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CORRELATION AND PATH COEFFICIENT ANALYSIS OF LINT YIELD AND ITS COMPONENTS IN EGYPTIAN COTTON

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ABSTRACT

This investigation was carried out at the experimental farm of the Faculty of Agriculture, El-Fayoum University, to study the relationship between lint yield per plant and some important yield components in three Egyptian cotton genotypes (Giza 90, Giza 90 x Aust., and [G.83 x (G.75 x 5844)] x G.80) during the two seasons of 2013 and 2014, using a randomized complete block design with three replications. The results revealed highly significant differences between the genotypes for all traits. Correlation analysis revealed highly significant and positive correlation between lint yield per plant with the number of open bolls/plant ($r = 0.929^{**}$), lint percentage ($r = 0.915^{**}$) and boll weight ($r = 0.872^{**}$). The path coefficient analysis indicated that direct effects of boll weight and the number of open bolls/plant were 47.21 % and 15.03 % on lint yield per plant and their interaction effect was 9.55 %. Total contribution of the above characters over all variation in lint yield per plant was 71.79 %. In general, the results obtained clarify that boll weight and the number of open bolls/plant were the most responsible attributes for lint yield per plant and could be, therefore, considered as selection criteria in cotton breeding programs.

Key words: *cotton, correlation, direct and indirect effects, path coefficient, lint yield.*

1. INTRODUCTION

Cotton (*Gossypium barbadanse* L.) is considered the main fiber crop through industry in Egypt as well as in the world. In Egypt, it was always and still the main cash crop for most growers. It grows mainly for its fiber, but cotton seed products are also of economic importance.

Yield, a complex quantitative character, depends upon the interactions of multiple component characters. Lint yield of Egyptian cotton is determined by its component traits, boll number, boll weight and lint percentage. Correlation and Path coefficient analysis are two common methods used to evaluate the relationships between a complex trait and its component traits.

The nature of the association between yield and its components determine the appropriate traits to be used in indirect selection for seeking improvement in cotton yield. The correlation studies simply measure the association between yield and other traits, while the Path coefficient analysis permits the separation of coefficient into direct effects (Path coefficient) and indirect effects (effect exerted through other variables) (Dewey and Lu 1959).

The correlation coefficient between yield and other traits have been estimated by Al-Rawi and Ahmed (1984), Al-Bayaty (1999) and Dawod and Al-Bayaty (2003). In general they found that yield was highly positively correlated with the number of open bolls per plant, boll weight, seed index and the number of seeds per boll.

The relationships between yield and yield components have been discussed by a number of authors; Lasheen *et al.*(2003), Hassan and Abdel-Aziz (2004), Muthu *et al.* (2004), Rauf *et al.* (2004), Iqbal *et al.* (2006), Mohamed (2006), Ismail *et al.* (2008), Saeed *et al.* (2008), Zeng and Meredith (2009), Ekinci *et al.* (2010), Shazia *et al.* (2010), Alkuddsi *et al.* (2013), Farooq *et al.* (2014), Latif *et al.* (2014) and Singh *et al.* (2014).

This study was undertaken in order to determine the dependence relationship between lint yield and yield component characters of some Egyptian genotypes of cotton by using correlation and path coefficient analysis.

2. MATERIALS AND METHODS

The present study was carried out in the Agriculture Experiment Farm, Faculty of Agric., El-Fayoum University, during the two seasons of 2013 and 2014 to study the contribution of yield components to the quantity of lint yield per plant of some Egyptian cotton genotypes (Giza 90, Giza 90 x Aust. and [G.83 x (G.75 x 5844)] x G.80). Plot size was 3 x 3.5 m with five rows 60 cm apart and 3.5 long. The seeds were planted on the third week of March in both seasons. Seedlings were thinned 20 days after sowing to secure two plants per hill. The other cultural practices were carried out according to the common practices in cotton fields Nitrogen (60 kg N/fed.), as ammonium nitrate (33.5% N, and potassium (48 kg K_2O/fed.), as potassium sulphate (48% K_2O), were side dressed before the first and the second irrigations. Phosphorus (30 kg P_2O_5/fed) as super phosphate (15.5% P_2O_5) was broadcasted during seedbed preparation. Ten guarded plants were taken at random from each plot to determine the relative importance of the main yield components.

Individual analysis of variance was performed for all the studied traits on each season according to the procedure described by Gomez and Gomez (1984) for a randomized complete block design with three replications. The combined data across the two seasons were subjected to an ANOVA using MSTAT-C computer software. Data for the 2 years were tested for homogeneity using F-test of homogeneity and were found to be homogeneous so the data were combined for analysis.

