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PATH COEFFICIENT ANALYSIS FOR LINT YIELD AND ITS CONTRIBUTING VARIABLES IN F_2 AND F_3 GENERATIONS OF THE EGYPTIAN COTTON CROSS GIZA 83 X GIZA 75

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Abstract

Simple correlation coefficients between all possible pairs of thirteen characters were calculated for plants of both F_2 and F_3 generations of an Egyptian cotton hybrid between Giza 83 and Giza 75 (Gossypium barbadense L.). Moreover, path coefficients were studied for lint yield and its contributing characters in both F_2 and F_3 generations.

The results indicated that lint yield/plant (LY/P) was highly and positively correlated with number of harvested bolls/ plant (B/P), boll weight (BW), lint index (LI), Pressley index (PI), number of vegetative branches (NVB), lint percentage (L%, in F2 generation) and days to first open boll (DFB, in F_3 generation).

The results obtained from path coefficient analysis revealed that the main sources of LY/P variation could be arranged according to their relative importance in F_2 generation as follows: B/P, LI X SI (seed index), LI and SI. Whereas, in F_3 generation, B/P, B/P through each of BW and PI and the direct effect of BW were the main sources of variation in the same order. Also the results indicated that DFF and DFB were the main contributors to B/P. An increase in B/p.An increase B/p was almost offset by a decrease of either DFF, DFB or both. Selection to improve lint yield should be directed toward the prolificacy of these characters in the breeding material.

INTRODUCTION

The cotton breeding program is still depending fully on hybridization for breeding and production of new varieties that possess higher yield and better quality. However, selection for yield on individual plant basis has been mostly ineffective. Selection for some other morphological and agronomical characters to achieve high yielding potential was adopted. A promising alternative to direct selection is the indirect selection for yield via its components. Hence, several investigators attempted to improve yield indirectly through the improvement of characters associated with yield. They applied different statistical techniques, included correlation and regression analysis as well as path coefficient procedure (Singh et al., 1968, Zaitoon, 1973, El-Marakby et al., 1980, Elayan, 1982, El-Shaer et al., 1984, Shafshak et al., 1987, Ismail et al., 1988 a and b, and Ghaly et al., 1990).

The objective of this study was to use path coefficient analysis technique to determine the relative importance of traits contributing to lint yield in F2 and F3 generations of the Egyptian cotton cross Giza 83 X Giza 75.

MATERIALS AND METHODS

The material used in this study consisted of the F_2 and F_3 populations of a cross between the two long staple Egyptian cotton varieties Giza 83 and Giza 75 of (*Gossypium barbadense* L.). The cross was made in 1991 season at Giza Experimental station, Agricultural Research Center.

In 1992 season, the hybrid seeds, as well as selfed seeds of both parents were grown. In the same season, the parents were crossed to obtain more F_1 hybrid seeds and artificial selfing for the F_1 hydrid plants was made to obtain F_2 Selfed seeds.

In 1993 season, a part of F1 and F2 selfed seeds were saved to be sown with F_3, while the other part of F2 seeds were planted. Many flower were selfed on F2 plants in order to obtain seeds for progeny testing in F3.

In 1994, five populations, i.e., the two parents (P_1 and P_2), F_1, F_2 and F_3 were planted in a randomized complete block design with four replications. Each replication included two rows for each P_1, P_2, F_1 and four rows F_2 and F_3. Plants were grown in rows 7 meters long and 60cm. wide. Each row had ten hills 70cm. apart. Agter 40 days all hills were thinned to a single plant per hill. All the agricultural practices were done as recommended.

A representative random sample of 25 individual guarded plants per plot for each of F_2 and F_3 populations, were screened for the following characters: days to first flower (DFF); days to first open boll (DFB); position of the first node (PFN); number of harvested bolls/plant (B/P); Boll weight (BW; lint yield/plant (LY/P); lint percentage (L%); seed index (SI); lint index (LI); Microinaire reading (Mic); Pressley index (PI); number of fruiting branches (NFB); and number of vegetative branches (NVB).

Simple correlation coefficient of F_2 and F_3 population were computed between various characters according to the method described by Snedecor and Cochran (1967).

The phenotypic linear correlation coefficients of 12 traits contributed to lint yield in both F_2 and F_3 generations were partitioned into direct and indirect effect by using path coefficient method proposed by Deway and Lu (1959).

