Pedigree Selection for Yield and its Components in Sesame (*Sesamum indicum L.*)

1- Response to selection for yield, correlation and path coefficients analyses

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Abstract:

The present study was carried out at Shandaweel Agricultural Research Station, Sohag, 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 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 % 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.

In the base populations, the phenotypic correlation coefficients between seed yield/plant and each of days to 50 % flowering, plant height, length of fruiting zone, number of capsules/plant, and 1000-seed weight accounted for 0.443, 0.246, 0.253, 0.466 and 0.293 in population 1 and 0.181, 0.481, 0.428, 0.543 and 0.406 in population II, respectively. Moreover, seed yield/plant has low values of correlation with number of branches/plant (0.199) and capsule length (0.135) in population II.

After two cycles of early pedigree line selection for seed yield/plant the coefficients of phenotypic correlation between seed yield and each of plant height, fruiting zone, capsule length, number of capsules /plant and 1000-seed weight increased to 0.626, 0.685, 0.863, 0.803 and 0.745 in population I and to 0.731, 0.805, 0.827, 0.729 and 0.627 in population II, respectively. Also, high positive and significant correlation coefficients in late pedigree selection with values ranged from 0.55 to 0.72 were found between seed yield / plant and each of length fruiting zone, capsule length, number of capsules / plant and 1000-seed weight in both populations. Otherwise, negative and significant values of correlation were recorded between seed yield/plant and oil % with the early and late selection for both populations.

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The direct effect of number of capsules /plant exhibited superiority on seed yield/ plant for selection especially in late selection comparing to their base population in both populations. That direct effect of number of capsules on seed yield/plant was 0.4330 and 0.4056 in base increased to 0.5611 and 0.4429 in early and to o.9083 and 0.7558 in late selection for population I and II, respectively. Likewise, its indirect effect on seed yield/ plant via length fruiting zone were 0.0234 in base increased to 0.2873 in early and to 0.7639 in late selection for population I.

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 for its taste, dating back 2000 year to China. The Egyptian used sesame seed as medicine around the same time. The total cultivated area in the world was 66,288,276 ha produced seeds of 4,092,236 tons, while in Egypt the cultivated area was 33,768 ha produced 44,427 tons of seeds (FAO 2011). In Egypt, there is a large gap between oil production and its consumption. So, high seed yield and oil varieties of oil crops are needed such as sesame. 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. Backiyarani *et al* (1999) studied correlation and path coefficient in F2 and F3 generations of one cross of sesame. Single plant yield showed a positive correlation with capsule number, 1000-seed weight and plant height, but a negative association with seed oil percentage. In both generations, path coefficient analysis revealed the importance of the number of primary branches as a selection criterion for improving yield and oil percentage simultaneously. Arulmozhi *et al* (2001) revealed the maximum direct effects of number of branches, number of capsules and 1000 seed weight on seed yield. Raghuwanshi *et al.* (2003), Sankar and Kumar (2003) and Tamina and Dasgupta (2003) found that positive correlation of seed yield with plant height, number of capsules per plant and 1000-seed weight. The understanding of the relationship between yield and its components is crucial for selection process and this relationship can be explained by means of correlation, factor and path coefficient analyses. Factor analysis provides more information than a simple correlation matrix because it discriminates between groups of variables (factors) and indicates percentage contribution of variables (Biabani and Pakniyat, 2008). Path coefficient analysis permits the separation of direct effects from indirect effects and gives more realistic relationship of the characters and helps in effective selection (Sumathi *et al.*, 2007).

Therefore the objective of this study was to estimate the effect of pedigree line selection method on selection response and correlation coefficients among the studied traits as revealed by path coefficient analysis 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, Egypt during the period of 2009-2011 summer seasons.The breeding material used in this study was 200 F3-families traced back to random F2 plants from two crosses i.e. (Introductions, 143 x Introductions, 245) as population I and (Introductions 520 x Giza 32) as population II.

In 2009 season, the 200 F3-families from each population with the original parents, F3-bulked random sample (a mixture of equal number of seeds from each plant to represent the generation mean) were sown at 10^{th} May in 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. The following traits were measured on ten random plants in each plot:-

Days to the 50% flowering for each plot/replication, plant height (cm), Length of fruiting zone (cm), Number of branches/plant, Capsule length (cm); Number of capsules/plant, seed yield/plant (g), 1000-seed weight (g) (calculated from the selected plants), seed oil percentage: 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 F4 generation.

