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# ESTIMATES OF GENOTYPIC AND PHENOTYPIC VARIANCES AND STEPWISE REGRESSION ANALYSIS IN EGPTIAN COTTON AND THEIR IMPLICATION IN SELECTION

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## ABSTRACT

Stepwise multiple regression analysis was carried out during 1998 and 1999 seasons using ten Egyptian cotton varieties i.e., Giza 83, Giza 45, Giza 84, Giza 70, Giza 75, Giza 76, Giza 77, Giza 79, Giza 85 and Giza 81 to study the effective variables that accounted for the variance of lint yield/plant. The results indicated that number of open bolls/plant was the variable that exerted the greatest influence on lint yield/plant and contributed about 84.55%, 79.14% and 90.55% of the total lint yield variation in 1998, 1999 and combined analysis over the two seasons, respectively. Lint percentage and boll weight contributed about 8.90%, 4.60% and 2.0%; and about 4.94%, 12.39% and 6.48% of the total lint yield/plant variation in 1998, 1999 and combined analysis over the two seasons, respectively. This study indicated that number of open/boll was the major and the most consistent source that account for variation of total lint yield/plant, therefore, this trait must be considered in any breeding program for increasing yield of Egyptian cotton. The data indicated slight discrepancy between p.c.v. % and g.c.v. % for the most studied traits, reflecting the high estimates of genotypic variances. The genotypic and phenotypic correlation among pairs of traits over the two seasons, as well as the stepwise prediction equation and implications of the present results in breeding programs were discussed.

## INTRODUCTION

Yield is a complex polygenic character, they direct selection would not be a reliable approach because it is highly influenced by environmental factors. The study of the relationship between yield and its components, upon which the performance of cotton cultivars depend, is very important in breeding for high yielding ability. Thus, knowledge concerning the association between characters is of prime importance to the breeder as it broadense the perspective which could manipulate indirect selection for yield while selecting for two or more characters simultaneously.

Several investigators have shown different relationships between yield and its components. Number of bolls per plant was considered the most important component by many workers (Christidis and Harrison 1955, Marani 1967, Zaitoon 1973, Seyam *et al*., 1984a, Ghaly *et al*., 1990 and Younis and Shalaby, 1997). The correlation between boll weight and yield was positive in some investigations (Singh *et al*., 1968; Gad, 1973 and Zaitoon, 1973), and negative in others (Al-Jibouri *et al*., 1958 and Kamel and Omran, 1962). Path-coefficient analysis was used to estimate the relative contribution of yield components to yield variation in cotton varieties by Butany *et al*., 1966, Warley *et al*., 1974, El-Shaer *et al*., 1984 and Younis and Shalaby, 1997.

The technique of stepwise multiple regression was used in cotton by El-Hariry *et al*., 1990 and Sawires *et al*., 1990. Seyam *et al*. (1984b). Using stepwise regression analysis had shown that number of bolls/plant, boll weight and node of first sympodium were the main attributes contributing to the total yield variation in Egyptian cotton.

The present investigation was under taken to study the variability among Egyptian cotton varieties and genotypic and phenotypic correlations among the studied traits. The technique of stepwise multiple regression analysis was used to evaluate the relative contribution of yield components and developmental characters on yield capacity.

## MATERIALS AND METHODS

The present study was carried out at Al-Azhar Univ., Assiut Exp. Station during the summer seasons of 1998 and 1999 on cotton. The Egyptian cotton varieties were: Giza 83, Giza 45, Giza 84, Giza 70, Giza 75, Giza 76, Giza 77, Giza 79, Giza 85 and Giza 81. These varieties were grown in a randomized complete blocks design with four replications. Each plot consisted of five rows, 5 meter long, 65 cm, apart and 20 cm, between hills. Seedlings were thinned to two plants per hill after full emergence. The recommended cultural practices for cotton were adopted throughout the growing seasons.

