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HETEROSIS AND COMBINING ABILITY FOR YIELD COMPONENTS,
FIBER AND YARN PROPERTIES IN INTRA-AND INTERSPECIFIC
CROSSES OF COTTON

By

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INTRODUCTION

Heterosis effects in interspecific cotton hybrids between Gossypium hirsutum L. x G. barbadense L. offer a possibility for achieving progress in cotton production . Previous experiments investigating interspecific hybrids , in many cotton producing regions , indicated an overall tendency for F_1 's to possess the high yielding ability of the G. hirsutum parents and a close resemblance in fiber properties to those of G. barbadense . For these reasons , interest in research concerning hybrid vigor or heterosis in cotton has been increasing steadily . However , the cost of producing hybrid cotton seed could be the deciding factor in determining if hybrid cotton is planted on a large scale . In India , for example , the conventional hand emasculation and pollination method was used for the development of a number of intraspecific and interspecific hybrids released for commercial cultivation on a large acreage . This might be due to that manual labor is abundant and inexpensive . The technique used in India is impractical in many other cotton producing regions especially where labor costs are high . However , with the recent development of a complete cytoplasmic male-sterile and a genetic fertility restorer system in cotton , commercial production of F_1 hybrid seed is feasible .

In addition information on the type of gene effects involved in the inheritance of economic traits of cotton is useful for formulating appropriate breeding procedures . Therefore , the present investigation comprised four Egyptian cotton cultivars (G. barbadense L.) and four American Upland cultivars (G. hirsutum L.) which were crossed in a diallel

pattern then analyzed to estimate the heterotic effects , combining ability and gene action for earliness , yield and its components , fiber and yarn properties .

REVIEW OF LITERATURE

Studies on heterosis, combining ability and gene action for agronomic and economic traits in crosses of cotton were reviewed by many workers. The following is a review for some studies dealing with the studied traits in this dissertation grouped under four headings: earliness characters, yield and yield components, fiber properties, and yarn properties.

Earliness Characters :

Earliness characters include days to first flower, height or position of first fruiting node, days to first boll opening and earliness index.

1- Days to first flower :

Marani (1963) conducted two diallel cross experiments involving G. hirsutum and G. barbadense. He found that interspecific hybrids started to flower earlier than the mean of their parents while, intraspecific crosses of hirsutum exhibited heterosis for earlier flowering but neither general nor specific combining ability effects were significant.

Al-Rawi and Kohel (1969), found heterosis for days to first flower (- 3.9%) and stated that additive genetic component (D) was significantly different from zero and greater than the dominance

component (H_1) which was also significant . This trait exhibited partial dominance and was polygenetically inherited . Heritability was relatively high (46 %) .

Singh et al. (1974) selected three testers and twelve pollinators . They obtained ten out of 36 intervarietal crosses showed hybrid vigour over the mid parent for flowering time but magnitude of heterosis was low . When compared with better parent , only two crosses should hybrid vigour for lateness and the majority of crosses showed negative heterosis , which is desirable . The range of heterois over mid parents and better parents was -12.9 to 6.7 % and - 9.6 to 6.7 % , respectively . Combining ability analysis revealed the importance of both additive and non additive components of genetic variance for this trait .

Krishnaswami and Kothandaraman (1977) , crossed three varieties of G. hirsutum with two varieties of G. barbadense . The hybrids showed significant and negative heterosis for flowering .

Selim et al. (1979) found a small heterotic effect for days to first flower in diallel cross of Egyptian cotton . Variance of general combining ability was significant and ~~larger~~ in magnitude than specific combining ability for days to first flower .

Shokry et al. (1981) studied a diallel crosses of G. barbadense . They found that dominance and additive effects were equal for days to

first flower and the average degree of dominance indicated over dominance for this trait . Heritability estimate for this trait showed that half of the variance was additive in nature .

Khattab et al. (1982) stated that no heterosis was noted for date of first flower in three crosses except ,for negative mid parent heterosis in one cross (Giza 72 x Giza 67) .

Silva and Alves (1983) , stated that additive gene action was predominant for days to first flower initiation . Evidence for dominance gene action was also obtained for this trait . Epistasis did not affect the expression of days to first flower initiation.

Wriboko (1983) noted that additive gene effect for days to first flower was very low or absent indicating that selection efficiency would be very poor .

Udayakumar et al. (1984) crossed six females from G. herbeceum with four males from G. arborium . They found that almost all hybrids exhibited negative heterosis over mid-parent and better parent for days to 50 % flowering .

2- Possition of first fruiting node :

White and Kohel (1964) estimated by broader diallel analysis that additive component ' D ' and dominance component's' H_1 or H_2 ' were not significant for the first fruiting node .

Ray and Richmond (1966) found that heritability for first fruiting node in broad sense was 60% in the cross C.B 3051 x Z-106 and 43% in C.B 3051 x Contextum cross .

Shokry et al. (1981) , stated that dominance had greater effect for first fruiting node . The average degree of dominance indicate over dominance . The heritability estimates revealed the $\frac{1}{4}$ of variance was additive in nature for first fruiting node .

