Genetic basis of sensitivity to late planting in Egyptian cotton

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SUMMARY

Sixteen cultivated and obsolete Egyptian cotton varieties were evaluated under early and late planting conditions for two seasons at Assiut Univ, Exper. Farm. Four tolerant (Giza 95, Giza 90, Giza 80, and Giza 90 × Australian) and four sensitive to late plating stress condition (Giza 92, Giza87, Giza86, and Giza45) were selected from the sixteen varieties and crossed in a diallel fashion excluding reciprocals. In the third season the eight parents and their F_1- hybrids were evaluated at Shandaweel Res. Stn. ARC. Sohag, Egypt. So, sixteen varieties were evaluated for two seasons, and eight were evaluated for three seasons.

The results could be summarized as:

1-Tolerance of Egyptian cotton varieties to late planting.

A- Evaluation of 16 varieties for two seasons

Mean squares of all the studied traits indicates significant ($p \leq 0.01$) differences among varieties in separate and combined analysis under early and late plantings. The combined analysis showed significant ($p \leq 0.01$) differences between dates for all traits. However, the interactions of varieties × dates and varieties × dates × years were not significant. The varieties × years' mean squares was significant only for lint percentage, boll weight and days of first flowers. Furthermore, the interaction mean squares of varieties x years under early planting and under late planting was not significant indicating that the different traits were stable from year to year either for early or for late planting.

- Mean seed cotton yield /plant indicated that Giza 87 showed the lowest and Giza 90× AUS had the highest yielding ability in both years and planting dates. Average seed cotton yield/plant was 92.99 g/plant under early and 75.12 g/plant under late planting. Late planting caused severe reduction in seed cotton yield reached 19.28, 19.14 and 19.21 % in the first, second year and combined date; respectively.

- The highest susceptibility index(s) was recorded for the varieties Giza 81 and Menoufi (1.29) followed by Giza 85 (1.20), Giza 88 (1.20), Giza 69 (1.15), Giza 95 (1.15), Ashmouni (1.10) and Giza 92 (1.04). These varieties could be considered susceptible to late planting, but the other eight varieties could be considered tolerant to late planting. It should be indicated that the highest yielding varieties (G90×Aus, Giza 90, Dandera, Giza 86 and Giza 80) were tolerant to late planting and scored stress susceptibility index less than unity.
- The highest varieties in lint yield were G90× Aus, followed by Giza 90, Giza 80, Giza 86 and Giza 95 under both planting dates. Average lint yield/plant was 34.67 and 26.80 g/plant under early and late planting; respectively. The reduction % in lint yield caused by late planting was very high and larger than that in seed cotton yield, and reached 22.88, 22.56 and 22.72 in the first, second year and combined data; respectively.
- The highest lint percentage was for G90× Aus and the lowest for Giza 45 under early and late planting, and the combined means. The combined means of lint percentage ranged from 36.98 to 35.33% under early planting; respectively. The combined reduction % was 4.47%. Stress susceptibility index of the evaluated varieties for lint percentage indicated that Giza 81 was the most affected varieties followed by Giza 45, Giza 8, Giza 95, Giza 92, Dandera, and Giza 88, and the least affected varieties were Giza 45, Giza 69, and Giza 90.
- Mean boll weight was 2.93 under early and 2.31 g under late plantings. The combined reduction was 31.31%. The most affected varieties respect to boll weight as measured by stress susceptibility index were Giza 95, Giza 92, Giza 86, Giza 85, Giza 80, Menoufi, Ashmouni and Dandera varieties. These varieties could be considered susceptible. The tolerant varieties were Giza 69, Giza 45, and Giza 87 which showed susceptibility index less than unity (0.65- 0.67).