The observations were recorded on ten random plants from each plot. The following characters were measured: number of open bolls/plant (N.O.B/P), lint percentage (L.P), boll weight gm (B.W.), seed index (S.I.), lint index (L.I.), number of fruiting branches/plant (N.F.br./p), number of seeds/boll (N.S./B), seed cotton yield/plant (S.C.Y/P) and lint yield/plant (L.Y./P).

Estimates of phenotypic ($r_{pij}$) and genotypic ($r_{gij}$) correlations were evaluated as outlined by Miller *et al*., 1958. The phenotypic and genotypic coefficients of variability were estimated using the formula developed by Burton (1952). Also, simple correlation coefficients between lint yield (Y) and the other variables were calculating.

Stepwise multiple regression analysis was carried out according to Draper and Smith (1966) to determine the effective variables that accounted for most of variance in lint yield. The relative contribution was calculated as coefficient of determination $R^2$.

## RESULTS AND DISCUSSION

The analysis of variance in Table 1 indicates the presence at significant differences among the varieties in 1998 season for the studied traits i.e., number of open bolls/plant, number of seeds/boll and seed cotton yield/plant. While significant differences among varieties in 1999 season were observed for all the studied traits except number of open bolls/plant, line percentage and number of seeds/boll.

The combined analysis over the two seasons in Table 2 revealed the presence of significant differences among varieties for number of open

bolls/plant, seed index, lint index, number of seeds/boll and seed cotton yield/plant. On the other hand, insignificant differences among varieties were reported for lint percentage, boll weight, number of fruiting branches/plant and lint yield. These traits were highly affected by seasons in which the year main effect was highly significant for all the studied traits and varieties x years interactions were highly significant for number of open bolls/plant and number of seeds/boll. Estimates of variance components for the studied traits are presented in Table 2. The error variances exceeded their respective $\sigma^2_g$ and $\sigma^2_{gy}$ reflecting the large sampling error involved. The plot error variances were high for the must studied traits. These results indicates the need of evaluation of the cotton breeding materials under different environments. Miller *et al*. 1958 and Younis *et al*. 1989 reported that the magnitude of the interaction variances ($\sigma^2_{gy}$) were negative. Such negative estimates were obtained because of the large size of the sampling error involved.

Giza 85 was the superior varieties over the two seasons for number of open bolls/plant, lint percentage and lint yield/plant as shown in Table 3. While Giza 81 variety exhibited high values for boll weight, number of seeds/boll and seed cotton yield. Giza 45 and Giza 79 were the lowest seed cotton yield/plant and line yield over the two seasons.

The phenotypic and genotypic coefficients of variability were large in magnitude for all the studied traits except boll weight. The data indicated a slight discrepancy between p.c.v and g.c.v. for the most studied traits reflecting the high estimates of genotypic variances as calculated from the analysis of variance. O'Brien *et al*. (1978) reported that the genotypic variance estimated from field trial conducted at one location for one year is based upward, this could be due to the confounding estimate of genetic variance by components of genotypic x year, genotypic x location and genotypic x year x location interactions.

Estimates of the genotypic and phenotypic correlations among pairs of traits over the two seasons are presented in Table 4. The phenotypic and genotypic correlations between seed cotton yield/plant and each of number of bolls/plant, lint percentage, seed index and number of fruiting branches/plant were positive and large in magnitude. It is worth to mention that number of bolls/plant showed the highest "r" values with seed cotton yield/plant in general, followed by lint percentage, seed index and number of fruiting branches/plant. These results are in agreement with those obtained by El-Kilany (1976), Mahdy (1984) and Younis *et al*. (1989). Worley *et al*. (1974) reported that number of bolls/plant played the major role and lint/seed played the secondary role in improving lint yield because of their close genetic correlations with yield.

The "r" values between number of fruiting branches/plant and most of studied traits were positive and high. El-Kilany 1976 and Younis 1986, reported contradictory, results.

