MATERIALS AND METHODS

The experiments reported herein were conducted at the Experiment Station of the Agricultural Research Center, Giza , during the three successive seasons 1983 , 1984 and 1985 . Six parental stocks of sesame were used in the present study . These parents were chosen to represent a wide range of variability in most of the studied traits . The characters of the parental lines used in this study and the source of their seeds are shown in Table 1 .

In 1983 season, complete diallel crosses involving the six parents were carried out . Again, in 1984 , the same work was repeated to have more F_1 seeds . All possible crosses including reciprocal ones were made between parents in 1983 and 1984 seasons following the hybridization technique described by El-Ahmar (1967) which consists of the following steps :

1. Removal of the formed capsules of 3-4 nodes below the zone of the emasculated buds on the female plants.
2. Keeping the leaves subtending the bud and removing the petals carrying the stamens .
3. Tightly bagging the emasculated zone on the female plants , and then bagging the flowering zone on the male plants which will open on the next day .

Table 1 . Some moraphyaialogical characters of parental genotypes .

Item	Genotype					
	Giza 25 (P_1)	Giza 32 (P_2)	N.A. 413 (P_3)	N.A. 282 (P_4)	N.A. 372 (P_5)	N.A.130 (P_6)
Origin	Egypt	Egypt	U.S.A	U.S.A.	U.S.A.	U.S.A.
Growth habit (Type)	Branched	non-branched	non-branched	non-branched	branched	branched
Plant height (cm)	230	242	198	221	178	212
Number of fruiting branches	8.20	0.85	1.15	0.95	4.35	5.15
Flowering date	Mid-late	Mid-late	Mid-late	Mid-late	Mid-late	Early
Maturity	Mid-late	Late	Mid-late	Late	Late	Early
Number of capsules/leaf oxil.	One	One	Three	Three	Three	One
Dehiscence of capsule	Shuttring	Shuttring	Shuttring	Shuttring	Non-Shuttring	Shuttring
Seed colour	White	Creamy	White	White	Brown	White
1000-seed weight (gm)	3.79	4.66	3.57	3.11	3.48	3.42

4. On the following morning, artificial pollination is performed , by brushing the stigma of the emasculated flowers by the stamens of the male flowers .
5. Rebagging the female and male plants after emasculating new buds on the female plants . Then, continuing the previous steps until obtaining a suitable number of hybrid capsules .
6. At last , removing the buds of the 3-4 nodes above the crossed zone on the female plants .

In 1985 season , the six parents and their 30 possible F_1 hybrids were grown in a randomized complete block design with four replications . Each plot consisted of four rows , 4 meters long and 50 cm. apart . Seeds were sown in hills of 15 cm within row . After a complete emergence , hills were usually thinned out to two plants per hill .

Data of the following traits were recorded on five guarded plants per plot .

1- Days from sowing to flowering;expressed as the number of days from sowing to the emergance of the first flower .
2- Days from sowing to maturity : expressed as the number of days from sowing to the maturity of plants (10 days after leaves colour turned from green to yellow) .
3- Plant height : the height of the main stem, in cm.

4- Height of the first capsule : stem height in cm from the soil surface to the first capsule on the main stem.

5- Fruiting zone height : length of fruiting zone in cm. from basic capsule to plant apex .

6- Number of fruiting branches per plant as indication for growth habit (i.e. non-branched main stem or branched) non-branched 1-2 branches and branched more than 2 .

7- Number of capsules per plant at harvest time .

8- Number of seeds per capsule at harvest time .

9- Seed yield per plant in gm .

10- Weight of 1000 seeds in gm .

11- Seed oil percent .

12- Seed protein percent .

<u>Statistical procedures</u> :

The data obtained for each trait were analysed on individual plant basis . An ordinary analysis of variance was performed . In this analysis the parental varieties , one set of F_1's and reciprocal F_1's were included . The effect of blocks and genotypes were considered fixed . A one tail F ratio was used to test the significance of different sources of variation . When the differences between genotypes reached the significant level , further appropriate analysis was carried out .

Normal analysis of variance was conducted for all genotypes as a complete randomized block design .

The source of variation , degrees of freedom and expected mean squares , are given in Table 2 .

Table 2 . Source of variation , degrees of freedom and expected mean squares .

Source of variation	d.f.	M.S.	E.M.S.
Genotypes	(a-1)	Mg	$\sigma^2_e + C\,\emptyset\,g$
Replications	(r-1)	Mr	$\sigma^2_e + ac\,\emptyset\,(r)$
Gen. x replications	(a-1)(r-1)	Mgv	$\sigma\,e + c\,\emptyset\,(gv)$
Sampling error	ar (c-1)	Me	$\sigma\,e$

Where :

$$\emptyset\,(g) = \frac{1}{a-1}\; g^2_1 \;, \qquad \emptyset\,(r) = \frac{1}{r-1}\; r^2_k$$

$$\text{and } \emptyset(rg) = \frac{1}{(a-1)\,(r-1)}\;(rg)^2_{ijk}$$

a = number of genotypes , parents and F_1's

r = number of replications .

c = number of plants per plot .

Differences among genotypes were tested by F ratio of Mv/Me, with their respective degrees of freedom .

Heterosis :

Since hybrid vigor is the most important result of heterosis, i.e. the F_1 hybrid performance excells the range of it's parents , this useful concept of heterosis was to be intended .

The following comparisons were made among the tested genotypes i.e. parental cultivars and their cross combinations .

1- The F_1 hybrid versus high-parent, i.e. ($\bar{F}_1$ Vs. $\bar{H}p$).

2- The F_1 hybrid versus mid-parent, i.e. ($\bar{F}_1$ Vs. $\bar{M}p$).

These comparisons were used in calculating the following estimates :

$$\text{Heterosis} = \frac{\bar{F}_1 - \text{Mid parent}}{\text{Mid parent}} \times 100$$

$$\text{True heterosis} = \frac{\bar{F}_1 - \text{High parent}}{\text{High parent}} \times 100$$

A test of significance for the F_1 cross mean from the mid-parent values was conducted by the following appropriate " t " value as suggested by Wynne et al. (1970) .

$$t = (\bar{F}_{ij} - \bar{M}P_{ij}) / \sqrt{3/8\ \sigma^2_e}$$

Where :

$\bar{F}_{ij}$ = the mean of the $_{ij}F_1$ cross .

$\bar{M}P_{ij}$ = the mid-parent value for the ij th cross .

σ_e^2 = estimate of error variance .

Combining ability and reciprocal effect :

Estimates of combining effects were made by applying Griffing's method 1 model 1 . The method of employing parents and their all possible crosses, including reciprocal in the analysis was chosen as recommended by Griffing (1956) .

Analysis of variance for general and specific combining ability :

General and specific combining ability estimates were obtained by employing Griffing's (1956) diallel cross analysis designated as method 1 model 1 . A partitioning of genotypes sum of squares was performed as presented in Table 3 .

Table 3 . Analysis of variance for method 1 giving expectations of mean squares for the assumption of model 1 .

Source	D. F.	Sum of squares*	Mean of squares	Expectation of mean squares
G.C.A.	P-1	S_g	M_g	$\sigma^2 + 2p(\frac{1}{P-1}) \sum \hat{g}_i^2$
S.C.A	P(P-1)/2	S_s	M_s	$\sigma^2 + \frac{2}{P(P-1)} \sum\sum_{ij} S_{ij}^2$
Reciprocal effects	P(P-1)/2	S_r	M_r	$\sigma^2 + 2(\frac{2}{p-(P-1)}) \sum\sum_{i>j} r_{ij}^2$
Error	rn	S_e	$M_{\bar{e}}$	σ^2

* Where :

$$S_g = \frac{1}{2P} \sum_i (Xi.+ X.i)^2 - \frac{2}{P^2} X..^2 ,$$

$$S_s = \frac{1}{2} \sum_i \sum_j X ij (Xij + Xji) - \frac{1}{2P} \sum_i (X.i + Xi.)^2 + \frac{1}{P2} X..^2 ,$$

$$S_r = \frac{1}{2} \sum_{i<j} \sum (Xij - Xji)^2 .$$

and $M_{\bar{e}}$ = The error mean square for the randomized block design divided by number of replications .

The F ratio ; $F \left[(P-1) M \right] = M_g / M_{\bar{e}}$;

$F \left[P (P-1) / 2 , m \right] = M_s / M_{\bar{e}}$ and $F \left[P(P-1)/2, m \right] = M_r / M_{\bar{e}}$

were used to test for G.C.A. ; S.C.A. and reciprocal effects, respectively .

The general combining ability ($\hat{g}_i$), specific combining ability ($\hat{S}_{ij}$) and reciprocal ($\hat{r}_{ij}$) effects along with their respective standard error (S.E.) were calculated as presented in Table 4 .

Table 4 . Different effects and their standard error .

Estimate	Formula Method 1	Restriction
$\hat{g}_i$	$\frac{1}{2P}(X_{i.} + X_{.i}) - \frac{1}{P^2} X_{..}$	
$\hat{S}_{ij}$	$\frac{1}{2}(X_{ij} + x_{ji}) - \frac{1}{2P}(x_{i.} + x_{.i} + x_{j.} + x_{.j}) + \frac{1}{P^2} x_{..}$	
$\hat{r}_{ij}$	$\frac{1}{2}(X_{ij} - X_{ji})$	
S.E. ($\hat{g}_i$)	$\sqrt{\frac{P-1}{2P^2} \hat{\sigma}^2}$	
S.E. ($\hat{S}_{ij}$)	$\sqrt{\frac{1}{2P^2}(P^2 - 2P + 2) \sigma^2}$	$i \neq j$
S.E. ($\hat{r}_{ij}$)	$\sqrt{\frac{1}{2} \sigma^2}$	$i \neq j$
S.E. ($\hat{g}_i - \hat{g}_j$)	$\sqrt{\frac{1}{P} \sigma^2}$	$i \neq j$
S.E. ($\hat{S}_{ij} - \hat{S}_{ik}$)	$\sqrt{\frac{P-1}{P} \sigma^2}$	$(i \neq j, k, j \neq k)$
S.E. ($\hat{S}_{ij} - \hat{S}_{kL}$)	$\sqrt{\frac{P-2}{P} \sigma^2}$	$(i \neq j, k, L, j \neq k, L, k \neq L)$
S.E. ($\hat{r}_{ij} - \hat{r}_{kL}$)	$\sqrt{\hat{\sigma}^2}$	$(i \neq j, k \neq L)$

Joint regression analysis for Wr versus Vr :

Different types of gene action were interpreted strictly from the visual ispection of the Wr / Vr of each trait as outlined by (Mather and Jinks , 1971) . Vr is the variance of the r th array and Wr is the covariance of the r th array with nonrecurrent parents . The mean over reciprocals were averaged and the Vr and Wr were calculated from the half diallel . To obtain the necessary statistics for plotting the limiting parabola , the means over replications were used . The necessary statistics for plotting the limiting parabola were derived from : Wr = Vr. Vp , $Wr = \sqrt{V_r \cdot V_p}$. The regression coefficient and its standard error were calculated according to Singh and Chaudhary (1977) .

$$b = \frac{\text{Cov. (Wr , Vr)}}{\text{Var. (Vr)}}$$

$$\text{S.E.(b)} = \left[\text{Var, Wr} - \text{b Cov. (Wr, Vr) / Var. Vr (n-2)} \right]^{\frac{1}{2}} .$$

Where : n = number of parents .

To test the regression line is significantly different from either unity or Zero , the folowing t-test was used .

$$t = \frac{b - b_o}{\text{S.E. (b)}}$$

Where :

b = regression coefficient .

S.E. (b) = standard error of the regression coefficient

b_o = 1 or 0 , respectively .

