RESULTS AND DISCUSSION

4- RESULTS AND DISCUSSION

4.1. First cross (Line 103 x ILB 938):

4.1.1. F3 generation :

The mean squares associated with F3 families were found to be significant for all studied traits except number of seeds /pod (Table,2).

The mean performance of F3-families as well as two parents Line 103 and ILB 938 for the four traits are presented in Table(3).

For number of pods/plant, families no.1, 2, 4, 7, 8,10, 11,12,16,17,18, 23, 27, 31: 36, and 40 significantly surpassed the better origin parent L.103 . While, the other families showed lower number of pods/plant relative to L.103. All F3 families surpassed significantly the heavier parent of 100-seed weight.

With respect to seed yield/ plant, all F3 families except no. 4:7, 9,14,19: 21 and 31 significantly out yielded the better parent L.103.

The genetic component of variation Table (3) showed estimates of Δg, $\Delta g\%$ and G.C.V.

High to moderate estimates of heritability in broad-sense were detected of all studied traits except no.of seeds/pod which ranged from 64.24 to 70.54 the same results had been reported by El-Hosary (1983), Hendawy (1994) and Gad (1995) for yield and its component.

Genetic gain was rather higher for no.of pods/plant, 100-seed weight and seed yield/plant. Also,

such results were detected for G.C.V except 100-seed weight, the same results had been reported by El-Hosary *et al.* (1997) in soybean for 100-seed weight and El-Hosary *et al.*(2001) for no.of pods/plant.

4.1.2. F4 generation:

Mean squares due to F4 families were found to be significant for all studied traits (Table,4).The mean performances of 60 F4 families as well as two parents for the four traits under study are presented in (Table, 5).

For number of pods/plant, the range of selected families varied from 108 to 25 pods/plant. All families had significant superiority than the best parent. The family no.25 gave the highest no. of pods/plant. However, the family no.55 gave the lowest one.

With regard to 100-seed weight, all families except family no.10 surpassed significantly the best parent. The mean values of selected families ranged from 96.51 gm, (Family no.51) to 54.85 gm, (Family no.10).

For no.of seeds/pod, the range of selected families varied from 4.59 (Family no.4) to 2.39 (Family no.54). All selected families surpassed significantly the best parent for seed yield/plant. The range of selected families varied from 259.9 gm (Family no.21) to 75.67 gm (Family no.40). The best families were no.21, 25 and 19. The forty nine families gave two, three or four times much of seed yield than the better parent (Table, 5).

Table(2): Mean square of the F3 families for the four studied traits in the first cross.

Source of variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Rep	2	6.53	23.55	0.85	227.37
F3 families	39	301.75**	273.54**	0.98	919.03**
Error	78	47.21	33.42	0.85	124.45

** significant at 0.01 level of probability.

Table (3): Mean performance of the selected F3 families for yield and yield component of some genetic parameters in the first cross.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
1	40.00	78.55	2.74	81.32
2	34.00	75.69	2.59	90.59
3	21.00	74.48	2.60	72.56
4	28.00	75.66	2.36	50.44
5	21.30	74.46	2.53	33.50
6	15.00	76.72	2.44	41.96
7	37.00	72.30	2.10	56.01
8	30.00	95.80	2.25	68.00
9	21.00	95.37	3.45	52.65
10	49.33	86.64	2.84	76.05
11	36.00	73.62	2.83	95.27
12	50.00	69.04	2.84	86.40
13	22.00	69.78	2.84	62.08
14	24.00	93.54	2.48	57.11
15	26.00	95.16	2.48	76.06
16	38.00	91.92	2.21	95.41
17	45.00	91.84	2.37	84.05
18	52.00	91.88	2.29	106.78
19	9.33	74.28	3.16	34.90
20	12.00	74.11	2.45	23.92
21	23.00	64.80	2.35	42.88
22	21.00	74.54	2.47	60.46
23	35.00	98.36	3.14	85.55
24	20.00	94.46	3.00	71.31
25	18.00	94.46	3.80	66.24
26	23.00	94.35	1.21	79.57
27	35.00	103.00	2.63	84.35
28	20.00	83.30	2.58	66.24

Table(3): Cont.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
29	14.66	101.12	2.65	59.57
30	24.66	86.18	2.32	69.84
31	29.00	81.47	2.48	52.84
32	27.00	82.99	2.45	67.12
33	31.00	87.83	2.69	64.49
34	30.00	86.38	2.32	65.31
35	31.00	87.74	2.68	73.59
36	32.00	89.63	2.60	70.75
37	25.33	88.79	2.63	68.21
38	23.00	90.38	2.61	67.55
39	22.33	98.20	3.80	64.93
40	28.00	77.57	4.83	61.17
Line 103	27.00	56.87	3.21	59.18
ILB 938	17.60	62.81	2.29	23.98
L.S.D at 0.05	11.16	9.39	NS	18.12
L.S.D at 0.01	14.75	12.41	NS	23.95
Heritability(b)	64.24	70.54	NS	68.03
ΔG	15.20	15.74	NS	22.80
ΔG %	15.20	15.74	NS	27.64
G.C.V %	32.78	10.42	NS	24.30

Table(4): Mean square of the selected F4 families for the four studied traits in. the first cross

Source of variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Rep	2	45.70	6.57	0.40	21.12
F4 families	59	795.79**	146.07**	0.67**	3548.93**
Error	118	73.66	16.96	0.19	138.09

** significant at 0.01 level of probability.

Table(5): Mean performance of the selected F4 families for yield and yield components of some genetic parameters in the first cross.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
1	60.33	77.60	3.21	142.66
2	74.33	81.30	3.22	177.29
3	67.66	73.23	3.75	181.98
4	51.33	66.14	4.59	140.80
5	43.33	73.87	3.92	149.81
6	56,66	66.06	3.50	120.53
7	69.00	73.31	2.70	137.00
8	71.33	65.29	3.06	140.67
9	50.33	81.62	2.97	121.47
10	70.66	54.85	3.51	133.77
11	66.33	79.41	3.14	159.97
12	59.00	69.67	4.16	161.42
13	49.33	69.81	3.71	135.16
14	70.00	69.48	2.83	138.83
15	60.00	68.23	3.24	140.05
16	53.66	79.63	4.39	184.90
17	51.60	77.07	3.30	121.23
18	51.60	76.69	2.90	115.57
19	74.00	72.94	3.41	190.85
20	43,66	73.13	3.47	111.47
21	106.00	83.47	2.97	259.90
22	64.66	82.66	3.03	115.41
23	57.33	67.15	3.04	101.77
24	67.66	75.14	3.08	157.84
25	108.00	73.90	2.42	198.19
26	52.00	78.33	3.83	153.06
27	62.33	74..82	3.16	153.21
28	74.33	78.29	3.25	185.68

Table(5): Cont.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
29	51.33	74.91	3.04	108.59
30	87.33	74.52	2.75	178.01
31	84.00	71.84	3.06	119.42
32	36.66	89.24	2.69	89.66
33	37.00	78.06	3.77	129.62
34	60.00	67.21	3.32	131.10
35	43:00	63.46	2.98	75.84
36	43.00	68.96	3.42	107.15
37	51.00	69.70	3.14	112.88
38	46.00	77.38	2.58	108.86
39	62.00	66.42	2.85	113.30
40	27.00	69.89	3.64	75.67
41	60.33	82.04	2.87	104.54
42	48.33	72.63	3.55	130.36
43	43.00	66.03	3.20	91.49
44	60.33	73.54	2.86	106.87
45	71.33	68.16	3.24	94.48
46	65.00	79.16	2.63	160.98
47	71.00	81.33	3.22	177.39
48	48.00	79.08	3.73	170.26
49	66:33	70.29	3.70	148.19
50	52.33	79.62	4.20	181.47
51	74.00	96.51	3.38	165.89
52	66.00	84.18	3.25	160.75
53	77.00	73.03	2.45	185.50
54	37.00	75.43	2.39	154.13
55	25.00	69.46	3.29	126.71
56	68.00	80.30	2.92	169.18

Table(5): Cont.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
57	56.00	74.68	3.72	159.25
58	63.00	85.40	3.79	173.67
59	71.33	78.61	2.85	173.13
60	31.00	72.46	2.84	140.42
Line 103	22.00	53.16	3.77	45.81
ILB 938	21.00	57.30	2.61	39.65
LSD at 0.05	13.94	6.69	0.71	19.09
LSD at 0.01	18.43	8.84	0.94	25.23
Heritability	76.56	71.74	45.71	89.17
ΔG	27.96	11.43	0.55	65.56
ΔG %	74.40	15.30	17.13	46.02
GCV %	26.30	8.78	12.30	24.00

Heritability in broad-sense in the F4 families for the four studied traits was estimated and the obtained values are presented in (Table, 5).