The characters taken as accepted variables in multiple liner regression analysis were number of bolls/plant ($X_1$), lint percentage ($X_2$) and boll weight ($X_3$) to the variation of lint yield/plant.

**Table 4.Phenotypic ($r_p$) and genotypic ($r_g$) correlation coefficients over the two seasons for the studied traits.**

| Traits | | No. B./p | L.P | Boll weight | S.I | L.I | No.fr. bra. | No.S/boll | S.C. Y/p |
|---|---|---|---|---|---|---|---|---|---|
| L.Y./p | rp | 0.24 | 0.22 | 0.84 | 0.10 | 0.63 | 0.89 | -0.04 | 0.31 |
| | rg | 0.85 | 0.09 | 0.01 | -0.41 | 1.00 | 1.00 | 0.01 | 0.14 |
| N.B./p | rp | | 0.91 | 0.37 | 0.90 | -0.08 | 0.54 | 0.69 | 0.99 |
| | rg | | 1.00 | 0.01 | 1.01 | -1.01 | 1.00 | 0.01 | 1.00 |
| L.P. | rp | | | 0.34 | 0.92 | 0.16 | 0.50 | 0.42 | 0.92 |
| | rg | | | 0.01 | 1.00 | 1.00 | 1.00 | 0.01 | 1.00 |
| B.W. | rp | | | | 0.38 | 0.13 | 0.95 | 0.25 | 0.39 |
| | rg | | | | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 |
| S.I | rp | | | | | -0.35 | 0.49 | 0.25 | 0.91 |
| | rg | | | | | -0.61 | 1.00 | 0.01 | 1.00 |
| L.I. | rp | | | | | | 0.27 | -0.28 | -0.01 |
| | rg | | | | | | 1.01 | 0.02 | 0.37 |
| N. fra. | rp | | | | | | | 0.25 | 0.58 |
| br. | rg | | | | | | | 0.02 | 1.00 |
| N.S./b | rp | | | | | | | | 0.61 |
| | rg | | | | | | | | 0.01 |

The relationship between lint yield and each of the 8 variables for 1998, 1999 and combined analysis over the two seasons is presented in Table 5. Highly significant simple correlation was found between lint yield/plant and the characters that might have contributed to it i.e., number of open bolls/plant ($X_1$), lint percentage ($X_2$), and boll weight ($X_3$) in both the two seasons (1998 and 1999) and combined analysis over the two seasons which signifies the importance of breeding for number of bolls/plant, lint percentage and boll weight to produce high yielding cultivars. No significant correlation was reported between lint yield/plant and both seed index and number of seeds/boll.

The stepwise multiple regression analysis was used to evaluate the relative contribution of three variables i.e., number of bolls/plant, lint percentage and boll weight on lint yield/plant. They had the highest coefficient of multiple determination with lint yield variable and they also had a significant “F” value in regression analysis of variance (Table 6). Number of open bolls/plant was the first accepted character and it was responsible for reducing 84.55%, 79.14% and 90.55% of lint yield variance in 1998, 1999 and combined analysis over the two seasons, respectively [Table 7]. In 1998 season lint percentage ($X_2$) was the main source of variability in lint yield/plant after number of open bolls for contribution of lint yield variance [$R^2$ % = 8.90] followed by boll weight [$R^2$ % = 4.90]. While in 1999 season boll weight was the second accepted character of variability in lint yield ($R^2$ = 12.39) after number of open bolls/plant followed by lint percentage ($R^2$ = 4.60) for contribution of lint yield variance. The arrangement of accepted variables according to relative contribution ($R^2$ %) in lint yield variance over the two seasons (1998 and 1999), were number of bolls/plant, boll weight and lint percentage.

The three characters i.e., number of open bolls/plant, lint percentage and boll weight were responsible in reducing 98.39%, 96.13% and 99.04% of the total lint yield variance of 1998, 1999 and combined analysis over the two seasons, respectively. Whereas the other sources made slight contributions to lint yield of 1.61%, 3.87%, and 0.96% for 1998, 1999 and combined over the two seasons, respectively.