- Mean number of bolls/plant indicated increase in late planting than in early planting. This is due to that the reduction in boll weight was more than that in seed cotton yield. Therefore, the increase in number of bolls /plant under late planting is expected. The highest number of bolls/plant in both seasons and combined data either under early or late planting was recorded by G 90× Aus followed by Giza 90, Dandera and Giza 81, but the lowest one was for Giza 87. The combined data showed that the varieties G 90× Aus recorded 47.37 and 49.71 bolls /plant at early and late planting; respectively.
- Mean seed index was 9.80 under early and 8.44 g under late plantings. The combined reduction was 13.86 %. Stress susceptibility index indicated that Giza 92, Giza 90, Giza 87, Giza 86, Giza 85 and Giza 80 were susceptible in seed index to delay planting and scored more than unity. However, varieties Dandera, Ashmouni, Giza 95 and G 90× Aus were tolerant to late planting. The best tolerant varieties in seed index were Dandera and Giza95.
- Mean lint index was 6.05g under early and 6.45g under late plantings, and the reduction was -8.07%. This could be due to that lint index is an estimated character (seed index * weight of lint / weight of seeds in a sample) and the lint was more affected than seeds by delaying planting date as mentioned before. Therefore, the stress susceptibility index become of no meaning.
- Means of earliness index was 66.78% under early and 66.08% under late plantings, and the reduction was 1.06%. Therefore, stress susceptibility index is less profitable. This could be due to that the first pick is determined visually when the open bolls of most varieties reached about 60 %. On the other hand, earliness index considered the easy applicable method to differentiate earliness of different varieties.
- Mean days to first flower was 88.72 under early and 72.99 under late plantings and the reduction was 11.34%. The combined means of the stress - susceptibility index indicate that Giza90 was the best tolerant variety under delay planting followed by Ashmouni, Giza90, Giza95 and Giza77, while

Giza 87, Giza 86, Giza 85, Giza 81, Giza 80, Giza 69 and Giza 45 were susceptible.

B - Evaluation of eight varieties for three seasons

- The differences among varieties were significant ($P \leq 0.01$) either under early or late planting. The interaction of varieties with year was not significant for all traits in both cases. These results indicate that the main cause of reduction in cotton yield is late planting date. This is due to that all the Egyptian cottons were bred to grow under full season and not for short season conditions. However, the stress susceptibility index indicated to the presence of tolerant varieties to late planting, and there is a chance to select for short season condition from the progenies of such tolerant varieties.
- Mean seed cotton and lint yield/plant indicated that the varieties G90× Aus was the highest yielding in the three seasons and combined means, while Giza 87 showed the lowest yield. The combined means showed that seed cotton yield/plant ranged from 65.41 to 126.73 with an average of 95.92g/plant under early, and from 56.10 to 107.03 an average of 79.27g/plant under late planting. The combined reduction % reached 17.36
- Likewise, lint yield/plant ranged under early planting from 21.31 to 51.01 with an average of 36.55g/plant, and from 17.17 to 41.32 with an average of 28.67g/plant under late planting. The high yielding varieties were G90 × Aus, Giza 90, Giza 90, Giza 86, Giza 80 and Giza 45. Generally, the reduction % in yield caused by delay planting was higher in lint than in seeds. The stress susceptibility index in both of seed cotton and lint yields was alike to large extent, Giza 95, Giza 92 were susceptibility to late planting. The varieties Giza 90, Giza 86 and Giza 45 tended to showed average susceptibility, whereas G90× Aus, Giza87and Giza80 were tolerant to delay planting.
- Mean lint percentage indicated that G90 × Aus, Giza 95, and Giza 80 showed the high lint percentage in the three seasons, while, Giza87 was the lowest. The combined means showed that lint percentage varied from 32.74 (Giza80)

to 41.49 (Giza95) under early planting, and from 30.61 (Giza87) to 38.60 (G90× Aus). The reduction % was 4.80, 4.63 and 7.40 with an average of 5.78. The low reduction % in lint percentage was due to lint yield was more affected by delay planting than seed cotton yield. The varieties Giza95 and Giza45 were susceptibility to delay planting, Giza87 and Giza92 showed average susceptibility, while Giza90, G90× Aus, Giza86 and Giza80 were tolerant in lint percentage and showed stress susceptibility index lower than unity.

