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Studies on Heterosis for yield and yield components in sesame (*Sesamum indicum* L.)

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ABSTRACT: *A study was made in sesame* (Sesamum indicum *L.) to assess the extent of heterosis in 25 F_1 hybrids derived from line X tester fashion. The 25 F_1 hybrids and their ten parents (5lines X 5 testers) were used to estimate the heterosis ten traits including seed yield. The derived twenty five crosses were studied to investigate heterosis over standard checks JLT-408 and Phule Til. The best crosses based on heterosis and sca effect per se performance were RT-54 x NIC-16194, SSD-01 x NIC-16194, MT-10-13-01 x SI-982, MT-10-13-01 x IS-200 and MT-10-13-01 x NIC-86000-A was identified as the best crosses combination. These better performing hybrids can be used for exploiting hybrid vigour.*

Key words: *sesame, heterosis, L x T.*

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important oilseed crop grown all over india. It can be grown either as pure or mixed crop. It has attracted special attention as an important salad dressing and edible oil. The seed contains 45-52% oil, which has excellent stability due to the presence of natural antioxidants such as sesamolin, sesamin and sesamol. The exploitation of heterosis has been a practical proposition in many allogamous crops and a few autogamous crops. In India, sesame is cultivated on an area of 1.94 million hectare with a productivity of 389 kg/ha and 0.755 million tons production. (Anonymous, 2012). Studies on heterosis breeding in sesame are of paramount importance to achieve the goal. In the present investigation, attempts have been made to evaluate ten parents (5 line and 5 testers) and 25 hybrids through Line X Testers analysis to bring out the best parents and cross combinations with good general and specific combining abilities for seed yield and its component characters.

MATERIAL AND METHODS

The present investigation on sesame was conducted at the Oilseed Research Station, College of Agriculture, Latur-413512 during *Rabi-2013.* The present material consisting of five line and five testers were crossed in a line X testers mating design resulting in twenty five hybrids with two standard checks *viz;* JLT-408 and Phule Til.Twenty five hybrids and their ten parents were sown in rows with spacing 45 cm between row and 10 cm between plants in row during octomber 2013. The experiment was conducted in randomized block design with two replications. A fertilizer schedule of 30:60:30 kgs of NPK per hectare was followed a long with the recommended cultural operations and plant protection measures. Observations were recorded on eleven biometrical traits viz; days to first flower, days to 50 percent flowering, days to maturity, plant height (cm), number of branches per plant, number of capsule per plant, number of seed per capsule, length of capsule (cm), 1000 seed weight (g), oil content and seed yield per plant (g). The estimation of heterosis was done based on the method developed by Rai, (1979) and The analysis of variance for combining ability was done based on the method developed by Kempthorne (1957) on five randomly selected plants.

RESULT AND DISCUSSION

The analysis of variances for various economic traits are presented in table 4.1. Analysis of variance showed significant differences among parents for all eleven traits studied. This revealed the presence of significant variability in the experimental material. Earliness in the flowering is highly desirable. The crosses exhibiting significant negative heterosis effects

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for days to first flower, days to 50 per cent flowering and days to maturity are considered as desirable. The range of heterosis for days to first flowering was from (-12.33) MT-10-13-01 x NIC-8600-A to (3.65) RT-54 X NIC-16194 over mid parent, from (-13.51) MT-10-13-01 x NIC-8600-A to (1.43) OSC-207 x IS-200 over better parent, from (-9.86) MT-10-13-01 x NIC-8600-A to (2.82) SSD-01 x SI-982 over standards checks JLT-408 and from (-12.33) MT-10-13-01 x NIC-8600-A to (-1.37) MT-10-13-01 x KMR-11 over standards checks Phule Til. The range of heterosis for days to 50% flowering was from (-15.61) RT-54 x KMR-11 to (-0.60) OSC-207 x IS-200 over mid parent, from (-17.98) RT-54 x KMR-11 to (3.49) OSC-560 x IS-200 over better parent, from (-12.05) MT-10-13-01 x NIC-8600-A to (1.20) MT-10-13-01 x KMR-11 over standards checks JLT-408 and from (-15.12) MT-10-13-01 x NIC-8600-A to (3.49) OSC-207 x IS-200 over Phule til. The range of heterosis for days to maturity was from -7.53 (OSC-560 x NIC-16194) to 1.31 (SSD-01 x SI-982) over mid parent, from-9.74 (OSC-560 x NIC-8600-A) to 1.04 (SSD-01 x SI-982) over better parent result obtained by Thiyagu *et al* (2007) & Sundari and Kamala (2012).

