COMPARISON OF THE EFFICIENCIES OF THE DIFFERENT SELECTION PROCEDURES IN THREE POPULATIONS OF EGYPTIAN COTTONS (*Gossypium barbadense* L.)

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Abstract

Different selection methods i.e. phenotypic individual trait selection, selection index and recurrent selection were used to improve lint yield in three populations of Egyptian cotton, G. 45 x G. 75, G. 87 x G. 89 and G. 86 variety grown in open-pollinated bulks for four years. In population I (G. 45 x G. 75), the direct phenotypic trait selection procedure in F_4 generation for lint yield (I_{xw}) was superior to the other selection procedures. Concerning population II (G. 87 x G. 89), the recurrent selection and phenotypic trait selection for bolls/plant (I_{x1}) in F_4 generation were more efficient than the other selection procedures. Regarding population III (G. 86 open-pollinated cultivar), both recurrent selection and index I_{xw} in S_2 generation were superior compared with the other selection procedures.

INTRODUCTION

Lint yield is a complex character. It is the product of the contributions made by its components. The selection index technique provides an appropriate approach for the simultaneous improvement of two or more characters by selection. Recurrent selection aims to increase the genetic recombinations and desirable gene frequencies in plant population. Kerr (1966) proposed yield model for comparing the effects of various yield components on lint yield of selected genotypes. Culp and Harrell (1975) found that through a program of hybridization and selection, lint yield of Pee Dee lines was raised 12%. El-Okkiah (1979) showed that the predicted yield advance was decreased following deletion of any one of the two yield components (seeds/boll and lint/seed). Mahdy *et al.* (1987a and b) reported that the selection index "I_{w13}" was the only one that gave significant increase of lint yield/plant (28.63%) over mid-parent. Means of recurrent selection hybrids exceeded the mid-parent by 19.71% for lint yield/plant and the five superior hybrids exceeded the mid-parent by 59.21% for lint yield. Gooda (2001) found that the selection indices I_{w12} and I_{w2} resulted in an increase of predicted advance form F_3 to F_4 for lint yield.

The present study aimed to evaluate the relative effectiveness of within and between different selection procedures-selection index,phenotypic trait selection and recurrent selection-in improving lint yield in the three populations.

MATERIALS AND METHODS

Field procedures:

The present investigation was carried out at Sakha Agricultural Research Station, A.R.C., Egypt, during 2000-2002 growing seasons. Three populations were used devoted in this study. The first population was the cross between the extra-long staple cotton variety Giza 45 and the long staple cotton variety Giza 75. The second population stemmed from the cross between the Egyptian extra-long staple variety Giza 87 and the long staple-variety Giza 89. The third population was Giza 86 variety grown in an open-pollinated bulks for four years.

1. Selection index and phenotypic trait selection:

In the first season (2000), the F_2 of both populations I and II, and the S_0 of population III with original parents were grown in non-replicated rows. 15 superior plants were chosen for each phenotypic trait selection i.e., lint yield/plant (x_w), bolls/plant (x_1), seeds/boll (x_2) and lint/seed (x_3). The final selection of plants for the four phenotypic trait selection were 50 plants. In 2001, selfed seeds (F_3 and S_1) were evaluated with the two parents and F_3 bulked seeds in RCB design with three replications. The progenies were ranked using twelve selection procedures involving the four characters. In 2002, applying 6% selection intensity among progenies, each selection procedure gave three superior progenies, the number of selected progenies were 10, 13 and 11 for populations I, II and III respectively, they were evaluated with the two parents and F_4 bulked seeds in RCB design with three replications. Selection index and phenotypic trait selection were as follows:

I_{w123} = Selection index involving lint yield/plant, bolls/plant, seeds/boll and lint/seed.

I_{123} = Selection index involving bolls/plant, seeds/boll and lint/seed.

I_{w1} = Selection index involving lint yield/plant and bolls/plant.

I_{w2} = Selection index involving lint yield/plant and seeds/boll.