- The combined means showed that Giza86, Giza80, Giza92 and Giza45 were the best varieties in boll weight. The reduction % in boll weight caused by late planting was high; 22.14, 19.44 and 20.03 % in the first, second and third seasons, with an average of 20.54 %, respectively. The stress susceptibility index of the different varieties respect to boll weight indicate that Giza86 (1.35), Giza95 (1.10) and Giza92 (1.11) were susceptible, Giza90 (1.04) and Giza80 (0.94) were average susceptible and G90× Aus (0.84), Giza87 (0.67) and Giza45 (0.61) were tolerant to delay planting.
- Mean number of bolls/plant indicated that G90× Aus gave the highest number in the three seasons, while Giza87 gave the lowest number in two seasons and combined means. At early planting the combined means ranged from 24.49 (Giza87) to 46.68 (G90× Aus) with an average of 32.40, and from 24.15 to 49.15 for the same respective varieties under late planting with an average of 33.67 bolls/plant. The reduction % in number of bolls/plant was negative.
- The combined means of seed index ranged from 9.14 (G90 × Aus) to10.89 (Giza80) with an average of 9.94g under early planting, and from 7.97 (Giza45) to 9.34 (Giza80) with an average of 8.45g under late planting. The reduction % in seed index was 15.33, 14.63, 14.82 and 14.93% in the first, second and third seasons and combined means; respectively. Average of stress susceptibility index of Giza92, Giza90, Giza87 and Giza86 was more

than unity (susceptible). The best tolerant variety was Giza95 which showed stress susceptibility index of 0.46.

- The combined means of lint index ranged from 4.87 (Giza87) to 7.37 (G90 × Aus) with an average of 6.12g, and from 5.33 to 7.84 for the same respective varieties with an average of 6.58g under late planting. The reduction % was negative because of the high reduction % in lint yield compared seed cotton yield.
- The combined means of earliness index ranged from 59.52 (Giza87) to 80.69 (Giza 90) with an average of 69.75 % under early planting, and from 60.57 to 80.69 with an average of 69.70 % under late planting. The reduction % in earliness index was very small and negative in two seasons. This mainly due to that the first pick is estimated visually when open bolls of most varieties reached about 60 %. Therefore, stress susceptibility index become of no meaning.
- The combined of days to first flower means ranged from 68.33 for Giza90 to 85.56 for G90 × Aus with an average of 79.42 days. Under late planting, days to first flower ranged from 66.84 (Giza 90) to 77.78 (G90× Aus) with an average of 77.65. Days to first flower was reduced by delay planting, and the reduction % reached 11.85, 11.92, 0.86, 8.52 % in the first, second and third seasons and combined means; respectively. The combined stress susceptibility index indicated that Giza 95 (0.68), Giza92 (0.61) and Giza90 (0.23) were the tolerant varieties to delay planting; however, the other varieties were susceptible.
- It could be concluded that the main cause of reduction in cotton yield is late planting date. This is due to that all the Egyptian cottons were bred to grow under full season and not for short season conditions. However, the stress susceptibility index indicated to the presence of tolerant varieties to late planting, and there is a chance to select for short season condition from the progenies of the crosses of such tolerant varieties.

2- A study of phenotypic and genotypic correlations and path analysis of seed cotton yield components.

- Phenotypic and genotypic correlation coefficients among the first set of varieties (16) were very close together and some limes were similar. This could be due to the small error variance. Under early and late planting seed cotton yield/plant showed the highest genotypic correlation (0.989) with lint yield/ plant followed by the correlation with number of bolls/plant (0.856) and boll weight (0.296). However, the genotypic correlation of seed cotton yield/plant and seed index was very small (0.042). The genotypic correlation of lint yield/ plant with number of bolls/plant was high (0.820), followed by the correlation with boll weight (0.345). The genotypic correlation between boll weight and seed index was positive, high and expected (0.736). Another genotypic correlation worthy of attention were the negative correlation between number of bolls/plant and each of boll weight (-0.241) and seed index (-0.357). Therefore, simultaneous improvement of boll weight and number of bolls in Egyptian cotton is difficult because of this unfavorable negative correlation. The small boll size of Egyptian cotton is an obstacle to improve yield. The high yielding plants produced high number of bolls rather than heavy bolls. Recurrent selection could be effective in breaking up such unfavorable linkage groups for simultaneous improvement of boll weight and number of bolls/plant.
- Under late planting the genotypic and phenotypic correlations among traits of the 16 varieties were very close together. The genotypic correlations between seed cotton yield and lint yield was high (0.986) followed by number of bolls/plant (0.965), boll weight (0.284) and seed index (0.215). Otherwise, the negative correlations between number of bolls and each of boll weight and seed index obtained under early planting changed to very small positive of 0.054 and 0.074; respectively under late planting.