High heritability values were detected for all traits except no.of seeds/pod indicating the effectiveness of selection in this materials for the studied traits.

The values for expected genetic advance (ΔG) and (ΔG%) shown in (Table,5) indicated the possible gain from selection as percent increase in the F5 over the F4 plants. Genetic gain was moderate for no.of pods/plant, relatively high for seed yield/plant. However, low gain was found for 100-seed weight and no.of seeds/pod. These results are in general agreement with those obtained by El-Hosary *et al.* (1997) in soybean for 100-seed weight.

Table (5) shows moderate genetic coefficient of variation for no.of pods/plant, seed yield/plant and low G.C.V for 100-seed weight.

Using the genetic coefficient of variation alone, however, is impossible estimate the magnitude of heritable variation. The heritable portion of the variation could be found out with help of heritability estimates and genetic gain under selection (Swarup and Chaugle, 1962).

Johanson *et al.* (1955) reported that heritability estimates along with genetic gain upon selection were more valuable than the former alone in predicting the effect of selection. On the other hand, Dixit *et al.*(1970) reported that high genetic coefficient of variation G.C.V and high heritability weren't always associated with high genetic advance for a trait. But to make effective selection, high heritability should be associated with high genetic advance.

Quantitative characters having high heritability values may be of great help for selection on basis of phenotypic performance. In the present work number of pods/plant and seed yield/plant, moderate genetic gain was found to be associated with high heritability and moderate G.C.V estimates. Hence it could be concluded that selection for this traits will be effective but probably of less success than characters which has high genetic gain which associated with rather high heritability and G.C.V estimates.

Relatively low genetic gain was associated with moderate heritability value for 100-seed weight. Hence, selection for this trait may be less effective.

4.1.3 F5 generation:

4.1.3.1 Comparison between three breeding methods :

Mean squares due to breeding methods were significant for 100-seed weight only (Table,6). This result indicated that the pedigree method gave the heaviest values of seed index followed by bulk method then single pod descent (Table,7). However, two later methods were non-significant .

Working on self pollinated crops, breeders applied one or more different breeding methods in order to investigate or compare their efficiency in selecting high seed yield. Among those Torrie (1958), Voigt and Weber (1960), Shutz *et al.*(1968), Allard and Adams(1969), Omer (1989) and Safia Dorgham (2003) on barley, wheat, soybean and faba bean using two or more methods of breeding .

Table (6): Mean square of method of plant breeding and lines/methods in the selected F5 lines in the first cross

Source of variation	d.f	No. of pods/plant	100-seed weight	No .of seeds/pod	Seed yield/plant
Reps.	2	1.43	4.11	0.50	386.69
Line	29	86.79**	124.40**	5.57**	498.69**
Method	2	100.80	217.58**	0.23	401.57
Line/method	27	85.57**	117.50**	5.96**	505.88**
Error	58	25.09	21.18	1.06	124.34

** significant at 0.01 level of probability

Table (7) : Mean values of the three breeding methods in the first cross.

Trait / Breeding method	No. of Pods/pllant	100-seed weight	No. of seeds/pod	Seed Yield/plant
Pedigree method	20.63	74.06	5.08	66.34
Bulk method	23.03	69.48	5.00	72.09
Single pod descent	19.43	69.32	5.17	65.29
Average	21.03	70.96	5.08	67.91
L.S.D at 0.05	NS	1.95	NS	NS
L.S.D at 0.01	NS	2.78	NS	NS

Table(8): Mean performance of the selected F5 lines for the three breeding methods in the first cross.

Method	Line	No. of pod/plant	100-seed weight (gm)	No. of Seed/pod	Seed yield/plant (gm)
Pedigree method	1	16.33	55.62	4.49	77.42
	2	20.33	84.11	4.37	95.03
	3	22.66	79.28	5.04	64.01
	4	23.00	83.00	5.59	75.10
	5	16.33	72.08	5.71	71.66
	6	30.00	82.49	4.53	94.59
	7	17.00	69.65	3.87	61.02
	8	16.67	73.37	5.79	56.27
	9	23.00	73.27	4.06	46.69
	10	21.70	64.80	3.24	45.65
Bulk method	1	25.60	72.84	3.90	70.98
	2	29.33	64.03	4.15	77.29
	3	28.20	71.24	5.53	70.89
	4	15.33	64.53	7.44	70.75
	5	25.00	69.28	6.13	63.42
	6	18.33	71.54	5.58	61.36
	7	19.67	64.96	5.43	63.75
	8	32.33	69.69	3.98	97.96
	9	28.67	75.94	3.83	81.52
	10	18.00	70.78	6.04	71.00
Single pod descent method	1	20.00	70.37	8.16	99.19
	2	15.67	67.14	7.06	78.34
	3	14.33	77.73	7.13	78.72
	4	27.00	70.45	3.78	72.97
	5	28.67	64.55	3.32	55.52
	6	21.00	61.36	4.29	59.78
	7	18.00	69.78	5.75	69.04
	8	17.33	71.50	4.47	52.22
	9	20.67	67.32	2.91	38.15
	10	17.67	73.06	4.89	58.04

Table (8) : Cont.

Method	No. of pod/plant	100-seed weight (gm)	No. of Seeds/pod	Seed yield/plant (gm)
Line 103	21.50	61.77	3.57	79.38
ILB 938	13.00	66.231	4.00	31.60
LSD at 0.05	6.69	6.17	1.39	15.15
LSD at 0.01	9.55	8.80	1.98	21.61

Whan *et al.* (1982) found that the effect of selection using the means of lines from the F3 and F4 rather than the individual F2 or F3 derived lines can be assessed by the yields obtained in the following generation.

The improvement obtained in the F5 by selecting F2 derived lines was much greater in the first cross. When selection is carried out in an early generation *e.g.* among F2 derived lines. The important consideration is the response to this selection in a late generation *e.g.* the F5 when lines are approaching homozygosity. In the simulated schemes considered here, the selected lines could not be, reselected and the available data enabled each selected line to be continued with one random line only . This caused a loss of variation for yield and the gain from selection was often reduced in the generation following selection .

Also, the efficiency of the breeding methods in the present study was evaluated based on the number of superior lines having higher values of seed yield/plant than the best parent. Data presented in (Table,8) show that either pedigree breeding method or bulk breeding method produced consistently more superior lines compared the best parent in the first cross with 2 lines both of them and one of single pod descent. The best line was no.1 of single pod descent (99.19 gm/plant) and line no.8 of bulk method (97.96 gm/plant) and line no.2 (95.03 gm/plant), no.6 (94.59 gm/plant) in pedigree method for seed yield/plant.

For no.of pods /plant, the results indicated that the bulk breeding method produced more superior lines followed by pedigree and then by single pod descent SPD compared the best parent with four, one and one lines, respectively. The best line was no.8 of bulk method (32.33) and line no.6 of pedigree method (30).

Regarding 100-seed weight, six, two and two lines were significantly higher than heavier parent in seed index for pedigree, bulk and SPD methods, respectively. The heavier line was no.2 (84.11 gm) followed by line no.4 (83 gm) in pedigree method.

Concerning number of seed/pod, four, five and four lines gave significant higher values than the best parent in pedigree, bulk and SPD methods, respectively. The line no.1 in SPD method then no.4 in bulk method gave the highest no.of seeds/ pod.

4.1.3.2 Direct and indirect selection:

Selection for yield and its components deserves considerable interest. A crop breeding program aimed at increasing plant productivity requires considerable interest not only of yield but also of its components which have a direct or indirect bearing on yield . Present work was under taken to compare the efficiency of indirect selection for yield via yield components with direct selection for seed yield/ plant.

Mean squares due to four selection criteria, no. of pods/plant,100 -seed weight, no.of seeds/pod and seed yield/plant were significant except no.of seeds/pod (Table,9). Significant differences among the three selection criteria in no.of pods/plant, 100-seed weight and seed yield/plant were detected revealing that the selection criteria differed among them.