The estimates of simple correlation coefficients were computed among lint yield and other studied characters according to Steel *et al.* (1997).

Path coefficient analysis was used as determined by Dewey and Lu (1959) to partition the correlation coefficient and to determine the direct and indirect effects of:

1- Number of open bolls/plant (X_1).
2- Boll weight (X_2).
3- Lint percentage (X_3).
4- Seed index (X_4).
5- Lint index (X_5).

The path coefficients (direct effects) of the five characters on lint yield (Y) were determined. They were obtained by solving the following simultaneous equations:

$$r_{16} = p_{16} + r_{12}\,p_{26} + r_{13}\,p_{36} + r_{14}\,p_{46} + r_{15}\,p_{56} \ldots (1)$$
$$r_{26} = r_{21}\,p_{16} + p_{26} + r_{23}\,p_{36} + r_{24}\,p_{46} + r_{25}\,p_{56} \ldots (2)$$
$$r_{36} = r_{31}\,p_{16} + r_{32}\,p_{26} + p_{36} + r_{34}\,p_{46} + r_{35}\,p_{56} \ldots (3)$$
$$r_{46} = r_{41}\,p_{16} + r_{42}\,p_{26} + r_{43}\,p_{36} + p_{46} + r_{45}\,p_{56} \ldots (4)$$
$$r_{56} = r_{51}\,p_{16} + r_{52}\,p_{26} + r_{53}\,p_{36} + r_{54}\,p_{46} + p_{56} \ldots (5)$$

Where: r_{16}, r_{26}, r_{36}, r_{46} and r_{56} are the simple correlation coefficients of the five traits involved in the model with lint yield (6), respectively.

The following formula were used in calculating coefficient of determination (C.D) and percentage contributed (P.C %) by Al-Bayaty (1999).

$R^2\,(x_i)\ Y = P_iY)^2$; $i = 1,2,\ldots..,5$.

$R^2\,(x_i\,x_j)\ Y = P_iY\,[r_{ij}\,P_jY] + P_jY\,[r_{ji}\,P_iY]$; $i = j = 1,2,\ldots\ldots\ldots,5$

Where:

x_i = independent variables.

$x_i\,x_j$ = interactions between independent variables.

P.C % : by using the absolute values of the coefficient of determination (R^2) for any source of variation

$$\text{1- P.C \% }(x_iY) = \frac{R^2\,x_iY}{\text{Total } R^2} \times 100$$

$$\text{2- P.C \% }(x_ix_j)\,Y = \frac{R^2(x_ix_j)Y}{\text{Total } R^2} \times 100$$

$$\text{3- P.C \% }(P_{wy}) = \frac{R^2(\text{residuals})}{\text{Total } R^2} \times 100$$

3. RESULTS AND DISCUSSIONS

3.1. Means of lint yield per plant ant its components

Basic statistical parameters; Mean values, standard deviation, minimum and maximum values and coefficient of variation, for the three genotypes under investigation of all the studied traits are presented in Table (1). In the present investigation, there was a considerable variation with regard to all characteristics under study (Table 1).

The results presented in Table (1) show that the coefficient of variation was the highest for lint yield per plant, followed by boll weight. Lint percentage had the least value, followed by the number of open bolls/plant. Number of open bolls/plant, lint index, seed index and boll weight showed moderate values for the coefficient of variation Table (1). Coefficient

Table (1): Values of range, mean, standard deviation (SD) and coefficient of variation (C.V. %) for lint yield and its components in some Egyptian cotton genotypes across two seasons.

Characters	Range		Mean	SD	C.V. %
	Min.	Max.			
No. of bolls/plant (X_1)	13.41	18.11	15.91	1.38	8.67
Boll weight (X_2)	2.01	3.11	2.72	0.31	11.40
Lint percentage (X_3)	32.92	37.73	35.47	1.35	3.81
Seed index (X_4)	8.83	12.81	10.79	1.10	10.19
Lint index (X_5)	5.35	7.41	6.40	0.56	8.75
Lint yield per plant (Y)	24.81	53.21	40.36	7.69	19.05

of variation, also known as "relative variability", calculated as a percentage is a measure of how much variability exists for selection.

Means of lint yield per plant varied between 24.81 and 53.21 g. per plant. Number of open bolls/plant ranged from 13.41 to 18.11, whereas lint percentage was between 32.92 and 37.73 %. Seed index, lint index and boll weight were between 8.83 and 12.81 g., 5.53 and 7.41 g. and 2.01 and 3.11g, respectively.