The plant height is highly desirable for this positive heterosis effects are desirable. The cross RT-54 x SI-982 (7.59) exhibited the highest significant positive heterosis over mid parent followed by OSC-207 x SI-982 (6.41), OSC-207 x IS-200 (6.10) and OSC-207 x NIC-8600-A (19.04). The cross OSC-207 x IS-200 (4.82) exhibited the highest significant positive heterosis over better parent followed by MT-10-13-01 x KMR-11 (3.68). The Number of branches per plant ranged between -28.57 (SSD-01 x NIC-8600-A) to 23.08 (SSD-01 x NIC-16194) over mid parent, from -37.50 (SSD-01 x NIC-8600-A) to 16.67 (MT-10-13-01 x SI-982) over better parents, from -16.67 (SSD-01 x NIC-8600-A) to 33.33 (RT-54 x NIC-16194) over the check JLT-408 and Phule Til .For number of capsule per plant. The cross RT-54 x NIC-16194 (47.11) exhibited the highest significant positive heterosis over mid parent followed by MT-10-13-01 x SI-982 (31.97), RT-54 X KMR11 (23.08) and OSC-207 x KMR-11 (17.27). The cross RT-54 x NIC-16194 (36.92) exhibited the highest significant positive heterosis over better parent followed by SSD-01 x NIC-16194 (23.85), RT-54 X KMR11 (12.59), and OSC-207 x KMR-11 (8.15) result showed that Thiyagu *et al* (2007), Mishra *et al*. (2008).

The range of heterosis for number of seed per capsule was from -10.91 (SSD-01 x SI-982) to 25.77 (MT-10-13-01 x IS-200) over mid parent, from -14.55 (MT-10-13-01 x SI-982) to 24.49 (MT-10-13-01 x IS-200) over better parents, from -16.07 (MT-10-13-01 x SI-982) to 8.93 (MT-10-13-01 x IS-200) over the check JLT-408 and from -17.54 (MT-10-13-01 x SI-982) to 7.02 (MT-10-13-01 x IS-200) over the check Phule Til. The range of heterosis for length of capsule was from –6.60 (OSC-560 x NIC-8600-A) to 6.52 (OSC-560 x KMR-11) over mid parent, from -9.67 (OSC-560 x NIC-8600-A) to 5.15 (OSC-560 x KMR-11) over better parents. The cross OSC-207 x NIC-8600-A (15.26) exhibited the highest significant positive heterosis over mid parent followed by OSC-560 x NIC-8600-A (6.16). The cross OSC-207 x NIC-8600-A (10.82) exhibited the highest significant positive heterosis over better parent followed by SSD-01 x IS-200 (6.87) and SSD-01 x NIC-8600-A (6.72). The cross OSC-207 x NIC-8600-A (14.97) exhibited the highest significant positive heterosis over the check JLT-408 followed by SSD-01 x NIC-8600-A (10.71). The cross OSC-207 x NIC-8600-A (17.16) exhibited the highest significant positive

Table 1
Analysis of variance of parents and hybrids for 11 characters in Sesame

Sr. No.	*Characters*	*Sources of variation*			*S.E.(±)*
		Replication MSS	*Treatment MSS*	*Error MSS*	
		d.f. (1)	*d.f. (32)*	*d.f. (32)*	
1	Days to first flowering	0.357	3.321*	1.533	1.215
2	Days to 50 per cent flowering	5.157	8.081**	2.374	1.505
3	Days to maturity	3.214	19.141**	4.949	2.197
4	Plant height (cm)	4.628	18.111**	6.187	2.509
5	Number of branches / plant	0.112	0.324*	0.064	0.3949
6	Number of capsule / plant	9.657	200.90**	10.363	3.260
7	Number of seed / capsule	4.628	29.327**	2.157	1.484
8	Length of capsule (cm)	0.00052	0.01603**	0.00127	0.0347
9	1000 seed weight (gm)	0.0025	0.1445**	0.0076	0.0850
10	Oil content (%)	0.112	8.611**	0.333	0.598
11	Seed yield / plant (gm)	0.155	17.534**	0.796	0.914