RESULTS AND DISCUSSION

1. Association between characters:

Simple correlation coefficients of (LY) with various contributing characters for the two generations of F_2 and F_3 are shown in Table (1). Data showed strong positive association between LY/P, B/P, BW, L%, LI, PI and NVB. It is also evident that positive and significant correlation could be detected between LY/P and each of SI (in both generations) and DEF (in F3 generation). The magnitude of correlation co-efficients between lint yield and each of DFB and L% were relatively low in F_2 and F_3 generations, respectively.

Number of harvested bolls/plant (B/P) was highly and positively correlated with BW, PI, and NVB in each generation. Significant and positive correlations were recorded between B/P and each of DFB, L% and LI (in F_2 generation). The same character (B/P), correlated significantly and negatively with LI in F_2 generation. Moreover, highly significant and positive correlation coefficients were obtained be-tween BW and each of SI, LI and Mic and Mic; L and LI; SI and each of LI and between P_I and each of DFF and NVB.

In F_3 generation, the correlation coefficients beteen L% and each of PFN, SI and NVB were negative and highly significant. Therefore, improving LY/P through increasing NFB may be a formidable task in F_3 generation due to the negative associ-ations between NFB and each of BW and SI.

These results are in agreement with those reported by Zatioon (1973), Shaf-shak et al. (1987), Ismail et al. (1988 a and b), and El-Adly (1996).

2. Path coefficient analysis:

The relative contribution of various lint components to lint yield for both F_2 and F_3 generations as derived from path coefficient analysis for the cross Giza 83 X

Table 1. Simple correlation coefficients between all possible pairs of the thirteen traits for F_2 and F_3 generations of the Egyptian cross Giza 83 X Giza 75.

Traits	Generations	NVB	NFB	PI	Mic	LI	SI	L%	LY/P	BW	B/P	PFN	DFB
DFF	F_2	0.123	0.230*	0.260**	0.309**	0.174	0.281*	-0.068	0.185	0.279**	0.157	0.759**	-0.058
	F_3	0.321**	-0.129	0.256**	0.003	0.029	0.151	-0.125	0.221*	0.187	0.231*	0.131	0.884**
DFB	F_2	0.098	0.053	-0.045	-0.131	-0.118	-0.059	-0.127	-0.011	-0.070	0.026	-0.042	
	F_3	0.278**	-0.052	0.267**	0.065	0.073	0.160	-0.072	0.280**	0.253*	0.270**	0.110	
PFN	F_2	0.175	0.125	0.183	0.159	0.123	0.201	-0.117	0.132	0.186	0.115		
	F_3	0.200*	-0.079	-0.028	-0.132	-0.155	0.075	-0.271**	-0.047	-0.052	-0.021		
B/P	F_2	0.416**	0.187	0.804**	0.018	0.228*	0.108	0.233*	0.974**	0.312**			
	F_3	0.432**	-0.035	0.883**	0.039	0.103	0.158	-0.045	0.963**	0.337**			
BW	F_2	-0.069	0.100	0.221*	0.532**	0.674**	0.510	0.220	0.475**				
	F_3	0.001	-0.010	0.247*	0.525**	0.537**	0.989**	0.065	0.536**				
LY/P	F_2	0.381**	0.176	0.797**	0.122	0.354**	0.196*	0.310**					
	F_3	0.348**	-0.019	0.818**	0.179	0.264**	0.248*	0.065					
L%	F_2	-0.013	-0.108	0.325**	0.089	0.421**	-0.149						
	F_3	-0.220	0.187	-0.136	0.081	0.603**	-0.248*						
SI	F_2	0.039	0.137	0.071	0.534**	0.831**							
	F_3	0.091	-0.155	0.175	0.480**	0.620**							
LI	F_2	0.027	0.067	0.249*	0.541**								
	F_3	-0.095	0.016	0.043	0.452**								
Mic	F_2	-0.006	0.164	0.035									
	F_3	-0.250*	-0.041	-0.056									
PI	F_2	0.437**	0.064										
	F_3	0.520**	-0.075										
NFB	F_2	0.066											
	F_3	-0.285**											

