Early and Late Pedigree Selection for Seed Yield/Plant in Sesame (*Sesamum indicum* L.)

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Abstract:

The present study was carried out at Shandaweel Agricultural Research Station, Sohag Governorate, Egypt during the period of 2009-2011 summer seasons. The means of selected families after two cycles of early selection for seed yield/plant ranged from 31.88 to 43.50 with an average of 37.36 compared to 17.83, 25.47 and 23.33g for P1, P2 and bulk sample in population I, respectively. Likewise, these means varied from 29.33 to 39.67 with an average 34.03 compared to their respective parents P1 (19.00) P2 (29.00) and bulk sample (30.0g) in population II. The average of seed yield/plant overall selected families of 41.24 and 42.37 after one cycle of late selection surpassed their averages of 37.36 and 34.03 g after two cycles of early selection by 10.38 and 24.51% for population I and II, respectively.

The slight discrepancy between (GCV) and (PCV) resulted in high estimates of broad sense heritability for most studied traits in the two base populations. The selection response to one cycle of late selection for seed yield/plant was large comparing to their values after two cycles of early selection in both populations. The values accounted 61.94 and 76.74 % in population I and 46.11 and 41.24 % in population II with late selection comparing to 46.70 and 60.11 % in population I and 17.36 and 13.44 % in population II as a deviation from the best parent and bulk, respectively.

Keywords: sesame, early selection, late selection and seed yield

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Introduction:

Sesame (*Sesamum indicum* L.) is one of the most ancient cultured oil plants. It has an early origin in East Africa (in ancient Egyptian tombs dating back 4,000 years) and in India (since over 5,000 years ago) (Nayar and Mehra, 1970). Sesame seed is probably the oldest crop grown in China for its taste, dating back 2000 year. The Egyptian used sesame seed as medicine around the same time. The total cultivated area in the world was 66,288,276 ha produced 4,756,752 tons, while in Egypt the cultivated area was 30,000 ha produced 40,000 tons of seeds (FAO 2014). In Egypt, there is a large gap between oil production and its consumption. So, sesame cultivars with high seed yield and high content oil are needed. Fortunately sesame is cultivated in hot regions with high solar insulation and tolerates soil droughts (Ustimenko-Bakumovsky, 1983). Consequently, the invention of new varieties of sesame is desirable to grow in Egypt. Holbrook *et al.* 1989, Pathirana (1995) and El-Shimy (2005) reported that the direct selection for seed yield was the most effective for the improvement of yield in sesame. Ismail *et al.* (2005) reported that the realized heritability in the two studied populations for seed yield per plant was low compared to that estimated on the basis of mean of the three replications.

Therefore the objective of this study was to estimate the response of pedigree line selection in early and late generations of two sesame (*Sesamum indicum L.*) populations.

Materials and Methods:

The present study was carried out at Shandaweel Agricultural Research Station, Sohag Governorate, Egypt during the period of 2009-2011 summer seasons. The breeding material used in this study was 200 F_3-families traced back to random F_2 plants from each of two crosses i.e. (Introduction 143 x Introduction 245) as population I and (Introduction 520 x Giza 32) as population II.

In 2009 season, the 200 F_3-families from each population with the original parents, F_3-bulked random sample (a mixture of equal number of seeds from each plant to represent the generation mean) were sown on 10th May in two separate experiments in a randomized complete block design with three replications. Each plot was a single row 4 m long, 55 cm apart, 10 cm between hills within a row.

The recommended cultural practices were adopted throughout the growing season. Days to the 50% flowering for each plot/replication, was recorded. The following traits were measured on ten random plants in each plot; plant height, length of fruiting zone, number of branches/plant, capsule length; number of capsules/plant, seed yield/plant, 1000-seed weight and seed oil percentage which determined by using petroleum either (Bp 40-60°) as solvent in soxhalet apparatus according to the method of A.O.A.C 1980.

The first cycle of pedigree line selection (early selection) was applied on the base population for seed yield/plant. The best plant of the best 40 families saved rise the F_4 generation.

Season 2010 (F_4- generation): all the selected and non-selected families for each population, respective parents and the bulk were sown on 13th of May. The same procedures

and experimental design of the previous season were followed.

Each family was grown in a single row 4 m long, 55 cm between rows and 10 cm between hills. Data were recorded as previously mentioned. The best plant from the best 10 families for seed yield was saved to give the F_5 generation.

Season 2011 (F_5- generation): The same experimental design and field procedure were used to evaluate the two cycles (in F_3 and F_4) of early direct and one cycle of the late direct selection for seed yield/plant (F_4).

The respective parents and F_5-bulked as random sample were involved in all experiments. Sowing date for all experiments was on 15th of May.

It is of interest to indicate that the comparisons among early and late direct selection was done to detect the effective procedure and the related traits with seed yield/plant in each case.

Statistical Analysis:

For each season, estimates of phenotypic and genotypic variance and covariance, as well as heritability estimates were calculated from EMS of the variance and covariance components of the selected families.

