factor. Evidently, drought stress is most commonly encountered in such areas and the success of a genotype under such conditions will depend entirely on its ability to resist drought (Fischer and Maurer, 1978). Drought resistance is simply the sum of drought avoidance and drought tolerance (Levitt, 1972). Drought escape through rapid morphological development (earliness) or by developmental plasticity is the simplest mechanism by which plant can resist drought. Estimating the genetic parameters is an important step for identifying the best progenies to be used in the breeding program (Rosielle and Hamblin, 1981 and Hayman 1954b). The present work was designed to investigate the effect of drought stress on the performance and genetic behaviour of some local cotton genotypes crossed in a half diallel fashion and grown in stressed and non-stressed environments. The genetic parameters and heritability were estimated for plant height, number of opened bolls and number of closed bolls under both environments in order to determine the appropriate breeding strategy for cotton improvement.

Materials and Methods

The material used in this study consisted of six Egyptian cotton varieties namely Giza-88 (P1), Giza-90 (P2), Giza-87 (P3), Giza-89 (P4), Giza-91 (P5) and Giza-83 (P6). In 2005 season, the six cotton genotypes were sown into the field of Al-Azhar University Experimental Farm to be crossed in all possible combinations, excluding reciprocals, in order to obtain a total of 15 F_1 crosses. In 2006 growing season, seeds of the six parents and the 15 F_1 hybrids were sown into the field of Al-Azhar University Farm in order to produce the F_2 seeds. Crosses were also made to produce more F_1 seeds. In 2007 season, seeds of the six parents, the 15 F_1' s and the 15 F_2' s of the six-parent half diallel cross were sown into the field at two experimental sites. The first experiment was conducted under the favourable conditions of the fertile clay-loam soil of the Al-Azhar University Experimental Farm and was irrigated each three weeks after the planting irrigation. Meanwhile, the second experiment was carried out under the stressed conditions of the infertile sandy-calcareous soil of the El-Ghoraieb Experimental Station which is located in the eastern desert 15 Km south of Assiut. The soil at this site was classified as sandy calcareous soil (Typic Torripsamments). Some soil physical and chemical properties of this experimental site are summarized in Table(A) (From Soil Analysis Laboratory, Faculty of Agriculture, Assiut University). The plants was irrigated each two weeks after the planting irrigation. The experimental lay out in each site was a complete randomized block design with three replications. The parents and the F1 hybrids were represented by one row of plants per block, while four rows per block were used for each of the 15 F_2 populations. Each row was 4.0 meters long, spaced 60 cm apart with plants spaced 50 cm within rows, on one side of the ridge with one seed per hill using the dry planting method. The agricultural practices recommended for cotton production were applied throughout the growing season. Measurements were recorded on a random sample of seven guarded plants for parents and the F_1 hybrids and 20 guarded plants for each F_2 populations in each replicate in the two experiments. The following characters were recorded for each plant: plant height at maturity (the distance from the base of plant to the tip of the main stem), number of opened bolls and number of closed bolls.

Statistical analysis: the data collected were analyzed using the diallel analysis as developed by Hayman (1954 a, b and 1957a, b), Mather and Jinks (1971) and Gomez and Gomez (1984).

Table (A): Some soil physical and chemical properties of the El-Ghoraieb experimental site (From Soil Analysis Laboratory, Faculty of Agriculture, Assiut University). Soil depth (0.0 – 30) cm. Each value represent the mean of 3 replications.

Soil Properties			
Physical Properties		Chemical Properties	
Particle size distribution:		CaCO3 (%)	14.5
Sand (%)	88.7	ECe (ds / cm)	1.6
Silt (%)	8.0	pH (1:1 suspension)	8.1
Clay (%)	3.3	Organic matter (%)	0.6
Texture	Sandy	Total N %	0.05
Field capacity(vol. %)	14.9	Available nutrient (ppm):	
		Phosphorus	4.5
		Potassium	130.0
		Iron.	2.3
		Manganese	10.4
		Zinc	0.6
		Copper	0.9

