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Correlation and Path Coefficient Analysis of Some Earliness Measures in Egyptian Cotton

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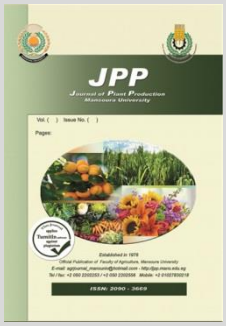

ABSTRACT

This study was carried out at the experimental farm of the Faculty of Agriculture, Fayoum University, Egypt, during 2018 and 2019 seasons to assess the relationship between seed cotton yield per plant and five earliness measures in three Egyptian cotton varieties (Giza 80, Giza 90 and Giza 95). The results revealed that significant differences between varieties in all characters under study. The correlation analysis indicated that earliness index and production rate index were had a high correlation and positive with seed cotton yield per plant, while days to the first flower appearance, days to the first boll opening and mean maturity date showed negative correlation with seed cotton yield per plant. The path coefficient analysis showed that earliness index had a high direct effect (43.21%) on seed cotton yield per plant followed by production rate index (27.11%) and their interaction effect was 9.23%. The total contribution of all characters under study was 96.81%. From the above it is clear that earliness index and production rate index were the maximum traits contribution in seed cotton yield per plant therefore, may be used as useful criteria to increase Egyptian cotton yield.

Keywords: Simple correlation, Path coefficient, Cotton yield, Earliness, Varieties

INTRODUCTION

Egyptian cotton (*Gossypium barbadense* L.) is a favor as an extra-long staple and is excellent in the whole world for its good fiber properties. It plays a prominent role in raising the country's economy Cotton fibers are the basic raw material used in textile industry. The cotton is an strategic crop and grown in different regions of the world, although, it is very affected to environmental changes (Mahdi *et al.*, 2020).

Early cotton plants can grow in good condition through the most favorable environmental factors and thus, avoid damage caused by inappropriate climate. Besides, reduce the losses of decreasing seed and lint yield caused by diseases and insect pests (Ali *et al.*, 2003 & Shah *et al.*, 2010). Earliness traits in cotton are complicated to measure because the flowering in cotton plants and opening bolls done on over long periods. Earliness is impacted through the date of flowering, period development of flowers and the necessary days for the bolls to opening (Mahdi *et al.*, 2014). The progress of any breeding program depends on the available genetic variation to produce new early varieties that can replace the existing ones. Cotton breeders have a special interest in developing promising early varieties.

A breeder mostly reports results based on the selection of required economic characters by the nature of the correlation among yield and these traits which could be existing. The knowledge of the association among traits impacting yield is a prerequisite for selection an useful breeding program. (El-Kady *et al.*, 2015 and Abd El-Mohsen & Amein, 2016). Earliness measures of Egyptian cotton are very important in breeding programs to evaluate and select early varieties. Correlation and path coefficients are the most used statistical methods to measure the type of relationship between seed cotton yield and the different earliness measures.

The simple correlation coefficients give a useful indicator to understand the interrelationships between two variables one depends on the other (Farooq *et al.*, 2014). The study of association between seed cotton yield and other important characters is one of the basic statistical procedures to evaluated impact of the environmental conditions on cotton yield (Mahdi, 2015). The selection of effective measures to increase of seed cotton yield depend on knowledge of information on the magnitude and nature of correlation coefficients. Measurement of correlation coefficients among different cotton traits provides the best combination of characters to increase productivity of Egyptian cotton (Abd El-Mohsen & Amein, 2016). The simple correlation studies determine the correlation among the characters of each other and their relationship to the yield, while the path coefficient analysis divides of coefficients into the direct effects and indirect effects through separation the correlation coefficients (Dewey & Lu, 1959).

The understanding the nature of the correlation between yield and earliness measures helps in maximizing the productivity of the cotton crop. Shakeel *et al.* (2008) found that the direct effect of monopodia was negative on yield through correlation analysis between earliness and other attributes of cotton varieties. Badr (2003) indicated the good performance of earliness and other yield contributing characters in various cotton varieties. Saeed *et al.* (2008) reported that the association between all earliness parameters and a the weight of first picking was

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positive. Baloch & Veesar (2007) found that the association between plant characters and earliness was significantly and suggested that the depending on one character for earliness indirectly.