Data were subjected to proper statistical analysis according to Steel and Torrie (1980). Genotypes means were compared using Revised Least Significant Differences test (RLSD) according to El-Rawi and Khalafala (1980)

- The phenotypic (PCV %) and genotypic (GCV %) coefficients of variability were estimated using the formula developed by Burton (1952) as follows:

Phenotypic coefficient of variability:

$$PCV\ \% = \frac{\sigma p}{\overline{X}} \times 100$$

Genotypic coefficient of variability:

$$GCV\ \% = \frac{\sigma g}{\overline{X}} \times 100$$

Where: σ p and σ g are the phenotypic and genotypic standard deviations of the family means, respectively, and $\overline{X}$ is a family mean for a given trait.

Realized heritability was calculated according to Falconer (1989) from the equation of response $R = S\ h^2$ and the heritability being estimated as the ratio of the $h^2 = R/S$

where: R is response to selection, and S is selection differential.

Results and Discussion:

I- Description of the base population:

The analysis of variance (Table 1) revealed that the F_3- families differed highly significantly for all the studied traits in the two base populations. These results reflect the genetic differences among the F_3-families for all the studied characters and could be used for pedigree line selection in the two base populations.

The slight discrepancy between (GCV) and (PCV) (Table 2) resulted in high estimates of broad sense heritability for most studied traits in the two base populations. These data resulted in wide ranges and high estimates of broad sense heritability (more than 56%) for all studied characters in both base populations, except seed yield / plant (39.51%) in base population I.

Table 1: Analysis of variance for the studied traits of the base population (F_3) for population I and II

S.O.V		D.F	Mean squares								
			Days to flowering	Plant height, cm	Length of fruiting zone, cm	No. of branches /plant	Capsule length, cm	No. of capsules /plant	Seed yield /plant, gm	1000-seed weight, gm	Oil %
Pop. I	Rep.	2	65.01	1223.06	1197.13	0.15	0.07	2491.95	167.70	0.46	299.95
	Fami.	199	228.04**	2840.56**	1824.47**	1.56**	3.81**	4180.06**	135.79**	1.26**	148.96**
	Error	398	25.12	431.52	368.05	0.31	0.48	499.95	45.89	0.15	17.69
Pop.II	Rep.	2	50.00	792.61	775.02	0.24	1.81	672.66	109.97	0.37	12.35
	Fami.	199	257.39**	2875.59**	2735.45**	4.00**	7.04**	2473.53**	214.26**	2.30**	127.67**
	Error	398	26.08	335.75	404.56	0.83	0.89	354.22	33.70	0.42	16.00

** Significant 0.01 level of probability.

High genotypic and phenotypic variations and heritability estimates for yield and its components were reported by Singh *et al* (2000), Reddy *et al* (2001), Saravanan *et al* (2003), Solanki and Deepak (2003), Singh and Singh (2004), Ganeshan (2005), Mothilal (2006), Supriya (2007), Ganapathy *et al* (2007), Khan *et al* (2007), Prasad et al (2007), Iwo *et al* (2007), Ghulam *et al* (2008a), Gangarde *et al* (2009), Jadhav and Mohrir (2012) and Kumar *et al* (2012). Otherwise, moderate heritability for plant height, number of capsules, 1000 seed weight and oil was reported by Asha (2005).

Table 2: Means, phenotypic (PCV %), genotypic (GCV %) coefficients of variability and heritability in broad-sense for the studied traits in the two base populations.

Item		Days to 50% flow.	Plant height, cm	Length of fruit-ing zone, cm	Capsule length, cm	No. of branches / plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, gm	Oil %
		Population I								
Range	**Min.**	25.00	145.00	70.00	2.40	1.00	36.33	8.90	2.00	39.64
	Max.	65.00	280.00	205.00	5.10	6.60	244.00	45.40	5.20	85.00
P_1		49.17	189.33	116.67	3.40	3.33	79.00	16.33	3.12	52.33
P_2		48.83	201.67	124.33	3.67	3.67	95.33	24.47	2.90	48.33
F_3 selected families		51.94	190.00	108.00	3.50	3.37	92.33	20.33	3.67	51.00
Pop. bulk		43.54	208.24	129.94	3.62	3.40	87.48	23.92	3.75	59.01
PCV %		22.07	16.89	22.52	23.61	37.05	47.49	36.50	19.33	13.31
GCV %		18.85	13.62	16.98	17.87	30.92	40.03	22.94	16.28	11.23
B.S.H %		72.92	65.05	56.88	57.29	69.65	71.05	39.51	70.98	71.22
		Population II								
Range	**Min.**	34.00	124.33	50.00	1.50	1.00	62.95	9.33	2.00	38.00
	Max.	66.70	253.67	170.00	6.29	7.67	174.33	46.20	5.80	66.67
P_1		49.67	199.50	116.00	3.75	4.67	85.00	16.67	3.72	57.84
P_2		52.67	204.00	137.00	4.75	2.33	116.67	28.00	4.32	58.67
F_3 selected families		53.33	203.00	147.00	3.60	3.00	96.33	20.67	3.20	52.57
Pop. bulk		49.03	191.10	121.71	3.66	2.68	95.00	20.92	3.64	53.01
PCV %		20.70	17.98	28.20	37.47	63.65	34.26	46.29	28.13	13.75
GCV %		17.90	15.21	22.87	28.08	53.19	27.96	37.06	21.72	11.50
B.S.H %		74.72	71.60	65.76	56.13	69.83	66.60	64.11	59.66	69.94