The prediction equation for the two seasons (1998 and 1999) and combined analysis over the two seasons are presented in Table 8. According to these equations 98.39%, 96.13% and 99.04% of the total variation in lint yield could be attributed to the three accepted variables i.e., number of open bolls/plant ($X_1$), lint percentage ($X_2$) and boll weight ($X_3$) in 1998, 1999 and the combined analysis over the two seasons, respectively. El-Shaer *et al*. (1984) found that the direct effects were responsible for 91.80% of the variation in plant yield. Similar results were also obtained by Ghaly *et al*. 1990. Sayam *et al*. (1984a and b) using factor analysis and stepwise regression analysis showed that number of bolls/p, boll weight and node of first sympodium were the main attributes contributing to the total yield variation in Egyptian cotton cultivars.

In general, the results obtained in this study indicated that number of open bolls/plant, lint percentage and boll weight were the major and the most consistent sources that contribute to lint yield/plant. Therefore, it is inevitable for the breeder to consider these characters in formulating the breeding programmes to obtain a considerable gain by selection for lint yield/plant.

**Table 5:Simple correlation between lint yield and the other characters for the two seasons (1998 and 1999) and combined analysis.**

| **Variables** | **Lint yield/plant** | | |
|---|---|---|---|
| | 1998 | 1999 | Combined |
| Seed cotton yield/p. | 0.96** | 0.75** | 0.85** |
| No. of open bolls/p. | 0.92** | 0.89** | 0.79** |
| No. of fruiting branch. | 0.14 | 0.72** | 0.47** |
| Lint percentage | 0.64** | 0.55** | 0.75** |
| Boll weight | 0.47** | 0.35** | 0.79** |
| Seed index | 0.27 | 0.01 | 0.15 |
| Lint index | 0.64** | 0.43** | 0.80** |
| No. of seeds/boll | -0.20 | 0.03 | -0.05 |

*** and ** significant at 0.05 and 0.01 levels, respectively.**

**Table 6:Multiple linear regression analysis of accepted variables in 1998 and 1999 seasons and combined analysis over the two seasons.**

| **Source of variation** | **d.F.** | **Mean square** | | |
|---|---|---|---|---|
| | | 1998 | 1999 | Combined over two seasons |
| Regression | 3 | 83.37** | 16.99** | 1715.28** |
| Residual | 6 | 0.90 | 0.56 | 0.86 |

*** and ** significant at 0.05 and 0.01 levels, respectively.**

**Table 7: Accepted variables according to stepwise analysis and their relative contribution ($R^2$ %) in lint yield variance in the two seasons (1998 and 1999) and combined means.**

| Variables | Relative contribution ($R^2$ %) | | |
|---|---|---|---|
| | 1998 | 1999 | Combined |
| $X_1$ No. open bolls | 84.55 | 79.14 | 90.55 |
| $X_2$ Lint percent | 8.90 | 4.60 | 2.00 |
| $X_3$ B.W. | 4.94 | 12.39 | 6.49 |
| Residual | 1.61 | 3.87 | 0.96 |

**Table 8: Stepwise prediction equation ($\hat{Y}$) for the 1998 and 1999 seasons and combined over the two seasons.**

| Seasons | The prediction equation ($\hat{Y}$) |
|---|---|
| 1998 | $\hat{Y} = -26.441 + 1.590 X_1 + 0.410 X_2 + 0.202 X_3$ |
| 1999 | $\hat{Y} = 6.17 + 1.18 X_1 + 0.17 X_2 + 6.03 X_3$ |
| Combined over the two seasons | $\hat{Y} = -38.32 + 4.60 X_1 + 0.46 X_2 + 6.80 X_3$ |

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## قيـاس التبـاين الـوراثى والمظهـرى وتحليـل الانحـدار المتعـدد المراحـل فـى القطـن المصرى وتطبيقه فى الانتخاب