The objectives from the work were evaluation the nature of the relationship between seed cotton yield per plant and five earliness measures by correlation and path coefficient analysis in three Egyptian cotton varieties and estimate the relative contribution of these characters to determine the most influencing on yield and their selection as useful criteria to increase Egyptian cotton yield.

MATERIALS AND METHODS

Site and experimental design:

This investigation was conducted in 2018 and 2019 seasons at the experimental farm of the Faculty of Agriculture, Fayoum University, Egypt, to evaluation the relationship between seed cotton yield per plant and five earliness measures in three varieties. These varieties were arranged in a randomized complete blocks design (RCBD) with three replications.

Plant management and treatments:

The experimental material used in this investigation included three Egyptian cotton varieties (Giza 80, Giza 90 and Giza 95) which give great range of the differences in their important characteristics. Cotton varieties were obtained from Cotton Res., Institute, Giza. The varieties were planted on 27th March during 2018 and 2019 seasons in experimental units (10.5 m^2) included on five ridges 3.5 m length and 60 cm width, and in hills spaced 25 cm with using of 30 kg fed^{-1}. The thinning was on two plants per hill after three weeks of planting based on the optimum planting density. All other cultural practices were done as recommended for cotton yield trial packages.

Data collection:

Seven individual plants were chosen at random from each experimental unit to estimate the following traits:

1- Days to the first flower appearance (x_1): The number of days from planting to the appearance of first flower.

2- Days to the first boll opening (x_2): The number of days from planting date to the opening of first boll.

Seven pickings were obtained weekly from all ridges of each experimental unit then weigh it during two seasons of the study and the numbers of days from planting to picking are presented in (Table 1).

Table 1. The Number of days from planting to picking during 2018 and 2019 seasons.

Seasons	Periods picking						
	P_1	P_2	P_3	P_4	P_5	P_6	P_7
2018	147	154	161	168	175	182	189
2019	145	152	159	166	173	180	187

3- Earliness index % (x_3): It was estimated through following formula:

$$Earliness\ index = \frac{Weight\ of\ seed\ cotton\ yield\ of\ the\ first\ pick}{Weight\ of\ the\ total\ picks} \times 100$$

4- Mean maturity date (x_4): The number days from planting to picking measured by Christidis & Harrison (1955) through following equation:

$$Mean\ maturity\ date = (W_1H_1 + W_2H_2 + \ldots + W_nH_n)$$

Where:

W = The weight of yield (kg).
H = The picking duration (days).
1, 2 and n = The picking numbers.

5- Production rate index (x_5): It was estimated in grams by Bliboro & Quisenberry (1973) through following equation:

$$Production\ rate\ index = \frac{(W_1 + W_2 + \ldots + W_n)^2}{(W_1H_1 + W_2H_2 + \ldots + W_nH_n)}$$

Where:

W = The weight of yield (kg).
H = The picking duration (days).
1, 2 and n = The picking numbers.

6- Seed cotton yield per plant (y): It was the average seed cotton yield in grams of seven individual plants from each experimental unit.

Basic statistical estimates:

The raw data were obtained through the means of the plants which chosen from each experimental unit for various characters during experimental seasons. These collected means of both years were subjected to the descriptive analysis. Descriptive measures i.e. minimum (Min) and maximum (Max) values, mean values, standard deviation (SD) and coefficient of variation (CV%) were analyzed by Steel *et al.* (1997).

Combined analysis of variance:

All data in this investigation were exhibited to analysis of variance (ANOVA) for (RCBD) according to (Gomez & Gomez, 1984), for all the characters to test the null hypothesis of no differences between varieties. Combined analysis of the two years was done whenever homogeneity of variance was detected according to Bartlett's (1937), to measure the major impact of the various sources of variation and their interactions.