2. Selection for seed yield/plant

2.1. Early pedigree selection

- Families' mean squares were highly significant in both populations after one and two cycles of early selection for all the studied characters (Table 3). This result reflects the genetic make-up of those selected families in both populations, indicating that selection could be effective.

Table 3: Analysis of variance after the first cycle and second cycle of early pedigree selection for seed yield/plant in populations I and 2.

S.O.V			D.F	Mean squares								
				Days to flowering	Plant height, cm	Length of fruit-ing zone, cm	No. of branches /plant	Capsule length, cm	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
Pop.1	C1 (F4)	Rep.	2	53.33	129.93	96.13	0.08	0.24	107.36	0.56	0.91	2.70
		Families	39	102.34**	1578.01**	824.12**	0.59**	6.19**	1838.76**	48.02**	1.45**	76.90**
		Error	78	9.23	157.38	83.59	0.06	0.57	103.13	7.15	0.19	6.67
	C2 (F5)	Rep.	2	7.82	19.66	34.36	0.04	0.58	8.25	3.68	0.01	7.99
		Families	9	87.67**	787.09**	969.77**	0.39**	5.87**	485.28**	43.01**	0.77**	73.74**
		Error	18	4.91	39.35	27.40	0.03	0.31	25.74	2.10	0.03	7.19
Pop.1I	C1 (F4)	Rep.	2	44.10	252.41	257.56	0.22	0.42	581.93	48.84	0.48	2.45
		Families	39	73.03**	608.00**	701.94**	0.36**	2.65**	2165.14**	73.45**	1.89**	58.60**
		Error	78	3.28	47.54	74.04	0.03	0.25	287.99	13.97	0.20	2.57
	C2 (F5)	Rep.	2	7.43	111.70	97.23	0.38	0.16	159.11	2.63	0.06	0.64
		Families	9	47.66**	520.83**	112.07**	0.64**	1.37**	678.82**	24.39**	1.19**	18.79**
		Error	18	2.29	26.87	5.44	0.03	0.06	29.00	1.43	0.05	0.84

** Significant 0.01 level of probability.

The means of selected families after two cycles of early selection for seed yield/plant (Tables 4 and 5) ranged from 31.88 g to 43.50 g with an average of 37.36g compared to 17.83g, 25.47g and 23.33g for P1, P2 and bulk in population I, respectively. Likewise, these means varied from 29.33 to 39.67 with an average of 34.03g compared to their respective parents P1 (19g), P2 (29g) and bulk (30g) in population II.

The genotypic coefficients of variation (gcv) for seed yield/plant decreased from 22.94 and 37.06% in F_3 to 9.88 and 8.13% after two cycles of selection in population I and II, respectively, expressing the increasing of homogeneity in C_2 comparing C_1.

The phenotypic coefficients of variation (pcv) values were in line with those recorded for gcv in both populations.

The realized heritability estimated from the realized gain in both cycles of in the two studied populations decreased from C_1 to C_2 for the selection criterion of seed yield per plant and all correlated traits, revealing the less genetic variation in C_2 comparing to C_1.

Table 4: Mean, range, phenotypic (PCV%), genotypic (GCV%) coefficients of variability, heritability in broad-sense (H.B.S) and realized heritability in the two cycles of early pedigree line selection for seed yield/plant in population I.