The Wr / Vr graph provides information on three points :

a - It supplies a test of adequacy of the model ; in the absence of non allelic interaction and with independent distribution of the genes among the parents Wr is related to Vr by a straight regression line of unit slope ($b = 1$) .

b - If the model is adequate , a measure of the average level of dominance is provided by the departure from the origin of the point where the regression line intercepts the Wr axis .

The distance of this point from the origin in $\frac{1}{4}(D-H_1)$: $D > H_1$ when the intercept is positive and it is then that the dominance is partial or incomplete . When $D = H_1$, the line passes through the origin , and dominance is complete . If $D < H_1$ then the intercept is negative and over dominance is indicated .

c - The position of the array point nearest the origin indicates that a parent contains a preponderance of dominant genes and when furthest from the origin indicates that the parent contains fewer dominant genes or mostly recessive genes .

that some insight inheritance of relatively complex traits might be recognized by using Hayman's analysis inspite that its inherent assumptions were not always satisfied .

Data were recorded on all genotypes for growth , yield, yield components and technological traits .

For better respresentition and discussion of the results obtained herein , it was prefered to outline these results into two parts , namely heterosis and genetical studies .

(A) : Heterosis :

Table 5 . presents the analysis of variance for all the studied traits . Genotypes mean squares reached the significant level of probability for all traits .

Parental performances :

Parents mean square was highly significant for all traits indicating overall differences between the parental lines. The mean performances of the tested six parental lines are presented in Table 5 . P_6 parental line was the best of tested lines in flowering and maturity dates .

Giza 32 local cultivar significantly surpassed all the tested parents in plant height . N.A. 413 and N.A. 282 gave the lowest values for height of the first capsule . Giza 32 and N.A. 282 were the best performing parents for length of fruiting zone . Local variety Giza 25 gave the highest value for number of fruiting branches .

Local variety Giza 25 significantly surpassed all the tested parents in number of capsules per plant, seed yield per plant and oil percent . It was also on the top of these varieties for number of seeds per capsule . This situation could be explained on adaptation basis . More fruiting branches, and higher values of plant height , length of fruiting zone,

Table 5 . Observed mean squares from analysis of variance for various agronomic and chemical characters .

Source	D.F.	Mean Squares					
		Days to flowering	Days to maturity	Plant height (cm)	Height of the first capsule (cm)	Fruiting zone length (cm)	No. of fruiting branches
Replications	3	1.31	4.94	1159.91*	115.65	793.80	8.07
Genotypes	35	182.66**	1068.74**	6182.44**	1806.41**	4904.34**	128.15**
Parents	5	565.87**	2402.62**	10450.71**	5300.33**	12032.71**	178.25**
Crosses	29	122.45**	874.96**	5292.70**	1262.62	3547.25**	116.36**
Par.Vs. cross	1	12.84**	19.06**	10643.35**	106.78	8618.03**	219.54**
Error	576	1.40	2.00	159.60	237.00	380.60	2.00

* Significant at P = 0.05 ; ** Significant at P = 0.01 .

Table 5 . Continued ......

Source	D.F.	Mean Squares					
		No.of capsules/ plant	No.of seeds/ capsule	1000-seed weight (gm)	Seed yield/ plant (gm)	Oil %	Protein %
Replications	3	168.29	14.72	23.45	0.051*	0.07	0.06
Genotypes	35	44428.55**	431.72**	2.788**	960.11**	18.76**	3.20**
Parents	5	56408.81**	1112.03**	5.647**	1388.15**	33.47**	8.11**
Crosses	29	38028.02**	293.93**	2.386**	655.41**	16.13**	2.44**
Par. Vs. Cross	1	170142.50**	1026.14**	0.160**	7656.25**	21.65**	0.726**
Error	576	2534.80	35.60	0.012	0.012	0.20	0.13

* Significant at P = 0.05 ; ** Significant at P = 0.01

seed yield per plant, the yield components and oil percent, therefore, could be expected to be obtained by the local varieties.

N.A. 372, N.A. 130 had the highest number of capsules per plant following Giza 25. While, N.A. 282 gave the highest number of seeds per capsule and protein percentage. Local variety Giza 32 had the highest value in seed index.

F_1 hybrid performance :

Hybrids mean squares for all traits were highly significant revealing over all differences between these hybrids (Table 6). F_1 means were significantly higher than parental means for all the studied traits except height of the first capsule. None of the hybrids surpassed the highest performance parent allover the tested genotypes for earliness, height of the first capsule, number of fruiting branches, number of seeds per capsule, 1000-seed weight, seed yield per plant, oil and protein content. Also, for plant height and fruiting zone length, the hybrids were within the range of parental lines with the exception of cross N.A. 282 x G. 32 for both traits and cross G.25 x G. 32 for plant height which was characterized by its high sature. The crosses (G. 25 x N.A. 282), (G. 25 x N.A. 372), (G. 25 x N.A.130), (N.A. 372 x N.A. 130), (N.A. 372 x G. 25), (N.A. 372 x N.A. 282) and (N.A. 130 x N.A. 282) exhibited high number of capsules per plant overall genotypes.

Table 6 . The genotype mean performance for the studied characters .

	Parents and F_1 generation	Days to flowering	Days to maturity	Plant height (cm)	Height of the first capsule (cm)	Fruting zone length (cm)	No. of frutiong branches
1	P_1	L-P 44.80	h-j 108.85	c-h 230.75	c 83.75	b-f 147.00	ab 8.20
2	P_2	P 46.20	op 117.85	a-c 242.25	a-e 68.75	a-c 173.50	i 0.85
3	P_3	d-j 41.50	ef 104.80	j-l 198.50	a 42.50	b-f 156.00	i 1.15
4	P_4	P 45.80	Pq 119.25	c-i 221.00	ab 46.25	ab 174.75	i 0.95
5	P_5	OP 45.65	q 120.50	L 178.75	b-e 69.50	g 109.25	fg 4.35
6	P_6	a 32.45	a 92.20	g-j 212.50	c-e 74.25	d-g 138.25	d-g 5.15
7	$P_1 \times P_2$	m-p 44.90	no 115.95	ab 258.00	d-e 82.00	ab 176.00	b-g 6.55
8	$P_1 \times P_3$	f-k 42.50	e-g 105.95	c-h 225.75	b-e 70.25	b-f 155.50	b-g 6.10
9	$P_1 \times P_4$	n-p 45.25	no 115.60	c-g 232.00	b-e 70.00	b-f 162.00	b-f 6.85
10	$P_1 \times P_5$	n-p 45.30	no 116.05	e-j 215.25	c-e 75.00	c-g 140.25	a-d 7.80
11	$P_1 \times P_6$	c-g 40.50	cd 102.10	d-j 219.00	b-e 71.00	b-f 148.00	b-e 7.20
12	$P_2 \times P_3$	i-m 43.05	g-i 107.85	d-j 218.50	a-e 67.25	b-f 151.25	i 1.15
13	$P_2 \times P_4$	op 45.65	pq 120.05	a-d 240.00	a-e 67.50	a-c 172.50	i 1.15
14	$P_2 \times P_5$	p 45.95	pq 120.05	c-h 224.75	a-e 66.25	b-f 158.50	fg 4.15
15	$P_2 \times P_6$	c-h 40.90	d-f 104.55	c-f 234.75	b-e 71.50	a-f 163.25	b-g 5.85
16	$P_3 \times P_4$	g-k 42.55	gh 107.40	h-k 209.50	ab 45.25	a-f 164.25	i 0.60
17	$P_3 \times P_5$	k-o 43.65	Lm 112.70	L 181.00	a-c 50.00	fg 131.00	d-g 5.05
18	$P_3 \times P_6$	bc 38.85	ab 99.55	i-L 199.50	a-e 59.75	c-g 139.75	e-g 4.45
19	$P_4 \times P_5$	p 46.30	pq 120.15	c-h 226.75	a-e 62.75	a-f 164.00	b-g 5.80
20	$P_4 \times P_6$	d-i 41.40	j-L 110.85	c-h 229.25	a-e 60.75	a-d 168.50	e-g 4.65
21	$P_5 \times P_6$	c-g 40.70	j-L 110.75	c-h 221.50	a-e 66.75	b-f 154.75	d-g 5.25
22	$P_2 \times P_1$	L-P 44.80	no 115.65	a-d 238.50	d-e 80.00	b-f 158.50	b-g 5.80
23	$P_3 \times P_1$	f-k 42.45	f-h 106.40	e-j 215.25	a-e 66.75	b-f 148.50	d-g 5.20
24	$P_4 \times P_1$	op 45.65	mn 115.15	b-e 236.75	a-e 65.50	a-d 171.25	a-c 8.10
25	$P_5 \times P_1$	p 45.80	mn 115.00	c-h 228.75	a-e 68.25	b-f 160.50	a 10.50
26	$P_6 \times P_1$	b-d 39.85	bc 100.50	c-h 226.00	a-e 67.50	b-f 158.50	b-e 7.15
27	$P_3 \times P_2$	h-L 42.80	f-h 106.90	c-h 228.25	a-e 65.75	b-f 162.50	hi 1.30
28	$P_4 \times P_2$	p 46.35	pq 119.80	a 259.00	a-e 62.00	a 197.00	i 1.10
29	$P_5 \times P_2$	p 45.85	pq 119.30	c-h 224.00	b-e 69.50	b-f 154.50	b-g 5.45
30	$P_6 \times P_2$	b-e 40.20	de 103.75	c-g 232.50	a-e 66.75	a-e 165.75	b-g 5.85
31	$P_4 \times P_3$	e-k 42.25	e-g 105.55	e-j 215.75	a-c 51.25	a-f 164.50	i 0.45
32	$P_5 \times P_3$	j-n 43.50	i-k 110.15	kL 189.75	a-d 56.25	e-g 133.50	c-g 5.35
33	$P_6 \times P_3$	b 38.25	bc 100.15	f-j 213.75	a-e 59.75	b-f 154.00	gh 4.05
34	$P_5 \times P_4$	p 46.25	q 120.75	c-h 226.50	a-e 61.25	a-e 165.25	b-g 5.70
35	$P_6 \times P_4$	c-h 40.85	i-k 110.00	c-g 234.25	a-e 60.00	ab 174.25	e-g 4.55
36	$P_6 \times P_5$	c-f 40.45	kL 111.75	c-h 223.75	b-e 69.50	b-f 154.25	e-g 4.55
	L.S.D.	0.747	0.897	7.829	9.542	12.090	0.996

Table 6 . Continued .....