Simple correlation coefficients:

To assess the relationship between various characters, simple correlation coefficients for each pair of characters were estimated. Simple correlation coefficients and the correlation matrix were estimated by Snedecor & Cochran (1990).

Path coefficient analysis:

Path coefficient analysis divides of correlation coefficients into direct and indirect effects by other variables. Path coefficient analysis was study by (Dewey & Lu, 1959), using OpenStat software version (1.9) a computer program according to William (2007).

RESULTS AND DISCUSSION

Basic statistical estimates:

The results regarding Min. and Max., mean values, SD and CV% for the three varieties under study of all test characters are show in (Table 2). The CV% is effective for comparison the rang of variation also, the CV% is a character that is not correlated to the unit of estimated parameters and good useful in comparison the tested characters. The CV% among various traits at different measures is presented in (Table 2). The CV% of the tested characters ranged from 4.63 % (for days to the first flower appearance) to 19.21 % (for seed cotton yield per plant). The data revealed that the CV% was the maximum for seed cotton yield per plant, followed by earliness index while, days to the first flower had the minimum value, followed by days to the first boll opening. Production rate index and mean maturity date exhibited moderate values for the CV%. Means of seed cotton yield per plant varied between 31.17 and 53.22 g per plant. Days to the first flower appearance ranged from 79.65 to 85.73 days and

days to the first boll opening was between 129.17 and 137.34 days. Earliness index was between 48.33 and 67.12%, whereas mean maturity date was between 145.55 and 175.25 days, and production rate index was between 0.61 and 0.67 g (Table 2). This wide range of the differences give a good index to enhances of cotton yield. This give justification for enough to selection depending on of these characters may be effective. These results are in harmony with those by Mahdi (2014), Mahdi (2015) and Abd El-Mohsen & Amein (2016).

Table 2. Minimum (Min) and maximum values (Max), mean values, standard deviation (SD) and coefficient of variation (CV%) over the two years.

Traits	Min.	Max.	Mean	SD	CV%
Days to the first flower appearance (x_1)	79.65	85.73	82.69	10.13	4.63
Days to the first boll opening (x_2)	129.17	137.34	133.26	15.93	6.03
Earliness index (x_3)	48.33	67.12	57.73	11.05	19.05
Mean maturity date (x_4)	145.55	175.25	160.40	23.17	12.87
Production rate index (x_5)	0.61	0.76	0.69	0.11	13.25
Seed cotton yield per plant (y)	31.17	53.22	42.20	7.74	19.21

Combined analysis of variance:

The results the combined analysis of variance (ANOVA) for seed cotton yield per plant and earliness traits are summarized in (Table 3). Data indicated that significant differences among varieties in all tested characters. This result revealed considerable amount of differences existing in these varieties. This indicating the existence of enough differences between the varieties for tested traits, this give good opportunity for selection from varieties, to improves cotton yield. Similar finding obtained by Jatoi *et al*. (2012), Mahdi (2014) and Soomro *et al*. (2015).

Table 3. Mean squares of the six characters in some cotton varieties across the two seasons.

SOV	d.f	Days to the first flower appearance	Days to the first boll opening	Earliness index	Mean maturity date	production rate index	Seed cotton yield per plant
Replications	2	3.94	1.59	6.02	4.15	5.035	6.64
Varieties	2	120.27*	61.33*	225.26**	79.16*	172.11**	277.25**
Error	4	5.57	2.67	9.42	2.94	7.72	12.17

* and ** Significant at 5 and 1 % probability levels.