Season 2010 (F4- generation):

All the selected and non-selected families for both populations, 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 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 F5 generation.

Season 2011 (F5- generation):

The same experimental design and field procedure were used to evaluate the two cycles (in F3 and F4) of early direct selection and one cycle of the late direct selection for seed yield/plant (F4).

The respective parents and F5-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 traits on seed yield/plant.

Statistical analysis:

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 correlation coefficient:

The phenotypic (σ^2 p) and genotypic (σ^2 g) variances were calculated as given by Al-Jibouri *et al* (1958). The phenotypic covariance (cov. p12) between each pairs of traits (1 and 2) followed the same form as variance analysis by Steel and Torrie (1980), phenotypic correlation coefficients was calculated as described by Johanson *et al* (1955)

Path coefficient analysis:

Simple correlation coefficients between each pairs of studied characters were estimated for each selection criterion. Path coefficient analysis was done according to the procedure followed by Dewey and Lu (1959). The contributions of length of fruiting zone, number of capsule / plant and 1000-seed weight on seed yield/ plant as will as residual factors (X) were included in the path coefficient analysis as shown in the following:

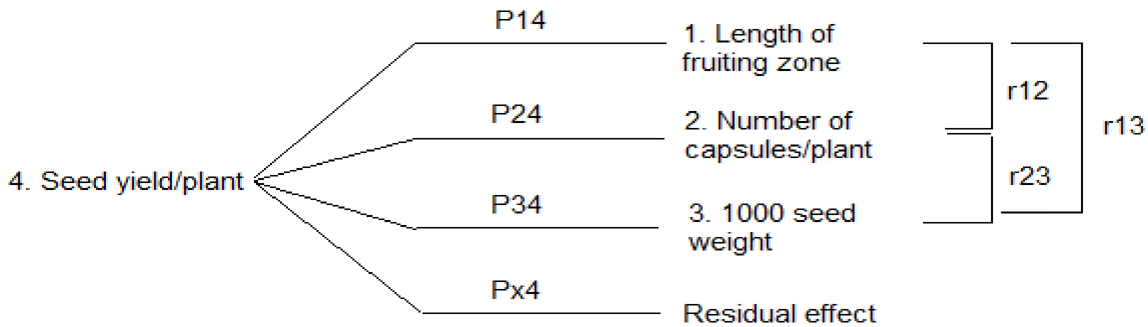

Fig.1: Direct and indirect effect of length of fruiting zone, number of capsules/plant and 1000-seed weight on seed yield /plant

$r14 = P_{14} + r12\ P24 + r13\ P34$

$r24 = P24 + r12\ P14 + r23\ P34$

$r34 = P34 + r13\ P14 + r23\ P23$

$1 = P^2\ X4 + P^2\ 14 + P^2\ 24 + P^2\ 34 + 2\ P14\ r12\ P24 + 2\ P14\ r13\ P34 + 2\ P24\ r23\ P34$

Results and Discussion:

–Means of early and late pedigree selection

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 (Table 1), respectively. Likewise, these means varied from 29.33 to 39.67 with an average 34.03 of compared to their respective parents P1 (19.00), P2 (29.00) and bulk sample (30.0g) in population II (Table 2).

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, in Tables 1, 2, 3 and 4, respectively. The same trend of observation could be found for number of branches and capsules/ plant in both populations and for plant height and length of fruiting zone in population I as well as 1000-seed weight and oil percentage in population II.

The overall mean of days to 50% flowering for 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 by 131.30, 61.92 and 76.77 % in population I and 122.84, 89 and 41.23% in population II, respectively (Tables 3 and 4).

–Realized response of early and late selection for seed yield/plant

The observed realized response after two cycles of pedigree line selection for seed yield/plant were 46.70 and 60.11% in population I and 17.36 and 13.44% 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 (Tables 1 and 2).

Table 1: 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 2: 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 3: 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 4: 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 fruit-ing 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

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 % 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 same view could be found for number of capsules and branches /plant in both populations and for plant height and fruiting zone in population I and 1000-seed weight and oil % in population II (Tables 3 and 4). Areeat (1992) noted that the pedigree selection could be used in early generation selection for yield in sesame. However, bulk selection could be used until the F5 generation followed by individual plant selection in later generation.