Cycle No.	Item		Days to 50 % flowering	Plant height, cm	Length of fruiting zone, cm	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
C_1 (F_4)	Range	Min.	46.33	193.67	108.33	2.97	1.33	76.00	22.86	2.81	38.00
		Max.	68.33	276.67	186.00	4.67	7.13	196.00	41.65	5.23	61.00
	P_1		48.00	201.17	119.00	3.40	3.33	82.33	17.33	3.12	48.00
	P_2		49.33	206.67	124.33	3.50	3.67	97.33	25.47	3.57	50.00
	Bulk		54.00	230.33	136.03	3.60	3.15	98.12	22.33	3.31	52.57
	F_4 selected families		57.46	228.05	145.94	3.84	4.23	129.68	32.27	3.92	52.82
	PCV %		11.04	11.01	12.46	12.70	36.99	20.13	14.12	20.00	10.38
	GCV %		9.70	9.54	10.77	11.01	32.38	18.55	11.44	16.55	9.16
	H.B.S %		77.08	75.06	74.70	75.19	76.59	84.87	65.57	68.50	77.83
	Realized heritability		0.77	0.89	0.77	0.52	0.98	0.59	0.38	0.54	0.73
C_2 (F_5)	Range	Min.	51.33	227.00	146.00	3.60	1.00	133.33	31.88	3.69	44.82
		Max.	67.33	281.50	192.50	4.55	5.73	168.17	43.50	4.87	59.01
	P_1		47.83	188.83	116.67	3.63	3.00	83.67	17.83	3.12	49.00
	P_2		50.17	204.17	121.00	3.57	3.33	95.33	25.47	3.57	51.00
	Bulk		54.67	221.67	140.00	3.70	4.00	104.67	23.33	3.97	52.57
	F_5 selected families		62.39	239.87	161.53	4.06	4.10	144.80	37.36	4.19	52.69
	PCV %		9.14	7.08	11.44	9.41	35.85	9.24	10.62	12.46	10.29
	GCV %		8.42	6.58	10.97	8.55	33.17	8.55	9.88	11.87	8.94
	H.B.S %		84.90	86.36	91.98	82.59	85.64	85.61	86.66	90.74	75.52
	Realized heritability		0.34	0.50	0.62	0.43	0.16	0.44	0.24	0.22	0.18

Table 5: Mean, range, phenotypic (PCV%), genotypic (GCV%) coefficients of variability, heritability in broad-sense (H.B.S) and realized heritability in the two cycles of early pedigree line selection for seed yield/plant in population II.

Cycle No.	Item		50 %Days to flowering	Plant height, cm	Length of fruiting zone, cm	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
C_1 (F_4)	Range	Min.	45.80	207.10	109.50	3.17	1.48	57.20	14.75	2.72	44.83
		Max.	64.80	257.50	189.90	4.67	5.17	179.00	40.99	5.76	62.64
	P_1		51.33	198.17	116.00	3.75	4.00	95.00	17.33	3.49	58.84
	P_2		53.00	199.67	123.00	4.58	3.00	104.00	29.00	4.08	59.67
	Bulk		53.67	204.18	131.67	3.80	3.03	108.28	27.00	3.51	52.57
	F_4 selected families		56.21	228.24	141.75	4.05	3.36	120.52	30.06	4.14	52.92
	PCV %		9.16	6.71	11.88	9.24	30.52	25.08	19.34	21.12	8.76
	GCV %		8.58	5.99	10.21	8.20	26.66	20.76	14.81	18.10	8.14
	H.B.S %		87.64	79.72	73.87	78.87	76.29	68.48	58.67	73.45	86.48
	Realized heritability		0.84	0.72	0.78	0.45	0.87	0.51	0.38	0.26	-0.87
C_2 (F_5)	Range	Min.	51.50	219.50	146.00	3.80	3.20	110.00	29.33	3.60	48.18
		Max.	65.17	257.50	167.17	5.12	5.20	164.17	39.67	5.30	55.38
	P_1		53.33	199.50	116.00	3.58	3.97	93.00	19.00	3.78	58.84
	P_2		54.33	204.00	121.67	4.42	3.00	103.00	29.00	3.75	59.67
	Bulk		54.00	223.70	123.93	3.73	3.53	106.00	30.00	3.64	52.57
	F_5 selected families		60.87	236.00	155.63	4.40	3.90	135.42	34.03	4.29	53.14
	PCV %		6.86	5.86	4.11	11.03	18.08	11.57	8.85	15.24	4.92
	GCV %		6.39	5.44	3.83	10.27	16.90	10.87	8.13	14.41	4.60
	H.B.S %		86.88	85.97	86.73	86.75	87.40	88.19	84.26	89.39	87.65
	Realized heritability		0.45	0.39	0.32	0.43	0.64	0.28	0.18	0.25	0.53

Realized response of early selection for seed yield/plant

The observed realized response after two cycles of pedigree selection for seed yield/plant were 46.69 and 60.14% in population I and 17.35 and 13.43% in population II as measured from the best parent and bulk sample, respectively. Moreover, the highest values of correlated response were recorded for number of capsules/ plant i.e. 51.89% and 38.35% in population I and 31.47% and 27.75% in population II, followed by length of fruiting zone which revealed 33.50 and 15.38 in population I and 27.92 and 25.58 in population II as a deviation from the best parent and bulk, respectively.

It is clear that the direct and correlated response values of selection were larger in population I than population II in most studied traits. This result exhibited the different genetic make-up of the two current populations.

The superior families after two cycles of selection

The selected families in both populations surpassed significantly

the respective parents and bulk, except two families (no. 21 and no, 116) in population II. The same trend could be found in correlated traits .i.e. plant height, length of fruiting zone and number of capsules / plant in both populations (Tables 6 and 7).