I_{w3} = Selection index involving lint yield/plant and lint/seed.

I_{12} = Selection index involving bolls/plant and seeds/boll.

I_{13} = Selection index involving bolls/plant and lint/seed.

I_{23} = Selection index involving seeds/boll and lint/seed.

Ixw = Phenotypic selection for lint yield/plant.

Ix1 = Phenotypic selection for bolls/plant.

Ix2 = Phenotypic selection for seeds/boll.

Ix3 = Phenotypic selection for lint/seed.

2. Recurrent selection:

Four superior plants in lint percentage and four elite plants in seed index of each population were chosen as parents to produce the first cycle of recurrent selection. Selfed seeds of the eight parents of recurrent selection were sown in 2001 season. Half diallel cross procedure was made giving 28 crosses. In 2002 season, the 28 crosses along with their eight selected parents were evaluated with the two original parents and random samples of F_4 and S_2 (bulked seeds) in three separate experiments. The experimental design was randomized complete block design with three replications. Standard agricultural practices and plant spacings were followed with index selection and phenotypic trait selection experiments.

Methods of Analysis:

The formula suggested by Smith (1936) and Hazel (1943) was used in calculating different selection indices. Predicted genetic advance in lint yield based on an index and one variable alone were estimated as outlined by Walker (1960) and Miller and Rawlings (1967). The actual changes in lint yield realized in 2001 and 2002 seasons of the different selection procedures were also estimated.

RESULTS AND DISCUSSION

Deviations of the realized advance from the predicted one for lint yield/plant using different selection procedures in the three populations are presented in Table(1). These deviations were positive and high for all indices in population III. Selection indices I_{w123}, I_{w1}, I_{w2}, Ix_2 and Ix_3 in population I resulted in realized advance that was higher than the predicted one. While indices I_{123}, I_{13} and Ix_3 gave high value of realized advances in population II. There was very close agreement between predicted and realized advance of lint yield in population I using the indices I_{w2}, I_{13}, Ix_w and Ix_1. While those of using indices I_{123}, I_{12}, I_{13}, Ix_2 and Ix_3 in population II were in very close agreement for lint yield. The close agreement between predicted and realized responses to selection indices may be due to the non additive effects (dominance, epistasis and interactions) which were relatively of minor importance and the additive genetic effects would appear to be prevalent . On the other hand, there was discrepancy between predicted and realized advance in lint yield when using the various models of selection indices for population III. Such large discrepancies did not raise doubt as to the validity of the general theory of selection index.

Table 1. Deviations of realized advance from predicted advance for lint yield/plant (g), using different selection procedures in the three populations.

Indices	Population I (G. 45 x G. 75) from F_3 to F_4	Population II (G. 87 x G. 89) from F_3 to F_4	Population III (G. 86 open-pollinated) from S_1 to S_2
I_{w123}	+0.88	-1.41	+3.29
I_{123}	-1.11	+0.42	+1.10
I_{w1}	+0.82	-1.42	+3.31
I_{w2}	+0.19	-2.21	+2.05
I_{w3}	-1.11	-2.71	+2.01
I_{12}	-0.85	-0.37	+1.96
I_{13}	-0.31	+0.45	+1.25
I_{23}	-2.53	-3.44	+5.55
Ix_w	-0.54	-2.47	+3.19
Ix_1	-0.35	-1.09	+2.28
Ix_2	+1.66	-0.19	+8.75
Ix_3	+2.95	+0.66	+5.71

Predicted and actual relative efficiencies of different selection procedures for improving lint yield (g)/plant as estimated from F_4 and S_2 in the three populations are shown in Table (2).