Results and Discussion

The means of the plant height (cm.), number of opened bolls and number of closed bolls for the six parental cultivars, the 15 F_1 hybrids and 15 F_2 populations under the fertile-clay (Al-Azhar) and the infertile-sandy soil (El-Ghoraieb) conditions are presented in Table (1). For plant height, the parental average height reached 109.17 cm. in the favourable environment but was reduced down to 76.88 cm. under stress indicating 29.58% reduction in plant height. The average plant height of the F_1 hybrids decreased from 117.72 cm. in the favourable environment down to 90.95 cm. under stress conditions making 22.74% reduction in plant height. These results are in agreement with the findings of Afiah and Ghoneim (1999) and Ahmed (2007). In the two environments, however, the cultivar Giza- 91 (P5) was the best in number of opened bolls (26 and 24.24 under favourable and stress conditions, respectively). Whereas, the cultivars Giza-90 (P2) and Giza-88 (P1) displayed the lowest opened bolls (15.37 and 11.83 under favourable and stressed environments, respectively). The average of opened bolls of the F_1 hybrids decreased from 30.36 in the favorable environment to 18.15 in the stress environment indicating 40.22% average reduction in the number of opened bolls. Also, Giza- 88 (P1) was the lowest for the number of closed boll (4.66 and 2.75 in both the favourable and stress conditions, respectively). Whereas, the Giza-91 (P5) displayed the highest number of closed boll (9.8 and 5.6 under the favourable and stressed environments, respectively). The average closed bolls of the F_1 hybrids decreased from 5.34 in the favorable environment down to 3.56 in the stressed environment. Such reductions under stress agree with those reported by Hendawy (1994), Kiani et al. (2007), Mohamed et al. (2000), Zerihum et al. (2004) and Rokaya et al. (2005). The analysis of variance (Table 2) revealed highly significant differences among the genotypes for all characters studied in both the favorable and the stressed environments except for number of closed boll under stress conditions.

The diallel analysis of variance for characters studied, both "a" and "b" items measuring additive and non-additive gene effects, respectively, were highly significant for both F_1 and F_2 generations in the two contrasting environments (Table 2) except item "a" in number of closed boll under stress conditions. Directional dominance towards greater expression was operating for all characters studied in the two contrasting environments as indicated by the significance of the "b_1" item. However, dominance was ambidirectional for number of closed boll in the F_2 under stressed environment. The "b_2" item was significant for all characters in the two contrasting environments

indicating unequal distribution of dominant and recessive alleles among the parents. The significance of the "b_3" item for all studied traits in the two environments in the F_1 and F_2 generations indicated further dominance due to specific cross combinations and / or epistasis except for both the F_1 and F_2 for number of closed boll under stress conditions.

The interpretation of the Wr / Vr graph:

The Wr, Vr, (Wr + Vr) and (Wr – Vr) values were calculated for each array in each block separately for the F_1 and F_2 diallel tables in both environments. The results of the analysis of the variance of the (Wr + Vr) and (Wr – Vr) values (Table 2) revealed significant array differences in the (Wr + Vr) value for the F_1 generations in most cases confirming the presence of non-additive genetic variation for all characters studied except number of closed bolls under stressed environment. The differences in the magnitude of the (Wr –Vr) values over arrays were significant in most cases indicating the presence of either non-allelic gene interaction or epistatic effects except in number of closed bolls under both environments. The Wr/Vr relationship is graphically illustrated in figure (1). For plant height, the slope of the Wr/Vr regression line was significantly different from zero (b = 0.34 ± 0.097 and 0.75±0.33 for the F_1 and F_2 under favourable conditions, respectively) as well as under stress conditions (b = 1.01 ± 0.35 and 1.18 ± 0.14 for the F_1 and F_2 generations, respectively) indicating the adequacy of additive-dominance model except for F_1 under favourable condition. The regression line of the F_1 under favorable condition intercepted the Wr axis above the origin point indicating partial dominance. However, the regression lines of both F_1 and F_2 intercepted the Wr axis near the origin point indicating almost complete dominance. For number of opened bolls, the slope of the regression lines were not significantly deviating from zero and significantly deviated from unity indicating that one or more of the assumption were not fulfilled for the F_1 (b = 0.073 ± 0.25) and the F_2 (b = 0.14 ± 0.47) under favourable conditions, as well as the F_1 (b = 1.25 ± 1.25) under stress conditions indicating non-allelic interaction was operating. The regression line of both F_1 and F_2 generations under favourable condition intercepted the Wr axis above the origin point indicating partial dominance. However, under stress conditions the regression lines of both F_1 and F_2 intercepted the Wr axis below the origin point indicating over-dominance. For number of closed boll, the slope of the regression line were significantly deviating from zero but not from unity for the F_1's (b = 0.91 ± 0.14) and the F_2's (b = 0.96 ± 0.23) under favourable conditions