Parent and F_1 generation		Variables: No. of capsules/ plant	No. of seeds/ capsule	Seed yield/ plant (gm)	1000-seed weight (gm)	Oil %	protein %
1	P_1	a-g 236.70	a-d 57.05	a 49.70	ef 3.795	a-c 55.24	q 20.81
2	P_2	j 101.75	b-f 50.80	e 27.40	a 4.658	i-k 52.29	m-o 22.04
3	P_3	d-j 162.90	a-f 52.00	d-e 29.35	g-j 3.569	pr 49.15	b-e 23.66
4	P_4	h-j 140.70	a 61.60	d-e 29.10	p 3.108	t 47.95	a 24.59
5	P_5	a-i 214.90	e 42.05	c-e 30.55	i-m 3.483	st 48.04	bc 23.95
6	P_6	a-i 221.35	e-f 44.05	a-e 34.95	j-n 3.425	jk 51.99	k-o 22.18
7	$P_1 \times P_2$	a-g 234.65	a-d 55.40	a 49.95	b-d 4.192	a 55.62	n-p 21.93
8	$P_1 \times P_3$	a-g 230.85	a-d 56.40	ab 47.75	e 3.893	fg 53.53	h-m 22.58
9	$P_1 \times P_4$	a-c 254.70	ab 59.95	a-e 43.75	L-o 3.365	mn 50.53	e-i 23.11
10	$P_1 \times P_5$	ab 259.05	a-f 51.85	a-d 44.45	g-j 3.568	g-i 53.00	h-m 22.62
11	$P_1 \times P_6$	ab 257.25	a-e 52.60	a-d 45.40	e-h 3.738	b-d 54.84	op 21.83
12	$P_2 \times P_3$	f-j 158.60	a-d 55.35	a-e 34.70	bc 4.330	h-j 52.62	f-i 22.97
13	$P_2 \times P_4$	i-j 136.00	a 61.25	b-e 32.50	e-g 3.745	or 49.54	b-d 23.78
14	$P_2 \times P_5$	b-i 193.50	a-e 52.80	a-c 46.45	b-d 4.223	h-j 52.41	g-j 22.85
15	$P_2 \times P_6$	a-g 228.40	a-e 52.50	a-d 45.25	d 4.075	ef 54.06	j-o 22.22
16	$P_3 \times P_4$	c-j 169.20	a-c 58.15	b-e 32.10	j-n 3.434	or 49.46	a-c 24.04
17	$P_3 \times P_5$	a-g 239.65	c-f 48.85	a-e 42.40	e-h 3.744	kL 51.60	a-c 23.97
18	$P_3 \times P_6$	b-i 189.95	a-f 51.60	a-e 41.50	i-L 3.545	jk 51.94	b-f 23.54
19	$P_4 \times P_5$	ab 267.30	a-d 55.00	a-d 44.95	m-o 3.310	rs 48.77	a-c 24.11
20	$P_4 \times P_6$	a-g 233.95	a-d 55.85	a-e 40.65	n-p 3.266	nq 49.83	b-d 23.75
21	$P_5 \times P_6$	a-f 245.30	d-f 46.70	a-e 41.40	j-n 3.451	no 50.11	e-i 23.03
22	$P_2 \times P_1$	a-i 213.10	a-d 55.30	a 49.80	a 4.352	ab 55.40	p 21.58
23	$P_3 \times P_1$	b-i 190.65	a-d 56.90	a-d 44.90	ef 3.821	g-i 52.96	h-L 22.69
24	$P_4 \times P_1$	ab 276.50	ab 59.55	a 49.30	m-o 3.347	no 50.21	e-i 23.03
25	$P_5 \times P_1$	a 299.50	a-e 53.45	ab 47.35	g-j 3.612	gh 53.18	i-n 22.52
26	$P_6 \times P_1$	a-d 249.35	a-e 53.70	a-d 44.20	f-i 3.661	c-e 54.60	op 21.63
27	$P_3 \times P_2$	h-j 140.60	a-d 56.15	b-e 31.05	cd 4.145	h-j 52.45	e-i 23.08
28	$P_4 \times P_2$	e-j 161.25	ab 60.70	b-e 32.40	g-j 3.600	np 49.90	b-f 23.60
29	$P_5 \times P_2$	a-i 215.10	a-e 54.05	a-c 47.25	b-d 4.189	ik 52.23	h-k 22.79
30	$P_6 \times P_2$	a-g 236.90	a-f 52.15	a-c 46.20	d 4.122	de 54.09	L-o 22.10
31	$P_4 \times P_3$	g-j 153.55	ab 59.40	b-e 31.30	k-o 3.381	qr 49.06	a-c 24.08
32	$P_5 \times P_3$	a-g 233.70	d-f 47.35	a-e 39.95	f-i 3.663	Lm 51.11	bc 23.82
33	$P_6 \times P_3$	b-i 198.20	a-e 52.70	a-e 41.25	h-k 3.562	kL 51.53	c-g 23.48
34	$P_5 \times P_4$	a 290.75	a-d 55.45	a-c 46.40	n-p 3.289	np 49.90	ab 24,16
35	$P_6 \times P_4$	a-e 246.95	a-d 55.40	a-e 41.45	o-p 3.218	oq 49.60	bc. 23.84
36	$P_6 \times P_5$	a-h 224.50	d-f 47.35	a-e 41.75	i-L 3.552	mn 50.42	d-h 23.16
L.S.D.		31.206	3.703	5.969	0.066	o.276	0.226

Parents vs. Hybrids :

Mean square for parents vs. hybrids as indication to average hetrosis overall crosses , was significant for all traits except height of the first capsule (Table 5) . Average heterotic values for flowering date , maturity date, 1000-seed weight and protein content were small in magnitude, but reached the level of significance . Average heterotic values were more pronounced for other traits . With the exceptianal of height of the first capsule, F_1 means were significantly higher than parental means for all the studied traits .

Heterotic effects :

Heterosis values measured of F_1 hybrids from mid-parent and better parent are presented in Table 7 .

Heterosis expressed as percent increase of F_1 hybrids above average of the parents , was significant for all traits except height of the first capsule . Similar results were obtained by Murty (1975), Issa (1978), Kotecha and Yermanos (1978) , Hassaballa et al. (1980 a,b) , Ibrahim et al.(1983a) and Sharan and Ragab (1986) .

The magnitude of the average heterotic effects was greater for all traits .

Superiority of the F_1's over the mid-parent values ranged from 0.05 for 1000-seed weight to 26.04 for seed yield per plant . The range of variability among the parents for each character was expressed as ratio of the mean for best parent to that of the lowest parent. Number of fruiting branches per plant exhibited the highest range of variability followed by number of capsules per plant, however, oil percent was the least variable .

The range of superiority of the F_1's over better parent values was from -6.54 for 1000-seed weight to 19.71 for height of the first capsule . Similar findings were also obtained by Srivastava and Prakash (1977) , Issa (1978) , Kotecha and Yermanos (1978) , Yermanos and Kotecha (1978) , Murty (1979), Hassaballa et al.(1980 a,b) , Ibrahim (1983a) and Sharan and Ragab (1986) .

Individual heterosis on basis of mid-parent value or higher parent were calculated for each cross. The number of crosses showing significant heterotic effects at 0.05 and 0.01 levels are presented in Table 7 . The number of crosses significantly surpassed their respective mid-parent or higher parent , or significantly lower than the lower parent , was greater for maturity date .

The critical test for yield and for quality in F_1 crosses is the heterosis expression , which means in simple way , significant superiority of F_1 hybrids over the mid-parent value . In other words, useful heterosis means significant superiority of the hybrids over the better performing parent involved in the cross combination . Moreover, true or real heterosis is significant superiority of F_1 hybrids over the best parental stock used . Besides different heterosis types previously mentioned , negative heterotic effects below mid-parent , higher parent , and best parental stock were also considered and discussed . All these estimates used herein as criteria interpretation of the obtained results concerning heterosis expression effects for all traits as shown in Table 7 .

Heterosis , expressed as percent increase of F_1 hybrids above the average of the parents , was significant for number of capsules per plant, seed yield per plant and oil content. Similar results were obtained by Riccelli and Mazzani(1964), Sarathe and Dabral (1969), Dixit (1976) , Srivastava and Prakash (1977), Murty (1979) , Hassabala (1980 a,b) , Ibrahim et al. (1983a)and sharan and Ragab (1986) .

The mean of F_1 crosses significantly exceeded the mean of better parents that entered in these crosses in flowering date , maturity date , height of the first capsule . The obtained results were in hormony with those previously reached

Table 7 . Average performance of F_0 , F_1 generations and over all heterosis measured of F_1 hybrids from mid-parent value or above higher parent (+) or below lower parent mean (-) for all the studied characters .

Character	Generation mean F_0	Generation mean F_1	Highest /lowest parent	Heterosis % (1)	Heterosis % (2)	No. F_1's Significantly exceeded Mid parent $\bar{M}$ P		No. F_1's Significantly exceeded Higher(+) or Lower (-)parent		No. F_1's Not significantly different From Mid parent $\bar{M}$ P	No. F_1's Not significantly different Higher(+) or Lower (-)parent
						-	+	-	+		
1. Days to flowering	42.73	43.09	1.42	0.83	7.78**	0	6	0	13	24	$\pm$ 17
2. Days to maturity	110.58	111.01	1.31	0.39	6.63**	5	6	0	24	19	$\pm$ 6
3. Plant height (cm)	213.96	224.28	1.36	4.82	-1.66	0	11	6	2	19	$\pm$ 22
4. Height of the first capsule(cm)	64.17	65.20	1.97	1.61	19.71*	0	0	0	7	30	$\pm$ 23
5. Fruiting zone length(cm)	149.79	159.08	1.60	6.20	-3.32	0	3	1	0	27	$\pm$ 29
6. No. of fruiting branches	3.44	4.92	9.65	42.99**	-5.20	1	10	3	1	19	$\pm$ 26

(1)(F_1 - $\bar{MP}$ / $\bar{MP}$) x 100

(2) (F_1 -- $\bar{HP}$ / $\bar{HP}$) x 100

Table 7 . Continued . ...

Character	Generation mean		Highest / lowest parent	Heterosis %		No. F_1's					
						Significantly exceeded				Not significant different from	
						Mid parent $\bar{M}P$		Higher(+) or lower (-)parent		Mid parent $\bar{M}P$	Higher(+) or lower (-)parent
	F_0	F_1	parent	(1)	(2)	-	+	-	+		
1. No. of capsules /plant	179.72	220.97	2.33	22.95*	4.23	0	9	0	3	21	± 27
2. No. of seeds/capsule	51.26	54.46	1.46	6.24	-2.50	0	2	0	0	28	± 30
3. Seed yield/plant(gm)	33.51	42.26	1.81	26.04*	11.65	0	8	0	6	22	± 24
4. 1000-seed weight (gm)	3.67	3.71	1.50	0.05	-6.54**	4	5	21	1	21	± 8
5. Oil %	50.78	51.82	1.15	2.04**	-1.32**	2	19	13	6	9	± 11
6. Protein %	22.87	23.06	1.18	0.84	-2.86	0	6	21	0	24	± 9

(1) $(F_1 - \bar{M}P / \bar{M}P) \times 100$

(2) $(F_1 - \bar{H}P / \bar{H}P) \times 100$

by Dixit (1976) , Yermanos and Kotecha (1978) , Hassabala et al . (1980 a), Ibrahim et al. (1983a) and Sharan and Ragab (1986) .

Negative values were detected for 1000-seed weight and oil content , revealing that F_1 means were significantly lower than better parental means for both traits .

Individual heterosis values on the basis of mid-parent value of higher parent were estimated for each cross. The number of crosses showing significant heterotic effects at 0.05 and 0.01 levels are presented in Table 7 .

The number of crosses significantly surpassed their respective mid-parent value or higher parent (+) , or significantly lower than the lower parent (-) , was greater for oil content , maturity date, plant height , number of fruiting branches , number of capsules per plant , 1000-seed weight and seed yield per plant .

Superiority of the F_1's over the mid-parent values ranged from 0.83 for flowering date to 42.99 for number of fruiting branches . Similar findings were also obtained by Sarathe and Dabral (1969) , Hassabala et al.(1980 a), and Sharan and Ragab (1986) .

Considering flowering date in all individual crosses ; five crosses decreased significantly than the mid-parent .

Non of the hybrids had was earlier than the better parent . Similar results were obtained by Hassabala et al. (1980 a), Ibrahim et al.(1983 a)and Sharan and Ragab (1986) .

Considering maturity date , six crosses decreased significantly than the mid-parent. Non of the hybrids was earlier than the better parent . Similar findings were also obtained by Hassabala et al.(1980 a) .

For plant height , eleven and two hybrids exceeded significantly the mid-parent and better parent , respectively. The two crosses : G. 25 x G. 32 and G. 32 x N.A. 282 gave the highest heterosis . The foregoing results indicated that selection of tall mother parent is of major importance in breeding program aiming at achievement of plant height . Sesame plant in the two crosses , which in fact has a direct impact in improving the fruiting zone length . Similar results were obtained by Dixit (1976) , Issa (1978) , Kotecha and Yermanos (1978) , Hassabala et al. (1980 a) , and Sharan and Ragab (1986) .