Table (10) shows the effect of selection criteria on four traits under study.

For no.of pods/plant, it is clear that selection criteria significantly effected no.of pods/plant. The highest no.of pods/plant was recorded from selection for seed yield /plant followed by 100-seed weight. However, the selection for no. of seeds/pod gave the lowest one.

With respect to the effect of selection criteria on 100-seed weight, the results revealed that selection for no.of seeds/pod gave significant heavier seed index followed by selection for seed yield/plant then by selection high no.of pods/plant. However, the lowest values was detected by selection of 100-seed weight.

Concerning the effect of selection methods on no.of seeds/pod, the selection of high seed yield/plant gave highest no.of seeds/pod followed by selection plants with heavier seed index.

As for seed yield/plant, the selection method of high seed yield/plant exhibited significant higher value of this trait, followed by selected plants with heavier seed index then selected plants with higher no.of pods/plant and the selection of higher no.of seeds/pod.

The mean values of selected F5 lines for no.of pods/plant, 100-seed weight, no.of seeds/pod and seed yield/plant were affected by selection criteria (indirect selection high no.of pods/plant, heavier seed index) and (direct selection high seed yield/plant) (Table,11).

Regarding no.of pods/plant two lines record significantly higher values than population mean, when selected plants with high seed yield/plant, the best lines were no.5 and no.7 by selecting high seed yield/plant. This result is logically expected.

Table (9) : Mean square for the four selection criteria and lines/selection criteria in the selected F5 lines of the first cross

Source of variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Reps.	2	43.30	66.55	11.05	655.50
Lines	39	41.65*	405.33*	9.34	3616.20**
Selection criteria	3	290.29**	506.77	16.03	197.06**
Lines/selection criteria	36	20.93	396.88**	8.79	2275.40**
Error	78	24.72	81.17	6.58	114.97

** significant at 0.01 level of probability

Table (10) : Mean values of the four selection criteria in the first cross.

Trait / Selection criteria	No.of pods/plant	100-seed weight (gm)	No. of seeds/pod	Seed yield/plant (gm)
No.of pods/plant	20.46	88.47	5.20	92.23
100-seed weight	21.83	87.86	5.65	102.54
No.of seeds/pod	19.30	96.63	5.09	91.56
Seed yield/plant	26.40	89.09	6.69	145.71
LSD at 0.05	2.57	4.61	NS	5.81
LSD at 0.01	3.41	6.10	NS	7.70

Table(11):Mean performance of the selected F5 lines for the four selection criteria in the first cross.

Selection criteria	Line	No. of pod/plant	100seed weight (gm)	No. of seed/pod	Seed yield/plant (gm)
No. of pods/plant	1	18.33	61.66	6.13	69.84
	2	18.66	92.84	4.25	72.49
	3	22.00	81.82	5.44	95.78
	4	18.66	73.56	5.26	75.39
	5	21.66	79.08	5.25	89.33
	6	19.33	106.94	5.37	107.87
	7	24.33	105.08	4.20	105.35
	8	21.66	98.69	5.35	112.42
	9	21.00	93.71	4.60	87.71
	10	19.00	93.74	6.20	106.19
100-seed weight (g)	1	16.66	83.33	6.01	77.72
	2	19.33	98.30	5.44	100.65
	3	24.00	88.61	5.14	105.44
	4	21.66	81.94	7.31	110.17
	5	21.33	93.52	5.80	112.55
	6	22.33	79.39	4.86	84.42
	7	26.33	87.12	4.78	107.29
	8	25.00	83.13	5.44	114.94
	9	21.00	86.85	6.07	107.90
	10	20.66	96.43	5.66	104.30
No. of Seeds/pod	1	19.00	111.14	5.00	103.07
	2	20.66	101.82	5.40	113.14
	3	22.33	92.19	5.72	111.89
	4	18.33	96.33	5.80	96.16
	5	18.66	100.46	4.78	83.88
	6	19.66	93.73	6.49	112.81
	7	22.33	98.27	3.64	75.80
	8	16.66	93.43	4.79	74.86
	9	19.33	97.45	4.44	79.98
	10	16.00	81.54	4.90	64.02

Table (11): Cont.

Selection criteria	Line	No. of pod/plant	100seed weight (gm)	No. of seeds/pod	Seed yield/plant (gm)
Seed yield/plant	1	29.66	86.94	5.66	160.48
	2	29.33	102.51	7.57	230.00
	3	23.33	108.08	5.24	128.14
	4	27.00	105.47	6.78	186.25
	5	32.00	85.42	4.70	123.69
	6	24.33	55.53	5.33	102.57
	7	30.66	92.84	5.47	155.39
	8	25.00	94.81	5.32	121.38
	9	26.33	84.93	4.52	102.39
	10	24.33	75.38	6.39	115.57
Line 103		31.00	61.77	3.57	79.38
ILB 938		13.00	66.21	4.00	31.60
L.S.D at 0.05		8.14	14.53	NS	18.38
L.S.D at 0.01		10.78	19.31	NS	24.35
x		22.00	90.51	5.66	108.01

For seed index, two, zero, one and two lines surpassed heavier population mean for selection high no.of pods/plant, seed index, no.of seeds/pod and high seed yield/ plant, respectively.

With respect to seed yield/plant, the values of selected lines ranged from 69.84 gm to 112.42 gm, 77.72 gm, to 114.94 gm, 64.02 gm to 113.14 gm, 102.39 gm to 230 gm when selected plants with high no.of pods/plant, seed index, no.of seeds/pod and high seed yield/plant, respectively. Also, zero lines surpassed the population mean when selection based on mentioned selection criteria except that based on high seed yield/plant where, 5 lines surpassed significantly higher seed yield /plant. The line no.2 was the heaviest one being 230 gm followed by line no.4 (186.25 gm).

It could be concluded that direct selection for yield is more efficient than indirect selection for yield.

4.2. Second cross :

4.2.1. F3 generation :

The results indicated that F3 families mean square were highly significant for all studied traits, indicating wide differences between the F3- families (Table,12).

Mean performances of F3-families as well as the two parents Triple white and Line 103 for the four traits are presented in Table(13). With respect to no. of pods/plant the families no.2, 7, 17, 18, 29 and 30 significantly surpassed the better parent Line103.The family no.17 was the best one having 55 pods/plant followed by family no.29 (50) pods per

plant. However, family no.25 was the lowest one recording 14 pods/plant. As for seed index twenty one families recorded significant superiority than the heaviest parent. The range of selected families varied from (103.74 gm) family no.8 to (43.16 gm) family no. 28. Regarding no.of seeds/pod, one family no.(7) of F3 families gave significant higher values of this trait than the better parent (Line 103). For seed yield/plant seven families surpassed significant higher than the heaviest parent (Line 103). The best family was no.16 being 115.69 gm. These results showed the importance of selection in this material.

The genetic components of variation G.C.V (Table,13) showed moderate estimate of heritability in broad-sense for no. pods/plant and no. of seeds/pod. However high values were detected for 100-seed weight and seed yield/plant. The same results had been reported by Leleji *et al.* (1972), Habeeb (1998), Leory *et al.* (1991), Darwish (1993) in soybean, Bastawisy *et al.*(1997) and El-Hosary *et al.* (2001) in soybean for seed yield/plant. In the same table it is clear that high estimates of ΔG, ΔG% and GCV% were obtained for 100-seed weight and seed yield/plant. However moderate values of them were detected for other traits.

4.2.2. F4 generation:

Mean squares due to F4 selected families were found to be significant for all studied traits except no. of seeds/pod (Table,14) Indicating that the sixty F4 selected families behaved somewhat differently from one to another for this traits. Concerning number of pods /plant the range of selected families varied from 29.66 to 55.66 pods.

Table(12): Mean square of the F3 families for the four studied traits in the second cross.