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

Giza 75 are shown in Table 2. The direct effect of each of B/P (0.874 and 0.9334 in F2 and F3 generations, respectively) and LI (0.623 in F_2 only) was the major component for the highly significant correlation between LY/P and each of these characters. The direct effect of BW in both generations F_2 (0.198) and F_3 (0.226) was lower in magnitude than the indirect effect of BW via LI (0.421) in F_2 and BW via B/P (0.273 and 0.315 in F2 and F3, respectively). In F_2 generation, the negative direct effect of L% (-0.298) and SI (-0.583) were moderate in magnitude while their indirect effects L% via LI (0.263), L% via B/P (0.203) and SI via LI (0.519) were the major contributors for the highly significant correlation coefficients between LY/P and each of L% and SI. Evidently, the positive indirect effects of PI and NVB through B/P in both F2 (0.702 and 0.364, respectively) and F3 (0.825 and 0.404, respectively) were the major components for the highly singgificant correlation coefficients between LY/P and each of PI and NVB while, its direct effects were positive (in F_2) or negative (in F_3) and lower in magnitude.

In F_3 generation (Table 2), the direct effects of DFF (-0.012) and DFB (-0.001) were negative and with low magnitude while, their indirect effects through B/P (0.216 and 0.253, respectively) were the main components for significant or highly significant correlation coefficients between LY/P and each of these traits. An increase in B/p was almost offset by a decrease of either DFF, DFB or both, or so to speak. On the other hand, the same generation showed that the main contributor for the significant correlation coefficient between LY/P and SI was the indirect effects of SI via B/P (0.147) and SI via BW (0.133) while, the direct effect of SI was positive and low in magnitude (0.046). Meanwhile, the direct effect of LI was negative and with low magnitude however, the indirect effect of LI x BW (0.121) was the greatest component for the highly significant correlatio coefficient between LY/P and LI.

In general, the results (Table 3 and Figure 1) indicated that B/P was the major contributing component for LY/P in both F_2 (0.76) and F_3 generations (0.76 and 0.87 respectively). The second contributor to LY/P in F_2 was the negative indirect effect of SI X LI (-0.6044) followed in order by the direct effect of LI (0.39), SI (0.34), the joint effects of B/P though each of LI (0.2483) and BW (0.166). Meanwhile, the second contributor to LY/P in F_2 was the indirect effect of B/p x BW (0.1422) followed in arrangement by the negative joint effect of B/P x PI (-0.0629) and the positive direct effect of BW (0.05). Other direct and indirect effects for the rest for the rest of the studied characters were negligible and show very slight contributions to lint yield/plant.

Table 2. Partitioning of simple correlation coefficient between lint yield per plant and its contributing characters in F2 and F3 generations of the Egyptain cross Giza 83 X Giza 75.