With respect to stem height to the first capsule , non of the hybrids showed better performance than mid-parent or better parent , as those obtained by Issa (1978) , Hassabala et al. (1980 a) , Ibrahim et al.(1983 a)and Sharan and Ragab (1986).

For length of the fruiting zone , three crosses exceeded significantly the mid-parent value . Non of the hybrids showed better performance than the better parent. The present results are in agreement with those obtained by Ibrahim *et al*. (1983 a)and Sharan and Ragab (1986) .

For number of fruiting branches , significantly positive heterotic effect was detected for ten crosses than mid-parent and one hybrids than better parent . Similar findings were also obtained by Hassabala *et al*.(1980 a), Ibrahim *et al*. (1983 a) and Sharan and Ragab (1986) .

For number of capsules per plant , the crosses G. 25 x G. 32 , G. 25 x N.A. 282 , G. 32 x N.A. 130 , N.A. 282 x N.A. 372 , N.A. 282 x G. 25, N.A. 372 x G.32 , N.A. 130 x G. 32 , N.A. 372 x N.A. 282 and N.A. 130 x N.A. 282 , N.A. 282 x N.A. 372 , N.A. 372 x G. 25 and N.A. 372 x N.A. 282 showed significantly positive heterotic effect than mid-parent and better parent , respectively . The obtained results are in agreement with those obtained by Sarathe and Dabral (1969) , Dixit(1976), Srivastava and Prakash (1977) , Kotecha and Yermanos (1978), Ibrahim *et al*. (1983a), Sharan and Ragab (1986) .

For number of seeds per capsule , the crosses G.32 x N.A. 372 and N.A. 372 x G. 32 had a positive and significant heterotic effect than mid-parent . Similar findings were also obtained by Tyagi and Singh (1981) .

For 1000-seed weight, significantly positive heterotic effect was obtained for crosses G. 25 x N.A. 413 , G. 32 x N.A. 413 , G. 32 x N.A. 372 , N.A. 413 x N.A. 372 and N.A.372 x N.A. 413 than mid-parent and cross N.A. 413 x N.A. 372 than better parent . The present results are in agreement with those obtained by Sarathe and Dabral (1969) , Srivastava and Prakash (1977) , Murty (1979), Ibrahim et al. (1983a).

For seed yield per plant , the crosses G. 32 x N.A.372, G. 32 x N.A. 130 , N.A. 413 x N.A. 372 , N.A. 282 x N.A. 372 , N.A. 372 x G. 32 , N.A. 130 x G. 32 , N.A.372 x N.A. 413 and N.A. 372 x N.A. 282 ; and G. 32 x N.A. 372 , N.A. 413 x N.A.372, N.A. 282 x N.A. 372 , N.A. 372 x G.32 , N.A. 130 x G. 32 and N.A. 372 x N.A. 282 showed significantly positive heterotic effect than mid-parent and better parent , respectively . Similar results were obtained by Sarathe and Dabral (1969) , Dixit (1976) , Srivastava and Prakach (1977) , Kotecha and Yermanos (1978) , Ibrahim et al.(1983a)and Sharan and Ragab (1986) .

Comparing the F_1 hybrids for oil percent revealed that 19 crosses exceeded significantly heterotic effect than mid-parent value and six crosses surpassed their higher parent showing useful heterosis . The obtained results are in agreement with those obtained by Hooks *et al*. (1971) , El-Ahmar (1978), Ibrahim *et al*. (1983a)and Sharan and Ragab (1986) .These results are different from those of Sarathe and Dabral(1969).

With respect to protein percent, crosses surpassed significantly the mid-parent value . Non of the hybrids showed significantly than the better parent .

(B) Genetical Prameters :

Analysis of variance for combining ability :

The mean performance of genotypes; i.e. the parental lines , and their F_1 and the reciprocal crosses , were analysed for combining ability as outlined by Griffing's (1956) method 1 model 1 .

Table 8 presents the mean squares for , general (GCA) ; specific (SCA) combining ability , reciprocal effect (R.SCA) and GCA / SCA ratios for all studied traits . The mean squares associated with general and specific combining ability were significant for all traits .

Variances of general and specific combining ability have been determined and related to the possible types of gene action involved (Spraque and Tatum , 1942) . To get an idea about the prediction performance of single-cross progeny in each case , the relative size of general to specific combining ability mean squares may be helpful . High ratios which largely exceed the unity were obtained in all traits, indicating that the largest part of the total genetic variability associated with those traits was a result of additive and additive by additive gene action .

The genetic variance was previously reported to be mostly due to additive type of gene action for , days from

Table 8 : Observed mean squares for general and specific combining ability from diallel cross analysis for various agronomic and chemical characters .

Source	D.F	Mean Squares					
		Days to flowering	Days to maturity	Plant height (cm)	Height of the first capsule (cm)	Fruiting zone length (cm)	No.of fruiting branches
Replications	3	1.31	4.94	1159.91*	115.65	793.80	8.07
G.C.A.	5	1224.80**	6927.20**	32596.80**	10517.20**	23645.00**	699.60**
S.C.A.	15	16.20**	172.20**	2523.60**	545.60*	2258.80**	57.40**
R.S.C.A.	15	1.80	12.40**	1036.60**	163.60	1303.00**	8.40**
Error	576	1.40	2.00	159.60	237.00	380.60	2.00
G.C.A./S.C.A		75.60:1	40.23:1	12.92:1	19.28:1	10.47:1	12.19:1

* Significant at p = 0.05 ; ** Significant at p = 0.01

G.C.A. refers to general combining ability

S.C.A. refers to specific combining ability

R.S.C.A. refers to reciprocal specific combining ability .

Table 8 . Continued.....

Source	D.F	Mean Squares: No. of capsules / plant	No. of seeds / capsule	1000-seed weight (gm)	Seed yield / plant (gm)	Oil %	Protein %
Replications	3	168.29	14.72	0.051*	23.45	0.07	0.06
G.C.A.	5	201112.60**	2603.80**	18.560**	3266.88**	112.28**	21.40**
S.C.A.	15	31792.60**	131.00**	0.240**	1102.40**	6.00**	0.28**
R.S.C.A.	15	4836.40	8.40	0.080**	48.80	0.73**	0.08
Error	576	2534.80	35.60	0.012	92.80	0.20	0.13
G.C.A./S.C.A		6.33:1	19.88:1	77.33:1	2.96:1	18.71:1	76.43:1

* Significant at P = 0.05 ; ** Significant at P = 0.01

G.C.A. refers to general combining ability .

S.C.A. refers to specific combining ability .

R.S.C.A. refers to reciprocal specific combining ability .

sowing to flowering (Singh , 1973 ; Dixit, 1975 ; Murty , 1975 ; Chandhary _et al_., 1977 ; Fatteh _et al_., 1982 ; Ibrahim _et al_., 1983 b; Singh _et al_., 1983 ; Sharma and Chauhan, 1984; and Sharan and Ragab , 1986) ; days from sowing to maturity, (Fatteh _et al_., 1982 ; and Sharma and Chauhan , 1984) ; plant height (Anand and Murty, 1969 ; Singh, 1973 ; Murty , 1975 ; Chandhary _et al_, 1977 ; Kotecha and Yermanos , 1978 ; Gupt, 1981 ; Shrivas and Singh , 1981 ; Fatteh _et al_., 1982; Ibrahim _et al_., 1983 b; Singh _et al_., 1983 ; and Sharma and Chauhan , 1984) ; height of the first capsule (Shrivas and Singh , 1981 ; Ibrahim _et al_., 1983b; and Sharan and Ragab , 1986) ; fruiting zone length , (Singh , 1973 ; Ibrahim _et al_. 1983b; and Sharan and Ragab, 1986) ; number of fruiting branches (Anand and Murty , 1969 ; Singh , 1973 ; Dixit, 1975 ; Murty , 1975 ; Chandhary _et al_., 1977 ; Gupta, 1981 ; Shrivas and Singh , 1981 ; Fatteh _et al_., 1982 ; Ibrahim _et al_.,1983b; Singh _et al_., 1983 ; and Sharma and Chauhan , 1984) ; number of capsules per plant (Anand and Murty , 1969 ; Dixit, 1975; Kotecha and Yermanos , 1978 ; Gupta , 1981 ; Shrivas and Singh, 1981 ; Fatteh _et al_., 1982 ; Ibrahim _et al_., 1983b; Sharma and Chauhan , 1984 ; and Sharan and Ragab, 1986) ; 1000-seed weight (Giriraj , 1973 ; Fatteh _et al_., 1982 ; Ibrahim _et al_., 1983b; Singh _et al_, 1983 ; and Sharma and Chauhan, 1984) ; seed yield per plant (Badwal and Gupta , 1970 ; Singh, 1973; Murty , 1975 ; Kotecha and Yermanos , 1978 ; Gupta, 1981 ;

Shrivas and Singh , 1981 ; Fatteh *et al*., 1982 ; Ibrahim *et al*., 1983b; Singh *et al*., 1983 ; and Sharma and Chauhan , 1984) ; oil percent (Murty , 1975 ; Fatteh *et al*., 1982 ; Ibrahim *et al*., 1983b, and Sharma and Chauhan, 1984) .

The mean squares associated with reciprocal effect were highly significant for , days from sowing to maturity , plant height , fruiting zone length , number of fruiting branches , seed index and oil percent . However, insignificant mean squares for reciprocal effect were obtained for the other traits . The wide differences between hybrids and their reciprocals were showed in this study (Table 11) from the crosses N.A. 372 x G. 25, N.A. 130 x G. 25 , N.A. 413 x G.25 , N.A. 282 x N.A. 413 , N.A. 372 x N.A. 413 , N.A. 130 x N.A.372 for days to maturity , G. 32 x G. 25 , N.A. 413 x G. 25 , N.A. 372 x G.25 , N.A. 413 x G. 32 , N.A. 282 x G. 32 , N.A. 372 x N.A. 413 , N.A. 130 x N.A. 413 for plant height , G.32 x G. 25 , N.A. 372 x G. 25 , N.A. 282 x G. 32 , N.A. 130 x N.A. 413 for fruiting zone length , N.A. 282 x G.25, N.A. 372 x G.25 , N.A. 372 x G. 25 for number of fruiting branches , G. 32 x G. 25 , N.A. 413 x G. 25 , N.A. 130 x G.25 , N.A. 413 x G.32 , N.A. 282 x G. 32 , N.A. 372 x N.A. 413 , N.A. 130 x N.A. 372 for 1000-seed weight and N.A. 372 x N.A. 282 for oil content .

Significant reciprocal SCA mean squares was also obtained by Anand and Murty (1969) , Singh (1973) , Fatteh *et al*.(1982)

and Ibrahim *et al*.(1983b)for days to flowering , by Fatteh *et al*. (1982) for days to maturity by Anand and Murty (1969), Singh (1973) , Fatteh *et al*. (1982) and Sharma and Chauhan (1984) for plant height by Ibrahim *et al*. (1983b), for height of the first capsule by Singh (1973) , Fatteh *et al*.(1982) and Ibrahim *et al*. (1983b); for fruiting zone length by Anand and Murty (1969) , Singh (1973) , Fatteh *et al*.(1982) and Ibrahim *et al*. (1983b)for number of fruiting branches by Anand and Murty (1969) , Giriraj (1973) and Ibrahim *et al*.(1983,b) for number of capsules per plant by Giriraj (1973), Fatteh *et al*. (1982) and Ibrahim *et al*. (1983b)for 1000-seed weight by Singh (1973) , Fatteh *et al*.(1982) and Ibrahim *et al*.(1983 b) for seed yield per plant , by Fatteh *et al*. (1982) , Ibrahim *et al*. (1983b)and Sharma and Chauhan (1984) for oil percent.