In population 1, the superior family No.153 yielded the highest seed yield/plant (43.50g) and surpassed highly significantly the respective parents P1 (17.83g), P2 (25.47g) and the bulk sample (23.33g) by 144, 70.8 and 86.5%, respectively. Also, this family (No.153) exceeded significantly the respective parents and the bulk sample in plant height, capsule length, number of branches /plant, number of capsule /plant and 1000-seed weight indicating the strong correlation of those traits with seed yield/plant.

In population II, the superior family No. 47 significantly surpassed the respective parents and bulk sample by 108.08, 36.8 and 32.2%, respectively. This family (No 47) exceeded significantly the respective parents and bulk sample for plant height, Fruiting zone, capsule length, number of capsules/plant and 1000-seed weight, explaining the effectiveness' of those traits on seed yield/plant as also recorded in superior family No.153 of population 1.

It is clear from the obtained results that all families after two cycles of pedigree line selection were late in flowering comparing of their respective parents and bulk in both populations, except the family No. 143 in population II was significantly earlier than its second parent (P_2) and was early flowering comparing to its first parent (P_1) and bulk. Moreover, this family surpassed significantly its parents and bulk in seed yield/plant (34.83 g), plant height (251.0 cm), length fruiting zone (163.0 cm), capsule length (5.12 cm), number of branches/plant (4.53), number of capsules/plant (147.5) and 1000-seed weight (5.10 g). The obtained results indicated that the pedigree line selection was most efficient procedure for improving seed yield and other companied traits.

2-2. Late pedigree selection for seed yield/plant in the F_5 generation

The mean squares revealed to be highly significant for seed yield/ plant and all correlated traits, indicating the genetic differences among the selected families in both populations (Table 8).

The average of seed yield/plant overall selected families was 41.24 and 42.37g in late selection after one cycle surpassed the average from selected families (37.36 and 34.03 g) after two cycles of early selection by 10.38 and 24.51% for population I and II, respectively. The same trend was found for number of branches and capsules/ plant in both populations and for plant height and fruiting zone in population I as well as 1000-seed weight and oil % in population II (Table 9).

The overall mean of selected families in late selection was slightly earlier than those of early selection after two cycles of selection by 2.87 to 1.34 days in populations I and II, respectively. Moreover, the overall mean of seed yield/plant for selected families in late selection surpassed their respective parents and bulk sample.

Table 6: Selected families means after two cycles of early selection for seed yield/plant in population I.

Selected family No.	50 % Days to flow.	Plant height, cm	Len. of fruiting zone, cm	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
48	59.23	229.50	146.50	3.85	4.20	145.67	35.00	3.69	56.30
56	62.33	231.00	147.83	3.60	4.20	136.27	33.30	3.84	55.32
88	66.33	230.50	149.50	3.60	4.70	133.33	35.17	3.79	52.25
106	65.33	238.00	189.33	4.25	3.00	133.72	38.25	4.87	55.15
111	55.33	281.50	192.50	4.55	1.00	161.33	40.00	4.87	57.81
115	67.33	232.50	150.67	3.85	4.50	138.10	37.00	3.74	52.25
122	66.33	246.00	168.50	4.35	5.50	156.97	42.50	4.26	48.00
126	64.33	234.67	152.00	4.10	5.00	138.00	37.00	4.29	46.00
135	51.33	227.00	146.00	3.85	3.20	136.47	31.88	3.74	59.01
153	66.00	248.00	172.50	4.55	5.73	168.17	43.50	4.84	44.82
Mean	62.39	239.87	161.53	4.06	4.10	144.80	37.36	4.19	52.69
P1	47.83	188.83	116.67	3.63	3.00	83.67	17.83	3.12	49.00
P2	50.17	204.17	121.00	3.57	3.33	95.33	25.47	3.57	51.00
Bulk	54.67	221.67	140.00	3.70	4.00	104.67	23.33	3.97	52.57
RLSD $_{0.05}$	3.801	10.761	8.980	0.273	0.956	8.704	2.485	0.272	4.600
RLSD $_{0.01}$	5.206	14.741	12.301	0.374	1.310	11.923	3.404	0.373	6.301

Table 7: Selected families means after two cycles of early selection for seed yield/plant in population II.