- The phenotypic and genotypic correlations among traits of eight varieties evaluated for three years under early planting showed the same trend and lend support to the conclusion from that of the sixteen varieties. However, under late planting, the genotypic correlations of boll weight with yields decreased than those under early planting.
- Under early planting of the first set of genotypes, the correlations coefficient of lint yield / plant with seed cotton yield/plant was positive and very large in magnitude (0.989) under phenotypic and genotypic levels. However, it showed negative direct effect of (-1.949) at phenotypic and (-0.186) at genotypic level. Otherwise, lint yield showed high positive indirect effects via number of bolls/plant of 2.313 and 0.951, and via boll weight of 0.635 and 0.224 at phenotypic and genotypic levels; respectively.
- The path analysis showed somewhat different picture from genotypic and phenotypic correlations. The direct effect of lint yield/plant was the highest and negative (-1.949) at genotypic level, and the effect of lint yield/plant was indirect effects via number of bolls/plant and boll weight.
- Under late planting, the direct effect of lint yield/plant was (0.465) at phenotypic and (0.331) at genotypic level. However, the indirect effects of lint yield on seed cotton yield via number of bolls/plant was the highest one. Phenotypic (0.283) and genotypic (0.284) correlation of boll weight with seed cotton yield showed low direct effects on seed cotton yield. The highest direct effects on seed cotton yield were for number of bolls/plant, which scored Phenotypic (0.514) and genotypic (0.643) direct effects.
- It could be concluded that, respect to the sixteen varieties evaluated for two seasons under late planting; the highest direct effect was for number of bolls / plant followed by lint yield and boll weight, while, the effect of seed index in improving seed cotton yield was low and negligible.
- The phenotypic and genotypic correlation coefficients of seed cotton yield/ plant with its contributing traits of the eight selected varieties evaluated for

three seasons were partitioned to direct and indirect effects under early planting the phenotypic and genotypic correlation of lint yield/plant with seed cotton yield/plant were similar (0.993). However, the direct effect of lint yield/plant was positive and differed greatly at phenotypic (0.485) and genotypic (2.178) levels. Furthermore, it differed from those negative direct effects in the first set of varieties. At phenotypic levels the effects of lint yield on seed cotton yield were through direct effects (0.485) and indirect effects via number of bolls/plant (0.449) and little via boll weight (0.059). The effect of lint yield via seed index was zero. At phenotypic levels, lint yield/plant worked through its direct effects on seed cotton yield/plant only, since its indirect effects were negative via number of bolls/plant (-0.911) and boll weight (-0.273). The phenotypic and genotypic correlation coefficients of the other traits; boll weight, number of bolls/plant and seed index were very close together or similar. Otherwise, their direct and indirect effects on seed cotton yield/plant mostly differed in sign and magnitude from phenotypic to genotypic level. The direct effects of boll weight were (0.183) and (-0.806), of number of bolls/plant were (0.466) and (-1.057) and of seed index were (0.002) and (0.161) for phenotypic and genotypic levels; respectively. Under late planting the direct effects were (1.24) and (0.914) for lint yield/plant, (-0.191) and (-0.026) for boll weight, (-0.247) and (0.097) for number of bolls/plant and (0.036) and (-0.035) for seed index at phenotypic and genotypic levels; respectively.

- Generally, it could be concluded that either under early or under late planting the direct effects of lint yield/plant on seed cotton yield/plant was the highest one. Furthermore, the effects of boll weight, number of bolls/plant and seed index on seed cotton yield/plant were via lint yield/plant, which was positive in all cases except with seed index under early planting.