3.2. Analysis of variance

Results from the combined analysis of variance across the two years revealed that lint yield per plant and yield components had significant differences between years, genotypes and the interaction of years x genotypes for most traits (Table 2).

The existed differences among cotton genotypes may be attributed to the genetical constitution of these genotypes and their adaptability with the environmental conditions prevailing across growth seasons. These results are in agreement with Saeed *et al.* (2008), Shazia *et al.* (2010) and Latif *et al.* (2014).

3.3. Correlation analysis

Knowing the interrelationships between lint yield and other characters is important to effective selection. Consistent with this, efforts were made to evaluate the nature of inter-relationships between different yield components.

The simple correlation coefficients were determined for six character combinations with the objective to obtain information about the relationships among different characters combinations.

Coefficients of correlation between lint yield and yield components from the data obtained over years are presented in Table (3). As for the relationship among the traits, the results of the correlation coefficients revealed tha number of open bolls/pant, lint percentage and boll weight had the highest significant positive correlation with lint yield per plant, $r = 0.929^{**}$, $r = 0.915^{**}$ and $r = 0.872^{**}$ (Table 3), indicating dependency of lint yield on these characters.

On the other hand, there was a negative correlation coefficient between the number of open bolls/plant and the three traits boll weight, seed index and lint index. Similar results were obtained by Hassan and Abdel-Aziz (2004) and Mohamed (2006), who showed positive and significant correlation between lint yield per plant and number of bolls/plant.

Table (2): Mean squares corresponding to various sources of variation for lint yield and other quantitative traits in some Egyptian cotton genotypes across two years.

SOV	df	Mean squares					
		No. of bolls/ plant	Boll Weight (g)	Lint percentage	Seed index	Lint index	Lint yield per plant
Years	1	29.33*	73.25**	21.21*	56.91**	14.23*	228.93**
Replications/years	4	13.75	5.23	1.73	3.93	1.31	35.13
Genotypes	2	152.17**	101.75**	46.91**	93.25**	29.73**	673.53**
Genotypes x Years	2	19.13	29.15*	9.25	11.13*	2.21	107.57*
Error	8	5.55	4.13	2.79	2.17	2.79	17.27

*, ** denotes significant at 5 and 1%, respectively.

Table (3): A matrix of simple correlation coefficient between lint yield and other important characters estimated over the two studied seasons.

Characters	X_1	X_2	X_3	X_4	X_5	Y
No. of open bolls / plant (X_1)	1	- 0.442^{ns}	0.914**	- 0.455^{ns}	- 0.626^{ns}	0.929**
Boll weight (X_2)		1	0.430^{ns}	0.870**	0.599^{ns}	0.872**
Lint percentage (X_3)			1	0.370^{ns}	0.627^{ns}	0.915**
Seed index (X_4)				1	0.927**	0.654^{ns}
Lint index (X_5)					1	0.738^{ns}
Lint yield per plant (Y)						1

ns,. and ..: Non significant, significant at 5 and 1%, of probability, respectively.

3.4. Path coefficient analysis

Partitioning of correlation into direct and indirect effects of five traits with lint yield per plant is illustrated in Table (4). It is clear that the direct effect of lint percentage in determining lint yield per plant was very high (0.992), followed by boll weight (0.669). Lint index had the least value (0.275), followed by the number of open bolls/plant (0.280). The indirect effect of lint percentage (0.637) *via* boll weight was

Table (4): Partitioning of simple correlation coefficients between lint yield and yield components combined the two studied seasons.

Source of variation	Correlation coefficients
1-No. of open bolls vs. lint yield/plant	
Direct effect (P_1y)	0.280
Indirect via boll weight	0.154
Indirect via lint percentage	0.536
Indirect via seed index	-0.027
Indirect via lint index	- 0.014
Total correlation (r_1y)	0.929
2- Boll weight vs. lint yield/plant	
Direct effect (P_2y)	0.669
Indirect via no. of open bolls	- 0.001
Indirect via lint percentage	0.230
Indirect via seed index	- 0.014
Indirect via lint index	- 0.012
Total correlation (r_2y)	0.872
3- Lint percentage vs. lint yield/plant	
Direct effect (P_3y)	0.992
Indirect via no. of open bolls	- 0.642
Indirect via boll weight	0.637
Indirect via seed index	- 0.010
Indirect via lint index	- 0.062
Total correlation (r_3y)	0.915
4- Seed index vs. lint yield/plant	
Direct effect (P_4y)	0.492
Indirect via no. of open bolls	- 0.050
Indirect via boll weight	0.331
Indirect via lint percentage	- 0.074
Indirect via lint index	- 0.045
Total correlation (r_4y)	0.654
5- Lint index vs. lint yield/plant	
Direct effect (P_5y)	0.275
Indirect via no. of open bolls	0.237
Indirect via boll weight	0.346
Indirect via lint percentage	- 0.085
Indirect via seed index	- 0.035
Total correlation (r_5y)	0.738