Traits	DFF	DFB	PFN	B/P	BW	L%	SI	LI	Mic	PI	NFB	NVB
						F_2 generation						
DFF	**-0.010**	0.001	-0.008	-0.002	-0.003	0.001	-0.003	-0.002	-0.003	-0.003	-0.002	-0.001
DFB	0.001	**-0.020**	0.001	-0.001	0.001	0.003	0.001	0.003	0.003	0.001	-0.002	-0.002
PFN	-0.001	0.000	**-0.002**	-0.000	-0.000	0.000	-0.001	-0.000	-0.000	-0.000	-0.001	-0.000
B/P	0.137	0.023	0.101	**0.874**	0.273	0.203	0.094	0.199	0.016	0.702	0.164	0.364
BW	0.055	-0.014	0.037	0.062	**0.198**	0.044	0.120	0.133	0.105	0.044	0.020	-0.014
L%	0.020	0.038	0.035	-0.069	-0.065	**-0.298**	0.045	-0.126	-0.026	-0.097	0.032	0.004
SI	-0.134	0.034	-0.118	-0.063	-0.355	0.087	**-0.583**	-0.484	-0.311	-0.042	-0.080	-0.023
LI	0.109	-0.074	0.077	0.142	0.421	0.263	0.519	**0.623**	0.337	0.156	0.042	0.017
Mic	0.000	-0.001	0.000	0.000	0.001	0.000	0.001	0.001	**0.002**	0.000	0.000	-0.000
PI	0.006	-0.001	0.005	0.020	0.006	0.008	0.002	0.006	0.001	**0.025**	0.002	0.011
NFB	-0.000	-0.000	-0.001	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	**-0.001**	-0.001
NVB	0.003	0.003	0.005	-0.002	-0.002	-0.000	0.001	0.001	-0.000	0.011	0.002	**0.026**
Total	0.186	-0.011	0.132	0.974**	0.475**	0.310**	0.196*	0.354**	0.122	0.797**	0.176	0.381**
						F_3 generation						
DFF	**-0.012**	-0.011	-0.002	-0.003	-0.002	0.002	-0.002	-0.001	-0.000	-0.003	0.002	-0.004
DFB	-0.001	**-0.001**	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000
PFN	0.002	0.002	**0.013**	-0.000	-0.001	-0.004	0.001	-0.002	-0.002	-0.001	-0.001	0.003
B/P	0.216	0.253	-0.020	**0.934**	0.315	-0.042	0.147	0.096	0.036	0.825	-0.032	0.404
BW	0.042	0.057	-0.012	0.076	**0.226**	0.015	0.133	0.121	0.119	0.056	-0.002	0.000
L%	-0.018	-0.010	-0.039	-0.006	0.009	**0.143**	-0.035	0.086	0.012	-0.020	0.027	-0.031
SI	0.007	0.007	0.004	0.007	0.027	-0.011	**0.046**	0.029	0.022	0.008	-0.007	0.004
LI	-0.002	-0.005	0.012	-0.008	-0.040	-0.045	-0.046	**-0.074**	-0.034	-0.003	-0.002	0.007
Mic	0.000	0.001	-0.003	0.001	0.011	0.002	0.010	0.010	**0.021**	-0.001	-0.001	-0.005
PI	-0.010	-0.010	0.001	-0.034	-0.009	0.005	-0.007	-0.002	0.002	**-0.038**	0.003	-0.020
NFB	0.001	0.000	0.001	0.001	0.000	-0.002	0.002	-0.000	0.000	0.001	**-0.009**	0.002
NVB	-0.004	-0.003	-0.002	-0.005	-0.000	0.003	-0.001	0.001	0.003	-0.006	0.003	**-0.012**
Total	0.221*	0.280**	-0.047	0.963**	0.536**	0.065	0.248*	0.264**	0.179	0.818**	-0.019	0.348**

Underlined values denote direct effect.

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

Table 3. Direct and joint effects of different characters contributed to lint yield per plant in both F2 generation of the Egyptian cross Giza 83 X Giza 75.

Traits	Generations	DFF	DFB	PFN	B/P	BW	L%	SI	LI	Mic	PI	NFB	NVB
DFF	F_2	0.0000	-0.0000	0.0000	-0.0028	-0.0011	-0.0004	0.0027	-0.0022	-0.000	-0.0001	0.0000	-0.0001
	F_3	0.0000	0.0000	-0.0000	-0.0053	-0.0010	0.0004	0.0002	0.0001	-0.000	0.0002	-0.0000	0.0001
DFB	F_2		0.0000	-0.0000	-0.0009	0.0006	-0.0015	-0.0014	0.0030	0.0000	0.0000	0.0000	-0.0001
	F_3		0.0000	-0.0000	-0.0004	-0.0001	0.0000	-0.0000	0.0000	-0.0000	0.0000	-0.0000	0.0000
PFN	F_2			0.0000	-0.0003	-0.0001	-0.0001	0.0004	-0.0002	-0.0000	-0.0000	0.0000	-0.0000
	F_2			0.0000	-0.0005	-0.0003	-0.0010	0.0001	0.0003	-0.0001	0.0000	0.0000	-0.0001
B/P	F_2				0.7600	0.1075	-0.1213	-0.1090	0.2483	0.0000	0.0356	-0.0004	0.0180
	F_3				0.8700	0.1422	-0.0120	0.0135	-0.0143	0.0015	-0.0629	0.0005	-0.0095
BW	F_2					0.0400	-0.0259	-0.1404	0.1660	0.0003	-0.0022	-0.0001	-0.0007
	F_3					0.0500	0.0042	0.0122	-0.0180	0.0050	-0.0043	0.0000	-0.0000
L%	F_2						0.0900	-0.0520	-0.1567	-0.0001	-0.0049	-0.0001	0.0002
	F_3						0.0200	-0.0032	-0.0128	0.0005	0.0015	-0.0005	0.0007
SI	F_2							0.3400	-0.6044	-0.0010	-0.0021	0.0002	-0.0012
	F_3							0.0000	-0.0042	0.0009	-0.0006	0.0001	-0.0001
LI	F_2								0.3900	0.0011	0.0079	-0.0001	0.0009
	F_3								0.0100	-0.0014	0.0002	0.0000	-0.0002
Mic	F_2									0.0000	0.0000	-0.0000	-0.0000
	F_3									0.0000	0.0001	0.0000	0.0001
PI	F_2										0.0000	-0.0000	0.0006
	F_3										0.0000	-0.0000	0.0005
NFB	F_2											0.0000	-0.0000
	F_3											0.0000	-0.0001
NVB	F_2												0.0000
	F_3												0.0000
Residual	F_2												0.0140
	F_3												0.0137