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أجرى تحليل الانحدار المتعدد المراحل عامى 1998 ، 1999 على عشرة أصناف من القطن المصرى هى جيزه 83 ، جيزه 45 ، جيزه 84 ، جيزه 70 ، جيزه 75 ، جيزه 76 ، جيزه 77 ، جيزه 79 ، جيزه 85 ، جيزه 81 . وذلك لدراسة أفضل المتغيرات التى يرجع اليها معظم تباين المحصول الشعر . وأوضحت النتائج أن صفة عدد اللوز المتفتح على النبات تعتبر اكثر الصفات تأثيراً على المحصول الشعر حيث ساهمت بمقدار 55ر84% ، 14ر79% ، 55ر90% من التباين الكلى للمحصول الشعر للنبات خلال مواسم 1999/1998 والتحليل المشترك للموسمين على التوالى بينما ساهمت صفة معدل الحليج فى التباين الكلى للمحصول الشعر للموسمين بمقدار 9ر8% ، 6ر4% ، 5ر2% للموسمين والتحليل المشترك للموسمين على التوالى بينما ساهمت صفة وزن اللوزة بمقدار 94ر4%، 39ر12% ، 48ر6% من التباين الكلى للمحصول الشعر للموسمين والتحليل المشترك على التوالى .

ومن هذه الدراسة يتبين أن صفة عدد اللوز على النبات تعتبر صفة هامة جداً فى تأثيرها على المحصول الشعر للنبات ويجب الانتخاب لها فى أى برنامج تربية لزيادة المحصول فى القطن المصرى . وأوضحت الدراسة أيضاً أن هناك تباين وراثى كبير فى معظم الصفات المدروسة . وقد تم مناقشة الارتباط الوراثى والمظهرى بين ازواج الصفات فى كلا الموسمين وفى التحليل المشترك للموسمين وكذلك تم مناقشة الانحدار المتعدد المراحل كما نوقشت تطبيقات هذه الدراسة فى برامج التربية .

**Table 1.Source of variation and mean squares of the studied traits in 1998 and 1999 seasons.**

| Source of Variation | Seasons | d.f. | Mean squares | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. of open bolls | Lint % | Boll weight | Seed index | Lint index | No. of fruiting branches | No.of seeds/ Boll | Seed cotton yield | Lint yield |
| Replication | 1998 | 3 | 5.65 | 10.30 | 49.51 | 0.64 | 3.09 | 70.43 | 1.67 | 39.47 | 504.46 |
| | 1999 | 3 | 0.05 | 1.37 | 0.26 | 0.34 | 12.68 | 32.57 | 5.46 | 1.14 | 0.33 |
| Varieties | 1998 | 9 | 109.64** | 37.92 | 13.69 | 2.37 | 0.86 | 19.73 | 27.92** | 517.76* | 136.34 |
| | 1999 | 9 | 0.08 | 0.68 | 3.64** | 1.84** | 10.51* | 1.12** | 8.29 | 19.01** | 0.15* |
| Error | 1998 | 27 | 30.82 | 21.79 | 13.67 | 1.36 | 0.85 | 14.91 | 0.83 | 213.94 | 107.82 |
| | 1999 | 27 | 0.05 | 0.50 | 0.18 | 0.18 | 3.35 | 0.34 | 4.90 | 1.51 | 0.05 |