Selected family No.	50 % Days to flow.	Plant height, cm	Len. of fruiting zone	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
21	58.50	230.50	152.17	3.80	3.20	117.50	30.83	3.78	55.38
38	65.17	248.50	154.67	4.70	5.20	164.17	35.83	4.33	55.34
44	62.83	244.50	155.67	4.66	3.53	137.50	34.50	4.28	53.82
47	64.50	257.50	167.17	4.93	3.53	140.00	39.67	5.30	50.56
57	58.50	225.00	152.17	4.32	3.20	137.50	34.83	4.18	54.38
63	62.50	230.50	157.17	4.53	4.20	137.50	35.00	3.65	50.50
67	60.50	219.50	150.67	4.11	4.20	135.00	33.00	3.73	53.54
116	63.17	224.00	146.00	3.83	3.20	110.00	29.33	3.60	55.29
135	61.50	229.00	157.67	3.98	4.20	127.50	32.50	4.95	54.38
143	51.50	251.00	163.00	5.12	4.53	147.50	34.83	5.10	48.18
Mean	60.87	236.00	155.63	4.40	3.90	135.42	34.03	4.29	53.14
P1	53.33	199.50	116.00	3.58	3.97	93.00	19.00	3.78	58.84
P2	54.33	204.00	121.67	4.42	3.00	103.00	29.00	3.75	59.67
Bulk	54.00	223.70	123.93	3.73	3.53	106.00	30.00	3.64	52.57
RLSD $_{0.05}$	2.59	8.89	4.00	0.30	0.43	9.24	2.05	0.37	1.57
RLSD $_{0.01}$	3.55	12.18	5.48	0.41	0.59	12.65	2.81	0.50	2.16

Table 8: Analysis of variance after one cycle of late pedigree selection for seed yield/plant in population I and II.

	S.O.V	D.F	Mean squares								
			50 % Days to flow.	Plant height, cm	Len. of fruiting zone	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
Pop. I	Rep.	2	5.31	21.01	8.42	0.08	0.51	7.54	1.98	0.01	2.20
	Fami.	9	84.96**	989.41**	1052.97**	0.68**	5.51**	378.05**	18.20**	0.86**	48.64**
	Error	18	6.96	46.93	36.90	0.04	0.35	18.30	1.28	0.04	3.57
Pop. II	Rep.	2	1.66	39.18	212.66	0.02	0.06	117.53	9.81	0.17	3.59
	Fami.	9	42.76**	768.87**	1168.13**	0.99**	4.94**	842.02**	12.91**	0.43**	128.09**
	Error	18	3.44	52.76	44.49	0.11	0.27	41.91	0.96	0.04	8.50

*, ** Significant and highly significant at 0.05 and 0.01 levels of probability, respectively.

Table 9: Means, range, phenotypic (PCV%), genotypic (GCV%) coefficients of variability, heritability in broad-sense (H.B.S) and realized heritability in the one cycles of late pedigree selection for seed yield/plant in populations I and II.

	Item		50 % Days to flow.	Plant height, cm	Len. of fruiting zone	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
Pop. I	Range	Min.	53.00	221.00	136.50	3.35	1.00	131.93	38.27	3.37	44.86
		Maxi.	66.33	281.50	198.50	4.55	5.53	166.17	44.67	4.87	57.82
	P_1		47.83	188.83	116.67	3.63	3.00	83.67	17.33	3.12	49.00
	P_2		50.17	204.17	121.00	3.57	3.33	95.33	21.00	3.57	51.00
	Bulk		54.67	221.67	140.00	3.70	4.00	104.67	23.33	3.97	52.57
	F_5 sele. Fami.		59.52	245.73	168.10	4.05	4.12	149.96	41.24	4.17	51.50
	PCV %		9.64	7.73	11.53	12.40	34.89	7.84	6.54	13.38	8.37
	GCV %		8.57	7.21	10.95	11.45	31.81	7.30	5.93	12.51	7.53
	H.B.S %		78.89	87.00	90.18	85.30	83.13	86.76	82.34	87.43	80.78
	Realized H.		0.11	0.38	0.69	0.30	0.28	0.31	0.45	0.29	0.29
Pop. II	Range	Min.	52.33	200.50	129.50	3.50	1.73	126.00	39.80	3.53	40.23
		Maxi.	63.33	246.50	181.00	5.25	5.50	166.67	45.80	5.00	61.45
	P_1		53.33	199.50	116.00	3.58	3.97	93.00	19.00	3.78	58.84
	P_2		54.33	204.00	121.67	4.42	3.00	103.00	22.67	3.75	59.67
	Bulk		54.00	223.70	123.93	3.73	3.53	106.00	30.00	3.64	52.57
	F_5 sele. Fami.		59.53	216.20	149.72	4.22	4.09	149.05	42.37	4.47	55.61
	PCV %		6.83	7.90	13.67	15.01	33.04	11.79	5.25	9.22	12.51
	GCV %		6.08	7.15	12.93	12.82	30.49	10.96	4.71	8.06	11.35
	H.B.S %		79.23	81.90	89.38	72.91	85.14	86.42	80.53	76.34	82.42
	Realized H.		0.61	0.56	0.45	0.34	0.26	0.31	0.86	0.33	0.17

by 131.30, 61.92 and 76.77 % in population I and 122.84,89 and 41.23% in population II, respectively.

The estimates of PCV, GCV and heritability in broad sense for seed yield/plant were low and accounted 6.54, 5.93 and 82.37 % and 5.25, 4.71 and 80.53 % after one cycle of late selection comparing to 10.62, 9.88 and 86.66%, and 8.85, 8.13 and 84.26 % after two cycles of early selection in populations I and II, respectively.

