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SEED YIELD IMPROVEMENT VIA SELECTION FOR CAPSULE NUMBERS IN EARLY SEGREGATING GENERATIONS OF SESAME (*Sesamum indicum* L.) HYBRIDS

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ABSTRACT

The breeding materials used in this study were 89 selected lines of sesame derived from crossing between 5 diverse parental genotypes. These lines were produced through selection for higher number of capsules per plant that practiced among the F_2 segregating plants and within F_3 lines. The 89 selected lines along with their parents (as checks) were evaluated for seed yield and yield contributing traits in the F_3 and F_4 generations. The objectives were to estimate means, variances, phenotypic and genotypic correlations, heritability and predicted direct and correlated response to selection for seed yield and its main components as well as to determine the actual response of selection for higher capsules/plant on seed yield improvement in both segregating generations. Results showed highly significant differences among the F_3 and F_4 lines for all characters studied. Mean performance of the F_3 and F_4 lines, as groups, was higher than that of the check parents for fruiting zone length, capsules/plant and seed yield/plant. Genotypic coefficient of variation among F_3 and F_4 lines was highest for branches/plant followed by stem height to first capsule, capsules/plant, capsule length and seed yield/plant, indicating that it is possible to achieve further improvement for those traits. High estimates of heritability in broad sense (80.2 - 94.5%) coupled with high expected genetic advance from selection were detected for capsules/ plant, capsule length and seed yield/plant in both generations, indicating that such traits have a high selection gain. Number of capsules/plant exhibited the highest phenotypic and genotypic correlation coefficients with seed yield/plant in both generations. Likewise, expected correlated response to selection showed that the maximum improvement in seed yield was expected from selection for high number of capsules/plant in both segregating generations. Moreover, the actual gain due to selection for increased number of capsules/plant in the F_2 and F_3 generations resulted in seed yield increase of F_4 lines up to 33.3% and 20.8% over the mid- and best parents, respectively. Therefore, indirect selection for seed yield improvement using capsule numbers/plant as a selection criterion could be successfully used in early segregating generations of sesame hybrids.

Key words: ***Sesame, Yield improvement, Selection criterion, Segregating generations Capsules/plant***

INTRODUCTION

Breeding efforts for improved performance and specific needs often require programs based on recombination and selection. In sesame, introductions that may be adopted directly or used as sources of valuable genes, has been very efficient and continue to be so in some areas (Ashri 1998). Mass selection has been important in developing improved cultivars from both local and introduced materials. Individual plant selection has also produced successful cultivars of sesame. However, there is a greater scope for this approach when new variability is created by controlled crosses (Sharma 1994 and Zhao 1994).

In highly self-pollinated crops like sesame, where the variability is limited, induced mutations and hybridization help to generate a new variability. Several varieties of sesame were produced through the direct use of induced mutations (Kang 1997) or through hybridization and pedigree selection (Sharma 1994 and Zhao 1994). The usefulness of mutation techniques is well recognized for the purpose of genetic improvement of sesame. At the same time, the necessity of crossing local and introduced varieties and of crossing different mutants was stressed. In some programs (Ibrahim 1994, Kang 1997 and Murty 1997) this was a standard procedure and has proved successful in generating promising sesame lines or varieties with increased yield potential and superior performance.

Breeding studies on sesame confirmed that the number of capsules per plant is the most important yield component which contribute significantly to the variation in seed yield, and showed a highly significant positive correlation with seed yield either in phenotypic or genotypic level (Ibrahim *et al* 1984, Mishra and Yadav 1997, Shrief 1997 and Rajaravindran *et al* 2000). These studies showed also that an indirect selection for capsules/plant helps to isolate high yielding genotypes in segregating populations of sesame hybrids due to substantial contribution of additive genetic variance in the expression of such trait.