*** and ** Significant at 0.05 and 0.01 levels of probability, respectively.**

**Table 2. Mean squares and variance components of the combined analysis for the studied traits.**

| Traits | Year Y | Rep. x year R/Y | Varieties | Var. year VxY | Error | $\sigma^2g$ | $\sigma^2ph$ | $\sigma^2vy$ | Herit-ability (H%) | g.c.v. % | p.c.v. % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of open bolls/p | 9071.88** | 2.85 | 56.98** | 52.74** | 15.44 | 5.19 | 7.12 | 4.66 | 72.80 | 13.56 | 15.88 |
| Lint percentage | 2991.71** | 5.84 | 20.71 | 17.88 | 11.14 | 1.20 | 2.59 | 0.84 | 46.33 | 2.95 | 4.34 |
| Boll weight | 440.35** | 24.88** | 6.87 | 10.46 | 6.92 | - | 0.86 | 0.44 | - | - | 30.50 |
| Seed index | 4.80* | 0.49 | 3.24** | 0.97 | 0.77 | 0.31 | 0.40 | 0.02 | 77.50 | 5.21 | 5.92 |
| Lint index | 3821.51** | 7.89** | 6.45** | 4.92* | 2.10 | 0.54 | 0.80 | 0.35 | 67.50 | 11.61 | 14.13 |
| No. of fruiting bra. | 57.76** | 35.38** | 10.63 | 10.22 | 7.63 | 0.37 | 1.33 | 0.32 | 27.80 | 14.48 | 27.46 |
| No. of seeds/boll | 6011.59** | 3.56 | 11.51** | 24.69** | 2.86 | 1.08 | 1.44 | 2.73 | 75.00 | 6.34 | 7.32 |
| Seed cotton yield/p. | 16335.79** | 20.30 | 320.14** | 216.63 | 107.72 | 26.55 | 40.02 | 13.61 | 66.34 | 10.14 | 12.45 |
| Lint yield/p | 20229.56** | 252.40** | 70.03 | 66.45 | 53.93 | 2.01 | 2.26 | 1.56 | 88.94 | 7.55 | 8.01 |

**- negative genotypic variance**
*** and ** significant at 0.05 and 0.01, respectively.**

**Table 3. The combined means of the ten varieties for the studied traits.**

| Trait Variety | No. of open bolls | Lint % | Boll weight | Seed index | Lint index | No. of fruiting branches | No. of seeds/boll | Seed cotton yield | Lint yield |
|---|---|---|---|---|---|---|---|---|---|
| Giza 83 | 18.33 | 36.71 | 2.98 | 11.37 | 6.59 | 4.58 | 16.62 | 53.84 | 20.86 |
| Giza 45 | 15.00 | 32.53 | 3.10 | 10.36 | 4.98 | 3.75 | 19.57 | 43.68 | 14.14 |
| Giza 84 | 15.65 | 39.28 | 3.06 | 10.80 | 6.98 | 3.91 | 17.39 | 47.44 | 18.56 |
| Giza 70 | 16.71 | 36.26 | 2.91 | 10.32 | 5.87 | 4.17 | 18.37 | 47.23 | 17.21 |
| Giza 75 | 18.62 | 37.64 | 3.07 | 11.00 | 6.58 | 4.65 | 17.65 | 57.09 | 21.23 |
| Giza 76 | 15.40 | 34.47 | 2.91 | 10.34 | 5.44 | 3.85 | 18.47 | 44.93 | 15.42 |
| Giza 77 | 18.16 | 37.06 | 3.00 | 10.19 | 6.00 | 4.54 | 18.82 | 54.18 | 20.07 |
| Giza 79 | 13.41 | 38.92 | 2.86 | 10.85 | 6.93 | 3.35 | 16.70 | 41.93 | 14.15 |
| Giza 85 | 19.10 | 40.86 | 3.08 | 11.10 | 7.55 | 4.77 | 16.50 | 57.49 | 23.39 |
| Giza 81 | 17.57 | 37.37 | 3.44 | 10.59 | 6.36 | 4.39 | 20.47 | 60.37 | 22.66 |
| Mean | 16.80 | 37.11 | 3.04 | 10.69 | 6.33 | 4.20 | 16.39 | 50.82 | 18.77 |
| LSD 5% | 3.93 | 3.34 | 2.63 | 1.45 | 2.29 | 0.85 | 1.69 | 10.37 | 7.34 |