Underlined values denote direct effect.

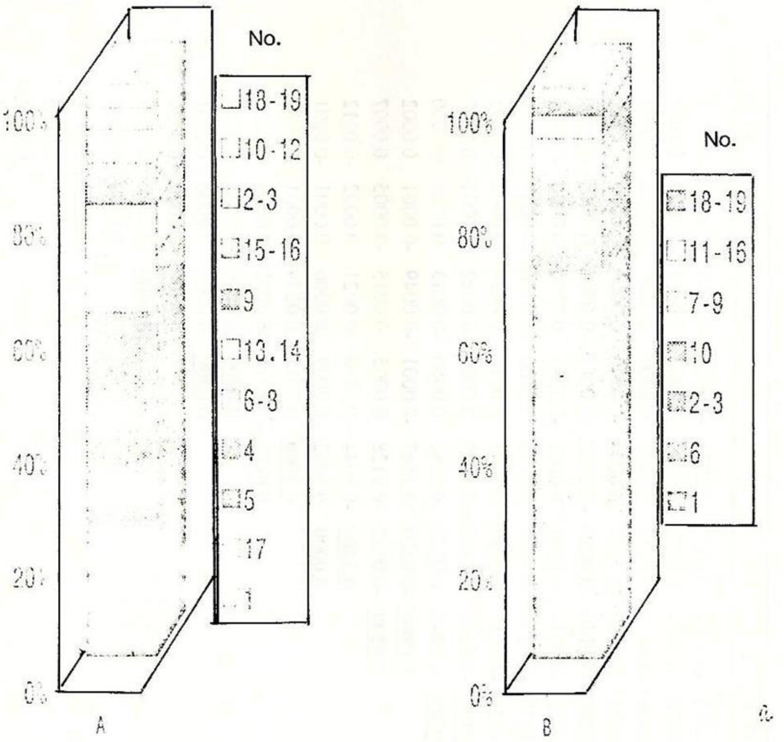

Fig. 1: The Components in percent for lint yield / plant in both F_2 (A) and F_3 (B) generations as depicted from the following table :

No	Characters	F2	F3	No	Characters	F2	F3
1	B/P	22.03	66.81	11	B/P x NVB	1.27	0.72
2	BW	1.13	3.90	12	BW x L%	0.75	0.00
3	L%	2.57	1.56	13	BW x SI	4.05	0.92
4	SI	9.81	0.00	14	BW x LI	4.79	1.38
5	LI	11.24	0.00	15	L% x SI	1.50	0.00
6	B/P x BW	3.10	10.89	16	L% x LI	4.52	0.98
7	B/P x L%	3.50	0.92	17	SI x LI	17.45	0.00
8	B/P x SI	3.15	1.04	18	Remaining effects	0.54	3.93
9	B/P x LI	7.17	1.09	19	Residual	0.40	1.05
10	B/P x PI	1.03	4.81	20			

These results indicated that the percentage contribution of lint yield components represented more than 98% of the total variability and that the characters under investigation included the actual yield components. The residual values were 0.40% and 1.05% in both F_2 and F_3 generations accounted for the rest of the studied characters which had negligible effects on lint yield/plant.

In summary, B/P was responsible for 22.03% and 66.81% of the total variatin of lint yield per plant (in both F_2 and F_3 generations, respectively). In F_2 generation, the joint effect of SI x LI, was responsible for 17.45% while, the direct effects of each of LI and the indirect effect of B/P x LI were responsible for 11.24%, 9.81% and 7.17% of the overall variation in LY/P, respectively. Meanwhile, in F3 generation, the joint effects of B/P through each of BW and PI and direct effect of BW were responsible for 10.89%, 4.81% and 3.90% of the total variation in lint yield per plant.