Source of variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Rep.	2	1.57	25.58	0.42	40.93
F3 families	39	201.82**	579.58**	1.83**	1257.38**
Error	78	45.25	24.59	0.63	58.62

** significant at 0.01 level of probability.

Table(13): Mean performance of the selected F3 families for yield and yield components of some genetic parameters in the second cross.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
1	28.00	73.56	2.14	49.50
2	42.60	61.62	1.30	46.43
3	35.00	67.25	1.72	47.92
4	34.00	67.38	3.08	63.15
5	24.00	53.06	2.66	55.78
6	29.00	60.16	2.52	48.42
7	40.00	71.96	5.52	90.23
8	26.00	103.74	3.19	80.80
9	22.00	80.48	3.77	66.88
10	25.00	60.73	2.71	33.16
11	32.00	59.49	2.75	48.39
12	36.00	62.66	3.61	29.73
13	30.00	58.17	1.79	26.89
14	24.00	46.80	1.27	22.96
15	27.60	52.48	1.53	24.92
16	35.30	91.54	2.73	115.69
17	55.00	83.83	2.08	91.30
18	45.00	76.12	2.56	100.49
19	33.00	75.60	3.30	71.66
20	30.00	83.02	2.31	76.05
21	36.00	79.31	2.80	73.85
22	24.00	95.95	3.00	70.23
23	16.00	86.38	2.51	62.74
24	20.00	80.21	3.00	54.73
25	14.00	52.00	3.17	41.36
26	21.00	48.00	2.75	26.79
27	28.00	63.06	2.23	35.56
28	33.00	43.16	3.55	55.62

Table(13): Cont.

Family number	No. of pod/plant	100seed weight (gm)	No .of seed/pod	Seed yield/plnat (gm)
29	50.00	44.42	2.21	77.74
30	38.00	53.34	4.31	63.66
31	32.00	71.21	3.15	57.59
32	30.00	72.72	2.70	58.57
33	30.00	68.00	2.74	57.98
34	35.00	69.39	2.57	57.89
35	34.00	69.92	2.38	63.57
36	33.00	75.68	2.23	60.69
37	26.30	63.42	2.68	56.76
38	27.00	65.07	3.23	63.32
39	29.00	65.24	2.95	56.20
40	32.00	62.07	2.95	65.78
Triple white	14.60	44.28	2.59	20.16
Line 103	27.00	56.87	3.21	59.18
L.S.D at 0.05	10.39	6.72	1.29	12.44
L.S.D at 0.01	14.44	10.64	1.70	16.44
Heritability(b)	53.35	88.26	65.57	87.21
ΔG	10.83	26.31	1.82	38.46
ΔG %	43.87	38.71	66.66	65.54
GCV %	23.00	20.00	40.12	29.41

All families except no. 3, 10, 12, 18, 22, 27 and 38 gave significant superiority than the best parent. The families no.33 and 1 followed by no. 40 record the highest no .of pods/plant. However, the family no. 38 was the lowest one.

Thirty eight families surpassed significantly the heavier parents of 100-seed weight. The family no. 22 followed by no. 19 gave the highest values of 100- seed weight being 84.95 gm and 79.68 gm, respectively.

All selected families except no. 6. 7 and 10 surpassed significant the better parent (Line 103) for seed yield /plant. Family no. 40, 8, 9, 17 and 1 gave significant higher values than the better parent, whereas family no. 40 gave a value of 120.85gm comparing with the better parent which recorded 39.65gm.

The estimates of heritability in broad-sense, genetic gain, genetic gain percent and genetic coefficient of variation are presented in (Table,15). Heritability in broad-sense was low for no. of pods /plant and relatively high for 100-seed weight and seed yield/plant indicating success of selection in the two later traits. The values of expected genetic advance (ΔG) and ($\Delta G\%$) reported in (Table,15) show the possible gain from selection as percent increase in the F5 over the F4 generation.

Genetic gain was rather low for number of pods/plant and 100-seed weight. However moderate gain was found for seed yield/plant. Moderate GCV% for no. of pods /plant and seed yield/plant were detected. However low G.C.V % for seed index was obtained. The heritable portion of the variation could be found out to estimate heritability and genetic gain under selection (Swarup and Chaugle, 1962).

Table (14) : Mean square of the selected F4 families in the second cross.

Source of variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Rep.	2	0.022	1.08	0.56	400.60
F4 families	59	110.11**	99.67**	0.58	683.11**
Error	118	52.32	18.13	0.41	91.64

** significant at 0.01 level of probability.

Table(15): Mean performance of the selected F4 families for yield and yield components of some genetic parameters in the second cross.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
1	54.00	62.65	3.15	102.27
2	39.00	67.73	3.35	89.41
3	30.33	76.23	2.71	64.42
4	35.00	59.62	4.35	81.60
5	44.33	62.54	3.10	87.58
6	34.33	49.56	2.47	44.69
7	37.66	64.56	2.10	51.23
8	48.33	66.10	3.58	114.21
9	51.33	69.48	2.91	109.35
10	31.00	63.05	2.79	53.78
11	46.33	65.20	3.25	95.83
12	32.33	67.92	3.53	73.01
13	39.00	56.05	2.78	65.55
14	43.00	65.45	2.84	82.72
15	41.00	66.34	2.82	81.56
16	42.00	66.21	3.50	70.30
17	51.33	63.45	3.17	102.54
18	32.66	72.31	2.67	60.70
19	35.66	79.68	2.90	78.50
20	49.66	58.06	2.85	75.95
21	35.00	65.35	4.39	99.44
22	32.00	84.95	2.51	66.62
23	41.00	60.99	2.93	59.00
24	39.33	70.88	2.38	59.73
25	36.33	68.43	2.80	80.45
26	46.33	64.83	3.33	86.44
27	33.33	75.99	2.92	69.61
28	42.00	61.71	3.62	87.70

Table(15): Cont.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
29	35.00	72.97	2.72	62.63
30	37.33	69.65	2.58	70.09
31	48.00	57.82	2.70	74.98
32	36:33	64.49	3.46	81.86
33	55.66	66.50	2.36	79.53
34	39.00	59.04	2.62	59.51
35	44.66	67.04	2.99	88.84
36	44.33	59.72	3.12	80.90
37	46.00	63.64	3.63	99.87
38	29.66	60.83	3.67	73.84
39	41.00	59.64	3.11	77.23
40	51.66	70.70	3.55	120.85
41	42.00	61.15	3.08	78.42
42	47.00	61.14	2.49	69.53
43	44.00	62.77	3.06	84.89
44	37.33	63.94	3.65	86.85
45	46.33	65.17	3.33	99.04
46	47:66	64.96	3.56	88.09
47	36.33	73.22	2.97	68.83
48	34.66	68.50	3.37	74.58
49	41.33	66.99	3.34	81.51
50	41.00	71.64	2.92	84.15
51	40.33	67.59	2.62	62.82
52	34.33	59.17	3.36	69.99
53	43.00	65.75	2.82	66.17
54	39.66	65.28	3.08	87.59
55	41.00	68.28	2.84	83.03
56	41.66	69.09	3.26	78.46

Table(15): Cont.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
57	37.33	67.74	3.35	78.06
58	40.33	69.61	2.77	73.48
59	38.33	62.46	2.96	68.08
60	40.00	66.78	2.93	85.07
Triple white	15.66	45.89	2.59	29.79
Line 103	22.00	57.30	2.61	39.65
L.S.D at 0.05	11.75	6.92	NS	15.55
L.S.D at 0.01	15.53	9.14	NS	20.55
Heritability(b)	26.53	59.98	NS	68.26
ΔG	4.64	8.31	NS	23.88
ΔG %	11.32	12.61	NS	30.26
GCV %	10.76	7.91	NS	17.79

Johanson *et al.*(1955) showed that estimation of heritability along with (ΔG) upon selection were more valuable than the former alone in predicting the effect of selection. On the other hand, Dixit *et al.* (1970) reported that high genetic coefficient of variation (GCV) and high heritability weren't always associated with high genetic advance for a traits. But to make effective selection high heritability should be associated with high genetic advance. Quantitative characters having high heritability values may be of great help for selection on the basis on phenotypic variance. In this investigation somewhat high heritability values associated with moderate genetic gain, ΔG% and G.C.V also were obtained for seed yield/plant. Hence it could be concluded that selection for this trait will be effective .

Low genetic gain was associated with low heritability value for no.of pods/plant. Hence selection for this trait may be less effective.

As it is well known that expected improvement of selection is directly proportional to the heritability value. Also, the expected response to selection, varies with the phenotypic standard deviation of population means. This is measure of the total variability in the trait and therefore reflects the total response that could be realize breeding techniques.

4.2.3. F5 generation :

4.2.3.1 Comparison between three breeding methods :

Mean squares due to breeding method were significant for all studied traits Table(16). This result indicated the differences between breeding methods. Table (17)showed that

Table (16): Mean square of method of plant breeding and lines/methods in the selected F5 lines in the second cross.