High genetic variation as revealed by genotypic and phenotypic variations and heritability for yield

and its components were reported by Valarmathi *et al* (2004), Ganeshan (2005), Mothilal (2006), Khan *et al* (2007), Prasad *et al* (2007), Iwo *et al* (2007), Gangarde *et al* (2009), Jadhav and Mohrir (2012) and Kumar *et al* (2012). Otherwise, moderate heritability for plant height, number of capsules, 1000 seed weight and oil was reported by Asha (2005). Moreover, low estimates for narrow sense heritability for seed yield / plant and some of its components were reported by Ranganatha *et al* (1994).

Realized response of late selection for seed yield/plant

The selection response to one cycle of late selection for seed yield/plant was large comparing to their values after two cycles of early selection in both populations. The values accounted 61.94 and 76.74 % in population I and 46.11 and 41.24 % in population II with late selection comparing to 46.70 and 60.11 % in population I and 17.36 and 13.44 % in population II as a deviation from the best parent and bulk, respectively.

The superior families after one cycle of late selection

As mentioned before the average of selected families after one cycle of late selection surpassed those obtained after two cycles of early selection. It is clear that, all selected families surpassed significantly their respective parents and bulk for the criterion seed yield /plant and correlated trait of number of capsules /plant in both populations (Tables 10 and 11).

In population I, the selected families No. 122 and 153 exceeded significantly the best parent and bulk sample in all studied traits, except oil%. Moreover, the selected family no 111 surpassed the best parent and bulk in all studied traits, except number of branches/ plant. It is importance to mention that those families were matched also the selections of two cycles of early selection in current population.

In population II, the highest family No. 82 in seed yield/plant surpassed significantly the best parent and bulk for all studied traits, except oil %. Same picture of view could be nearly found for selected families No. 13 and 98. Furthermore, the highest selected families for oil % No. 5, 25 and 109 exceeded significantly the best parent and bulk in oil %, seed yield/ plant, number of capsules/ plant and 1000-seed weight, as well as length fruiting zone for the former two families (No. 5 and 25).

It is clear that the selected family No. 98 exceed significantly its best parent and bulk for seed yield / plant, number of capsules/ plant, capsule length, length fruiting zone, plant height and 1000-seed weight. In addition to, it was earlier than its parents and bulk sample.

Direct selection for seed yield produced the greater yield response (Holbrook *et al.* 1989). The pedigree selection line exhibited highest values for seed yield, plant height, number of capsules and 1000-seed weight (Suwan-Jintaanankul 1989). Areeat (1992) noted that the pedigree selection could be used in early generation selection for yield in sesame.

El-Shimy (1**995**) found that the realized gain for seed yield/plot was 46.34, 26.83 and 21.95% in one population and 22.95, 36.07 and 40.16 in another population using selection index, independent culling levels and pedigree selection, respectively after two cycles of selection. Moreover, Pathirana (1995) found that the 80

highest yielding lines recorded a 10.8% increase in yield compared to the mean of 400 lines.

Baydar *et al* (1999) found two superior lines had 16.9% and 15.9 % higher seed yields than the control variety, while one line with 63.25% oil content was identified as superior for high oil content. Samar *et al* (2002) reported that selecting for increased yield via selection for number of capsules/plant would be effective.

Abo-Elwafa and Ahmed (2005) reported that significant differences among the F_3 families of sesame were recorded for seed yield and its components. The means after two cycles of pedigree line selection presented positive direct response of 25.24 and 33.03% and 15.22 and 22.39 % in seed yield/plant over the best parent and the check cultivar for population I and II, respectively. The indirect positive response in seed yield/plant after two cycles of selection yielded 12.62 and 19.63 %.

Ismail *et al.* (2005) reported that the realized heritability in the two studied populations for seed yield/plant was low compared to that estimated on the basis of mean of the three replications. Moreover, three cycles of pedigree selection increased seed yield by 28.64 and 31.53% from the bulk sample in populations I and II, respectively.

Table 10: Selected families means after one cycle of late selection for seed yield/plant in population I.

Selected family No.	50 % Days to flow.	Plant height, cm	Length of fruiting zone, cm	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
4	65.67	270.50	181.50	4.45	4.80	152.97	44.67	4.07	49.06
32	55.00	229.50	150.50	3.43	3.53	133.47	38.27	3.37	55.00
40	59.00	236.50	159.50	3.90	3.93	149.00	39.67	4.17	50.00
42	63.67	243.50	178.50	3.85	4.37	152.97	43.67	4.47	52.94
52	55.23	245.33	184.00	4.45	5.33	159.67	43.00	4.52	48.59
111	55.33	281.50	198.50	4.55	1.00	161.33	40.00	4.87	57.82
122	66.33	246.00	168.50	4.35	5.50	146.97	42.50	4.26	48.00
153	66.00	248.00	172.50	4.55	5.53	166.17	43.50	4.84	44.86
164	53.00	221.00	136.50	3.35	3.53	131.93	38.47	3.37	55.36
177	56.00	235.50	151.00	3.60	3.70	145.17	38.67	3.82	53.42
Mean	59.52	245.73	168.10	4.05	4.12	149.96	41.24	4.17	51.50
P1	47.83	188.83	116.67	3.63	3.00	83.67	17.83	3.12	49.00
P2	50.17	204.17	121.00	3.57	3.33	95.33	25.47	3.57	51.00
Bulk	54.67	221.67	140.00	3.70	4.00	104.67	23.33	3.97	52.57
RLSD $_{0.05}$	4.52	11.75	10.42	0.33	1.01	7.34	1.94	0.34	3.24
RLSD $_{0.01}$	6.20	16.10	14.27	0.45	1.39	10.05	2.66	0.47	4.44