–Phenotypic correlations coefficients among the studied traits in the base population

Phenotypic correlation coefficients among the studied traits in the base populations II and II are presented in Table 5.

The coefficients of phenotypic correlation between seed yield/plant and each of days to the 50 % flowering, plant height, length of fruiting zone, number of capsules/plant, and 1000-seed weight exhibited to be low to moderate values and accounted for 0.443, 0.246, 0.253, 0.466 and 0.293 in population I and 0.181, 0.481, 0.428, 0.543 and 0.406 in population II, respectively. Moreover, seed yield/plant has low values with number of branches/plant and capsule length 0.199 and 0.135 in population II.

Table 5: Estimation of phenotypic correlation coefficients for the studied traits in the base populations I and II

		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 %
Days to 50% flo.	PI	0.118*	0.029	0.138*	0.168**	0.276**	0.443**	0.072	-0.003
	PII	0.053	0.052	-0.087	0.044	0.002	0.181**	-0.053	0.061
Plant height,	PI		0.598**	0.246**	0.322**	0.159*	0.246**	0.278**	0.026
	PII		0.747**	0.206**	0.165**	0.351**	0.481**	0.416**	-0.091
Fruiting zone, cm	PI			0.172*	0.174*	0.054	0.253**	0.357**	0.038
	PII			0.166*	-0.167*	0.324**	0.428**	0.390**	0.031
Capsule length,	PI				0.673**	0.097	0.097	0.249**	0.018
	PII				-0.095	0.124*	0.135*	0.327**	-0.048
No. of branches	PI					0.147*	0.076	0.204**	0.012
	PII					0.114*	0.199**	-0.048	0.075
No. of capsules /plant	PI						0.466**	0.138*	0.108*
	PII						0.543**	0.399**	-0.040
Seed yield /plant, g	PI							0.293**	0.187**
	PII							0.406**	-0.017
1000-seed weight, g	PI								0.127*
	PII								-0.094

Moreover, length of fruiting zone possessed high phenotypic correlations with plant height in both base populations and recorded 0.598 and 0.747 in population I and II, respectively.

Negative and ngliable phenotypic correlations were recorded between days to 50% flowering and oil percentage (-0.003) in population I, and between oil percentage and all studied traits except days to 50% flowering, fruiting zone and number of branches/plant in population II.

Positive correlation coefficient was reported between seed yield and each of number of capsule, number of branches, length of fruiting zone, plant height, capsule length, 1000 seed weight and oil % by Arulmozhi *et al* (2001), Raghuwanshi *et al* (2003), Siddiqui *et al* (2005), Iwo *et* *al* (2007), Gnanasekaran *et al* (2008), Ibrahim and Khidir (2012). Otherwise, the negative correlation coefficients were reported between seed yield and days of 50% flowering by Raghuwanshi *et al* (2003) and Engin *et al* (2011) and oil percentage by Backiyarani *et al* (1999).

–Phenotypic correlation coefficients after two cycles of early selection for seed yield/plant and other studied traits

The phenotypic correlation coefficients between each pairs of the studied traits in the two populations after two cycles of early selection are shown in Tables 6 and 7.

After two cycles of selection, the coefficients of phenotypic correlation between seed yield and each of plant height, length of fruiting zone, capsule length, number of capsule /plant, 1000-seed weight and seed oil percentage were 0.626, 0.685, 0.863, 0.803, 0.745 and – 0.634 in population 1 and 0.731, 0.805, 0.827, 0.729, 0.627 and – 0.550 in population II, respectively.

Moreover, the phenotypic correlations were increased between number of capsule /plant and each of plant height, length of fruiting zone, capsule length, number of capsule per plant and 1000-seed weight as well as between fruiting zone and plant height, capsule length, and 1000-seed weight after two cycles of selection in both populations.