3- Genetic analysis of seed cotton yield /plant and its attributes

- The analysis variance of seed cotton yield/plant, boll weight, number of bolls/plant, seed index and number of seeds/boll indicated significant ($p \leq 0.01$) differences among entries (parents and crosses) except for boll weight and number of seeds/boll under early planting date.
- Mean scy/p of the parents was 95.88 and 78.64 g, and 75.55 and 61.76g for the hybrids under early and late plantings; respectively. The reduction caused by the stress of late planting reached 17.08 and 18.25% for the parents and hybrids; respectively.
- Mean boll weight of the parents was 2.98 and 2.38 g, and 2.89 and 2.43g for the hybrids under early and late plantings; respectively. The reduction caused by the stress of late planting reached 20.13 and 15.91% for the parents and hybrids; respectively.
- Mean NB/P of the parents was 32.40 and 33.26, and 26.26 and 25.48 for the hybrids under early and late plantings; respectively. The reduction caused by the stress of late planting reached -2.65 and 2.97% for the parents and hybrids; respectively.
- Mean seed index of the parents was 9.98 and 8.50 g, and 9.60 and 8.69g for the hybrids under early and late plantings; respectively. The reduction caused by the stress of late planting reached 14.82 and 9.47% for the parents and hybrids; respectively.
- Mean NS/B of the parents was 18.52 and 18.12, and 18.85 and 18.19 for the hybrids under early and late plantings; respectively. The reduction caused by the stress of late planting reached 2.16 and 3.5% for the parents and hybrids; respectively.
- The diallel analysis of variance indicated significant ($p \leq 0.01$) “a” and “b” items for all traits expect for “b” item of seed cotton yield/ plant and “a” item for number of seeds/boll under late planting. The significant “a” and “b”

items indicated that both additive and dominance effects of genes were involved in the inheritance of the respective traits.

- The "b_1" item mean squares was significant for seed cotton yield/plant and number of bolls/plant under early planting, and seed index under both planting conditions.
- The "b_2" item was significant for seed cotton yield/plant under early planting, boll weight under late planting, number of bolls and seed index under both planting conditions.
- The "b_3" item was significant for seed cotton yield/plant under early planting, boll weight under late planting, number of seeds /boll under late planting and number of bolls/plant and seed index under both planting dates.
- The diallel analysis of variance and graphical analysis indicated that the epistatic gene effects were involved in the inheritance of seed cotton yield/ plant.
- The analysis of boll weight under late planting condition showed that the regression coefficient of Wr/Vr was negative and differed significant ($p \leq 0.01$) from unity but not from zero indicating the presence of epistatic gene interaction in the inheritance of boll weight.
- The graphical analysis of number of bolls/plant indicated partial dominance under early and over-dominance under late planting. The regression coefficient showed significant difference from unity and zero under early and not significant from both under late planting declaring the presence of epistatic effects of genes controlling number of bolls/plant.
- The graphical presentation of seed index showed that under early planting the regression coefficient of Wr/Vr was not significant unity, but significant from zero, and Wr–Vr mean squares was not significant indicating the adequacy of the additive-dominance model for the data of seed index. Furthermore, the intercept of the regression line to the Wr axe was negative and very small (-0.0473) indicating nearly complete dominance. However,

under late planting, the regression coefficient was significant from both of zero and unity indicating, the presence of non–allelic gene interaction and the inadequacy of additive–dominance model for seed index under late planting.

- The results of seed cotton yield/plant under early planting showed that the additive parameter "D" was significant ($p \leq 0.01$). Likewise, the dominance parameters "H1" and "H2" were significant ($p \leq 0.01$). These results indicated that both additive and non–additive effects of genes were involved in the inheritance of seed cotton yield/plant. The "F" parameter was positive, but not significant from zero. Furthermore, the KD/KR was nearly equal one (1.0459) indicating symmetrical distribution of dominance and recessive genes in the parents. The estimate of UV of seed cotton yield under early planting was (0.2096) and showed slight departure from the theoretical value, and could be considered near the theoretical value (0.25) confirming the results of the insignificant "F" parameter and the ratio KD/KR. The slight departure of UV from the theoretical value may cause invalidity estimate of average degree of dominance. In which the intercept of regression line was positive indicated partial dominance. The high estimate of H1 and H2 respect to the "D" parameter and the significant of regression coefficient of Wr / Vr (Table 13) which indicate the presence of non–allelic interaction caused departure of narrow (0.5715) from broad sense heritability (0.8947). The parental mean (95.88g/plant) and the hybrids mean (75.55g/plant) indicated the absence of hybrids vigor in seed cotton yield/ plant in this set of diallel crosses.
- The genetic parameters of seed cotton yield/plant under late planting conditions) were negative because of the very large experimental error. However, the "a" and "b" items were significant indicating the presence of additive and dominance effects. The insignificant of regression coefficient of Wr / Vr from zero indicated non – allelic interaction. Generally, it could be

concluded that the inheritance of seed cotton yield /plant under both planting conditions controlled by additive, dominance and epistatic effects of genes.