Table 11: Selected families means after one cycle of late selection for seed yield/plant in population II.

Selected family No.	50 % Days to flow.	Plant height, cm	Length of fruiting zone, cm	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
5	60.33	212.00	138.50	4.27	4.00	165.00	42.00	4.50	61.45
13	63.33	220.00	148.00	4.67	5.50	166.67	45.33	4.60	49.57
25	62.33	211.00	143.00	4.00	3.00	135.50	41.50	4.70	60.00
45	62.33	216.50	137.00	4.00	4.67	166.67	43.80	4.48	56.78
82	63.00	242.00	181.00	5.00	5.50	165.00	45.80	5.00	40.23
98	52.33	246.50	177.67	5.25	1.73	137.00	43.00	4.65	57.00
109	55.33	202.50	129.50	3.75	5.00	152.50	40.00	4.33	61.31
110	56.00	206.00	173.00	3.50	2.67	126.00	41.50	4.45	53.81
119	59.00	200.50	132.50	3.75	3.83	126.17	39.80	3.53	56.00
136	61.33	205.00	137.00	4.03	5.00	150.00	41.00	4.40	59.93
Mean	59.53	216.20	149.72	4.22	4.09	149.05	42.37	4.47	55.61
P1	53.33	199.50	116.00	3.58	3.97	93.00	19.00	3.78	58.84
P2	54.33	204.00	121.67	4.42	3.00	103.00	29.00	3.75	59.67
Bulk	54.00	223.70	123.93	3.73	3.53	106.00	30.00	3.64	52.57
RLSD $_{0.05}$	3.18	12.46	11.44	0.57	0.89	11.11	1.68	0.34	5.00
RLSD $_{0.01}$	4.36	17.07	15.67	0.78	1.22	15.21	2.31	0.47	6.85

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الانتخاب المنسب المبكر والمتاخر لمحصول النبات في السمسم

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الملخص:

أجريت هذه الدراسة في مزرعة محطة بحوث جزيرة شندويل بمحافظة سوهاج التابعة لمركز البحوث الزراعية خلال ثلاث مواسم صيفية (من موسم ٢٠٠٩ وحتى ٢٠١١م).

كان متوسط محصول العائلات المنتخبة بعد دورتين من الانتخاب المبكر يتراوح ما بين ٣١.٨٨ جرام و٤٣.٥٠ جرام بمتوسط قدره ٣٧.٣٦ جرام مقارنة بالأب الاول (١٧.٨٣جرام) والاب الثاني (٢٥.٤٧جرام) والعينة المجمعة (٢٣.٣٣ جرام) وذلك في العشيرة الاولى، بينما العشيرة الثانية فكانت متوسطات العائلات المنتخبة يتراوح ما بين ٢٩.٣٣و ٣٩.٦٧جرام بمتوسط مقداره ٣٤.٠٣جرام مقارنة بالأب الاول (١٩جرام) والاب الثاني (٢٩جرام) والعينة المجمعة (٣٠ جرام). وكان متوسط محصول العائلات المنتخبة بعد دورة من الانتخاب المتأخر ٤١.٢٤جرام و٤٢.٣٧ جرام، وهذا المحصول اعلى من نظيرة في حالة الانتخاب المنسب بعد دورتين انتخابيتين حيث كان ٣٧.٣٦جرام و٣٤.٠٣جرام بنسبة بلغت ١٠.٣٨% و٢٤.٥١% للعشيرة الاولى والثانية على التوالي.

وجد اختلاف طفيف بين (GCV) و (PCV) مع وجود تقديرات عالية من درجة التوريث بالمعنى الواسع لمعظم الصفات المدروسة في عشيرتيا الاساس. الاستجابة المرتبطة للانتخاب بعد دورة واحدة من الانتخاب المتأخر لمحصول البذور للنبات أكبر من الاستجابة المرتبطة بعد دورتين من الانتخاب المنسب كما اشارت النتائج الى ان الاستجابة كانت ٦١.٩٤ و٧٦.٧٤ ٪ للعشيرة الاولى و٤٦.١١ ، ٤١.٢٤ ٪ للعشيرة الثانية وذلك مقارنة بأفضل الاباء والعينة المجمعة على التوالي.