Moreover, information on estimates of heritability and genetic advance from selection for seed yield and its contributing traits in segregating generations of sesame hybrids indicated that capsules/plant provide a good selection criterion for seed yield improvement (Mishra and Yadav 1997, Padmavathi 1997 and Rajaravindran *et al* 2000)

The objectives of the present study were: 1) to estimate the genetic variation, phenotypic and genotypic correlations, heritability and the expected direct and correlated response to selection for sesame seed yield and its attributes in the F_3 and F_4 generations, and 2) to measure the effect of actual selection for capsule numbers/plant on seed yield improvement in the early segregating generations of sesame hybrids.

MATERIALS AND METHODS

Breeding material and field layout

In an earlier study (HobAllah 2000) twenty one hybrids derived from crossing between seven parental genotypes of sesame, using a half diallel mating system, were utilized to estimate heterosis, combining ability and type of gene action in the F_1 and F_2 generations. Selection was practiced among the F_2 plants using number of capsules per plant as a selection criterion with 5% selection intensity.

The initial material used in the present study comprised 89 F_3 lines selected from the 1st segregating generation, i.e. among F_2 plants of nine out of twenty one crosses. The nine crosses involved 5 diverse parental genotypes. These genotypes were Giza 32, Mut.8, Mut.48, EUL92 and EXM90. Giza 32 is a local cultivar, Mut.8, Mut.48 and EUL92 are advanced mutant lines resulting from the mutation breeding program carried out at the Agron. Dept., Fac. of Agric., Cairo Univ., Giza. EXM90 is an F_7 hybrid population derived from crossing between Margo 201 (an exotic line from USA) and Mut.48.

The 89 F_3 lines along with the 5 parents of the original crosses were grown for evaluation in a Randomized Complete Block Design (RCBD) with 3 replications at the Agric. Exp. and Res. Station, Fac. of Agric., Cairo Univ., Giza on May 28, 2000. Each block contained 94 entries. Plot consisted of single- ridge for each F_3 line and three ridges for each parent. Each ridge was 3.5 m long and 60 cm wide. Seeds were sown in hills 20 cm apart. Thinning was done 30 days after sowing to secure 2 plants/hill. Before harvest, selection for a higher number of capsules per plant was practiced within F3 lines, with 5% selection intensity, to produce the F_4 lines.

The 89 F_4 lines along with the five parents were sown on May 21, 2001 using RCBD with 3 replications. Plot size, ridge length and spacing between ridges as well as between plants within a ridge were applied as in the F_3 generation. The normal cultural practices usually recommended for sesame cultivation at Giza were applied at the proper time in both generations.

Recorded data

At harvest, 10 guarded plants per plot were sampled to measure plant height, stem height to first capsule, fruiting zone length, no. of branches/plant, no. of capsules/plant, capsule length, no. of seeds/capsule, seed index (1000- seed weight) and seed yield/plant.

Biometrical analysis

Data were subjected to a regular analysis of variance of RCBD according to Snedecor and Cochran (1980). The degrees of freedom and sum of squares due to genotypes were further partitioned into lines, parents and lines *vs.* parents and tested for significance.

The expected genetic advance from selection (GA) in both F_3 and F_4 generations was calculated for each trait according to Allard (1960) using the following formula: $GA = K.(\sigma^2_{ph})^{1/2}.h^2$; where K is the selection differential at 5% intensity =2.06, $(\sigma^2_{ph})^{1/2}$ is the square root of the phenotypic variance (standard deviation), and h^2 is the heritability in broad sense (σ_g/σ^2_{ph}) for the character being evaluated. The genotypic coefficient of variation (GCV) for lines in each generation was computed as σ_g x100/m, where σ_g is the square root of the genotypic variance of lines and m is the general mean of lines. Phenotypic correlation coefficients among all possible pairs of the studied traits were computed.

Data on seed yield and its main components were also subjected to covariance analysis according to Gomez and Gomez (1984) and used to calculate the genotypic correlation (r_g) and correlated response to selection (CR). The genotypic correlation was computed as : $r_g = \sigma_{g1.2}/[(\sigma^2_{g1})(\sigma^2_{g2})]^{1/2}$, where $\sigma_{g1.2}$ is the genetic covariance between two traits, σ^2_{g1} and σ^2_{g2} are the genetic variances of the first and second trait, respectively. The correlated response to selection was calculated as shown by Al-Jibouri *et al* (1958) and Eckebil *et al* (1977) from the formula: $CR_{ij} = K. \sigma g_{ij} / \sigma_{phi}$, where K is again the selection differential, σ_{gij} is the genetic covariance between the selected (i) and unselected (j) traits, and σ_{phi} is the phenotypic standard deviation of the selected character.