The results agreed with those previously reported by Zaitoon (1973), Abo Alam and El-Marakby (1978), El-Bayoumy (1978), El-Marakby et al. (1980), El-Shaer et al. (1984), Seyam et al. (1984), Shafshak et al. (1987),Ismail et al. (1988 a and b), Ghaly et al. (1990) and Awaad et al. (1995).

Breeding implication:

1. The result of this study could be put in terms of applicability as follows: The major component of lint yield per plant in F_2 and F_3 generations is B/P followed by the joint effects of SI X LI and B/P X BW, respectively. The third contributor to lint yield was L1 and B/d x PI in F_2 and F_3 generations, respectively while, the fourth contributor in importance was SI and BW in F_2 and F_3 generations,respectively.

2. These results may indicate that using simple correlation coefficient only without taking into consideration the interactions between contributing characters is misleading.

3. It is an advantage for the breeder to consider these characters in planning his breeding programs to improve lint yield during selection.

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تحليل معامل المرور لمحصول القطن الشعر والمتغيرات المساهمة فيه في الجيلين الثاني والثالث لهجين القطن المصري جيزة ٨٣ x جيزة ٧٥

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أجرى هذا البحث لدراسة العلاقة بين محصول القطن الشعر وبعض الصفات المحصولية وكذا تحديد المساهمة النسبية لكل صفة من مكونات المحصول في كلاً من الجيلين الثاني والثالث لهجين القطن المصرى جيزة ٨٤ X جيزة ٧٥ , وقد تم تهجين الأبوين في عام ١٩٩١ ، وتم زراعة الجيلين الأول والثاني في عامي ١٩٩٢ ، ١٩٩٣ على التوالي. وفي عام ١٩٩٤ تم زراعة الأباء، والأجيال الأول والثاني والثالث في تجربة في قطاعات كاملة عشوائية في أربعة مكررات في مزرعة مركز البحوث الزراعية بالجيزة. أخذت بيانات ٢٥ نباتاً فردياً من كل مكررة في كلا الجيلين الانعزالين الثاني والثالث لهذه الدراسة.

وقد أوضحت النتائج وجود إرتباط موجب بين محصول القطن الشعر وكلاً من عدد اللوز المتفتح على النبات، متوسط وزن اللوزة، معامل البذرة، معامل الشعر، ومعامل البريسلي، وعدد الأفرع الخضرية على النبات (في كلاً من الجيلين الثاني والثالث)، وصافي الحليج (في الجيل الثاني فقط)، وعدد الأيام من الزراعة لتفتح أول زهرة، وعدد الأيام من الزراعة لتفتح أول لوزة (في الجيل الثالث فقط).

كما تم إستخدام تحليل معامل المرور لتقدير مقدار ما تسهم به كل صفة من الصفات المدروسة في محصول القطن الشعر، وأمكن بذلك ترتيب مكونات المحصول حسب مقدار أهميتها في الجيل الثاني كما يلي:

١) التأثير المباشر لعدد اللوز على النبات (٢٢,٠٣٪).
٢) التأثير غير المباشر لمعامل البذرة مع معامل الشعر (١٧,٤٥٪).
٣) التأثير المباشر لمعامل الشعر (١١,٢٤ ٪).
٤) التأثير المباشر لمعامل البذرة (٩,٨١٪).

وبالنسبة لمحصول القطن الشعر في الجيل الثالث كان ترتيب الصفات حسب أهميتها:

١) التأثير المباشر لعدد اللوز على النبات (٦٦,٨١ ٪).
٢) التأثير غير المباشر لعدد اللوز على النبات مع متوسط وزن اللوزة (١٠,٨٩٪).
٣) التأثير غير المباشر لعدد اللوز على النبات مع معامل البريسلي (٤,٨١٪).
٤) التأثير المباشر لمتوسط وزن اللوزة (٣,٩٠٪).

يتضح من هذه الدراسة انه من الضروري لمربي القطن أن يأخذ بعين الإعتبار هذه الصفات عند الانتخاب بهدف تحسن محصول القطن الشعر، بالاضافة الى عدد الأيام من الزراعة الى تفتح كل من أول زهرة، وأول لوزة لمساهمتهما غير المباشرة في زيادة المحصول عن طريق زيادة عدد اللوز المتفتح على النبات.