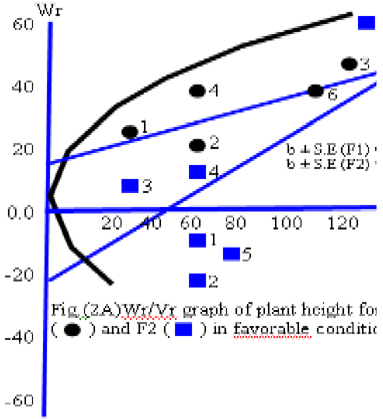

Fig.(2A)Wr/Vr graph of plant height fo
(●) and F2 (■) in favorable conditi

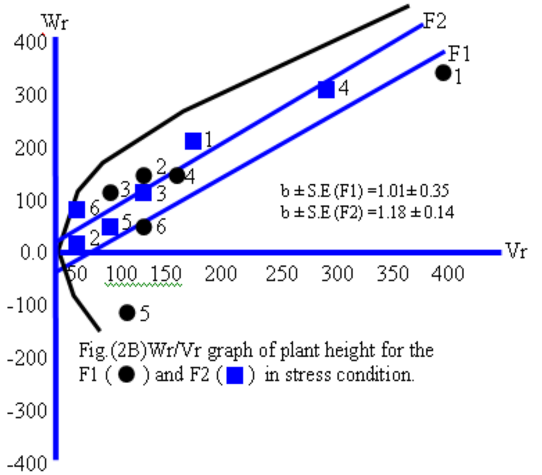

Fig.(2B)Wr/Vr graph of plant height for the F1 (●) and F2 (■) in stress condition.

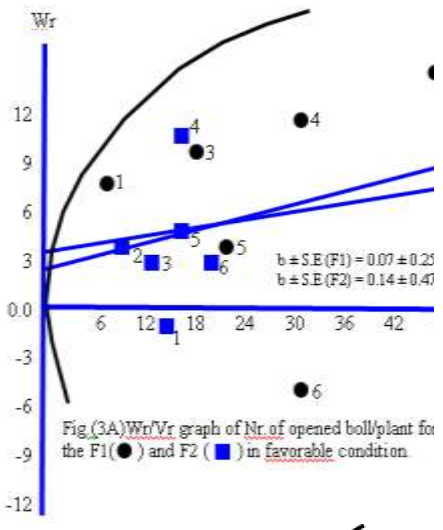

Fig.(3A)Wr/Vr graph of Nr.of opened boll/plant fo
the F1(●) and F2 (■) in favorable condition.

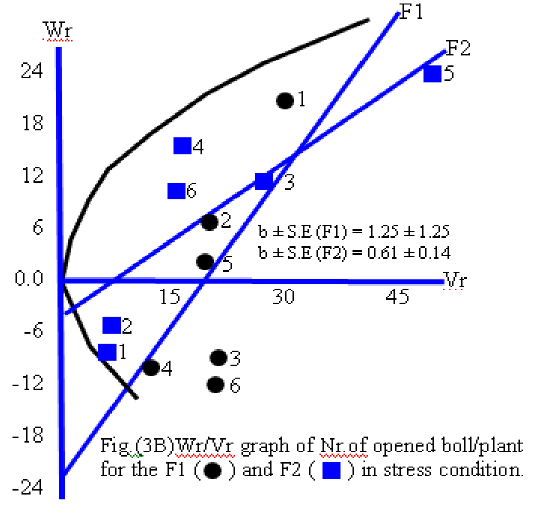

Fig.(3B)Wr/Vr graph of Nr.of opened boll/plant for the F1 (●) and F2 (■) in stress condition.