RESULTS AND DISCUSSION

Means and variances

Analysis of variance (Table 1) showed highly significant differences among F_3 and F_4 lines for all investigated traits. However, the variability between F_3 lines was higher than that of F_4 lines as indicated by mean square values.

The check genotypes were the five parents of the crosses from which the lines originated. Check parents were significantly different for all traits in both generations, except fruiting zone length and seeds/capsule in the F_4 generation.

Table 1. Mean squares from ANOVA for studied traits of 89 sesame lines and their parents in the F_3 and F_4 generations

Characters	Source of variation							
	Lines		Parents		Lines *vs.* parents		Error	
	F3	F4	F3	F4	F3	F4	F3	F4
Plant height	1230.6**	710.2**	2448.5**	914.2**	678.2	17.0	294.9	79.3
Height to first capsule	781.3**	342.0**	4115.9**	772.5**	8837.5**	547.0**	185.0	43.9
Fruiting zone length	1079.3**	460.5**	343.1*	156.4	14411 **	756.6**	305.1	86.5
Branches/ plant	1.49**	0.594**	1.30**	1.27**	0.08	0.94*	0.366	0.241
Capsules/ plant	5459.0**	2177.9**	1605.3**	3609.2**	18326 **	3892.4**	651.6	285.4
Capsule length	1.073**	1.204**	0.914**	0.992**	0.720**	0.15	0.083	0.063
Seeds/ capsule	74.8**	70.7**	56.0**	4.6	2.0	51.5	34.5	24.6
1000- seed weight	0.567**	0.449**	0.921**	0.387*	3.04**	2.90**	0.171	0.088
Seed yield/ plant	78.5**	47.3**	11.4**	23.2**	411.1**	204.0**	14.8	7.4

- Note that degrees of freedom are similar in both generations and equal to 88, 4, 1 and 186 for Lines, parents, lines *vs.* parents and error, respectively.

Mean squares for lines *vs.* parents were highly significant for stem height to first capsule, fruiting zone length, capsules/plant, 1000- seed weight and seed yield/plant in both generations. This indicates that the mean performance of the F_3 or F_4 lines, as a group, was significantly different from the mean performance of their parents for those traits (Table 1). Significant mean squares due to lines *vs.* parents were also recorded for capsule length in the F_3 and branches/plant in the F_4 generation.

The mean performance of F_3 and F_4 lines (Table 2) was higher than the mean of check parents for fruiting zone length, capsules/plant and seed yield/plant as also indicated by significant mean square values of lines *vs.* parents in Table 1. In addition, F_3 and F_4 lines, as groups, recorded desirable lower means for stem height to first capsule than that of check parents. However, the check parents showed higher means of 1000- seed weight than that recorded for lines in both generations.

The range of lines means (Table 2) showed wide variation either for F_3 or F_4 lines for almost all traits. The upper limit of the range of lines means exceeded mean of the check parents for all studied characters in both generations especially seed yield/plant, capsules/plant and other yield

Table 2. Mean performance, ranges, genotypic coefficient of variability (GCV), broad sense heritability (h^2) and expected genetic advance from selection (GA) for traits of F_3 and F_4 lines of sesame as well as means of the check parents.