Insignificant reciprocal SCA was reported by Yermanos and Kotecha (1978) and Shorma and Chauhan (1984) for days to flowering , by Sharma and Chauhan (1984) for days to maturity, by Yermanos and Kotecha (1978) for height of the first capsule, by Sharma and Chouhan (1984) for number for fruiting branches, Fatteh *et al*. (1982) and Sharma and Chauhan (1984) for number of capsules per plant , by Sharma and Chauhan (1984) for 1000-seed weight and by Sharma and Chauhan (1984) for seed yield per plant .

In autogamous crops like sesame , the breeder is normally aiming at isolating parental combinations that are likely to produce desirable homozygous segreates . The utility at identifying such pure lines is facilitated by the proponderance of additive genetic variance in many self-pollinated crops (Joshi and Dhawan, 1966) . In this investigation , the additive genetic variance which is predominant for all studied traits may be exploited for improvement of these traits through conventional breeding procedures .

1. General combining ability effects :

Estimations of general combining ability effects ($\hat{g}_i$) for individual parental lines in each trait are presented in Table 9 . Therortically an estimate of general combining ability effect of a hine is not an absolute value . It actually depends upon the group of lines to which this particular line was crossed in diallel crossing system . If the line is exactly average in its general combining ability , the expected estimate ($\hat{g}_i$) would be zero . Significant departure from zero , either positive or negative , would indicate that the line is much better or much poorer than the overall average of the parental lines involved in the test .

General combining ability effects ($\hat{g}_i$) computed herein were found to differ significantly from zero in all cases . High positive values would be of interest under most traits

Table 9 . Estimates of general combining ability effects .

Parents	Variables					
	Days to flowering	Days to maturity	Plant height (cm)	Height of the first capsule (cm)	Fruiting zone length (cm)	No. of fruiting branches
Giza 25	+ 0.85**	- 0.43**	+ 7.17**	+ 8.62**	- 1.44	+ 2.63**
Giza 32	+ 1.37**	+ 3.19**	+ 14.34**	+ 4.64**	+ 9.70**	- 1.34**
N.A. 413	- 1.13**	- 4.92**	- 14.72**	- 8.59**	- 6.13**	- 1.68**
N.A. 282	+ 1.48**	+ 4.38**	+ 6.76**	- 6.80**	+ 13.56**	- 1.27**
N.A. 372	+ 1.56**	+ 5.53**	- 12.60**	+ 0.35	- 12.94**	+ 1.02**
N.A. 130	- 4.13**	- 7.74**	- 0.95	+ 1.78*	- 2.74*	+ 0.64**
S.E. ($\hat{g}_i$)	0.071	0.085	0.744	0.907	1.149	0.086
S.E. ($\hat{g}_i - \hat{g}_J$)	0.110	0.038	1.153	1.405	1.781	0.134
$r^{(1)}$	0.99	0.98	0.94	0.96	0.90	0.98

* Significant at P = 0.05 ; ** Significant at p = 0.01 .

$r^{(1)}$ Correlation coefficient between the parental performance and its G.C.A. effects .

Table 9 . Continued ...

Parents	Variables					
	No. of capsules / plant	No. of seed / capsule	Seed yield / plant(gm)	1000 - seed weight (gm)	Oil %	Protein %
Giza 25	+ 30.83**	+ 1.84**	+ 6.39**	+ 0.06**	+ 2.05**	- 0.94**
Giza 32	- 37.29**	+ 0.84*	- 1.60**	+ 0.48**	+ 1.10**	- 0.45**
N.A. 413	- 28.19**	- 0.02	- 3.67**	+ 0.01**	- 0.43**	+ 0.43**
N.A 282	- 8.13**	+ 4.73**	- 3.05**	- 0.36**	- 2.25**	+ 0.86**
N.A 372	+ 27.42**	- 4.18**	+ 1.15*	- 0.08**	- 0.91**	+ 0.38**
N.A 130	+ 15.36**	- 3.21**	+ 0.78	- 0.12**	+ 0.44**	- 0.29**
S.E.($\hat{g}_i$)	2.967	0.352	0.568	0.006	0.059	0.048
S.E.($\hat{g}_i-\hat{g}_J$)	4.596	0.545	0.879	0.010	0.091	0.075
$r^{(1)}$	0.92	0.98	0.91	0.94	0.95	0.95

* Significant at P = 0.05 ; ** Significant at P = 0.01

$r^{(1)}$ Correlation coefficient between the parental performance and its G.C.A. effects .

in question , however for days to flowering and maturity and height of the first capsule , the reverse situation; i.e. high negative values, may be useful from the breeder point of view . N.A. 130 and N.A. 413 showed significant negative general combining ability effects for flowering and maturity dates, indicating that these parental lines could be considered as good combiners for developing early genotypes . Again, N.A.413 showed significant negative ($\hat{g}_i$) effect for height of the first capsule and plant height revealing that this parental line could be considered as good combiner for releasing short lines and lower of first capsule . Releasing short cultivars may be of special interest and N.A. 413 will be an exellent parent in such purpose as it gave the highest negative general combining ability effect . While G.25, N.A. 372 and N.A. 130 showed significant positive general combining ability effects for number of capsules per plant . The local cultivar contributed the highest value in this respect . The rest of parental lines gave significant negative general combining ability effect . G. 25 and N.A. 372 appeared to be good combiners for number of capsules per plant .

G. 25 , G. 32 and N.A. 282 had significant positive general combining ability effects for number of seeds per capsule . N.A. 282 appeared to be the good combiner for number of seeds per capsule . However, the rest parental lines showed either significant negative general combining ability values or nonappreciable positive .

local variety G. 32 seemed to be the best combiner for 1000-seed weight . G.25 and N.A. 413 showed significant positive general combining ability effects for 1000-seed weight , while the rest of the lines showed significant negative G C A for this trait . G. 25 and N.A. 372 had considerable significant positive general combining ability effects for seed yield per plant , and proved to be the good combiners in this respect and G. 25 contributed the highest value . The other parental lines showed either significant negative ($\hat{g}_i$) values or non significant for seed yield per plant .

Concerning yield and its components , it is worthnoting that the cultivar which possessed high general combining ability effects in seed yield might be also so in one or more of the traits contributing yield . On the other hand, the cultivars which had high general combining ability effects for yield components may not necessarily had high general combining effects for seed yield .

G. 25 , G. 32 and N.A. 130 had significant positive general combining ability effects for oil content , but the two local cultivars contributed the highest values in this respect . However, these parental cultivars gave significant negative ($\hat{g}_i$) for protein content . While, the other parental lines had significant positive ($\hat{g}_i$) for protein content.

It is interesting for plant breeder to ask whether the GCA for a parent agrees with its own performance or are some parents more potent when crossed than would be expected from their own performance . The results obtained herein proved an agreement between the parental performance and its ($\hat{g}_i$) effect for all traits . This finding indicates that intrinsic performance of parental lines gave a good index of their general combining ability effects . Therefore, selection with the tested parental population for intiating any proposed breeding program could be practised either an mean performance or ($\hat{g}_i$) effect basis with similar efficiency . Such agreement might add another proof about the preponderance of additive genetic variance in all traits , coinciding with the findings reached above in Table 9 . A rather good agreement between ranking the lines according to their ($\hat{g}_i$) effects and ranking based on parental performance per se was reported, by Murty (1975), Kotecha and Yermanos (1978) , Gupta (1981) , Fatteh *et al*.,(1982) , Ibrahim *et al*. (1983b), Singh *et al*., (1983) and Sharma and Chauhan (1984) .

2. Specific combining ability effects :

Estimates of the specific combining ability effects in the fifteen crosses for the studied traits are presented in Table 10 .

For flowering date , three combinations showed significantly negative specific combining ability effect . One out of these three combinations was between parental lines of high and low specific combining ability effects towards earliness . Considerable negative specific combining ability effects were obtained in the two crosses G.32 x N.A. 413 and N.A. 413 x N.A. 282 where each of both comprised two good combiners for earliness .

For maturity date, five crosses showed significantly negative specific combining ability effect . On the same order, however , seven crosses had significant positive S.C.A effect. Generally the crosses N.A. 413 x N.A. 282 and G.32 x N.A. 413 had the lowest values of S.C.A . effect for both flowering and maturity dates and these crosses could be considered as the best ones for earliness . On the contrary , the cross N.A. 282 x N.A. 130 exhibited the worst S.C.A. effect for the trait in question .

For plant height , seven crosses showed positive and significant S.C.A. effects . However, the crosses G.25 x N.A. 130 had significantly negative S.C.A. effect . Insignificant S.C.A. effect was detected in the other crosses .

With respect to the first capsule height, only the cross G. 25 x N.A. 130 gave significantly negative S.C.A. effect and

Table 10 . Estimates of specific combining ability effects for the crosses studied .

Crosses	Days to flowering	Days to maturity	Plant height (cm)	Height of the first capsule (cm)	Fruiting zone length (cm)	No. of fruiting branches
	Variables					
$P_1 \times P_2$	- 0.41**	+ 2.11**	+ 4.18**	+ 2.72	+ 1.47	+ 0.21
$P_1 \times P_3$	- 0.28	+ 0.59**	+ 5.49**	+ 3.44	+ 2.05	+ 0.02
$P_1 \times P_4$	+ 0.09	+ 0.49**	- 2.11	+ 0.90	- 3.01	+ 1.44**
$P_1 \times P_5$	+ 0.11	- 0.51**	+ 4.87**	- 2.37	+ 7.24**	+ 0.83**
$P_1 \times P_6$	+ 0.42**	- 1.46**	- 6.28**	- 6.18**	+ 0.10	- 0.77**
$P_2 \times P_3$	- 0.35*	- 1.83**	+ 1.20	+ 5.42**	- 4.22	- 0.44*
$P_2 \times P_4$	+ 0.12	+ 1.42**	+ 5.85**	+ 1.88	+ 3.97	- 0.94**
$P_2 \times P_5$	- 0.06	+ 0.01	+ 0.08	- 2.14	+ 2.22	+ 0.45**
$P_2 \times P_6$	+ 0.27	- 2.24**	- 2.32	- 2.33	+ 0.01	+ 1.87**
$P_3 \times P_4$	- 0.98**	- 3.92**	- 1.97	- 1.39	- 0.58	- 1.20**
$P_3 \times P_5$	+ 0.12	- 0.12	- 9.86**	- 3.66	- 6.20*	+ 1.18**
$P_3 \times P_6$	+ 0.77**	+ 1.58**	- 0.26	+ 1.53	- 1.78	+ 0.61**
$P_4 \times P_5$	+ 0.21	- 0.40*	+ 9.91**	+ 3.42	+ 6.49**	+ 1.33**
$P_4 \times P_6$	+ 0.74**	+ 2.85**	+ 3.39*	+ 0.36	+ 3.03	+ 0.55**
$P_5 \times P_6$	+ 0.12	+ 2.52**	+ 13.62**	+ 0.97	+ 12.65**	- 1.44**
S.E. ($\hat{S}_{ij}$)	0.149	0.179	1.561	1.903	2.411	0.181
S.E.($\hat{S}_{ij} - \hat{S}_{ik}$)	0.246	0.295	2.578	3.143	3.982	0.299
S.E(($\hat{S}_{ij} - \hat{S}_{kL}$	0.220	0.264	2.306	2.811	3.561	0.267

* Significant at P = 0.05 ; ** Significant at P = 0.01 .

Table 10 . Continued . .....