Simple correlation coefficients

The simple correlation coefficients between seed cotton yield per plant and earliness parameters, and the relationships between characters with each other depending on combined analysis of data over the two years are presented in (Table 4). The results clarified that seed cotton yield per plant showed high correlation and positive with earliness index (r = 0.943**) and production rate index. (r = 0.935**). However, days to the first flower appearance, days to the first boll opening and mean maturity date exhibited negative correlation with seed cotton yield per plant; r = - 0.795*, r = - 0.502^{ns} and r = - 0.817*, respectively. Therefore, variability for these characters between tested varieties is a good aim to selection between them in the different breeding programs. Regarding the correlation characters with each other, the results showed that positive correlation and significant between production rate index and each of mean maturity date, earliness index, days to the first boll opening and days to the first flower appearance. In this context, found significant correlation and positive and between earliness index and each of days to the first boll opening and days to the first flower appearance. In contrast, the correlation mean maturity date with earliness index, days to the first boll opening and days to the first flower appearance was negative. Concerning, days to the first boll opening was negative correlation with days to the first flower appearance. These results showed that enhancing of cotton yield is linked with these characters and their selection may be strong effect on cotton yield. This finding is agreement with Khan *et al.* (2000), Rauf *et al*. (2004) and Salahuddin *et al*.(2010).

Table 4. A matrix of simple correlation coefficients between seed cotton yield per plant and earliness measures in some cotton varieties over the two seasons.

Traits	X_1	X_2	X_3	X_4	X_5	y
Days to the first flower appearance (x_1)	1.000	- 0.815*	0.835*	- 0.749^{ns}	0.832*	- 0.795*
Days to the first boll opening (x_2)		1.000	0.789*	- 0.817*	0.797*	- 0.502^{ns}
Earliness index (x_3)			1.000	- 0.601^{ns}	0.903*	0.943**
Mean maturity date (x_4)				1.000	0.821*	- 0.817*
Production rate index (x_5)					1.000	0.935**
Seed cotton yield per plant (y)						1.000

*, ** and ns: Significant at 5 and 1 % probability levels and non-significant, respectively.

Path coefficient analysis

The direct and indirect effects of the five earliness characters on seed cotton yield per plant are show in (Table 5). The results of path analysis revealed that the direct effects of earliness index and production were high and positive on seed cotton yield per plant; 0.923 and 0.825, respectively. Thus, direct selection through these characters will be useful to increase cotton yield. Regarding the direct effects of mean maturity date, days to the first flower appearance and days to the first boll opening were moderate and negative on seed cotton yield per plant; - 0.669, - 0.665 and - 0.503, respectively. The indirect effects of earliness index and production rate index on seed cotton yield per plant through other characters were positive and moderate. The other indirect effects on seed cotton yield per plant were simple and negative. The same results were obtained by Iqbal *et al.* (2003), Farooq *et al.* (2014) and Mahdi (2015).

Table 5. Partitioning of simple correlation coefficients between seed cotton yield per plant and earliness measures across the two years.

Source of variation	Correlation coefficients
1- Days to the first flower appearance vs. seed cotton yield per plant	
Direct effect (P_1y)	- 0.665
Indirect effect via days to the first boll opening	- 0.673
Indirect effect via earliness index	0.505
Indirect effect via mean maturity date	- 0.593
Indirect effect via production rate index	0.631
Total correlation (r_1y)	- 0.795
2- Days to the first boll opening vs. seed cotton yield per plant	
Direct effect (P_2y)	- 0.503
Indirect effect via days to the first flower appearance	- 0.409
Indirect effect via earliness index	0.487
Indirect effect via mean maturity date	- 0.428
Indirect effect via production rate index	0.351
Total correlation (r_2y)	- 0.502
3- Earliness index vs. seed cotton yield per plant	
Direct effect (P_3y)	0.923
Indirect effect via days to the first flower appearance	- 0.261
Indirect effect via days to the first boll opening	- 0.135
Indirect effect via mean maturity date	- 0.289
Indirect effect via production rate index	0.705
Total correlation (r_3y)	0.943
4- Mean maturity date vs. seed cotton yield per plant	
Direct effect (P_4y)	- 0.669
Indirect effect via days to the first flower appearance	- 0.575
Indirect effect via days to the first boll opening	- 0.503
Indirect effect via earliness index	0.513
Indirect effect via production rate index	0.417
Total correlation (r_4y)	- 0.817
5- Production rate index vs. seed cotton yield per plant	
Direct effect (P_5y)	0.825
Indirect effect via days to the first flower appearance	- 0.196
Indirect effect via days to the first boll opening	- 0.127
Indirect effect via earliness index	0.711
Indirect effect via mean maturity date	- 0.278
Total correlation (r_5y)	0.935

The coefficients of determination and relative contribution according to path analysis, for five earliness measures in seed cotton yield per plant are presented in (Table 6). The results showed that the earliness index and production rate index were the maximum characters contribution in seed cotton yield per plant. The direct effects of these characters were 43.21% and 27.11%, respectively and their interaction effect was 9.23%.