Characters	Generation	Lines		GCV %	h^2 %	Parents mean	GA	
		Mean	Range				% of lines mean	% of parents
Plant height	F3	195.2	147-228	9.0	75.2	188.3	16.1	16.8
	F4	150.4	119-182	9.5	86.3	149.3	18.2	18.3
Height to first capsule	F3	44.6	18-79	31.5	75.5	69.5	56.3	36.1
	F4	34.5	14-60	28.8	86.8	40.7	55.4	46.9
Fruiting zone length	F3	150.7	103-203	10.6	70.4	118.8	18.3	23.1
	F4	115.9	88-142	9.6	80.9	108.6	17.8	19.0
Branches/ plant	F3	1.5	0.0-2.7	40.5	74.1	1.10	71.3	97.3
	F4	0.9	0.0-2.0	37.5	57.6	0.78	58.9	67.9
Capsules/ plant	F3	143.6	80-260	27.8	87.5	107.7	53.7	71.6
	F4	144.6	77-212	17.3	86.5	128.1	33.3	37.5
Capsule length	F3	3.29	2.6-5.2	17.4	91.9	3.10	34.3	36.5
	F4	3.35	2.6-5.3	18.4	94.5	3.24	36.7	38.0
Seeds/ capsule	F3	60.5	50-71	5.9	51.6	60.1	8.8	8.8
	F4	69.1	53-78	5.6	63.8	71.0	9.3	9.0
1000- seed weight	F3	3.08	2.26-4.04	11.7	68.8	3.54	20.1	17.5
	F4	3.22	2.50-4.10	10.8	80.0	3.67	19.9	17.4
Seed yield/ plant	F3	26.40	15.7-37.4	17.3	80.2	21.0	32.2	40.5
	F4	26.35	17.0-38.1	13.8	83.5	22.2	25.8	30.6

components. This indicates the presence of superior individual lines involved in the breeding material.

Genetic variation among lines, estimated by GCV., was highest for branches/plant followed by stem height to first capsule, capsules/plant, capsule length and seed yield/plant in both F_3 and F_4 lines. The high values of GCV were also reflected in the values of range observed for these traits (Table 2), indicating that it is possible to achieve further improvement by selection. On the other hand, genetic variation was limited for other traits in the following descending order: 1000- seed weight, fruiting zone length, plant height and seeds/capsule in both generations. Wide range of variability and high magnitudes of GCV among sesame genotypes were reported in other studies for branches/plant, capsules/plant and seed yield/plant (Kandasamy *et al* 1991, Mishra and Yadav 1997) and for stem height to first capsule (Osman and Khidir 1974). However, low to moderate values of range and GCV were recorded for plant height, seeds/capsule (Tangavel *et al* 2000) and 1000- seed weight (Osman and Khidir 1974).

As a result of selection within F_3 lines for high number of capsules/plant, the resulting F_4 lines continued to show inter-line variation for most traits. However, comparison between GCV of F_3 and F_4

generations reveals less genetic variation among F_4 lines than among F3 lines particularly for capsules/plant and seed yield/plant, suggesting that within-line selection in the F_3 generation negatively affected F_4 variability in both traits.

According to Burton (1952) the genotypic coefficient of variability together with heritability estimate would give the best indication of the amount of genetic advance to be expected from selection.

Heritability and expected genetic advance from selection

Response to selection for quantitative traits is directly proportional to the function of its heritability, selection intensity and it's of phenotypic variance. Heritability enables the plant breeder to recognize the genetic differences among the traits and the genotypic variance indicates the potential for the improvement of particular trait (Jarwar *et al* 1998).

Table (2) shows broad- sense heritability estimates, computed from components of variance, and expected genetic advance from selection for different traits in the F_3 and F_4 generations. Results showed, in general, that capsule length, capsules/plant and seed yield/plant recorded high heritability with values varying from 80.2% to 94.5% in both generations. Other characters like plant height, stem height to first capsule, fruiting zone length and 1000- seed weight recorded relatively moderate to high heritability with values ranging from 68.8% to 86.8% in both generations. However, heritability was low for seeds/capsule in both generations, and for branches/plant in the F_4 generation. Comparable estimates of heritability were reported in other studies for capsule length and capsules/plant (Osman and Khidir 1974), seeds/capsule and 1000- seed weight (Mishra and Yadav 1997), seed yield/plant (Jarwar *et al* 1998) and for capsules/plant (Rajarvindran *et al* 2000).