- Generally, the results of boll weight suggested that additive, dominance and epistatic genes interaction were involved in the inheritance of boll weight under the stress of late planting. The large experimental error resulted in unreliable genetic parameters, ratios and estimators.
- Generally, it could be concluded that additive, dominance and epistatic effects of genes were involved in the inheritance of number of bolls/plant.
- The genetic analysis of number of seeds/boll under late planting indicated insignificant of the additive effects “a item”, however, the dominance item “b” was significant ($p\leq 0.01$) indicating the presence of dominance effects of genes. The analysis of $b_{Wr/Vr}$ indicated the presence of epistatic effects of genes.

4- Genetic analysis of earliness and lint yield/plant and its attributes

- The analysis variance indicated significant ($p \leq 0.01$) differences among entries (parents and crosses) for lint yield/plant, lint %, lint index, days to first flower and earliness index. Therefore, the diallel analysis was perfromed.
- Mean lint yield/plant was 36.7 and 28.18g for the parents with reduction of 23.21%, and was 28.48 and 21.68g, for the hybrids with reduction of 23.87% under early and late plantings; respectively.
- Mean lint % was 37.75 and 35.31% with reduction of6.46% for the parents, and was 37.53 and 35.02% with reduction of 6.68% for the hybrids under early and late plantings; respectively.
- Mean lint index was 3.13 and 6.46g with reduction of -5.38% for the parents, and was 6.29 and 6.23g with reduction of 0.95% for the hybrids under early and late plantings; respectively.

- Mean earliness index was 69.97 and 70.19% for the parents with reduction of -0.31%, and was 67.64 and 67.71% with reduction of 2.97% for the hybrids under early and late plantings; respectively.
- Mean days to first flower was 72.79 and 72.17 with reduction of 0.85% for the parents, and was 73.35 and 72.30 with reduction of 9.47% for the hybrids under early and late plantings; respectively.
- The diallel analysis of variance showed insignificant ($p \leq 0.01$) mean squares of the item "a" and "b" indicated that both additive and dominant effects of genes were involved in the inheritance of the all traits. The "b_1" item mean squares was significant for lint yield/plant, lint index and earliness index under both planting dates, and lint % and days to first flower under late planting condition.
- The "b_2" item was significant for the five studied traits except for lint % and earliness index under early planting. Significant "b_2" item indicating asymmetrical distribution of dominance recessive genes among the parents.
- The "b_3" item mean squares was significant ($p \leq 0.01$) for all traits.
- The graphical analysis of lint yield / plant indicated that the regression coefficient of Wr/Vr under early planting did not differ from unity, but, significant differ from zero indicating the adequacy of additive dominance model. Furthermore, the mean squares of Wr + Vr was significant, and Wr - Vr was not, indicating absence of epistatic effects of genes. However, under late planting the regression coefficient was significant ($p \leq 0.01$) from unity and zero indicating the presence of non-allelic interaction despite insignificant Wr – Vr mean squares. The intercept of the regression line was positive under the two planting dates indicating partial dominance. However, it could be considered complete dominance for two reasons. First, the Wr and Vr must be corrected to the environmental component. Second, the intercept under early planting was 7.4321 and the maximum Wr and Vr (G.95) was about 60. Under late planting G.90×Aus recorded Wr of 35 and Vr of 50, and

intercept was 5.1253 (near the origin). The distribution of the parents around the regression line were consistent to large extent, and G.45, G.87, G.92 have most dominant genes and located near the origin, while G.90×Aus, G.80 and G.92 were located in the upper most of the regression line and have most of recessive genes. The correlation between Wr + Vr and mean perfromance of the parents was positive and significant indicating that the recessive genes controlling lint yield / plant in this set of diallel are increasers.