considerable and positive followed by the number of open bolls/plant (0.536) *via* lint percentage. Lint index (0.346) and seed index (0.331) *via* boll weight were negligible positive effect. While, indirect effect of lint percentage – (0.642) *via* the number of open bolls/plant was high in magnitude and negative. The other indirect effects were low positive and/or negative on lint yield per plant. These results are in agreement with Mohamed (2006).

The path coefficient analysis in Table (5) indicated that boll weight and the number of open bolls/plant were the most prominent direct and indirect effects on lint yield per plant with the highest percentage contributed being 47.21 % and 15.03 %. Joint effects of boll weight with the number of bolls/plant were 9.55 %. The total contribution of the five traits and interactions were responsible for 94.71 % of the total variation in lint yield per plant.

The residual effect of the other yield components in the present investigation was 5.29%. It is clear that the residual effect has slight importance and showed very small contribution in lint yield per plant variation. This finding is in agreement with Lasheen *et al.* (2003), Hassan and Abdel-Aziz (2004) and Mohamed (2006). They reported that direct effects were the number of bolls and boll weight as well as, their indirect effects were responsible for 91.80 % of the variation in plant yield.

Table (5): Coefficient of determination (direct and joint effect) in percentage of lint yield variation combined data between the two studied seasons.

Source of variation	C.D.	P.C. %
No. of open bolls (X_1)	3.759	15.03
Boll weight (X_2)	0.973	47.21
Lint percentage (X_3)	3.257	4.47
Seed index (X_4)	0.002	0.57
Lint index (X_5)	0.022	0.67
X_1 x X_2	- 0.556	9.55
X_1 x X_3	- 5.579	7.27
X_1 x X_4	- 0.117	1.18
X_1 x X_5	- 0.027	0.19
X_2 x X_3	- 0.390	3.13
X_2 x X_4	0.014	1.24
X_2 x X_5	- 0.073	3.36
X_3 x X_4	- 0.113	0.12
X_3 x X_5	- 0.189	0.63
X_4 x X_5	- 0.078	0.09
Total	0.905	94.71
Residual	0.095	5.29

C.D. = Coefficient of determination.
P. C. % = Percent contributed.

Conclusion

In general, the results obtained herein indicated that boll weight and the number of open bolls/plant were the major and the most constant source accounting for variation as total contribution in lint yield per plant variation. Therefore, it is important for the breeder to consider these characters in formulating his breeding programs to obtain the best gain in selection.

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تحليل الارتباط ومعامل المرور لمحصول الشعر ومكوناته في القطن المصري

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ملخص

أجري هذا البحث في مزرعة كلية الزراعة بجامعة الفيوم - لدراسة العلاقة بين محصول القطن الشعر ومكوناته خلال موسمي 2013 ، 2014 ، واستخدم لهذه الدراسة التراكيب الوراثية (جيزة 90 ، جيزة 90 x استرالي، [جيزة 83 x (جيزة 75 x 5844)] x جيزة 80) باستخدام تصميم قطاعات كاملة العشوائية في ثلاثة مكررات. وكانت أهم النتائج المتحصل عليها فيما يلي: أوضحت النتائج وجود اختلافات عالية المعنوية بين التراكيب الوراثية، كما وجد ارتباط موجب وعالي المعنوية بين محصول القطن الشعر وكلا من عدد اللوز المتفتح علي النبات ونسبة التصافي ووزن اللوزة. أظهرت نتائج تحليل معامل المرور أن التأثير المباشر لوزن اللوزة 47.21 % ، التأثير المباشر لعدد اللوز المتفتح علي النبات 15.03 % ، التأثير المشترك لعدد اللوز المتفتح علي النبات مع وزن اللوزة 9.55 % ، ومجموع مساهمة هذه المتغيرات يبلغ حوالي 71.79 % من التباين الكلي لمحصول القطن الشعر. يتضح مما سبق أن وزن اللوزة وعدد اللوز المتفتح علي النبات من أكثر الصفات تأثيراً في محصول القطن الشعر وبذلك يمكن استخدامهما كمعيار للانتخاب في برامج تربية القطن.

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