Source of Variation	d.f	No. of pods/plant	100-seed weight	No .of seeds/pod	Seed yield/plant
Reps.	2	14.53	0.93	0.66	0.93
Line	29	26.14**	373.27**	4.92**	532.42**
Method	2	142.50**	1241.00**	41.04**	1533.00**
Line/method	27	17.52	309.00**	2.25**	458.30**
Error	58	13.47	18.17	0.57	63.05

** significant at 0.01 level of probability.

Table (18) : Cont.

Method	No. of pods/plant	100-seed weight (gm)	No. of seeds/pod	Seed yield/plant (gm)
Triple white	18.00	35.08	4.88	29.19
Line 103	31.00	61.77	3.57	79.38
LSD at 0.05	4.99	5.70	1.03	10.61
LSD at 0.01	7.12	8.13	1.48	15.14

the bulk method gave the highest values for no.of pods/plant, 100-seed weight and seed yield/plant. While the SPD method record significantly highest no.of seeds/pod. It could be concluded that bulk method considerd the best breeding method for seed yield/plant, no.of pods/plant and seed index than those pedigree and SPD in this cross.

Breeders of self pollinated crops applied one or more different breeding methods efficiency in selecting high seed yield. Among those Torrie (1958), Voigt and Weber (1960), Shutz *et al.* (1968), Allard and Adams (1969), Omer (1989), Shalaby *et al.* (2001), Safia Dorgham (2003) on barley, wheat, soybean and faba bean using two or more methods of breeding .

Whan *et al.*(1982) found that the effect of selection using the means of lines from the F3 and F4 rather than the individual F2 or F3 derived lines, can be assessed by the yields obtained in the following generation. The improvement obtained in the F5 by selecting F2 derived lines was much greater in the first cross. When selection is carried out in an early generation *e.g.* among F2 derived lines, the important consideration is the response to this selection in a late generation *e.g.* the F5 when lines are approaching homozygosity. In the simulated schemes considered here, the available data enabled each selected line to be continued with one random line only. This caused a less of variation for yield and the gain from selection was often reduced in the generations following selection.

Also, the efficiency of the breeding methods in the present study was evaluated based on the number of superior lines having higher values of seed yield/plant than the best parent. Data presented in Table (18)

showed that non line was significant over the three breeding methods for no.of pods/plant.

As for 100-seed weight, three, ten and six lines record significant higher than the better parent over lines for pedigree, bulk and SPD methods, respectively. The heavier line was no.3 (95.02 gm) in bulk method followed by line no.1(88.14 gm) in pedigree method then line no. 8 (87.17gm) in SPD.

Regarding no. of seeds/pod, nine, one and one lines exhibited significant higher seed number than the better parent for pedigree, bulk and SPD methods, respectively. The line no. 10 and no.5 in pedigree gave the highest ones followed by line no. 8 in bulk method then line no.1 in SPD method.

Concerning with seed yield/plant, four, three and non lines were significant comparing the better parent for pedigree, bulk and SPD methods, respectively, line no. 6 (102.82 gm) in bulk method was more superior than the best parent (79.38 gm) followed by line no.10 (96.4 gm) in pedigree method.

4.2.3.2. Direct and indirect selection:

Selection for yield and its components are of considerable interest. A crop breeding programme aimed at increasing plant productivity, requires consideration interest not only of yield but also of its components which have a direct and indirect bearing on yield. This part was carried out to compare the efficiency of indirect selection for yield via yield components with direct selection for seed yield/plant.

Mean square due to four selection criteria *i.e.* number of pods/plant, 100-seed weight, number of seeds/pod (indirect selection) and high seed yield/plant (direct selection) were significant (Table,19). Significant differences between the four selection criteria were found in no. of pods/plant, seed index, no. of seeds/pod and seed yield/plant.

As early as 1964 Grafius suggested that improvement of complex characters like yield may be accomplished through breeding for yield components, subsequently, many workers (Takeda and Frey, 1970, McNeal *et al.* 1978; Johanson *et al.*,1983; Bahi and Viond, 1991 and kumar and Bahi, 1992) suggested that selection for component traits can help to increase productivity.

Mean values of the four selection criteria are presented in Table (20). With respect to the effect of selection criteria on no. of pods/plant, the results revealed that selection for high no. of seeds/pod gave the highest no. of pods/plant then selection on high no. of pods pods/plant. Selection based on no. of seeds/pod gave the highest values of no. of pods/plant and also heaviest seed index.

Selection based on high seed yield/plant lead to highest no. of seed/pod and heaviest seed yield/plant. lt is clear that selection based on high seed yield/plant gave the highest value for seed yield/plant followed by selection based on high no. of pods/plant as shown at (Table,20).

The mean performance of selected F5 lines for no. of pods/plant, 100-seed weight, no. of seeds/pod and seed yield /plant were affected by selection criteria indirect selection *i.e.* (high no. of pods/plant, heavier seed index and high no. of seeds /pod) and direct selection (high seed yield/plant) are shown in Table (21).

With respect to no. of pods/plant, one and one line in the F5 generation were significantly higher than the over all mean when selected plants with heavier seed index and high no. of seeds/pod, respectively. But none of the selected lines gave significantly higher differences than the best parent.

For seed index, two and two, zero and four, one and six and two and three lines were significantly heavier than population mean and best parent when selected plants with high no. of pods/plant, heavier seed index, high number of seed/pod and high seed yield/plant respectively. The best lines were no.1 and no.9 when selected plants with high seed yield /plant followed by no.9 when selected plants with high no. of seeds/pod then no.2 when selected plants with high no. of pods /plant.

As for no. of seeds/pod, zero and ten, zero and six, zero and three and six and ten lines surpassed significantly higher number of seeds/pod than grand mean and best parent, respectively, in the same order, in addition, the best lines were no.10 and 5 when selected plants with high seed yield/plant.

For seed yield/plant, the range of selected lines varied from (63.77gm) to (77.67gm); (55.38gm) to (80.84gm); (42.56gm) to (79.3gm) and (52.64gm) to (96.4gm) when selecting plants with high no. of pods/plant, heavier seed index, high no. of seeds/pod and high seed yield/plant, respectively. Also, zero and six, zero and two, zero and four and four and eight lines exceeded significantly higher seed yield/plant than the population mean and best parent, respectively, in the same order. Morevere, the best four lines were no.10, 5, 1and 9 when selecting plants with high seed yield/plant.

It could be concluded that direct selection for yield via heavier seed yield/plant is more efficient than indirect one for yield.

Table (19) : Mean square for the four selection criteria and lines/selection criteria in the selected F5 lines of the second cross.

Source of variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Reps.	2	13.25	55.32	0.23	29.76
Lines	39	22.52**	187.00**	4.65**	443.75**
Selection criteria	3	97.09**	224.71**	38.97**	1708.40**
Lines/selection criteria	36	16.31	183.85**	1.79**	338.36**
Error	78	11.79	20.10	0.57	69.03

** significant at 0.01 level of probability.

Table (20) : Mean values of the four selection criteria in the second cross.

Trait / Selection criteria	No.of pods/plant	100-seed weight (gm)	No. of seeds/pod	Seed yield/plant (gm)
No.of pods/plant	20.03	67.02	5.39	70.07
100-seed weight	19.56	63.29	5.28	63.85
No.of seeds/pod	20.56	69.85	4.35	61.56
Seed yield/plant	16.50	67.75	7.08	78.43
LSD at 0.05	1.76	2.34	0.38	4.23
LSD at 0.01	2.33	3.11	1.22	5.60

Table(21): Mean performance of the selected F5 lines for the four selection criteria in the second cross.