- The graphical presentation of lint% indicated the presence of epistatic effects of genes controlling this trait.
- The graphical presentation of lint index indicated the presence of epistatic effects of genes controlling this trait under late planting, but the additive-dominance model was adequate under early planting, and correlation of the parental perfromance and Wr + Vr was positive (0.5754) but not significant indicating bidirectional dominance.
- The analysis of Wr / Vr for earliness index showed non-allelic interactions of genes under both of early and late plantings. The correlation between the parental perfromance and Wr + Vr was positive and significant ($p \leq 0.01$) indicating that the recessive genes were increasers. The distribution of the parental lines around the regression line were not consistent under the two planting conditions.
- The graphical presentation of Wr / Vr of days to first flowers under early and late planting conditions indicated that the regression coefficient of Wr / Vr was significant ($p \leq 0.01$) from zero, but not from unity indicating absence of epistatic gene effects in the inheritance of days to first flowers. The regression line intercepted the Wr axe near the origin showing near complete dominance. The correlation of the parental perfromance with Wr+Vr was negative but not significant indicating ambidirectional dominance.

- The additive parameter "D" was significant ($p \leq 0.01$) from zero for lint yield/plant under both planting conditions. Likewise, the dominance parameters "H_1" and "H_2" were significant ($p \leq 0.01$). These results indicate that both additive and dominance effects of genes involved in the inheritance of lint yield/plant. Furthermore, the "H_1" was larger than "D" under late planting indicating the importance of dominance under the stress of late planting. The parameter "H_2" was less than "H_1" indicating that the positive and negative alleles at the loci of this trait were not equal in proportion in the parents. The "F" parameter of lint yield/plant was positive and significant ($p \leq 0.01$) indicating that the dominance alleles were more than the recessive alleles in the parents. In like manner, estimate of the ratio of dominant to recessive alleles in the parents (K_D/K_R) were greater than one which indicated asymmetry of distribution of dominate and recessive genes in the parents. The estimates of $\bar{U}V$ were lower than the theoretical value (0.25) suggesting that positive and negative alleles were not equally among the parents, and the parents seemed to carry more dominant than recessive genes as indicated by the positive significant parameter "F". The average degree of dominance $(H_1/D)^{1/2}$ showed nearly complete dominance. The pronounced effect of dominance was reflected in the departure of narrow from broad sense heritability; they were 0.627, 0.916 and 0.495 and 0.835 for early and late planting; respectively.
- The results of lint index under early planting indicating that the additive parameter "D" was not significant from zero and significant ($p \leq 0.01$) under late planting. Under early planting the UV (0.235) was very close the theoretical value (0.25) indicating equal distribution of dominant and recessive genes in the parents. However, the "F" parameter was positive but not significant from zero, and the (K_D/K_R) was larger than one. The mean squares of "b_2" was significant. These results indicate that lint index under early planting mainly controlled by dominance gene effects, the dominant

genes were more than the recessive genes and the dominance nearly complete. The larger effects of dominance than additive were reflected in the departure of narrow sense (0.4829) from broad sense heritability (0.8587). The parental mean was near the hybrids mean indicating very small hybrid vigor. On the other hand, lint index under late planting was mainly controlled by additive genes and the parameters of dominance; H1 and H2 were not significant.

- The earliness characters; earliness index and days to first flowers were mainly controlled by additive genes, in which the additive parameter "D" was significant ($p \leq 0.01$) for both planting conditions. However, the dominance parameters; H1 and H2 were not significant except for days to first flowers under late planting. The "F" parameter in the two earliness traits were positive and significant differed from zero except for earliness index under early planting indicating excess of dominant genes than recessive genes. The average degree of dominance indicated partial dominance. However, the "UV" estimates were far from the theoretical value (0.25) which invalidated the values of average degree of dominance. Heritability estimates in broad sense of the two traits ranged from 0.5245 to 0.6727, and narrow sense ranged from 0.2820 to 0.5527. The differences between the parental means and the hybrid means were small indicating absence of hybrid vigor in general, but may some individual hybrids show hybrid vigor.