Table 2
Range of heterosis and number of crosses showing significant heterosis in desired direction for yield & yield and yield contributing characters in sesame

Sr.No.	*Name of the character*	*Heterosis (%) over MP*		*Heterosis (%) over BP*		*Heterosis (%) over SC-1*		*Heterosis (%) over SC-2*	
		Range	*No. of desired crosses*	*Range*	*No. of desired crosses*	*Range*	*No. of desired crosses*	*Range*	*No. of desired crosses*
1	Days to frist flowering	-12.33 to 3.65	8	-13.51 to 2.90	9	-9.86 to 2.82	3	-12.33 to -1.37	13
2	Days to 50 per cent flowering	-15.61 to 0.60	13	-17.98 to -3.49	12	-12.05 to 3.61	4	-15.12 to -2.33	13
3	Days to maturity	-7.53 to 1.31	15	-9.74 to 1.04	12	-7.37 to 2.11	9	-9.28 to -1.03	14
4	Plant height (cm)	-6.02 to 7.59	4	-8.05 to 4.82	2	-4.88 to 6.10	0	-5.95 to 3.57	1
5	Number of branches per plant	-28.57 to 23.08	4	-37.50 to 16.67	2	-16.67 to 33.33	8	-16.67 to 33.33	8
6	Number of capsule per plant	-22.30 to 47.11	12	-29.29 to 36.92	17	7.61 to 93.48	24	-1.98 to 59.41	19
7	Number of seed per capsule	-10.91 to 25.77	16	-14.55 to 24.49	9	-16.07 to 8.93	8	-17.54 to 7.02	10
8	Length of capsule (cm)	-6.60 to 6.52	10	-9.67 to 5.15	11	-13.55 to 0.80	15	-12.85 to 1.61	14
9	1000 seed weight (g)	-33.74 to 15.26	14	-38.12 to 10.82	14	-26.02 to 14.97	18	-24.61 to 17.16	15
10	Oil content (%)	-15.75 to 6.45	12	-17.47 to 5.35	14	15.30 to 5.57	13	-17.38 to 2.99	19
11	Seed yield / plant (g)	-14.00 to 158.04	13	-25.61 to 133.83	14	10.19 to 146.60	17	-3.24 to 116.54	15

Table 3
Estimates of heterosis in percentage over better parent (B.P.) and standard check (S.C.) for yield and yield contributing characters in sesame