Selection criteria	Line	No. of pod/plant	100seed weight (gm)	No. of seed/pod	Seed yield/plant (gm)
No. of pods/plant	1	22.00	62.43	5.36	72.68
	2	21.00	76.49	4.89	77.67
	3	18.66	64.87	5.55	63.77
	4	21.00	57.17	5.53	65.35
	5	23.00	63.72	5.01	74.57
	6	20.33	67.57	5.91	73.73
	7	20.00	61.95	5.60	71.71
	8	19.33	75.46	5.05	70.61
	9	18.33	68.11	5.29	64.30
	10	16.67	72.47	5.66	66.31
100-seed weight	1	15.66	70.03	5.31	55.38
	2	19.00	58.76	5.47	60.48
	3	19.33	71.93	4.09	56.51
	4	17.00	69.55	4.84	57.14
	5	26.66	52.47	5.86	80.84
	6	21.00	45.62	6.28	58.71
	7	18.66	64.65	4.78	62.82
	8	18.00	66.65	5.66	64.89
	9	19.00	70.03	4.84	64.73
	10	21.33	63.22	5.66	76.96
No. of Seeds/pod	1	22.00	68.88	5.29	79.30
	2	20.66	72.45	4.92	72.45
	3	22.00	69.44	3.86	53.57
	4	20.33	71.00	3.58	51.22
	5	20.00	68.73	4.54	67.81
	6	17.33	58.30	4.55	42.56
	7	26.33	73.61	3.53	68.68
	8	19.00	72.78	5.09	69.27
	9	21.00	79.17	3.45	57.35
	10	18.00	63.89	4.69	53.44

Table (21): Cont.

Selection criteria	Line	No. of pod/plant	100seed weight (gm)	No. of seeds/pod	Seed yield/plant (gm)
Seed yield/plant	1	18.00	88.14	6.20	90.58
	2	14.00	66.37	8.31	79.82
	3	16.00	62.40	7.01	70.05
	4	14.66	64.88	7.25	80.71
	5	19.33	57.26	8.46	93.39
	6	16.00	59.31	5.10	52.64
	7	17.00	69.61	6.15	70.41
	8	14.33	60.91	7.66	60.04
	9	16.66	83.76	6.13	90.30
	10	17.00	64.84	8.59	96.40
Triple white		18.00	35.08	4.88	29.19
Line 103		31.00	61.77	3.57	79.38
L.S.D at 0.05		5.57	7.43	1.22	13.37
L.S.D at 0.01		7.38	9.84	1.62	17.72
x		19.14	66.98	5.53	68.48

The comparison showed the effectiveness of selecting for high seed yield/plant in improving mean yield of F5 lines in this cross.

4.3 Third cross:

4.3.1. F3 generation:

The results showed highly significant mean square of F3 families for all the four studied traits, indicating wide diversities between the F3 families (Table,22).

Mean performance of this generation as well as the two parents (Rina blanca) and (Line 18) for the four traits are presented in (Table,23). For no. of pods/plant, families no.5, 6, 9 and 19 record the highest values than the better parent (Line 18) at five of percent of significant. Regarding 100-seed weight, 21 families showed high significant differences compared the better parent. However, the best ones were family no.29 followed by family no.28. With respect no. of seeds/pod no family surpassed significantly the mean of the better parent (R.B).

With respect to seed yield/plant, only six families surpassed significant higher than the best parent (R.B). This results indicated the important of selection in this material.

The genetic components of variation (Table,23) exhibited the high estimates of heritability in broad-sense for 100-seed weight and seed yield/plant. However, moderate values were detected for no.of pods/plant and no.of seeds/pod. The high estimates of ΔG for seed index and seed yield/plant

Table(22): Mean square of the F3 families for the four studied traits in the third cross.

Source of variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Rep.	2	8.10	344.37	0.36	167.13
F3 families	39	122.48**	1483.19**	1.92**	959.85**
Error	78	32.53	80.23	0.81	86.62

** significant at 0.01 level of probability.

Table(23): Mean performance of the selected F3families for yield and yield component of some genetic parameters in the third cross.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
1	30.00	67.84	1.60	40.27
2	21.00	88.50	2.90	58.60
3	20.00	78.17	2.25	50.00
4	24.00	84.84	2.44	97.62
5	33.00	91.76	4.26	86.82
6	40.60	83.44	3.51	107.90
7	16.00	101.10	2.75	46.65
8	14.00	79.79	3.25	47.52
9	32.30	73.06	2.80	36.42
10	16.30	74.11	2.50	93.85
11	21.60	94.60	3.32	76.55
12	26.00	72.11	2.90	100.69
13	17.60	106.71	3.80	32.03
14	11.60	69.45	2.56	46.09
15	16.00	67.76	2.55	59.68
16	16.60	111.32	3.19	57.80
17	10.30	111.12	2.80	34.15
18	13.30	111.22	2.99	50.00
19	36.00	110.08	2.83	75.06
20	21.00	108.91	2.85	67.80
21	13.60	109.52	2.84	70.00
22	16.00	85.76	2.55	50.13
23	11.00	97.80	1.95	54.14
24	20.00	91.78	1.75	52.30
25	14.00	103.24	1.92	47.07
26	18.60	113.04	5.00	76.74
27	10.60	112.65	3.71	83.23
28	22.00	116.79	2.74	73.83

Table(23): Cont.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
29	11.00	124.00	2.45	53.12
30	21.00	106.44	4.43	70.30
31	24.00	93.97	3.10	65.82
32	24.00	94.90	4.50	58.55
33	22.00	90.19	2.91	75.19
34	18.00	108.76	3.81	62.23
35	20.00	106.62	4.01	65.73
36	19.00	106.82	2.17	60.11
37	14.30	106.55	1.82	66.69
38	17.60	106.24	3.40	63.07
39	16.60	105.19	2.18	59.79
40	19.00	91.92	3.81	57.47
Rina blanca	13.30	83.06	5.36	61.62
ILB 938	23.00	72.88	3.16	46.11
L.S.D at 0.05	9.26	14.48	1.46	15.12
L.S.D at 0.01	12.25	19.23	1.93	19.98
Heritability(b)	47.96	85.35	31.35	77.06
ΔG	7.80	41.15	0.69	26.35
ΔG %	40.50	43.05	23.38	48.73
GCV %	28.44	22.74	20.97	26.96

were accompand with low gain for no.of pods/plant and no.of seeds/pod. However, high estimates of ΔG% for no.of pods/plant, seed index and seed yield/plant, were obtained with moderate for no.of seed/pod. With respect GCV%, the estimates of this parameter for the previous mentioned traits were moderate.The same results were previously reported by Bastawisy *et al.* (1997) in soybean for seed yield/plant, El-Hosary *et al.*(1997) in soybean for no of pods/plant and El-Hosary *et al.*(2001) in soybean for seed yield per plant and no. of pods/plant.

4.3.2. F4 generation:

Mean squares due to F4 selected families were found to be significant for all studied traits (Table,24) indicating that the sixty F4 selected families behaved somewhat differently from each to other. For no.of pods/plant, the range of the selected families varied from 20 to 61.66. Twenty five families had higher values compared with better parent. The best families were no.3 and no.47 being 61.66 followed by family no.56 being 55.

Thirty one of the selected families surpassed significantly the best parent for seed index. The mean values of selected families ranged from (65.18gm) to (106.4gm). The heaviest one was no. 23 followed by no. 39.

As for no.of seeds/pod, none of the selected families surpassed significantly the best parent.

With respect to seed yield/plant, 44 selected families surpassed significantly the best parent (R.B). The range of selected families varied from (53.48gm) family no.5 to (169.37gm) family no.19

The estimates of the genetic coefficient of variation, genetic gain, genetic gain percent and heritability in broad-sense are presented in (Table,25).

Heritability in broad-sense values were high for both seed index and seed yield/plant and moderate for no.of pods/plant and no.of seeds/pod.

Genetic gain was rather moderate for no.of pods/plant, 100-seed weight; low for no.of seeds/pod, and somewhat high for seed yield/plant.

Concerning GCV, it was moderate for all studied traits. However, it is impossible to estimate the magnitude of heritable variation. The heritable portion of the variation could be find out to estimate heritability and genetic gain under selection (Swarup and Chaugle, 1962).

Johanson *et al.* (1955) reported that heritability estimates along with genetic gain upon selection were more valuable than the former alone in predicting the effect of selection. On the other hand, Dixit *et al.*(1970) reported that high genetic coefficient of variation GCV and high heritability weren't always associated with high genetic advance for a trait. But to make effective selection, high heritability should be associated with high genetic advance. Quantitative characters having high heritability values may be of great help for selection on basis of phenotypic variance. In the present work number of pods/plant moderate genetic gain was found to be associated with rather moderate heritability and GCV estimates. High heritability values associated with high gain for seed yield/plant and with moderate gain for seed index. Hence it could be concluded that selection for this traits will be effective.