Broad-sense heritability, however, indicates only the effectiveness in which selection of a genotype can be based on the phenotypic performance, but it fails to indicate the genetic progress (Johnson *et al* 1955). Therefore, high heritability does not always mean greater genetic gain. Since heritability in broad sense involving both additive and non-additive gene effects it will be reliable only if accompanied by high genetic advance (Ramanujam and Thirumalachari 1967). In other words, an association of high heritability along with high genetic advance is indicative of additive gene effects and consequently a high genetic gain from selection would be anticipated. Dixit *et al* (1970) stated also that high heritability was not always associated with high genetic advance, but to make effective selection, high heritability should be coupled with high genetic gain.

The expected genetic advance (GA) from selection as % of lines mean was very high for branches/plant followed by height to first capsule, capsules/plant, capsule length and seed yield/plant with greater values in the F_3 than that recorded in the F_4 generation, except for capsule length (Table 2). However, GA was intermediate for 1000- seed weight, fruiting zone length, and plant height and was lowest for seeds/capsule in both generations. Similar trend was also observed for GA magnitudes as % of mean parents and this hold true for all mentioned traits. It was also noticed, in both generations that traits, which recorded the highest GCV also, had the highest expected genetic advance and vice versa.

High heritability coupled with high genetic advance was realized for capsules/plant, capsule length and seed yield/plant in both F_3 and F_4 generations and for stem height to first capsule in the F_4 generation. Because of the high values of GCV, heritability and genetic advance of these traits, the high selection gain may be attributed to a high degree of additive gene effects. The association between high heritability and high genetic advance was already reported for capsules/plant (Mishra and Yadav 1997, Padmavathi 1997 and Rajarvindran *et al* 2000), seed yield/plant (Padmavathi 1997 and Jarwar *et al* 1998), capsule length (Rajarvindran *et al* 2000) and stem height to first capsule (Osman and Khidir 1974).

Characters associations

Characters associations estimated by phenotypic correlation among traits are of interest to plant breeders because they indicate the correlated responses that may occur when single- trait selection or index selection are practiced, particularly if the associations among traits were measured on the genotypic level.

Phenotypic correlation coefficient among studied traits (Table 3) revealed that seed yield/plant was positively and significantly associated with capsules/plant and branches/plant. There was also significant positive correlation among the last two traits. Similar findings were reported by Reddy *et al* (1984), Shrief (1997) and Mishra and Yadav (1998).

A desirable significant negative correlation between yield/plant and stem height to first capsule was recorded. HobAllah and Manal Salem (1999) reported similar association. Whereas, an undesirable significant negative correlation between yield/plant and 1000- seed weight was also observed. Ibrahim *et al* (1983) and Ahmed (1988) also found a negative correlation among the last two traits.

Table 3. Phenotypic correlation coefficients between all pairs of studied traits using pooled data of F_3 and F_4 generations

Characters	Yield/ plant	Capsul-es/plant	1000-seed weight	Seeds/ capsule	Capsule length	Branch-es/plant	Fruiting zone length	Height to first Capsule
Capsules/ plant	0.706**							
1000-seed weight	-0.228**	-0.414**						
Seeds/ capsule	0.118	0.081	0.082					
Capsule length	-0.063	-0.187*	0.267**	0.268**				
Branches /plant	0.168*	0.353**	-0.384**	-0.189*	-0.434**			
Fruiting zone length	0.139	0.047	-0.057	-0.507**	-0.047	0.104		
Height to first capsule	-0.167*	-0.105	-0.224**	-0.274**	-0.346**	0.563**	-0.230**	
Plant height	0.044	0.051	-0.160*	-0.555**	-0.213**	0.369**	0.864**	0.573**

* and ** denote significance at 5 % and 1 % level of probability, respectively

These results reflected the importance of the three characters that exhibited significant desirable correlation with seed yield/plant either in positive (capsules/plant and branches/plant) or negative (stem height to first capsule) direction. However, it is worthy to note that the highest magnitude of correlation coefficient ($r = 0.706^{**}$) was recorded among capsules/plant and yield/plant. Therefore, selection for increased capsules/plant through increased branches/plant and decreased stem height to first capsule might reflect increase of seed yield/plant. Moreover, such traits would be of interest for indirect selection for yield since it can be easily determined.