Table 6. Direct and indirect effects of earliness measures and their relative contribution in seed cotton yield per plant over the two years.

Source of variation	CD*	RC %**
Direct effects		
Days to the first flower appearance (x_1)	2.759	1.03
Days to the first boll opening (x_2)	0.873	3.21
Earliness index (x_3)	2.237	43.21
Mean maturity date (x_4)	1.002	1.37
Production rate index (x_5)	0.125	27.11
Total direct effects	6.996	75.93
Indirect effects		
X_1 via X_2	- 0.554	2.41
X_1 via X_3	- 5.479	2.29
X_1 via X_4	- 0.117	1.08
X_1 via X_5	- 0.027	3.13
X_2 via X_3	- 0.390	1.09
X_2 via X_4	1.017	0.24
X_2 via X_5	- 0.073	1.03
X_3 via X_4	- 0.123	0.13
X_3 via X_5	- 0.175	9.23
X_4 via X_5	- 0.178	0.25
Total indirect effects	- 6.099	20.88
Total (direct + indirect effects)	0.897	96.81
Residual effects	0.103	3.19
Total	1	100

*CD = Coefficient of determination. **RC % = Relative contribution.

The high contribution of these characters in yield help to their selection as effective criteria in cotton breeding programs. Accordingly, the total contribution of these characters yield was 79.55%. Generally, the direct

and indirect effects of all earliness parameters under study in yield were 96.81% and residual effects were 3.19%. These results are in harmony with those by Farooq *et al.* (2014), Mahdi (2014) and Mahdi (2015).

CONCLUSION

The results obtained from this investigation may be effective for cotton farmers and researchers in order to increase yield and understand the nature of the relationship among the most important variables impacting on cotton yield. Finally, the results of correlation and path coefficient analysis revealed that earliness index and production rate index were high and positive relationship with seed cotton yield per plant and the most earliness measures contribution in yield. Thus, may be considered as effective criteria for selecting to increase of Egyptian cotton yield.

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تحليل الارتباط ومعامل المرور لبعض مقاييس التبكير في القطن المصري

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أجريت هذه الدراسة بمزرعة كلية الزراعة بجامعة الفيوم خلال موسمي ٢٠١٨ و ٢٠١٩ لتقييم العلاقة بين محصول القطن الزهر للنبات وخمسة مقاييس للتبكير في ثلاثة أصناف من القطن المصرى (جيزة ٨٠ و جيزة ٩٠ و جيزة ٩٥) .أظهرت النتائج وجود اختلافات معنوية بين الأصناف في جميع الصفات تحت الدراسة - أشار تحليل الارتباط الي أن دليل التبكير ومعامل الإنتاجية في وحدة الزمن كانت عالية الارتباط وموجبة مع محصول القطن الزهر للنبات بينما كان الارتباط سالباً بين محصول القطن الزهر للنبات وكل من تاريخ خروج أول زهرة وتاريخ تفتح أول لوزة ومتوسط تاريخ النضج - أظهر تحليل معامل المرور أن أعلي تأثير مباشر علي محصول القطن الزهر للنبات كان لدليل التبكير 43.21 % ومعامل الإنتاجية في وحدة الزمن ٢٧,١١ % وأن التأثير المشترك لهما ٩,٢٣ % ومجموع مساهمة كل الصفات تحت الدراسة بلغ ٩٦,٨١ %. يتضح مما سبق أن صفتي دليل التبكير ومعامل الإنتاجية في وحدة الزمن كانت أكثر الصفات اسهاما في محصول القطن الزهر للنبات وبالتالي يمكن استخدامهما كمعايير مفيدة لزيادة محصول القطن المصري.