Crosses	No.of capsules / plant	No.of seeds /capsule	Seed yield/ plant (gm)	1000-seed weight (gm)	Oil %	Protein %
	Variables					
$P_1 \times P_2$	+ 16.25**	- 1.26	+ 4.29**	+ 0.026*	+ 0.72**	+ 0.11
$P_1 \times P_3$	- 5.97	+ 0.91	+ 2.80*	+ 0.081**	- 0.02	+ 0.11
$P_1 \times P_4$	+ 28.81**	- 0.75	+ 2.39*	- 0.047**	- 1.07**	+ 0.12
$P_1 \times P_5$	+ 6.94	+ 1.07	- 2.44*	- 0.096**	+ 0.30*	+ 0.10
$P_1 \times P_6$	- 6.98	+ 0.59	- 3.17**	+ 0.058**	+ 0.58**	- 0.08
$P_2 \times P_3$	+ 0.99	+ 1.00	- 2.65*	+ 0.032*	+ 0.22	+ 0.01
$P_2 \times P_4$	- 20.05**	+ 1.47*	- 3.70**	- 0.159**	- 0.77**	+ 0.25*
$P_2 \times P_5$	+ 0.08	+ 2.83**	+ 6.50**	+ 0.091**	+ 0.49**	- 0.14
$P_2 \times P_6$	+ 40.49**	+ 0.76	+ 5.75**	+ 0.028*	+ 0.89**	- 0.14
$P_3 \times P_4$	- 16.39**	+ 0.14	- 2.38*	+ 0.045**	+ 0.30*	- 0.26*
$P_3 \times P_5$	+ 23.36**	- 1.32*	+ 2.89*	+ 0.058**	+ 1.05**	+ 0.05
$P_3 \times P_6$	- 7.18	+ 1.45*	+ 3.46**	- 0.048**	+ 0.08	+ 0.33**
$P_4 \times P_5$	+ 45.64**	+ 0.75	+ 6.77**	+ 0.028*	+ 0.85**	- 0.14
$P_4 \times P_6$	+ 19.12**	+ 0.17	+ 2.52*	+ 0.014	- 0.12	+ 0.19
$P_5 \times P_6$	- 21.98**	+ 0.49	- 1.16	- 0.009	- 0.91**	- 0.03
S.E. ($\hat{S}_{ij}$)	6.223	0.738	1.190	0.013	0.123	0.101
S.E.($\hat{S}_{ij} - \hat{S}_{ik}$)	10.277	1.219	1.966	0.022	0.203	0.167
S.E.($\hat{S}_{ij} - \hat{S}_{kL}$)	9.192	1.091	1.758	0.019	0.182	0.149

* Significant at P = 0.05 ; ** Significant at P = 0.01

this cross could be considered as the best one for lower capsule . However, cross G.32 x N.A. 413 had significantly positive S.C.A. effect .

Regarding fruiting zone length, three crosses G.25 x N.A. 372 , N.A. 282 x N.A. 372 and N.A. 372 x N.A. 130 had significant positive S.C.A. effect . On the contrary , the cross N.A. 413 x N.A. 372 showed significantly negative S.C.A. effect .

For number of fruiting branches , eight crosses showed significantly positive S.C.A. effects . The cross N.A.413 x N.A. 372 had the highest S.C.A. effect . However, five hybrids gave significantly negative S.C.A. effects (Table 10).

For number of capsules per plant, the crosses G.25 x G.32 , G.25 x N.A. 282 , G. 32 x N.A. 130 , N.A. 413 x N.A. 372, N.A. 282 x N.A. 372 and N.A. 282 x N.A. 130 showed significantly positive S.C.A. effects . While crosses G.32 x N.A. 282, N.A.413 x N.A. 282 and N.A. 372 x N.A. 130 had significantly negative S.C.A. effects .

Regarding to number of seed per capsule, the crosses G.32 x N.A. 282 , G. 32 x N.A. 372 and N.A.413 x N.A. 130 had significantly positive S.C.A. effects . While , the other crosses showed insignificant effect of S.C.A.

For 1000-seed weight , nine combinations had significantly positive S.C.A. effect . On the contrary , four crosses showed significantly negative S.C.A. effects .

Regarding to seed yield per plant, the crosses G.25 x G. 32, G.25 x N.A. 413 , G.25 x N.A. 282 , G. 32 x N.A. 372 , G. 32 x N.A. 130 , N.A. 413 x N.A. 372 , N.A. 413 x N.A. 130, N.A. 282 x N.A. 372 and N.A. 282 x N.A. 130 gave significantly positive S.C.A. effect . The crosses N.A. 282 x N.A. 372 , G.32 x N.A. 372 and G.32 x N.A. 130 had the highest values of S.C.A. values for seed yield per plant .

For oil percent , the crosses G.25 x G. 32 , G.25 x N.A. 372 , G.25 x N.A. 130 , G.32 x N.A. 372 , G. 32 x N.A.130, N.A. 413 x N.A. 282 , N.A. 413 x N.A. 372 , N.A. 413 x N.A.130 and N.A. 282 x N.A.372 had significantly positive S.C.A. effects . While the crosses G.32 x N.A. 282 and N.A. 413 x N.A. 130 gave significantly S.C.A. effect for protein percent.

It is worthy to note that, crosses with significantly positive or negative S.C.A. values were obtained from crossing , good by good , good by low and low by low general combiners . General combining ability effects seemed to provide an apt way for describing the behaviour of the crosses , but specific effects did not . Therefore , it could be concluded that general combining ability effects of the parental lines were generally unrelated to specific combining ability values of their corresponding crosses .

Since an outstanding specific effects requires diversity of parental lines , it will be more difficult to produce agronomically acceptable hybrids . Diverse or exotic parents may in themselves be unadapted to the local environmental conditions , i.e. susceptible to disease, late in maturity, poor quality , ... etc. Thus, it may require considerable breeding efforts to change the combining ability of these parents to acceptable level before initiating a hybrid sesame program .

3. Reciprocal specific combining ability effects :

Estimates of reciprocal specific combining ability effects (R.S.C.A.) for the fifteen of reciprocal combinations were computed (Table 11) . If reciprocal specific combining ability effect was significantly positive reciprocal mean performance would be higher than its respective F_1 mean value. On the other side , significantly negative R.S.C.A. effect revealed that the hybrid mean performance was higher than its reciprocal one . Insignificant R.S.C.A. effect, meanwhile , would indicate that no differences between a hybrid and its reciprocal mean performances was detected .

For maturity date, significant positive R.S.C.A. effect was obtained in five crosses . Significant negative R.S.C.A. effect was detected in cross N.A. 130 x N.A. 372 .

Table 11 . Estimates of reciprocal specific combining ability effects .

Crosses	Variables					
	Days to flowering	Days to maturity	Plant height (cm)	Height of the first capsule (cm)	Fruiting zone length (cm)	No.of fruiting branches
P_2 x P_1	+ 0.05	+ 0.15	+ 9.75**	+ 1.00	+ 8.75**	+ 0.38
P_3 x P_1	+ 0.03	- 0.23	+ 5.25**	+ 1.75	+ 3.50	+ 0.45
P_4 x P_1	- 0.20	+ 0.23	- 2.38	+ 2.25	- 4.63	- 0.63**
P_5 x P_1	- 0.25	+ 0.53*	- 6.75**	+ 3.38	- 10.13**	- 1.35**
P_6 x P_1	+ 0.33	+ 0.80**	- 3.50	+ 1.75	- 5.25	+ 0.03
P_3 x P_2	+ 0.13	+ 0.48*	- 4.88*	+ 0.75	- 5.63	- 0.08
P_4 x P_2	- 0.35	+ 0.13	- 9.50**	+ 2.75	- 12.25**	+ 0.03
P_5 x P_2	+ 0.05	+ 0.38	+ 0.38	- 1.63	+ 2.00	- 0.65**
P_6 x P_2	+ 0.35	+ 0.40	+ 1.13	+ 2.38	- 1.25	+ 0.00
P_4 x P_3	+ 0.15	+ 0.93**	- 3.13	- 3.00	- 0.13	+ 0.08
P_5 x P_3	+ 0.08	+ 1.28**	- 4.38*	- 3.13	- 1.25	- 0.15
P_6 x P_3	+ 0.30	- 0.30	- 7.13**	+ 0.00	- 7.13*	+ 0.20
P_5 x P_4	+ 0.03	- 0.30	+ 0.13	+ 0.75	- 0.63	+ 0.05
P_6 x P_4	+ 0.28	+ 0.43	- 2.50	+ 0.38	- 2.88	+ 0.05
P_6 x P_5	+ 0.13	- 0.50*	- 1.13	- 1.38	+ 0.25	+ 0.35
S.E.($\hat{r}_{ij}$)	0.191	0.229	1.997	2.434	3.084	0.232
S.E.($\hat{r}_{ij} - \hat{r}_{kL}$)	0.270	0.324	2.825	3.442	4.362	0.327

* Significant at P = 0.05 ; ** Significant at P = 0.01 .

Table 11 . Continued . ...

Crosses	No.of capsule/ plant	No. of seeds/ capsule	Seed yield/ plant (gm)	1000-seed weight (gm)	Oil %	Protein %
P_2 x P_1	+ 10.78	+ 0.05	+ 0.08	- 0.080**	+ 0.11	+ 0.17
P_3 x P_1	+ 20.10*	- 0.25	+ 1.43	+ 0.036*	+ 0.29	- 0.06
P_4 x P_1	- 10.90	+ 0.20	- 2.78	+ 0.009	+ 0.16	+ 0.04
P_5 x P_1	- 20.23*	- 0.80	- 1.45	- 0.022	- 0.09	+ 0.05
P_6 x P_1	+ 3.95	- 0.55	+ 0.60	+ 0.039*	+ 0.12	+ 0.10
P_3 x P_2	+ 9.00	- 0.40	+ 1.83	+ 0.093**	+ 0.09	- 0.06
P_4 x P_2	- 12.63	+ 0.28	+ 0.05	+ 0.073**	- 0.18	+ 0.09
P_5 x P_2	- 10.80	- 0.63	- 0.04	+ 0.017	+ 0.09	+ 0.03
P_6 x P_2	- 4.25	+ 0.18	- 0.48	- 0.024	- 0.02	+ 0.06
P_4 x P_3	+ 7.83	- 0.63	+ 0.40	+ 0.027	+ 0.20	- 0.02
P_5 x P_2	+ 2.98	+ 0.75	+ 1.23	+ 0.041*	+ 0.25	+ 0.08
P_6 x P_3	- 4.13	- 0.55	+ 0.13	- 0.009	+ 0.21	+ 0.03
P_5 x P_4	- 11.73	- 0.23	- 0.73	+ 0.011	- 0.57**	- 0.03
P_6 x P_4	- 6.50	+ 0.23	- 0.40	+ 0.024	+ 0.12	- 0.05
P_6 x P_5	+ 10.40	- 0.33	- 0.18	- 0.051**	- 0.16	- 0.07
S.E. ($\hat{r}_{ij}$)	7.961	0.945	1.523	0.017	0.158	0.129
S.E.($\hat{r}_{ij} - \hat{r}_{kL}$)	11.258	1.336	2.154	0.024	0.223	0.183

* Significant at P = 0.05 ; ** Significant at P = 0.01

For plant height , the crosses G. 32 x G. 25 and N.A. 413 x G. 25 exhibited significantly positive R.S.C.A. effects. The crosses N.A. 372 x G. 25 , N.A. 413 x G.32 , N.A. 282 x G.32 , N.A. 372 x N.A. 413 and N.A. 130 x N.A. 413 , expressed significantly negative R.S.C.A. effects .

With respect to fruiting zone length the cross G. 32 x G. 25 had significantly positive R.S.C.A. effect. Meanwhile, the crosses N.A. 372 x G. 25 , N.A. 282 x G.32 and N.A. 130 x N.A. 413 exhibited significantly negative R.S.C.A. effects.

For number of fruiting branches , the crosses N.A.282 x G. 25 , N.A. 372 x G.25 and N.A. 372 x G.32 had significantly negative R.S.C.A. effects .