Table (24) : Mean square of the selected F4 families in the third cross.

Source of variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Rep.	2	11.15	3.05	0.034	86.61
F4 families	59	263.36**	291.41**	1.015**	2329.91**
Error	118	51.48	18.96	0.35	112.27

** significant at 0.01 level of probability.

Table(25): Mean performance of the selected F4 families for yield and yield components of some genetic parameters in the third cross.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
1	52.66	69.91	3.33	123.55
2	38.33	78.28	2.30	65.66
3	61.66	78.44	2.78	129.70
4	36.66	72.00	2.86	67.47
5	26.33	78.66	3.59	53.48
6	36.33	83.19	3.39	102.16
7	38.00	76.43	3.43	95.31
8	46.00	65.18	4.56	91.26
9	35.00	81.63	3.10	86.28
10	28.00	70.38	4.59	94.09
11	45.00	74.09	2.82	77.94
12	49.33	75.22	2.82	98.59
13	31.00	80.92	2.99	77.81
14	42.00	70.81	3.99	93.28
15	31.33	76.00	3.85	90.17
16	34.33	93.93	3.15	100.29
17	30.66	82.54	3.02	74.50
18	29.33	100.60	3.86	110.92
19	53.66	92.37	3.24	169.37
20	35.33	94.54	3.51	117.65
21	31.66	88.86	4.20	110.22
22	27.66	95.20	4.71	123.29
23	21.66	106.40	4.89	107.13
24	45.00	83.09	2.99	112.83
25	41.00	91.45	3.93	196.25
26	32.00	88.24	3.09	87.39
27	41.00	82.32	3.55	140.14
28	33.00	94.75	3.85	113.93

Table(25): Cont.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
29	24.00	102.33	4.80	115.21
30	43.00	87.27	3.46	154.59
31	32.66	84.37	2.74	69.76
32	37.00	75.89	3.53	68.56
33	44.66	69.90	2.60	71.45
34	23.33	80.46	3.55	69.26
35	20.66	82.27	3.70	77.87
36	41.33	86.16	3.19	87.24
37	32.66	85.88	2.94	76.85
38	28.33	79.50	4.02	90.86
39	25.00	103.76	3.87	111.94
40	42.66	103.57	3.69	105.23
41	34.33	80.13	3.13	69.16
42	32.33	75.19	3.07	70.35
43	31.00	84.21	3.46	82.56
44	30.00	82.69	3.48	83.85
45	33.66	103.50	3.78	108.59
46	49.33	88.82	2.98	108.31
47	61.66	85.82	3.14	137.78
48	50.33	77.19	2.83	105.33
49	48.66	90.05	3.01	129.92
50	36.33	83.19	3.37	101.95
51	42.66	93.28	3.51	139.61
52	44.66	83.86	4.17	157.00
53	31.66	91.71	3.81	109.13
54	30.00	104.86	432	128.63
55	36.33	95.04	3.34	114.29
56	55.00	87.32	3.06	123.04

Table(25): Cont.

Family number	No. of pods/plant	100-seed weight (gm)	No .of seeds/pod	Seed yield/plant (gm)
57	49.00	83.62	2.92	104.55
58	39.00	87.45	3.44	120.78
59	37.33	88.57	3.99	133.06
60	33.00	99.95	3.83	121.46
Rina blanca	13.66	76.63	4.56	67.18
Line 18	26.00	69.23	2.20	41.53
LSD at 0.05	11.65	7.07	0.96	17.21
LSD at 0.01	15.40	9.35	1.27	22.75
Heritability	57.84	82.71	65.34	86.81
ΔG	13.15	17.83	1.34	52.15
ΔG %	34.96	20.83	38.61	49.99
GCV %	22.34	11.12	23.41	26.05

Table (26): Mean square of methods of plant breeding and lines/methods in the selected F5 lines in the third cross.

Source of variation	d.f	No. of pods/plant	100-seed weight	No .of seeds/pod	Seed yield/plant
Reps.	2	80.83	18.01	1742.34	393.91
Lines	29	64.98**	364.51**	1761.30	4848.90**
Methods	2	354.03**	849.12**	1218.30	27184.00**
Line/methods	27	43.56	328.62**	1801.50	3194.40**
Error	58	22.41	16.70	1854.43	220.22

** significant at 0.01 level of probability.

Table (27) : Mean values of the three breeding methods in the third cross.

Trait / Breeding method	No. of pods/pllant	100-seed weight (gm)	No. of seeds/pod	Seed yield/plant (gm)
Pedigree method	26.50	89.47	5.73	145.71
Bulk method	19.93	79.04	7.67	124.08
Single pod descent	24.96	86.09	4.60	86.24
Average	23.80	84.87	6.00	118.68
L.S.D at 0.05	2.12	1.75	NS	6.45
L.S.D at 0.01	3.02	2.50	NS	9.21

As it is well known that expected improvement of selection is directly proportional to the heritability value. Also, the expected response to selection, varies with the phenotypic standard deviation of population means. This measure the total variability in the trait and therefore reflects the total response that could be realized in breeding techniques.

4.3.3. F5 generation:

4.3.3.1. Comparison between the three breeding methods.

Mean squares due to breeding methods were significant for all studied traits except no.of seeds/pod (Table,26). This results indicated the differences among breeding methods.

The pedigree method gave the highest values for no.of pod/plant, 100-seed weight and seed yield/plant. It could be concluded that the pedigree method considered the best breeding method for no. of pods /plant, seed index and seed yield/plant, as compared to bulk and SPD in this cross.

Whan *et al.* (1982) found that the effect of selection using the means of lines from the F3 and F4 rather than the individual F2 or F3 derived lines, can be assessed by the yields obtained in the following generation.

The improvement obtained in the F5 by selecting F2 derived lines was much greater in the first cross. When selection is carried out in an early generation *e.g.* among F2 derived lines, the important consideration is the response to this selection in a late generation, *e.g.* the F5 when lines are approaching homozygosity. In the simulated schemes considered here, the available data enabled each selected line to be continued with one random line only . This caused a less of

variation for yield and the gain from selection was often reduced in the generations following selection.

Also, the efficiency of the breeding methods in the present study was evaluated based on the no. of superior lines having higher values of seed yield/plant than the best parent. Data presented in Table (28) reflected that both pedigree and SPD methods produced three lines superior than the best parent for no. of pods/plant. The best lines were no.9 in SPD followed by line no.5 in pedigree method.

With regard to 100-seed weight, the results showed the pedigree method gave more superior lines followed by SPD method compared the best parent with five and three lines, respectively. The heavier ones were line no.3 and 4 in pedigree method.

For seed yield/plant, all, eight and three lines showed significant higher than the better parent for pedigree, bulk and SPD methods, respectively. The heavier line was no. 2 followed by no. 4, 1, 7 in pedigree method and line no.9, 4 in bulk method.

4.3.3.2. Direct and indirect selection:

Selection for yield and its components deserves considerable interest. A crop breeding programme aimed at increasing the plant productivity requires consideration interest not only of yield but also of its components which have a direct or indirect bearing on yield.The present work was under taken to compare the efficiency of indirect selection for yield via its components with direct selection for seed yield/plant.

Mean squares due to four selection criteria; no.of pods /plant,100-seed weight, no.of seeds/ pod and seed yield/plant

Table(28): Mean performance of the selected F5 lines for the three breeding methods in the third cross.

Method	Line	No. of pod/plant	100seed weight (gm)	No .of seed/pod	Seed yield/plant (gm)
Pedigree method	1	29.66	84.38	5.66	160.84
	2	21.33	102.36	7.57	259.24
	3	23.33	111.44	5.24	128.14
	4	27.00	104.03	6.78	186.25
	5	32.00	77.36	4.70	123.69
	6	24.33	73.62	5.66	102.57
	7	30.66	94.14	5.47	155.39
	8	25.00	89.73	5.32	123.38
	9	27.33	76.64	4.52	102.39
	10	24.33	81.02	6.39	115.57
Bulk method	1	16.66	84.20	8.43	118.31
	2	20.33	81.40	8.23	136.36
	3	17.66	59.43	8.52	94.08
	4	23.33	70.24	9.10	151.49
	5	18.33	84.49	6.89	105.37
	6	22.66	74.56	6.48	107.14
	7	19.00	82.60	8.33	136.88
	8	23.33	87.61	6.81	140.55
	9	19.00	82.34	7.40	153.85
	10	19.00	83.58	6.48	96.74
Single pod descent method	1	19.66	79.91	4.34	69.33
	2	24.33	70.06	4.17	68.18
	3	23.00	94.23	2.64	57.74
	4	29.33	82.22	4.36	104.09
	5	22.00	88.16	3.95	72.49
	6	20.00	97.90	5.66	102.86
	7	26.33	98.09	3.52	90.05
	8	28.00	77.49	4.54	94.94
	9	35.66	83.74	4.13	119.66
	10	20.66	89.08	4.79	83.04

Table (28):Cont.