Table 6: Estimation of phenotypic correlation coefficients for the studied traits of early (above diagonal) and late (blow diagonal) selection for seed yield/plant in population I

	Days to 50% flo.	Plant height, Cm	fruiting zone, cm	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
Days to 50% flo.		-0.195	0.035	0.014	0.673**	-0.030	0.454**	0.144	-0.722**
Plant height,	0.330		0.797**	0.773**	-0.533**	0.723**	0.626**	0.725**	0.022
Fruiting zone, cm	0.347	0.889**		0.827**	-0.477*	0.512*	0.685**	0.925**	-0.008
Capsule length, c	0.531*	0.803**	0.860**		-0.160	0.801**	0.863**	0.886**	-0.344
No. of branches	0.611**	-0.281	-0.085	0.216		0.045	0.222	-0.267	-0.793**
No. of capsules /	0.439	0.697**	0.841**	0.882**	0.148		0.803**	0.570**	-0.356
Seed yield /plant, g	0.792**	0.491*	0.649**	0.724**	0.620**	0.668**		0.745**	-0.634**
1000-seed weight, g	-0.439	0.683**	0.854**	0.856**	0.063	0960**	0.613**		-0.274
Oil %	-0.710**	-0.016	-0.156	-0.529*	-0.888**	-0.471*	-0.683**	-0.375	

Table 7: Estimation of phenotypic correlation coefficients for the studied traits of early (above diagonal) and late (blow diagonal) selection for seed yield/plant in population II

	Days to 50% flo.	Plant height, cm	fruiting zone, cm	Capsule length, cm	No. of branches /plant	No. of capsules /plant	Seed yield /plant, g	1000-seed weight, g	Oil %
Days to 50% flo.		0.026	-0.143	-0.164	-0.005	0.016	0.171	-0.190	-0.456*
Plant height,	-0.091		0.799**	0.841**	0.325	0.610**	0.731**	0.731**	-0.502*
Fruiting zone, cm	-0.259	0.766**		0.777**	0.279	0.487*	0.805**	0.850**	-0.760**
Capsule length, c	0.011	0.933**	0.583**		0.449*	0.785**	0.827**	0.623**	-0.744**
No. of branches	0.658**	-0.149	-0.359	-0.006		0.762**	0.294	0.249	-0.251
No. of capsules	0.552*	0.273	-0.136	0.385	0.734**		0.729**	0.418	-0.338
Seed yield /plant, g	0.451*	0.744**	0.545*	0.720**	0.327	0.639**		0.627**	-0.550*
1000-seed weight, g	0.215	0.659**	0.576*	0.583*	0.078	0.483*	0.704**		-0.493*
Oil%	-0.342	-0.572*	-0.655*	-0.492*	-0.352	-0.262	-0.762**	-0.400*	

-Phenotypic correlations after one cycle of late selection for seed yield/plant and other studied traits

The phenotypic correlation coefficients between each pairs of the studied traits in the two populations after one cycle of late selection for seed yield/plant are shown in Tables 6 and 7.

High positive values of correlation coefficients ranged from 0.545 to 0.724 were found between seed yield / plant and each of length fruiting zone, capsule length, number of capsules/ plant and 1000-seed weight in both populations (Table 6&7). This result revealed that the main contributions of seed yield / plant were length fruiting zone, number of capsules/ plant and 1000-seed weight and the selection for any of these traits could increase seed yield / plant. Otherwise, the negative values of correlations coefficients were recorded between seed yield / plant and oil % in both populations. These results are in accordance with those obtained after two cycles of early pedigree line selection (Table 6&7).

Moreover, 1000-seed weight recorded high positive correlated values with each of plant height, length fruiting zone, capsule length and number of capsules /plant in both populations. Also, plant height has high positive correlation with each of length of fruiting zone and capsule length in both populations. Furthermore, the positive and high correlation revealed to be true between length of fruiting zone and plant height in both populations. The last result may be due to the effect of genes controlling length in the genome of this plant. Otherwise, the oil % exhibited negatively correlated with all studied traits in both populations after one cycle of late pedigree selection and this result matched the correlation result after two cycles of early pedigree selection.

Finally, each obtained result may be due to the correlation genetic makeup for studied traits.

Positive correlation coefficient was reported between seed yield and each of number of capsule, number of branches, fruiting zone, plant height, capsule length, 1000 seed weight and oil % by Iwo *et al* (2007), Ibrahim and Khidir (2012). Otherwise, the negative correlation coefficients were reported between seed yield and days of 50 % flowering by Engin *et al* (2011) and oil percentage by Backiyarani *et al* (1999).

–Path coefficient analysis of studied traits for base population, early and late selection under selection criterion of seed yield/plant

The phenotypic correlation coefficients were calculated separately between each pairs of the studied traits under early and late selection for seed yield/plant criterion as well as their base in both populations (Tables 5, 6 and 7).