Genotypic correlation among seed yield and its main components, i.e. capsules/plant, branches/plant, seeds/capsule and 1000- seed weight was also computed (Table 4). Genotypic correlations tended to have the largest positive values among seed yield/plant and capsules/plant in both F_3 and F_4 generations. This was expected, as the latter is a main component of the former. Both traits exhibited also positive genetic correlations with branches per plant. Shreif (1997), and Ganesh and Sakila (1999) found similar associations. However, yield/plant, branches/plant and capsules/plant recorded negative correlation with seed index in both generations with relatively high values in the last case. Also, capsules/plant as well as yield/plant were positively correlated with seeds/capsule, but the correlation coefficient values were of low magnitude in both generations except for the last association, which possessed a moderate value.

Table 4. Genotypic correlation coefficients among main traits of sesame in the F_3 and F_4 generations

Traits	Generation	Branches/plant	1000-seed weight	Capsules/plant	Yield/plant
Seeds/capsule	F_3 F_4	-0.049 -0.137	0.179 -0.191	0.122 0.202	0.094 0.406
Branches/plant	F_3 F_4		-0.548 -0.205	0.419 0.310	0.173 0.120
1000-seed weight	F_3 F_4			-0.559 -0.509	-0.464 -0.254
Capsules/plant	F_3 F_4				0.724 0.756

Thus, it could be concluded that selection for higher number of capsules per plant would lead to an improvement in seed yield, since both traits showed the highest correlation coefficients at both phenotypic and genotypic levels. Mishra and Yadav (1997) reported similar conclusion.

Expected correlated response

The effectiveness of single- trait selection in improving seed yield and correlated traits was measured in terms of predicted response to selection in the F_3 and F_4 segregating populations of sesame (Table 5). Noteworthy is that the expected correlated responses are relatively similar, particularly in sign, to genetic correlations since the genetic covariance was used in both calculations. Also, the expected correlated responses show, in general, that selection for a given character (yield as an example) should affect a second character in about the same way that selection for the second character should affect yield. The same relationships likely would hold for characters other than yield.

Expected correlated response for each trait was expressed as % of expected gain from direct selection of this trait. Results of Table 5 indicated that selection for increased capsules/plant was expected to increase yield/plant by 75.2 and 77.4 % in the F_3 and F_4 generations, respectively, of direct selection for yield itself. Also, selection for capsules/plant resulted in a correlated response equal to 46.7 and 37.7 % as well as 15.9 and 23.6 % of direct selection for branches/plant and seeds/capsule in the F_3 and F_4 generations, respectively. However, negative response in seed index was noticed. These results are consistent with the genotypic correlation coefficients recorded among a fore-mentioned traits (Table 4).

Table 5. Expected gain from direct selection (diagonal) in the F_3 and F_4 segregating populations of sesame in absolute units of measurements for each trait and correlated responses in other traits, as % of expected gain from direct selection of these traits (above and below diagonal)

Character	Generation	Capsules/ plant	Branches/ plant	1000- seed weight	Seeds/ capsule	Seed yield/ Plant
Capsules/plant	F_3	77.1	46.7	-62.9	15.9	75.2
	F_4	48.1	37.7	-53.1	23.6	77.4
Branches/plant	F_3	38.4	1.07	-56.5	-5.8	16.4
	F_4	25.2	0.53	-17.2	-13.0	13.2
1000- seed weight	F_3	-49.4	-53.1	0.62	20.6	-42.7
	F_4	-48.9	-24.5	0.64	-21.4	-25.0
Seeds/capsule	F_3	9.3	-4.1	15.3	5.3	7.5
	F_4	17.4	-14.3	-17.0	6.4	35.6
Seed yield/ plant	F_3	69.4	17.8	-50.0	11.9	8.5
	F_4	74.0	11.3	-26.6	46.4	6.8

Similar trend was realized in respect to selection for yield *per se* which exhibited positive influence on capsules/plant (69.4 and 74.0 %), branches/plant (17.8 and 11.3 %), seeds/capsule (11.9 and 46.4 %) in both the F_3 and F_4 generations, respectively, and had negative effect on seed index.