In population I, the ranks of expected relative efficiencies relative to selection for lint yield alone (Ixw) in F_3 generation were 201.65% for I_{23}, 123.46% for I_{123}, 123.46% for I_{w3}, 115.23% for I_{w2} and 112.76% for I_{12}. On the other hand, the direct phenotypic selection procedure for lint yield only (Ixw) was superior to the other selection procedures in F_4 generation. The ranks of actual relative efficiencies relative to selection for lint yield alone (Ixw) were 274.60% for recurrent selection, 221.69% for Ix_3, 158.20% for I_{w123}, 158.20% for I_{w1}, 158.20% for I_{w2}, 125.40% for I_{23}, 123.81% for Ix_2 and 113.23% for I_{13}. This indicated that the recurrent selection method was more efficient than the other selection procedures in improving lint yield due to the enhanced genetic variability provided by recurrent selection compared to selection index. Comparable results were obtained by Ali (1977), Mahdy (1983) and Younis (1986).

Concerning population II, the selection index involving seeds/boll and lint/seed (I_{23}) was more efficient than the other selection procedures in F_3 generation. Both recurrent selection and index Ix_1 were more efficient than the other selection procedures in F_4 generation. The ranks of actual relative efficiencies relative to selection for lint yield alone (Ixw) were 550.00% for recurrent selection, 532.14% for I_{123}, 532.14% for I_{13}, 405.36% for Ix_3, 296.43% for I_{23}, 292.86% for I_{12} and 292.86% for Ix_1. These results indicted that the recurrent selection, selection index involving seeds/boll and lint/seed (I_{23}) and direct phenotypic selection procedure for bolls/plant were superior to the other selection procedures in population II. Kamalanathan (1967), El-Kilany (1976) and Gooda (2001) reported that the selection index involving seeds/boll and lint/seed (I_{23}) ranked first for improving lint yield in both generations relative to the higher-yielding parent.

Table 2. Predicted and actual relative efficiencies for the different selection procedures for improving lint yield (g)/plant as estimated from F_4, and S_2 in the three populations.

Populations	Selection procedures	Predicted advance From F_3 (S_1) to F_4 (S_2)		Actual advance From F_3 (S_1) to F_4 (S_2)		Predicted advance From F_4 (S_2) to F_5 (S_3)	
		i	ii %	i	ii %	i	ii %
Population I (G. 45 x G. 75)	I_{w123}	2.11	86.83	2.99	158.20	0.12	2.97
	I_{123}	3.00	123.46	1.89	100.00	1.21	29.95
	I_{w1}	2.17	89.30	2.99	158.20	0.12	2.97
	I_{w2}	2.80	115.23	2.99	158.20	0.16	3.96
	I_{w3}	3.00	123.46	1.89	100.00	1.10	27.23
	I_{12}	2.74	112.76	1.89	100.00	1.08	26.73
	I_{13}	2.45	100.82	2.14	113.23	0.90	22.28
	I_{23}	4.90	201.65	2.37	125.40	0.94	23.27
	Ix_w	2.43	100.00	1.89	100.00	4.04	100.00
	Ix_1	2.15	88.48	1.80	95.24	3.14	77.72
	Ix_2	0.68	27.98	2.34	123.81	0.40	9.90
	Ix_3	1.24	51.03	4.19	221.69	3.09	76.49
	Recurrent selection	-	-	5.19	274.60	3.15	77.97
Population II (G. 87 x G. 89)	I_{w123}	1.97	65.02	0.56	100.00	0.57	14.18
	I_{123}	2.56	84.49	2.98	532.14	0.84	20.90
	I_{w1}	1.98	65.35	0.56	100.00	0.58	14.43
	I_{w2}	2.77	91.42	0.56	100.00	0.90	22.39
	I_{w3}	2.71	89.44	0.00	0.00	1.45	36.07
	I_{12}	2.01	66.34	1.64	292.8	0.08	1.99
	I_{13}	2.53	83.50	2.98	532.14	0.81	20.15
	I_{23}	5.10	168.32	1.66	296.43	-0.17	-4.23
	Ix_w	3.03	100.00	0.56	100.00	4.02	100.00
	Ix_1	2.73	90.10	1.64	292.86	4.20	104.48
	Ix_2	0.23	7.59	0.04	7.14	1.65	41.04
	Ix_3	1.61	53.14	2.27	405.36	-2.92	-72.64
	Recurrent selection	-	-	3.08	550.00	4.87	121.14
Population III (G. 86 open-pollinated)	I_{w123}	3.28	97.04	6.57	100.00	0.43	9.79
	I_{123}	4.35	128.70	5.45	82.95	0.68	15.49
	I_{w1}	3.26	96.45	6.57	100.00	0.44	10.02
	I_{w2}	4.52	133.73	6.57	100.00	0.47	10.71
	I_{w3}	4.56	134.91	6.57	100.00	0.53	12.07
	I_{12}	4.61	136.39	6.57	100.00	0.37	8.43
	I_{13}	4.20	124.26	5.45	82.95	0.63	14.35
	I_{23}	1.67	49.41	7.22	109.89	2.07	47.15
	Ix_w	3.38	100.00	6.57	100.00	4.39	100.00
	Ix_1	3.17	93.79	5.45	82.95	1.53	34.85
	Ix_2	-0.13	-3.85	8.62	131.20	1.73	39.41
	Ix_3	0.58	17.16	6.29	95.74	4.02	91.57
	Recurrent selection	-	-	6.64	101.07	7.28	165.83