Sr No.	Name of crosses	Days to First flower		Days to 50% flowering		Days to maturity		Plant height (cm)	
		BP	SC	BP	SC	BP	SC	BP	SC-1
1	OSC-560 X NIC-16194	-5.63	-5.63	-5.88	-3.61	-8.72**	-6.32*	-3.45	2.44
2	OSC-560 X KMR-11	-9.59**	-7.04	-7.87*	-1.20	-4.62	-2.11	-2.87	3.05
3	OSC-560 X IS-200	-1.41	-1.41	-5.81	-2.41	-6.15*	-3.68	-4.60	1.22
4	OSC-560 X NIC-8600-A	-10.81**	-7.04	-11.36**	-6.02	-9.74**	-7.37**	-5.17	0.61
5	OSC-560 X SI-982	-4.23	-4.23	-6.98	-3.61	-7.69**	-5.26*	-8.05**	-2.44
6	OSC-207 X NIC-16194	-5.71	-7.04	-7.14	-6.02	-6.32*	-6.32*	-3.57	-1.22
7	OSC-207 X KMR-11	-4.11	-1.41	-11.24**	-4.82	-6.70**	-4.74	-4.82	-3.66
8	OSC-207 X IS-200	1.43	000	-3.49	000	000	1.05	4.82	6.10
9	OSC-207 X NIC-8600-A	-9.46**	-5.63	-14.77**	-9.64*	-7.37**	-7.37**	2.41	3.66
10	OSC-207 X SI-982	-5.71	-7.04	-10.47**	-7.23	-1.57	-1.05	0.00	1.22
11	MT-10-13-01 X NIC-16194	-5.56	-4.23	-8.33*	-7.23	-4.69	-3.68	2.38	4.88
12	MT-10-13-01 X KMR-11	-1.37	1.41	-5.62	1.20	-2.06	0.00	3.66	3.66
13	MT-10-13-01 X IS-200	-8.33*	-7.04	-9.30	-6.02	-5.21	-4.21	0.00	-1.22
14	MT-10-13-01 X NIC-8600-A	-13.51**	-9.86**	-17.05**	-12.05**	-7.81	-6.84**	-2.47	-3.66
15	MT-10-13-01 X SI-982	-2.78	-1.41	-4.65	-1.20	-2.08	-1.05	0.00	-1.22
16	SSD-01 X NIC-16194	-5.63	-5.63	-7.14	-6.02	0.00	1.05	-4.76	-2.44
17	SSD-01 X KMR-11	-10.96**	-8.45*	-13.48**	-7.23	-2.06	0.00	-7.14*	-4.88
18	SSD-01 X IS-200	-4.23	-4.23	-6.98	-3.61	-4.17	-3.16	-3.57	-1.22
19	SSD-01 X NIC-8600-A	-10.81**	-7.04	-13.64**	-8.43*	-6.25*	-5.26*	1.19	3.66
20	SSD-01 X SI-982	-2.82	2.82	000	3.61	1.04	2.11	-3.57	-1.22
21	RT-54 X NIC-16194	-2.90	000	000	1.20	-2.56	0.00	-1.18	2.44
22	RT-54 X KMR-11	-10.96**	-8.45*	-17.98**	-12.05**	-7.69**	-5.26	2.35	6.10
23	RT-54 X IS-200	-1.45	-1.41	-4.65	-1.20	-1.54	1.05	1.18	4.88
24	RT-54 X NIC-8600-A	-9.46**	-5.63	-11.36**	-6.02	-9.74**	-7.37**	-1.18	2.44
25	RT-54 X SI-982	-2.86	-4.23	-6.98	-3.61	-4.62	-2.11	0.00	3.66

* and ** indicated the significance at 5 and 1 per cent respectively

Sr No.	Name of crosses	No. of branches / plant		No. of capsule / plant		No.of seed /capsule		Length of capsule (cm)	
		BP	SC	BP	SC	BP	SC	BP	SC
1	OSC-560 X NIC-16194	0.00	16.67	-12.31*	23.91**	-7.55*	-12.50**	-5.14**	-4.38**
2	OSC-560 X KMR-11	0.00	33.33*	-14.81**	25.00**	3.77	-1.79	5.15**	-2.39
3	OSC-560 X IS-200	0.00	16.67	-8.00	50.00**	18.75**	1.79	-1.25	-5.58**
4	OSC-560 X NIC-8600-A	-12.50	16.67	-26.83**	30.43**	-4.50	-5.36	-9.67**	-12.55**
5	OSC-560 X SI-982	-14.29	0.00	-17.86**	25.00**	4.55	2.68	-0.41	-3.98**
6	OSC-207 X NIC-16194	-14.29	0.00	0.00	41.30**	3.77	-1.79	-6.32**	-5.58**
7	OSC-207 X KMR-11	-12.50	16.67	8.15	58.70**	-0.94	-6.25*	-6.87**	-13.55**
8	OSC-207 X IS-200	14.29	33.33*	-6.67	52.17**	17.35**	2.68	-6.25**	-10.36**
9	OSC-207 X NIC-8600-A	0.00	33.33*	-1.83	75.00**	-6.31*	-7.14*	0.00	-3.19*
10	OSC-207 X SI-982	14.29	33.33*	-10.00*	36.96**	0.00	-1.79	1.03	-2.59
11	MT-10-13-01 X NIC-16194	14.29	33.33*	-15.38**	19.57*	0.00	-5.36	-7.91**	-7.17**
12	MT-10-13-01 X KMR-11	-12.50	16.67	-8.15	34.78**	5.66	0.00	-1.65	-4.78**
13	MT-10-13-01 X IS-200	0.00	16.67	-13.33**	41.30**	24.49**	8.93**	2.88	-0.40
14	MT-10-13-01 X NIC-8600-A	-25.00*	0.00	-26.83**	30.43**	2.70	1.79	1.23	-1.99
15	MT-10-13-01 X SI-982	16.67	16.67	-1.43	50.00**	-14.55**	-16.07**	-1.44	-4.58**
16	SSD-01 X NIC-16194	14.29	33.33	23.85**	75.00**	10.91**	8.93**	0.00	0.80
17	SSD-01 X KMR-11	-12.50	16.67	-17.78**	20.65**	3.64	1.79	-0.80	-1.59
18	SSD-01 X IS-200	-14.29	0.00	-12.00*	43.48**	1.82	0.00	-1.61	-2.39
19	SSD-01 X NIC-8600-A	-37.50**	-16.67	-34.15**	17.39*	-0.90	-1.79	-3.21*	-3.98**
20	SSD-01 X SI-982	0.00	0.00	-29.29**	7.61	-10.91**	-12.50**	-4.02**	-4.78**
21	RT-54 X NIC-16194	-14.29	33.33*	36.92**	93.48**	7.02*	8.93**	-0.00	0.80
22	RT-54 X KMR-11	0.00	33.33*	12.59*	65.22**	1.75	3.57	-1.20	-1.59
23	RT-54 X IS-200	-2.86	13.33	-24.00**	23.91**	-3.51	-1.79	-4.00**	-4.38**
24	RT-54 X NIC-8600-A	-12.50	16.67	-14.63**	52.17**	1.75	3.57	-1.20	-1.59
25	RT-54 X SI-982	0.00	16.67	7.14	63.04**	-1.75	0.00	-4.00**	-4.38**