Selection for increased branches/plant is expected to increase capsules/plant by 38.4 and 25.2 %, and yield/plant by 16.4 and 13.2 % in the F_3 and F_4 generations, respectively, but with negative effect on seed index and seeds/ capsule in both generations.

Selection for seed index had negative influence on other traits in both generations except seeds/capsule in the F_3 generation in which positive correlated response (20.6 %) was recorded. Selection for seeds/capsule showed positive correlated response with capsules/plant and yield/plant in both generations and with seed index in the F_3 generation, whereas negative effect was observed on branches/plant.

From the above- mentioned results it could be concluded that the maximum improvement in seed yield was expected when selection for increased capsules/plant was practiced in both segregating generations, which may be attributed to the high positive genotypic correlation between both traits. This conclusion was previously reached by Mishra and Yadav (1998) who stated that to achieve a maximum gain through selection in the segregating populations of sesame, maximum weight should be given to the number of capsules per plant.

Efficiency of pedigree selection

The efficiency of pedigree selection in early segregating populations resulting from crosses between sesame genotypes, as practiced in this study, was evaluated by estimating the actual gain in seed yield of F_4 lines from selection for a higher number of capsules among F_2 plants and within F_3 lines.

The actual gain in seed yield for F_4 lines derived from each cross was calculated as the difference between the mean lines and either mean parents of the cross or the best parents over all others, and expressed as percentages (Table 6).

Table 6. Actual gain in seed yield of F_4 lines from selection for capsule numbers among F_2 plants and within F_3 derived lines of sesame, in % of mean parents and the best parent.

Crosses	F4 lines				Actual gain	
	Number	Mean	Range	GCV %	%of parents	%of best parent
Giza 32 x Mut.8	6	25.3	22.5 - 30.9	8.01	14.0	3.27
Giza 32 x Mut.48	9	22.5	19.7 - 24.2	2.61	1.4	-8.2
Giza 32 x EUL92	11	23.2	20.6 - 27.0	7.96	4.5	-5.3
Giza 32 x EXM90	9	24.0	17.0 - 31.6	17.14	8.1	-2.0
Mut.8 x EUL92	11	29.1	23.4 - 35.0	10.70	31.1	18.8
Mut.8 x EXM90	7	29.6	24.1 - 38.1	14.50	33.3	20.8
Mut.48 x EUL92	11	29.2	25.5 - 35.3	10.94	31.5	19.2
Mut.48 x EXM90	14	26.2	18.8 - 31.3	10.93	18.0	6.9
EUL92 x EXM90	11	28.0	23.9 - 31.6	2.41	26.1	14.3

Results of Table 6 revealed that the actual gain in seed yield differed between lines that derived from one cross to another. The highest gain was noted for lines, as a group, resulting from the cross (Mut.8 x EXM90) which recorded seed yield increase of 33.3% and 20.8% as compared to mean parents and the best parent, respectively. Comparable responses were also realized for the selected lines derived from crosses (Mut.48 x EUL92), (Mut.8 x EUL92), and (EUL92 x EXM90) that showed actual gain in seed yield/plant estimated by 31.5%, 31.1% and 26.1% as compared to the mean parents as well as 19.2%, 18.8% and 14.3 % as compared to the best parent, respectively. Lines derived from other crosses like (Mut.48 x EXM90) and (Giza 32 x Mut.8) exhibited positive actual gain but with lower magnitudes (6.9% and 3.27 %, respectively) relative to the best parent.

These lines, particularly that showed high positive actual gain in seed yield, could be valuable sources for yield improvement of sesame. Moreover, further improvement could be achieved by continual selection among and/or within lines in the next segregating generations since they had high means of yield/plant and the upper limit of range and GCV are still high for most of these lines.