Method	No .of pod/plant	100-seed weight (gm)	No .of seed/pod	Seed yield/plant (gm)
Rina blanca	17.33	84.10	5.31	79.30
Line 18	21.66	69.35	5.12	56.62
LSD at 0.05	6.70	5.56	NS	20.42
LSD at 0.01	9.56	7.93	NS	29.14

Table (29) : Mean square for the four selection criteria and lines/selection criteria in the selected F5 lines of the third cross.

Source of Variation	d.f	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
Reps	2	4.90	81.38	0.03	68.43
Lines	39	60.27**	194.04**	4.95**	1090.90**
Selection criteria	3	97.16**	38.33	1.06	4030.50**
Lines/selection criteria	36	57.19**	206.97**	5.28**	845.91**
Error	78	24.28	20.53	0.83	156.61

** significant at 0.01 level of probability.

were presented in Table(29). The mean squares were significant for no.of pods/plant and seed yield/plant only.

As for no.of pods/plant, the selection criteria of high no.of seeds per pod gave significant highest values followed by selection basis on high no.of pods/plant.

With respect to the effect of selection criteria on seed yield/plant, the results showed that selection for number of seeds/pod gave the significant heavier seed yield/plant. However, selection of seed yield /plant gave the lowest one.

Table (30) shows the effect of selection criteria on four studied traits. The results indicated that selection for no.of pods/plant was more efficient in breeding forword superior yielding F5 lines.

It could be concluded that selection for no.of pods/plant for the three generations was successful in improving the mean seed yield in the F5 lines.

The mean performance of selected F5 lines for selection criteria (indirect and direct selection) are presented in (Table,31). For no.of pods/plant, none and none, none and none, one and two, none and one line in the F5 generation had significantly the highest values than the population mean and the better parent, respectively when selected plants with high no.of pods/plant, 100-seed weight, no.of seeds/pod and seed yield/plant in the same order.

Regarding 100-seed weight, two and zero, two and one, one and zero and three and zero lines exhibited significantly heavier than the grand mean and the better parent when selection based on high no.of pods/plant, 100-seed weight, no.of seeds/pod and seed yield/plant, respectively.

Table (30) : Mean values of the four selection criteria in the third cross.

Trait / Selection criteria.	No. of pods/plant	100-seed weight	No. of seeds/pod	Seed yield/plant
No.of pods/plant	22.60	73.41	5.08	81.84
100-seed weight	22.10	75.96	4.76	74.00
No.of seeds/pod	24.96	73.78	5.14	93.50
Seed yield/plant	20.63	74.06	4.82	66.36
LSD at 0.05	2.50	NS	NS	6.37
LSD at 0.01	3.31	NS	NS	8.44

Table (31): Mean performance of the selected F5 lines for the four selection criteria in the third cross.

Selection Criteria	Line	No. of pod/plant	100seed weight (gm)	No. of seed/pod	Seed yield/plnt (gm)
No. of pods/plant	1	20.00	81.98	4.49	71.83
	2	22.66	75.37	4.37	72.80
	3	22.66	74.92	5.04	83.73
	4	28.00	67.49	5.61	129.55
	5	21.66	72.64	5.71	93.46
	6	28.00	83.24	4.53	101.06
	7	26.33	80.91	3.86	81.75
	8	14.66	66.55	5.79	67.50
	9	21.33	70.88	4.06	59.41
	10	20.66	60.17	7.33	57.29
100-seed weight	1	23.00	75.62	4.52	76.61
	2	21.00	69.39	3.73	54.38
	3	15.33	58.24	7.39	66.02
	4	20.00	92.76	4.04	73.20
	5	26.00	68.22	3.75	63.26
	6	23.66	72.45	5.77	97.81
	7	21.66	80.10	4.87	75.13
	8	26.33	82.76	2.90	61.64
	9	25.00	79.34	3.74	70.66
	10	19.00	80.77	6.92	101.28
No. of Seeds/pod	1	23.33	78.93	5.29	86.01
	2	27.66	76.73	4.92	113.90
	3	22.33	84.14	3.86	99.14
	4	16.33	62.57	3.58	110.73
	5	28.33	63.86	4.54	96.96
	6	23.00	68.38	4.55	110.76
	7	34.33	79.88	3.53	87.78
	8	18.66	72.09	5.09	77.55
	9	30.33	75.01	3.45	87.99
	10	25.33	76.22	4.69	69.20

Table (31): Cont.

Selection criteria	Line	No. of pods/plant	100-seed weight (gm)	No. of seeds/pod	Seed yield/plant (gm)
Seed yield/plant	1	16.33	55.62	7.76	77.42
	2	20.33	84.11	5.20	84.03
	3	22.66	79.28	3.69	64.01
	4	23.00	83.00	4.23	75.28
	5	16.33	72.08	6.51	71.66
	6	30.00	82.49	4.18	81.59
	7	17.00	69.65	5.34	61.02
	8	16.66	73.37	4.69	56.27
	9	23.00	76.27	2.99	46.69
	10	21.00	64.80	3.61	45.65
Rina blanca		17.33	84.10	5.31	79.30
Line 18		21.66	69.25	5.12	56.63
L.S.D at 0.05		7.91	7.61	1.48	20.15
L.S.D at 0.01		10.48	10.09	1.96	26.69
x		22.57	74.30	4.95	78.92

With respect to no.of seeds/pod, one and one, two and two, two and one and two and one lines surpassed significantly the overall mean and the best parent when selection carried out based on no.of pods/plant, 100-seed weight, no.of seeds/pod and seed yield/plant, respectively. Concerning seed yield/plant, two and two, one and one, four and three and no lines showed significant higher seed yield/plant compared to grand mean and the better parent when selecting plants with high no.of pods per plant, 100-seed weight, no.of seeds/pod and seed yield/plant in the same order. The best lines were no.6 being 129.55 gm when selection based on no.of pods/plant followed by line no.2 being 113.9 gm when selection based on no.of seeds/pod.

It could be concluded that indirect selection for yield via no.of seeds/pod and no.of pods/plant were more efficient than direct selection for yield.

The comparison revealed the efficiency of selection for no.of pods/plant followed by no.of seeds/pod in improving mean yield of F5 lines in this cross and also extracting a higher no.of high yielding lines (selection for high no.of pods/plant, high no.of seeds/pod). It also appeared that indirect selection for yield via no.of pods/plant and no.of seeds/pod were more efficient than direct effects of selection for yield. Similar observations have been reported by other workers in faba bean. Bisen *et al.* (1985) found that indirect selection for seed size was the best method for improving yield in chickpea. Khorgada *et al.* (1985) observed that seed weight selection was more efficient in increasing yield than selection for seed yield alone. Bahi and Vinod (1991) found that selection for no.of pods/plant was more effective in extracting maximum no.of high yielding F5 lines than other methods.

It is interesting to examine ability with regard to yield of the parents involved the crosses which yielded a relatively high portion of lines which excelled the check significantly in terms of seed yield. This information was available from 2 studied crosses (El-Hosary *et al.*1998).

The cross (Line 103 x ILB 938) gave the highest SCA effects for seed yield per plant and its components and its parents were good combiners.

The cross (Line103 x Triple white) gave low SCA effects for seed yield/plant and its components and its parents were poor combiners. The parent Line 103 gave significant positive (gi)for 100-seed weight.

The cross (Line 18 x Rina blanca) gave high SCA effects for 100- seed weight and seed yield per plant and Rina blanca showed significant (gi) effects for seed yield and its components.

Apparently, the cross with H x H or H x L general combining ability effects responsed to selection pressure for seed yield per plant in the first cross and no. of seeds/pod and no. of pods/plant in the 3rd cross.

It seems that sufficient additive genetic variation for seed weight was presented in the base material leading to fixation of transgressive segregants.