* and ** indicated the significance at 5 and 1 per cent respectively

Sr No.	Name of crosses	1000 Seed weight (g)		Oil content (%)		Seed yield /plant (g)	
		BP	SC	BP	SC	BP	SC
1	OSC-560 X NIC-16194	-4.43	-8.33**	-0.22	-1.31	8.51	19.57
2	OSC-560 X KMR-11	2.14	-10.71**	-1.86	-1.86	26.01*	54.95**
3	OSC-560 X IS-200	-2.82	-6.12	3.09*	5.57**	5.67	56.94**
4	OSC-560 X NIC-8600-A	-3.93	-0.34	-1.88	-2.95*	-11.17	28.58*
5	OSC-560 X SI-982	-5.69	-6.97*	1.22	0.11	13.83	18.54
6	OSC-207 X NIC-16194	-0.35	-4.42	5.35**	5.46**	26.63*	45.05**
7	OSC-207 X KMR-11	-8.88**	-12.76**	4.69**	4.81**	34.65**	65.58**
8	OSC-207 X IS-200	-9.51**	-12.59**	1.81	4.26**	28.94**	91.51**
9	OSC-207 X NIC-8600-A	10.82**	14.97**	3.93**	4.04**	2.45	48.30**
10	OSC-207 X SI-982	-13.62**	-14.80**	0.11	0.22	54.74**	77.25**
11	MT-10-13-01 X NIC-16194	-35.99**	-23.47**	0.33	-1.64	0.00	10.19
12	MT-10-13-01 X KMR-11	-25.89**	-11.39**	-3.17*	-3.17*	4.08	27.99*
13	MT-10-13-01 X IS-200	-23.33**	-8.33**	-5.34**	-3.06*	52.91**	127.10**
14	MT-10-13-01 X NIC-8600-A	-38.12**	-26.02**	1.90	-0.11	43.62**	107.90**
15	MT-10-13-01 X SI-982	-23.19**	-8.16*	-7.52**	-8.63**	133.83**	132.27**
16	SSD-01 X NIC-16194	0.53	-3.57	-2.73*	-2.51	100.49**	140.77**
17	SSD-01 X KMR-11	-1.48	-9.52**	-1.42	-1.20	-1.74	20.83
18	SSD-01 X IS-200	6.87*	3.23	-0.11	2.30	-2.34	45.05**
19	SSD-01 X NIC-8600-A	6.72*	10.71**	-4.36**	-4.15**	-21.33*	13.88
20	SSD-01 X SI-982	3.28	1.87	-0.98	-0.77	4.92	26.00
21	RT-54 X NIC-16194	-3.19	-7.14*	-17.47**	-15.30**	123.79**	146.60**
22	RT-54 X KMR-11	0.73	-6.46*	-16.83**	-14.64**	64.44**	102.22**
23	RT-54 X IS-200	-7.75*	-10.88**	-5.11**	-2.62*	-25.61**	10.49
24	RT-54 X NIC-8600-A	-6.23*	-2.72	-3.83**	-1.31	-15.51	22.30
25	RT-54 X SI-982	-8.62**	-9.86**	-2.88*	-0.33	49.59**	48.60**