The data revealed that significant and positive correlation coefficients were found between each pairs of studied yield traits such as length of fruiting zone, number of capsule /plant, 1000-seed weight, and seed yield / plant for early and late selection as well as their base in both populations, except between fruiting zone and number of capsule /plant of late selection in population II.

These obtained associations, if considered in detail become more complex. For clear understanding of such problem, the breeders may use path coefficient analysis, where direct influence of one variable upon another could be measured and correlation coefficients are easily partitioned into components of direct and indirect effects (Chaudhry, *et al*., 1993).

The partitioning of phenotypic correlation coefficients by path analysis into direct and indirect effects of some traits for selection in early and late selection as well as their base in both populations are presented in Table 8.

The direct effect of number of capsules /plant exhibited superiority on seed yield/ plant for selection especially in late selection comparing to their base in both populations. That direct effect of number of capsules on seed yield/plant was 0.4330 and 0.4056 in base increased to 0.5611 and 0.4429 in early and to o.9083 and 0.7558 in late selection for population I and II, respectively. Likewise, its indirect effect on seed yield/ plant via length fruiting zone were 0.0234 in base increased to o.2873 in early and to o.7639 in late selection as well as via 1000-seed weight were 0.0597 in base increased to 0.3198 in early and to 0.8720 in late selection for population I (Table 8).

The same view but with slight values could be found in population II where indirect effects of number of capsule /plant on seed yield/ plant via 1000-seed weight recorded 0.1618 in base increased to 0.1851 in early and to 0.3651 in late selection. Also, it`s indirect effects via length fruiting zone increased from 0.1314 in base to 0.2157 in early, but decreased to -0.1028 in late selection (Table 8). This last result correlated with the increasing of the direct effect of length fruiting zone on seed yield/ plant in population II which recorded 0.2375 in base increased to 0.7702 in early and to 0.6773 in late selection (Table 8).

Otherwise, the negative direct effects of 1000-seed weight on seed yield/plant were recorded in early and late selection in population II and in late selection in population I comparing to the positive direct effects in both base populations.

The obtained results exhibited the different genetic make-up in both populations. Consequently to determine parameters which possess powerful effects on seed yield should need to detect their contribution, such as number of capsule /plant in both populations and length fruiting zone in population II to be given weight before preparing selection program for the sesame.

It is clear that the effect of residual factor was decreased from 0.8396 and 0.7852 in base to 0.4825 and 0.4356 early and to 0.709 and 0.4289 in late selection in population I and II, respectively. Consequently, the strong effects were found for current studied traits on seed yield/plant of sesame.

Positive direct effect of number of capsules on seed yield was reported by Kumar and Vivekanandan (2009), Georgiev *et al* (2012) and Kumar *et al* (2012). Moreover, positive direct effect of number of capsules, fruiting zone and 1000 seed weight was found by Arulmozhi *et al* (2001), Mothilal (2005), Engin *et al* (2011), Yol *et al* (2010) and Ibrahim and Khidir (2012).

Table 8: Partitioning of phenotypic correlation into direct and indirect effects by path coefficient analysis for populations I and II.

	Population I			**Population II**		
	Base	**Early selection**	**Late selection**	**Base**	**Early selection**	**Late selection**
1- F.Z vs. seed yield/plant r=	0.2530	0.6850	0.6490	0.4280	0.8050	0.5450
Direct effect, P_{14} =	0.1677	0.0307	0.3926	0.2375	0.7702	0.6773
Indirect effects via N. of ca. $r_{12}P_{24}$ =	0.0234	0.2873	0.7639	0.1314	0.2157	-0.1028
Indirect effects via SI $r_{13}P_{34}$ =	0.0619	0.3670	-0.5075	0.0591	-0.1809	-0.0295
Total =	0.2530	0.6850	0.6490	0.4280	0.8050	0.5450
2- N. of ca. vs. seed yield/plant r =	0.4660	0.8030	0.6680	0.5430	0.7290	0.6390
Direct effect, P_{24} =	0.4330	0.5611	0.9083	0.4056	0.4429	0.7558
Indirect effects via length of F.Z $r_{2}P_{14}$=	0.0091	0.0157	0.3302	0.0769	0.3750	-0.0921
Indirect effects via SI $r_{23}P_{34}$ =	0.0239	0.2262	-0.5705	0.0605	-0.0889	-0.0247
Total =	0.4660	0.8030	0.6680	0.5430	0.7290	0.6390
3- S.I vs. seed yield/plant r =	0.2930	0.7450	0.6130	0.4060	0.6270	0.7040
Direct effect, P_{34} =	0.1734	0.3968	-0.5943	0.1516	-0.2128	-0.0512
Indirect effects via F.Z $r_{13}P_{14}$ =	0.0599	0.0284	0.3353	0.0926	0.6547	0.3901
Indirect effects via N. of ca $r_{23}P_{24}$=	0.0597	0.3198	0.8720	0.1618	0.1851	0.3651
Total =	0.2930	0.7450	0.6130	0.4060	0.6270	0.7040
Residual factor	0.8396	0.4825	0.7090	0.7852	0.4365	0.4289