For 1000-seed weight , significant positive reciprocal effect was detected for five crosses . However , significantly negative reciprocal effect was obtained in two crosses(Table 11).

For oil percent , the cross N.A. 372 x N.A. 282 had significantly negative R.S.C.A. effects . While, the insignificant R.S.C.A. effect was detected in rest crosses .

4. <u>Graphical analysis</u> :

The data obtained herein were also subjected to genetic analysis by means of diallel cross graphs as constructed by Jinks (1954) .

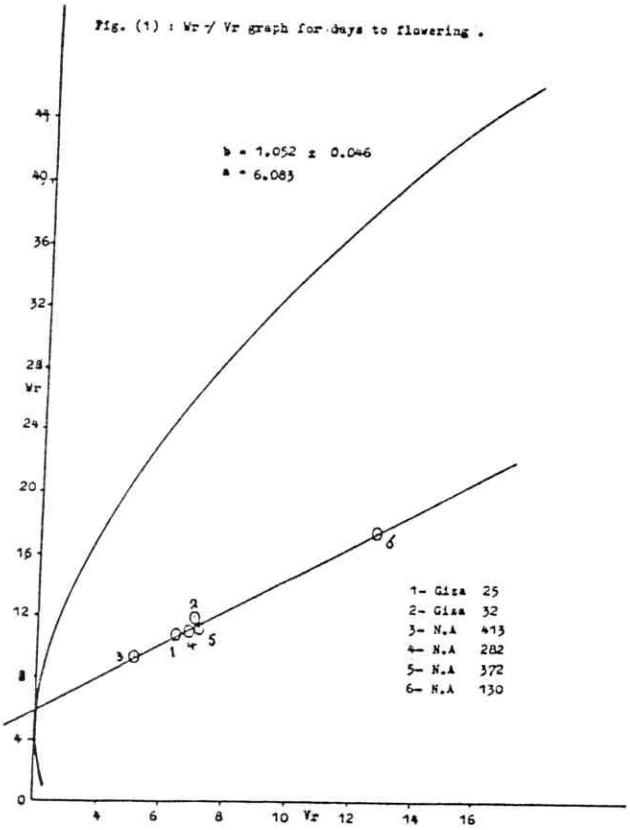

Fig. (1) : Wr / Vr graph for days to flowering .

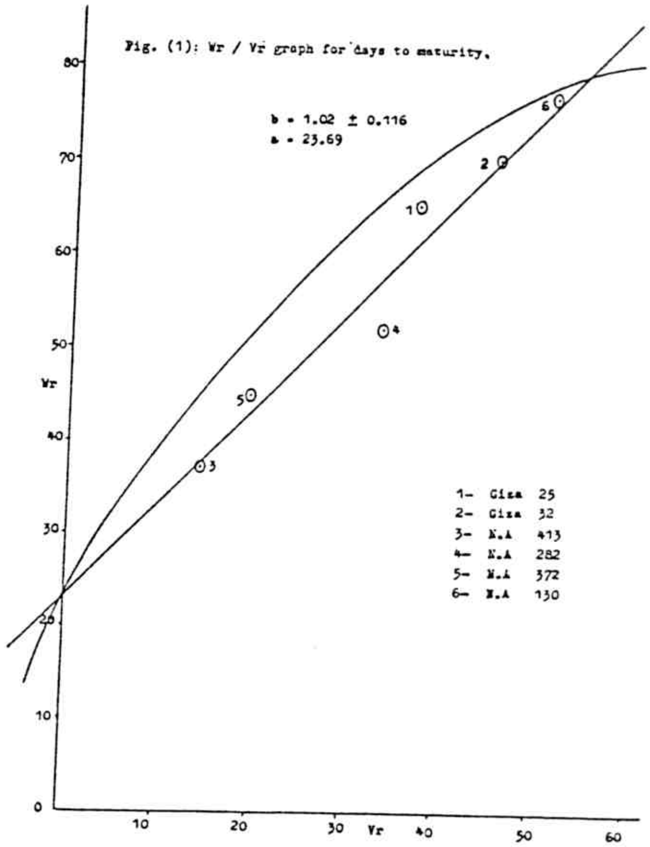

Fig. (1): Wr / Vr graph for days to maturity.

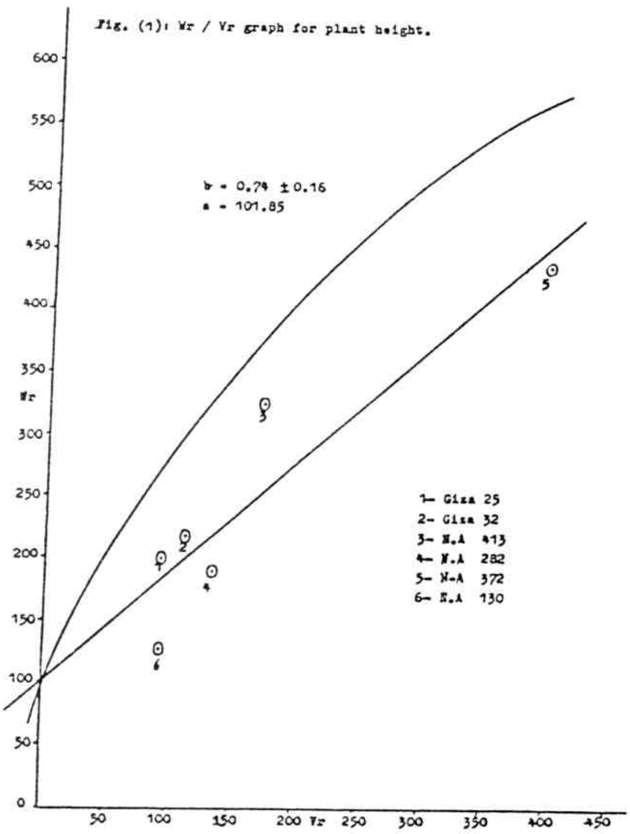

Fig. (1): Wr / Vr graph for plant height.

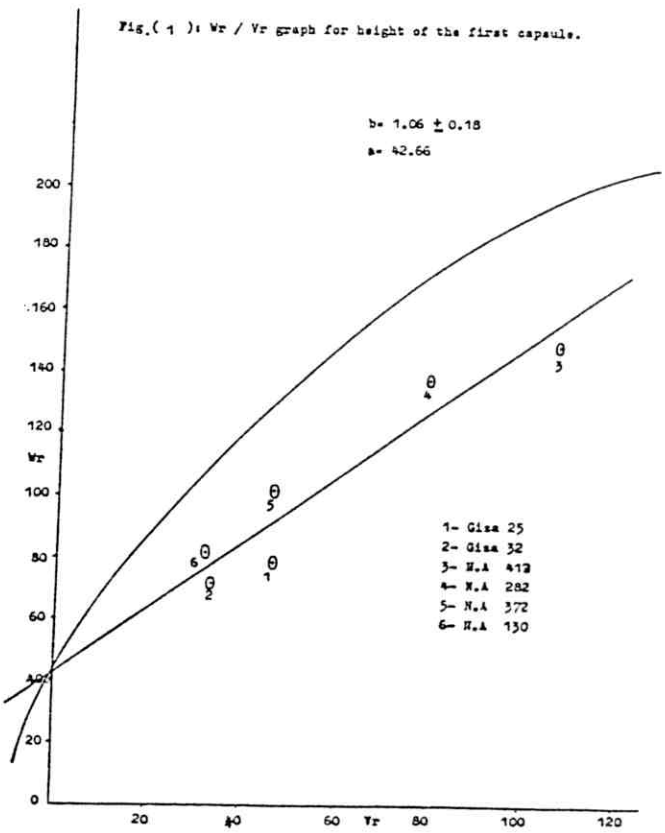

Fig.(1): Wr / Vr graph for height of the first capsule.

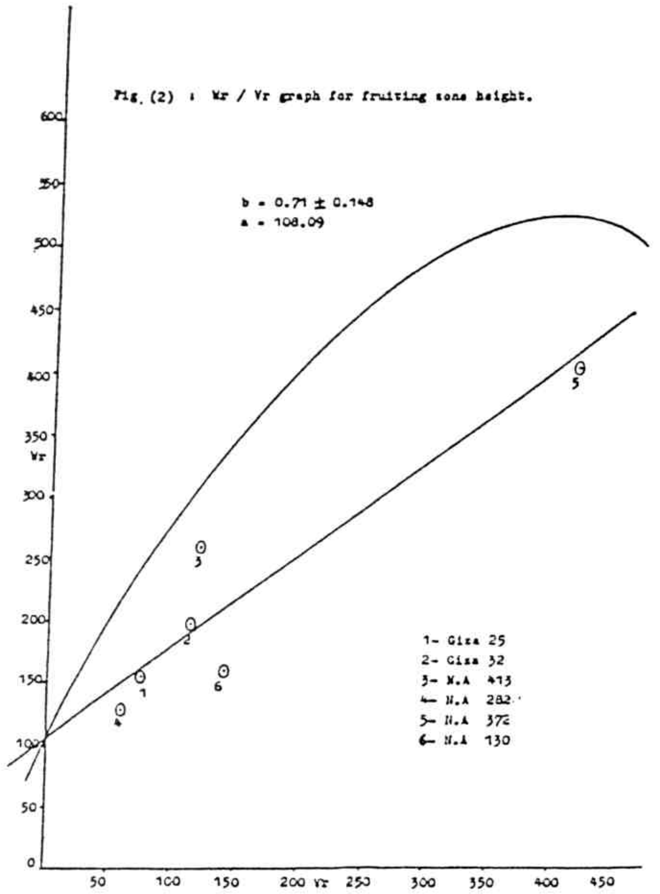

Fig. (2) : Wr / Vr graph for fruiting zone height.

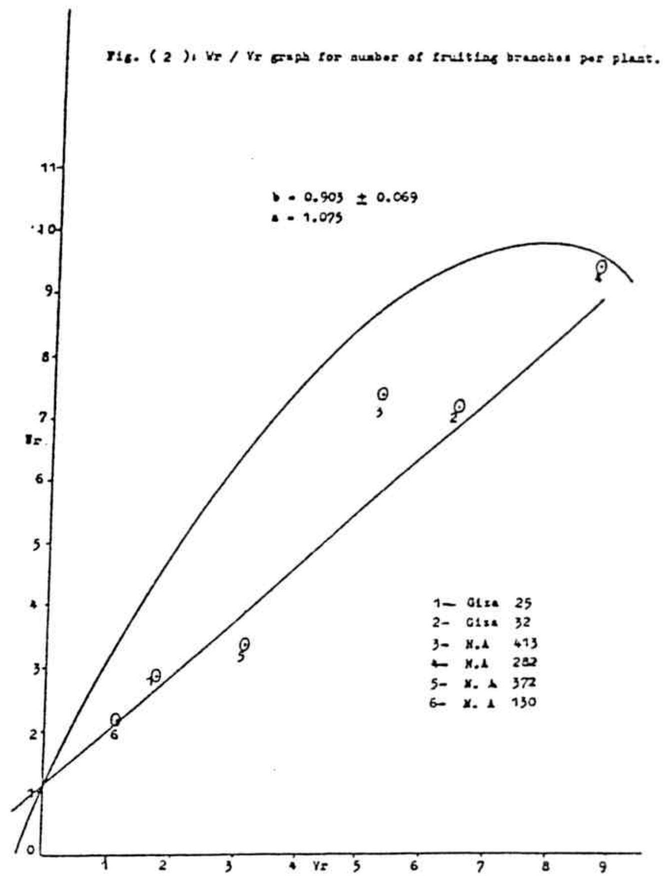

Fig. (2): Wr / Vr graph for number of fruiting branches per plant.