* and ** indicated the significance at 5 and 1 per cent respectively

heterosis over the check Phule Til followed by SSD-01 x NIC-8600-A (12.82) for 1000 seed weight.

The range of heterosis for oil content was from -15.75 (RT-54 x KMR-11) to 6.45 (OSC-207 x NIC-16194) over mid parent, from -17.47 (RT-54 x NIC-16194) to 5.35 (OSC-207 x NIC-16194) over better parents. For seed yield per plant, among crosses RT-54 x NIC-16194 (158.04) exhibited the highest significant positive heterosis over mid parent followed by (136.56) and (109.11). The cross MT-10-13-01 x SI-982 (133.83) exhibited the highest significant positive heterosis over better parent followed by RT-54 x NIC-16194 (123.79), SSD-01 x NIC-16194 (100.49) and RT-54 x KMR-11 (64.44). similar result that Toprope (2009), Georgiev *et al* (2011).

The cross RT-54 x NIC-16194 exhibited significantly high sca effects for three characters *viz*., number of capsule, number of seed per capsule and seed yield per plant. Likewise, the best crosses identified for various yield contributing characters were SSD-01 x NIC-16194 for character number of branches per plant, number of capsule per plant, number of seed per capsule and seed yield per plant. The cross MT-10-13-01 x SI-982 for number of capsule per plant, number of seed per capsule,1000 seed weight and seed yield per plant. The cross MT-10-13-01 x IS-200 for length of capsule, number of seed per capsule,1000 seed weight and seed yield per plant and The cross MT-10-13-01 x NIC-8600-A for length of capsule, number of seed per capsule,1000 seed weight, seed yield per plant and for oil content on the basis of sca effects indicating suitability for exploitation of respective characters.

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Table 4
Information on best 5 crosses based on per se performance in sesame

Sr. No.	*Cross*	*Per se performance Seed yield/ plant (g/pl.)*	*Heterosis*				*GCA effects*		*SCA effects*	*Significant heterosis in desired direction for other traits*	*Significant SCA in desired direction for other traits*
			M.P (%)	*B.P (%)*	*SC-1 JLT-408 (%)*	*SC-2 PHULE TIL (%)*	*Parent I (Female)*	*Parent II (Male)*			
1	RT-54 X NIC-16194	16.69	158.04**	123.79**	146.60**	116.54**	+0.440	0.873	4.581**	Plant height, No. of capsule / plant, No. of seed/ capsule, Length of capsule.	No. of capsule per plant, No. of seed/ capsule, Seed yield / plant.
2	SSD-01 X NIC-16194	16.30	109.11**	100.49**	140.77**	111.41**	-0.693*	0.873	5.319**	Days to maturity, Length of capsule, 1000 seed weight, No. of capsule/ plant.	No. of branches per plant, No. of capsule per plant, No. of seed/ capsule, Seed yield / plant.
3	MT-10-13-01 X SI-982	15.72	136.56**	133.83**	132.27**	103.96**	1.459**	0.067	3.398**	Days to maturity, Seed yield /plant.	No. of capsule per plant, , No. of seed/ capsule,1000 seed weight, Seed yield / plant.
4	MT-10-13-01 X IS-200	15.37	84.96**	52.91**	127.10**	99.42**	1.459**	0.452	2.663**	No. of seed per capsule, Oil content, Seed yield / plant.	Length of capsule, No. of seed per capsule, 1000 seed weight, Seed yield / plant.
5	MT-10-13-01 X NIC-8600-A	14.07	71.96**	43.62**	107.90**	82.56**	1.459*	-1.039*	2.854**	Days to first flowering, Days to 50 % flowering, Days to maturity, Seed yield / plant.	Length of capsule, No. of seed per capsule, 1000 seed weight, Seed yield / plant, Oil content

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