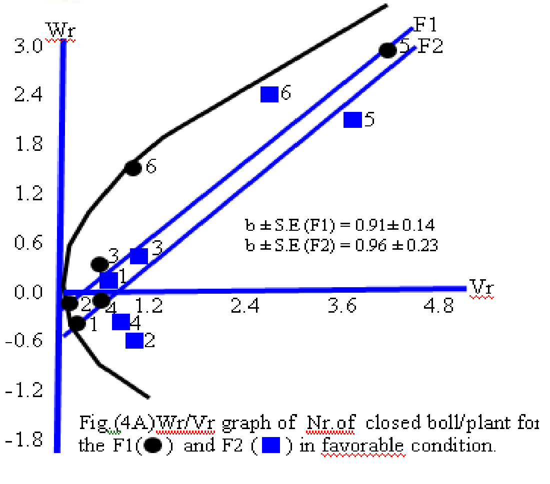

Fig.(4A)Wr/Vr graph of Nr.of closed boll/plant fo
the F1(●) and F2 (■) in favorable condition.

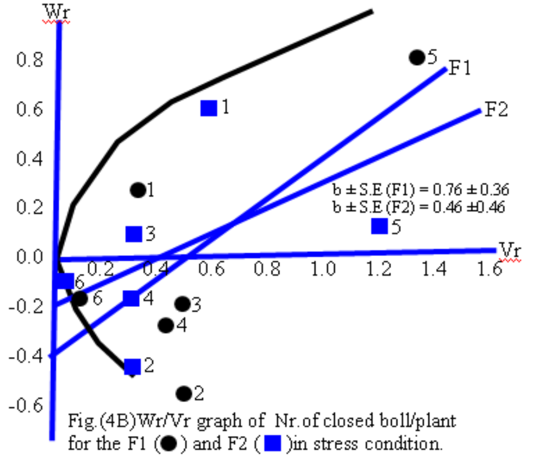

Fig.(4B)Wr/Vr graph of Nr.of closed boll/plant for the F1 (●) and F2 (■)in stress condition.

as well as for the F_1's (b = 0.76 ± 0.36) under stressed conditions indicating the adequacy of additive-dominance model. The regression line intercepted the Wr axis below the origin point indicating over-dominance for both the F_1 and F_2 generations under the two environments.

Genetic parameters:

The estimates of various component of genetic variation are given in Table 3. For plant height, the "D" parameter estimating the additive effect was much smaller than the dominance parameter "H_1" for both the F_1 and the F_2 in the two environments except for the F_2 under stress. The "F" parameter is positive for both the F_1 and F_2 in the two environments except for the F_1 in favorable environment indicating that there were more dominant than recessive alleles. Similar results were obtained by El-Ameen (1999); Esmail and Abdel-Hamid (1999) and El-Zahab et al., (2007). The average degree of dominance as measured by the $(H_1 / D)^{1/2}$ ratio reached 1.79 and 2.19 for the F_1 and the F_2 , respectively, in the favourable environment indicating over dominance. Whereas under stress, the $(H_1 / D)^{1/2}$ ratio reached 1.017 for the F_1 indicating complete dominance, but reached 0.81 for the F_2 generation indicating partial dominance. Which confirm the results revealed by the Wr/Vr graph. The $H_2 / 4H_1$ value indicated that the UV value was not equal to 0.25 indicating non-equal distribution of the dominant and recessive alleles among the six parents analyzed, which has been indicated before from the "b_2" item. Broad-sense heritability values were 0.84 and 0.67 in the favourable environment, but were 0.77 and 0.83 under stress for both F_1 and F_2, respectively, indicating that the major proportion of the total phenotypic variation was genetic variation. Meanwhile, narrow-sense heritability values were 0.57 and 0.25 in the favourable environment and amounted to 0.28 and 0.50 under stress for F_1 and F_2, respectively. These results confirm that additive gene effects are the main source of genetic variation for plant height in cotton and that selection applied in the early segregating generations could be very effective. Similar conclusion was reached by Iyanar et al. (2005). For number of opened boll, the "D" parameter was much smaller than the dominance parameter "H_1" for both the F_1 and the F_2 in the two environments. The $(H_1 / D)^{1/2}$ ratio reached 3.03 and 1.89 in the favourable environment, and reached 2.33 and 1.77 under stress for the F_1 and the F_2, respectively. The "F" parameter is positive for both the F_1 and F_2 in the two environments except for the F_1 in the favourable environment indicating that there were more dominant than recessive alleles. Similar results were obtained by Rajeswari (1995) and Zerihun et al. (2004). The value $(H_2 / 4H_1)$ that measures UV was not equal to 0.25