F.Z: length of fruiting zone; N. of ca: number of capsules /plant; S.I: 1000-seed weight.

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الانتخاب المنسب للمحصول ومكوناتة فى السمسم
1- الاستجابة للانتخاب لصفة المحصول والارتباط وتحليل معامل المرور

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أجريت هذه الدراسة في مزرعة محطة بحوث جزيرة شندويل بسوهاج التابعة لمركز البحوث الزراعية خلال ثلاث مواسم صيفية (من موسم 2009 وحتى 2011م.

كان متوسط محصول العائلات المنتخبة بعد دورتين من الانتخاب المبكر يتراوح ما بين 31.88جرام و43.50 جرام بمتوسط قدره 37.36جرام مقارنة بالأب الاول (17.83جرام) والاب الثاني (25.47 جرام) والعينة المجمعة (23.33 جرام) وذلك في العشيرة الاولى، بينما العشيرة الثانية فكانت متوسطات العائلات المنتخبة يتراوح ما بين 29.33 و 39.67جرام بمتوسط مقداره 34.03جرام مقارنة بالأب الاول (19جرام) والاب الثاني (29جرام) والعينة المجمعة (30 جرام). وكان متوسط محصول العائلات المنتخبة بعد دورة من الانتخاب المتأخر 41.24جرام و42.37 جرام، وهذا المحصول اعلى من نظيرة في حالة الانتخاب المنسب بعد دورتين انتخابيتين حيث كان 37.36جرام و34.03جرام بنسبة بلغت 10.38% و24.51% للعشيرة الاولى والثانية على التوالي. كانت 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 61.94 و76.74 ٪ للعشيرة الاولى و46.11، 41.24 ٪ للعشيرة الثانية وذلك مقارنة بأفضل الاباء والعينة المجمعة على التوالي. كما أظهرت النتائج زيادة معاملات الارتباط المظهري بعد دورتين من الانتخاب المبكر بين محصول البذور وكلا من ارتفاع النبات، طول المنطقة الثمرية، طول الكبسولة، عدد من الكبسولات / نبات ووزن 1000 بذرة إلى 0.626، 0.685، 0.863، 0.803 و0.745 في العشيرة الاولى وإلى 0.731، 0.805، 0.827، 0.729 و0.627 في العشيرة الثانية، على التوالي. كما بينت النتائج الى وجود ارتباط موجب وعالي المعنوية بعد دورة من الانتخاب المتأخر تراوحت ما بين 0.55 و0.72 بين محصول البذور وكلا من طول المنطقة الثمرية، طول الكبسولة، عدد من الكبسولات / نبات ووزن 1000 بذرة، كما سجلت قيم سالبة وعالية المعنوية من الارتباط بين محصول البذور / نبات والنسبة المئوية للزيت لكلا العشيرتين للانتخاب المبكر والمتأخر على حد سواء. كما أظهرت النتائج تفوق التأثير المباشر لعدد الكبسولات نبات على محصول البذور فى الانتخاب المتأخر مقارنة بالعشيرة القاعدية في كلا العشيرتين. وكان هذا التأثير المباشر لعدد الكبسولات على محصول بذور النبات 0.4330 0.4056 في العشيرة القاعدية وارتفع إلى 0.5611 و0.4429 في الانتخاب المبكر، وإلى 0.908 و0.7558 في الانتخاب المتأخر للعشيرة الاولى والثانية على التوالي. كما ان التأثير غير المباشر لعدد الكبسولات على محصول البذور عبر ارتفاع المنطقة الثمرية 0.0234 في العشيرة القاعدية، وارتفع الى 0.2873 في الانتخاب المبكر والى 0.7639 في الانتخاب المتأخر للعشيرة الأولى.