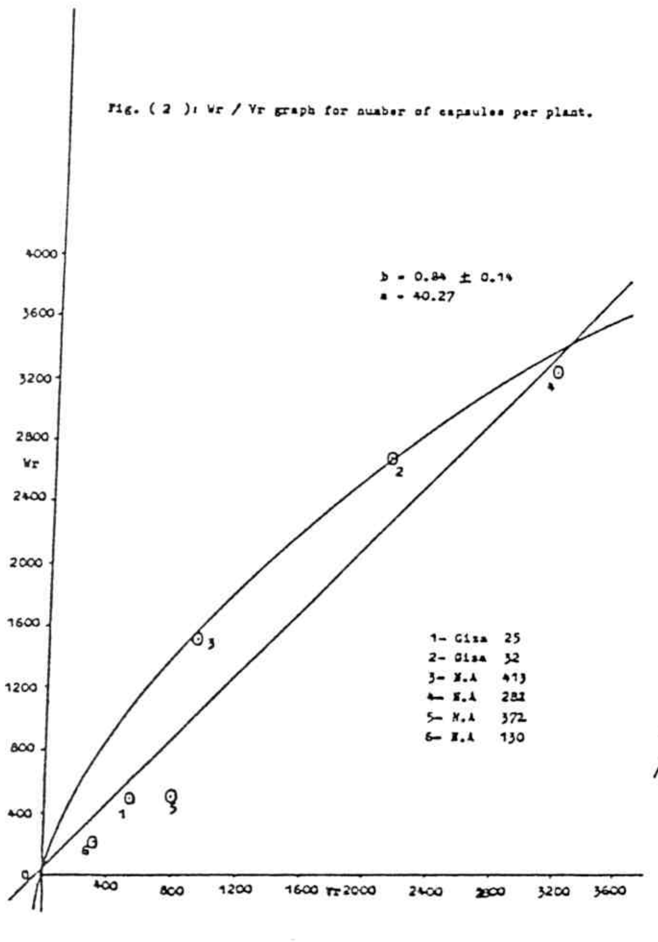

Fig. (2): Wr / Vr graph for number of capsules per plant.

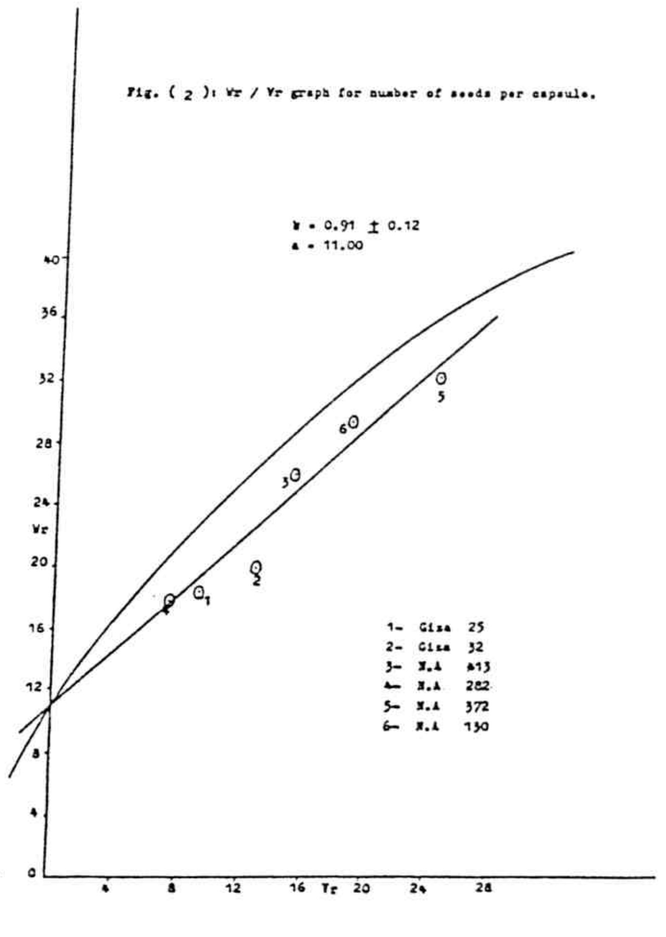

Fig. (2): Wr / Vr graph for number of seeds per capsule.

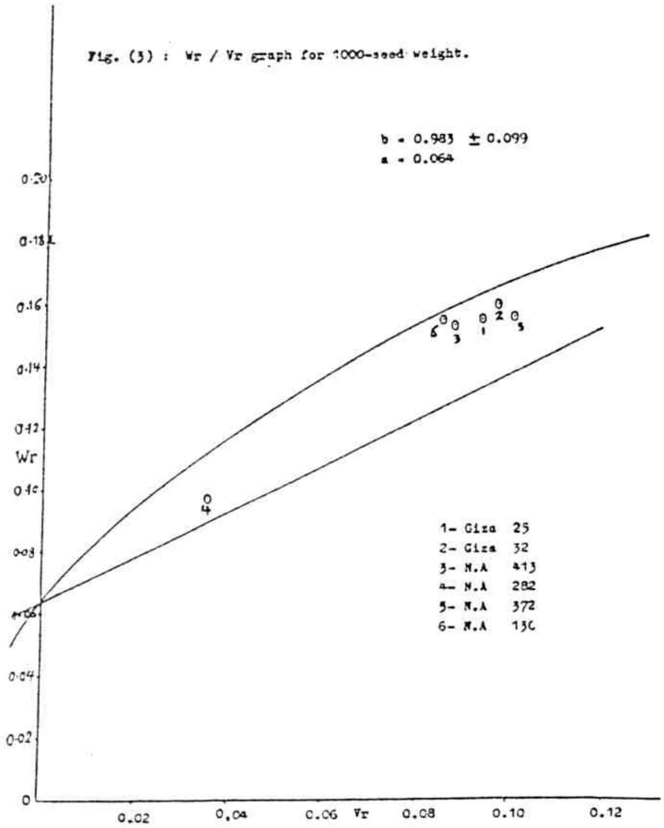

Fig. (3) : Wr / Vr graph for 1000-seed weight.

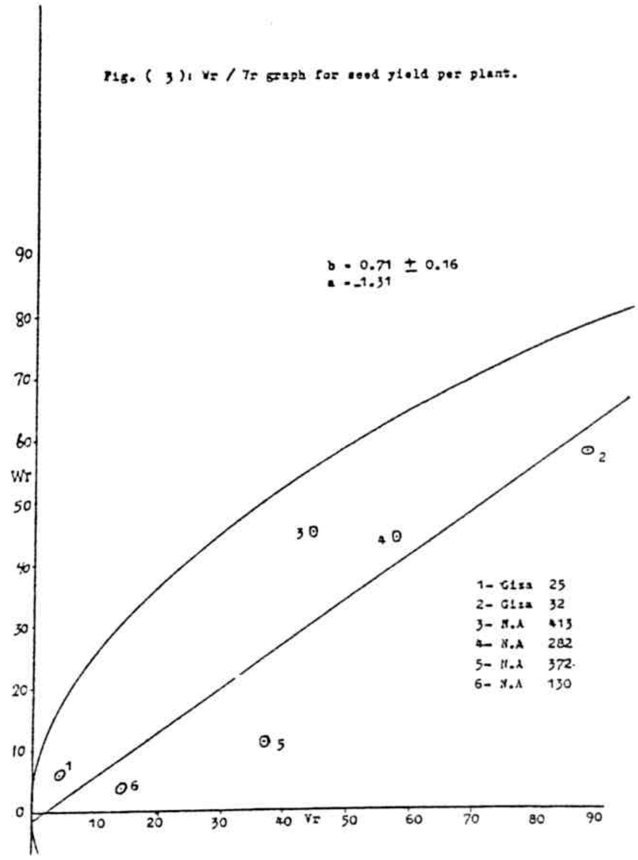

Fig. (3): Wr / Vr graph for seed yield per plant.

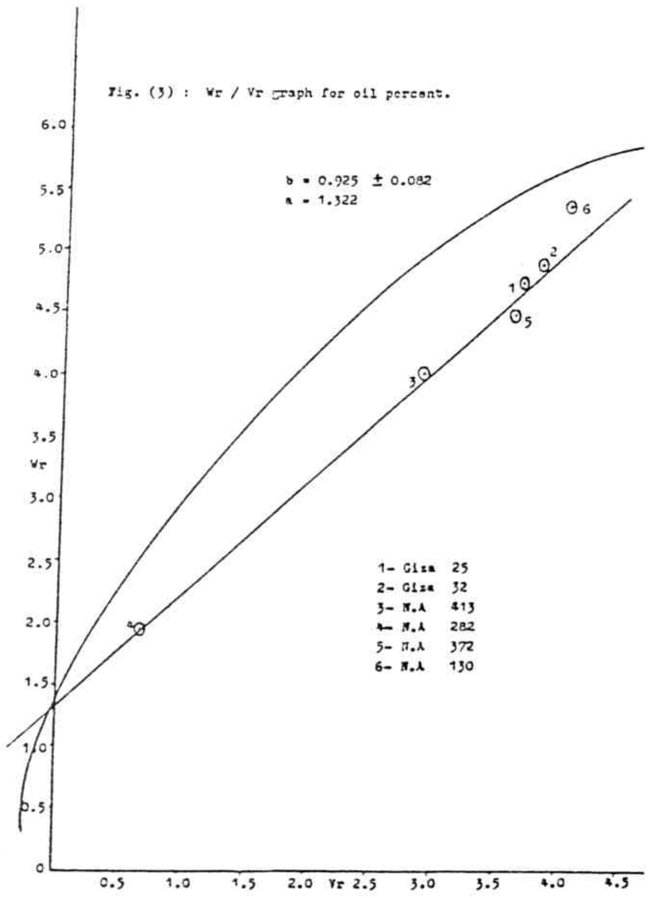

Fig. (3) : Wr / Vr graph for oil percent.

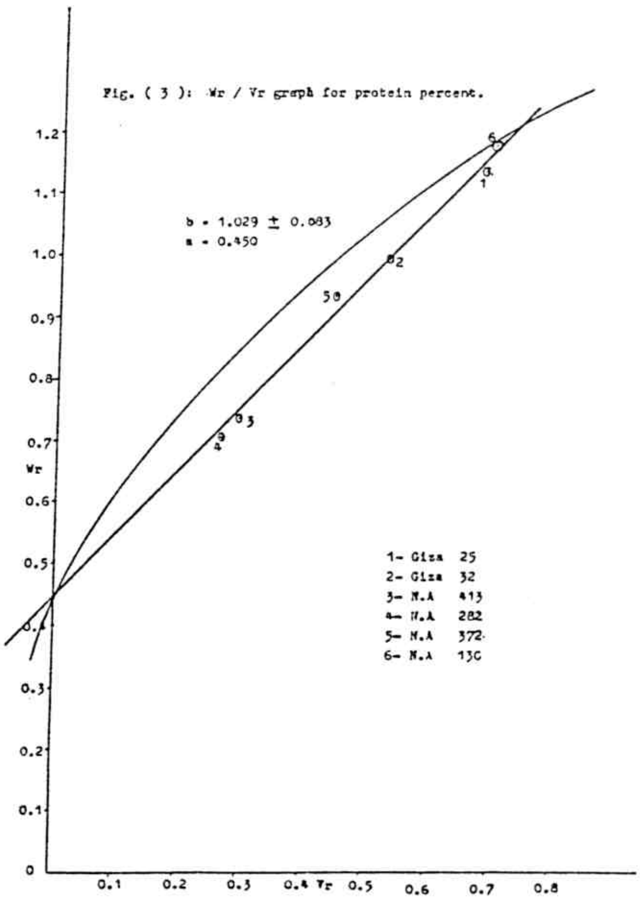

Fig. (3): Wr / Vr graph for protein percent.