indicating non-equal distribution of the dominant and recessive alleles among the six parents analyzed, which was indicated before from the "b_2" item. Broad-sense heritability values under favourable conditions were 0.72 and 0.84 for the F_1 and F_2, respectively, whereas under stress, the values were 0.77 and 0.93 for the F_1 and F_2, respectively. The narrow-sense heritability reached 0.22 and 0.15 under favourable conditions and 0.15 and 0.32 under stress. Similar results were obtained by El-Ameen (1999) and Nadeem et al. (1998). For number of closed boll, the "D" parameter estimating the additive effect was much smaller than the dominance parameter "H_1" for both the F_1 and the F_2 generations in the two environments, indicating over-dominance. The average degree of dominance as measured by the $(H_1 / D)^{1/2}$ ratio reached 1.09 and 1.32 for the F_1 and the F_2, respectively, in the favourable conditions. This ratio was 1.81 and 1.66 for the F_1 and the F_2, respectively, under stress. These results confirming the results of the Wr/Vr graph. The "F" parameter is positive for both the F_1 and the F_2 in the two environments indicating that there were more dominant than recessive alleles. The UV value was not equal to 0.25 indicating non-equal distribution of dominant and recessive alleles among the six parents analyzed. Broad-sense heritability values under favourable conditions were 0.75 and 0.69 for the F_1 and the F_2, respectively, whereas under stress, the values were 0.65 and 0.52 for the F_1 and F_2, respectively. These results indicate that the major proportion of the total phenotypic variation was genetic variation, except for the F_2 generation under stress. The narrow-sense heritability values indicated that the additive component was much smaller than the other components of variance especially under stress conditions. Similar results were obtained by Gerik et al. (1996), Esmail and Abdel-Hamid (1999) and Iqbal et al. (2005).

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التحليل الوراثي لبعض الصفات المورفولوجية في القطن المصري (*Gossypium barbadense* L.) تحت بيئات متباينة.

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** قسم المحاصيل بكلية الزراعة جامعة الازهر بأسيوط

تم عمل مجموعة من التهجينات بنظام التهجين النصف دائري (دياليلل) بين ست سلالات محلية من القطن المصري هي جيزة-88 ، جيزة-90 ، جيزة-87 ، جيزة-89 ، جيزة-91 ، جيزة-83 وذلك لتقدير القيم الوراثية للصفات الزراعية-فسيولوجية تحت ظروف إثنين من البيئات المتباينة لتربة طينية خصبة وتربة رملية غير خصبة. النتائج تشير الي أن التأثيرات الاضافية والغير اضافية للجين تشترك في التحكم في الصفات المدروسة في كلا البيئتين. معظم الاختلافات تعذي الي تأثيرات الجين الغير اضافية. ضغط الجفاف عكس تأثيرات الجين المتحكمة في أرتفاع النبات وعدد اللوز المتفتح تحت ظروف البيئة المواتية ، حيث التأثيرات الاضافية للجين كانت الاكثر أهمية تحت الظروف المواتية و لكن تحت ضغط الجفاف كانت التأثيرات السيادية للجينات هي الاكثر أهمية. تحليل الـ Wr/Vr يشير الي أن السيادة الفائقة كانت فعالة في الجيل الاول والسيادة الجزئية وجدت للجيل الثاني تحت ظروف البيئتين. أتجاه السيادة للسلالات جيزة-87 و جيزة-89 كان منعكسا تحت ظروف الجفاف. القيم الوراثية تشير الي التوزيع الغير متساوي للاليلات السائدة و المتنحية بين الست أباء المدروسة. قيم معامل التوريث بالمعني الضيق كانت أقل بالنسبة لمعامل التوريث بالمعني العريض في البيئتين فيما عدا بالنسبة لصفة طول النبات مما يشير الي أن المكون الاضافي كان أصغر من المكونات الاخري للتباين.