(i) Predicted and actual advances as lint (g)/plant.

(ii%) Predicted and actual advances as a percentage of the response to truncation selection to lint yield only.

Regarding population III, the ranks of predicted relative efficiencies relative to selection for lint yield alone (Ixw) in S_1 generation were 136.39% for I_{12}, 134.91% for I_{w3}, 133.73% for I_{w2}, 128.70% for I_{123} and 124.26% for I_{13}. Both recurrent selection and direct phenotypic selection procedure for lint yield/plant (Ixw) were superior to the other selection procedures in S_2 generation. Phenotypic selection of seeds/boll (Ix_2), index I_{23} and recurrent selection showed the highest percent of actual advance compared with phenotypic selection for lint yield alone (Ixw). Gooda (2001) reported that the highest predicted and actual advances for lint yield were obtained by using the indices I_{w12}, I_{w2}, Ix_3 and I_{w1} in population II (G. 45 open-pollinated).

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مقارنة كفاءة طرق انتخاب مختلفة فى ثلاث عشائر من القطن المصرى

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يهدف هذا البحث إلى مقارنة الكفاءة النسبية داخل وبين ثلاث طرق انتخاب في تحسين محصول القطن الشعر وذلك على أساس الانتخاب المظهري المباشر لصفة محصول القطن الشعر . **ولتحقيق ذلك** تم استخدام ثلاث طرق للانتخاب هي الانتخاب المظهري المباشر للصفة ، أدله الانتخاب والانتخاب الدوري وذلك في ثلاث عشائر من القطن المصري وهى (جيزة ٤٥ × جيزة ٧٥) ، (جيزة ٨٧ × جيزة ٨٩) و(جيزة ٨٦ المفتوح التلقيح) .

– ويمكن تلخيص أهم النتائج المتحصل عليها كما يلى :

١– بالنسبة للعشيرة الأولى (جيزة ٤٥ × جيزة ٧٥) : الانتخاب المظهري المباشر لصفة محصول القطن الشعر/نبات (Ixw) كان أعلى الطرق تأثيراً فى تحسين محصول القطن الشعر فى الجيل الرابع حيث أعطى أقصى تحسين وراثي متوقع .

٢– فى العشيرة الثانية (جيزة ٨٧ × جيزة ٨٩):أدت طريقتي الانتخاب الدوري والانتخاب المظهري المباشر لصفة عدد اللوز /نبات (I_{x1}) الى الحصول على أعلى تحسين لمحصول القطن الشعر فى الجيل الرابع .

٣– بالنسبة للعشيرة الثالثة (جيزة ٨٦ المفتوح التلقيح): أعطت طريقتي الانتخاب الدوري والانتخاب المظهري المباشر لصفه محصول القطن الشعر / نبات (Ixw) أعلى تحسين لمحصول القطن الشعر في الجيل الذاتي الثاني (S_2) .