Finally, it is evident from this study that number of capsules/plant showed wide variability, high GCV values and the highest phenotypic and genotypic correlation coefficients with seed yield/plant in both F_3 and F_4 generations. It exhibited also high heritability coupled with high genetic advance. Moreover, selection for such trait was expected to improve yield/plant as much as 75% of direct selection for yield itself in both segregation generations. Moreover, the actual gain due to selection for a higher number of capsules/plant among F_2 plants and within F_3 lines resulting in seed yield increase of F_4 line means up to 33.3% and 20.8% over the mean parents and the best parent, respectively. For these reasons, it is feasible that number of capsules/plant could be successfully used as a selection criterion for seed yield improvement in the segregating populations of sesame.

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تحسين محصول البذور بالانتخاب لعدد الكبسولات في الأجيال الانعزالية المبكرة لهجن السمسم

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أجريت هذه الدراسة بمحطة التجارب والبحوث الزراعية بكلية الزراعة جامعة القاهرة بالجيزة علي عدد ٨٩ سلالة منتخبة من نسل تسعة هجن بين خمسة آباء مختلفة من السمسم حيث اجري الانتخاب لزيادة عدد الكبسولات علي النبات. وكان الهدف هو تقدير الاستجابة الفعلية من الانتخاب لزيادة عدد كبسولات النبات علي تحسين المحصول في الأجيال الانعزالية المبكرة بالإضافة إلى تقدير التباين الوراثي، الارتباط المظهري والوراثي، كفاءة التوريث وكذا بيان التأثير المباشر وغير المباشر للانتخاب لصفات النمو والمحصول. ولهذا الغرض تم تقييم السلالات المنتخبة مع آبائها في تصميم قطاعات كاملة العشوائية في ثلاثة مكررات وذلك في الجيلين الثالث والرابع خلال موسمي ٢٠٠٠، ٢٠٠١. وقد أظهرت النتائج وجود فروق عالية المعنوية بين سلالات الجيل الثالث والرابع لكل الصفات موضع الدراسة وكان متوسط هذه السلالات (مجتمعة لكل جيل) أعلي من متوسط الآباء الخمسة التي استنبطت منها وذلك لصفات طول المنطقة الثمرية، عدد الكبسولات/النبات، محصول النبات الفردي. وقد سجلت أعلي قيم للتباين الوراثي في الجيلين الثالث والرابع لصفة عدد الأفرع/النبات يليها ارتفاع أول كبسولة، عدد الكبسولات/النبات، طول الكبسولة ثم محصول النبات الفردي. كما أشارت النتائج أن ثلاثة من هذه الصفات وهي عدد الكبسولات/النبات وطول الكبسولة ومحصول النبات الفردي حققت أعلي كفاءة توريث مع أعلي نسبة مئوية للتحسين الوراثي المتوقع من الانتخاب في الجيلين الثالث والرابع دلالة علي إمكانية التحسين الإضافي لتلك الصفات. ومن ناحية أخري سجلت صفة عدد الكبسولات/النبات أعلي قيم للارتباط المظهري والوراثي مع صفة المحصول للنبات بالإضافة إلى أن أعلي استجابة متوقعة مرتبطة بتحسين محصول البذور تحققت عند الانتخاب لهذه الصفة في الجيلين الثالث والرابع. علاوة علي ذلك فان الاستجابة الفعلية من ممارسة الانتخاب لزيادة عدد الكبسولات في الجيل الثاني والثالث نتج عنها زيادة في متوسط محصول البذور لسلالات الجيل الرابع وصلت إلي ٣ر٣٣ %، ٨ر٢٠ % عند المقارنة بمتوسط الآباء ومتوسط أحسن أب علي التوالي. وبناء علي ما تقدم فإن نتائج هذه الدراسة تشير إلى إمكانية استخدام صفة عدد الكبسولات علي النبات كمعيار للانتخاب غير المباشر لتحسين محصول البذور في الأجيال الانعزالية المبكرة من هجن السمسم.

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