Khattab et al. (1982) made two interspecific crosses and one intraspecific cross . No heterosis was noted for node of the first sympodium in the three crosses except positive useful heterosis for node of first sympodium in third cross . It might be an evidence that early parents would produce earlier hybrid cotton despite of the vigorous growth of F_1 's potence ratio indicated over dominance .

Rady and Gomaa (1983) used the six populations (P_1 , P_2 , F_1 , F_2 , BC_1 and BC_2) of an intraspecific (cross I) and of an interspecific (cross II) cross . Significant heterotic effects were detected for height of first fruiting node in cross I .The potence ratio indicated over dominance in cross I and partial dominance in cross II . The additive gene effect was significant and more important than the non-additive gene effect in the inheritance of height of first fruiting node in cross II while in cross I , the additive gene effect was also significant but non additive was relatively more important . The heritability for this

trait in narrow sene was high 55.29 % , 52.35 % in cross I and II , respectively .

Silva and Alves(1983)found that epistasis affected the expression of number of nodes or first fruiting branches while additive and dominance did not affect .

Wariboko (1983) found that additive genetic effects for first fruiting node was very low or absent .

Khajjidoni et al. (1984) obtained positive heterosis and found that specific combining ability was greater in magnitude than general combining ability .

3- Days to first boll opening :

Krishnoswomi and Kothondaroman (1977) observed heterosis for days to first boll opening ranged from 7.9 to 10.9 % and from 15.9 to 21.8 % relative to mid- and better parents , respectively .

Selim et al. (1979) found in a diallel cross of Egyptian cotton that mid-parent heterosis in days to first boll opening was not significant while ,small heterotic effect , relative to better parent ,was obtained . Also , variance of both general and specific combining ability for this trait was not significant .

Khajjidoni et al. (1984) used in line x tester analysis , two female parents of G. arborium and ten male parents of G. hirsutum . They observed positive heterosis for days to 50 % boll opening .

Vdayakumar et al (1984) stated that hybrid exhibited earliness over respective mid-parent in days to first boll opening .

4 - Earliness index :

Marani (1964) stated that there were no significant heterotic effects for mean date of maturity in 1959 but in 1960 the interspecific crosses matured later than the average of the parents though not as late as the G. barbadense . There was no significant difference for mean date of maturity among the G. barbadense and their intraspecific crosses. There was significant general combining ability effect of the G. hirsutum varieties in the inter-specific crosses for mean date of maturity in 1960. Significant general combining ability effect of G. barbadense varieties was found for mean date of maturity . Non-additive genetic variance seems to be of less importance for mean date of maturity because of smaller degree of hetirosis .

White and Kohel (1964) indicated that some reciprocal differences exist for earliness . Among the components estimated in diallel analysis the additive component (D) was significant for earliness while other components . F , H_1 , H_2 , h^2 , and E were not significant .

Marani (1967) found that interspecific hybrids mature later than G. hirsutum parents and earlier than G. barbadense parent . General combining ability was significant for G. hirsutum parents while specific

combining ability was not significant .

Marani(1968 a) found that maturity (% 1 st harvest) of F_1 plants was intermediate . No heterosis was caused by dominance and additive x additive epistasis parameters . Both parameter were being of nearly equal magnitude .

Al-Rawi and Kohel (1969) found that heterosis relative to mid-parent was small but significant for earliness . The results showed significant difference from zero for both genetic or significant derviation from zero . Components , addetive "D" and dominance (H_1) while the parameter 'F' was negative and significant indicating axcess of recessive genes in the parent . Heritability as ratio of additive or additive x additive epistatic variance , or both to total phenotypic was relatively high suggested that additive was major variance of total phenotypic .

Maurray and Verhalen (1969) found that the F_1 and F_2 means for earliness were very similar to mid-parent . These data suggested that genetic system for earliness was premarily additive . The heritability for earliness was 73 % indicating that selection in this later generation material was highly effective for earliness .

Baker and Verhalen (1973) stated that over-dimonance governed the earliness . The results indicated no significant difference from zero for both genetic components , additive "D" and dominance (H_1 , H_2) and the parameter "F" was positive and significant . This suggested

greater frequency of dominant alleles in the parents . The heritability was significant two fifths to earliness .

Baker and Verhalen (1975) studied a diallel of ten lines of Upland cotton . They found that degree of heterosis was greater for earliness (15.7 %) . Estimates of general and specific combining ability were highly significant and dominance variance was important for earliness . Relatively high levels of heterosis and specific combining ability effects for earliness in certain crosses , suggested that some potentially useful hybrid combination were present .

Abo-El-Zahab and Sallam (1979) investigated diallel of eight parents of *G. barbadense* . They found that additive gene effects were more important than dominance in determining earliness over both years and all sites . Dendara , Menoufi and Giza 68 had the best combining ability for earliness . Narrow sense heritability of the character was high (70 %) .

Zhalilov (1981) indicated that F_1 hybrids between parents of different growth periods were closer to earlier parent while , those between parents similar in earliness showed heterosis for this trait .

Rady and Gomma (1983) made two crosses ; cross I was *barbadense* intraspecific and cross II was *hirsutum*-*barbadense* inter-specific . Insignificant heterotic effects were detected for earliness index in both crosses . The additive gene effect was significant and more important than non-additive gene effect in the inheritance of earliness index in