Estimation of Magnitude of Heterosis for Seed Yield and Yield Component Characters in Sesame (*Sesamum Indicum* L.)

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Abstract

In the present investigation, attempts have been made to evaluate six parents and thirty hybrids through diallel mating system to study the magnitude of heterosis for different characters. The experiment was conducted at Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar during 2012-2013. Six sesame genotypes namely VRI 1, VRI 2, TMV 3, TMV 4, TMV 6 and CO 1 were selected for the study. The results revealed that the hybrid VRI 1 × TMV 6 possessed significant positive value for plant height at maturity and 1000 seed weight. Maximum significant positive standard heterosis was observed by the hybrids TMV 6 × CO 1 for number of branches per plant. The hybrid TMV 3 × VRI 1 had significant positive standard heterosis for seed yield per plant. Hence, from the foregoing discussion it may be concluded that TMV 6 × CO 1, VRI 1 × TMV 6 and TMV 3 × VRI 1 can be rated as best hybrids and the hybrids VRI 1 × CO 1 and VRI 2 × TMV 3 can be rated as better hybrids based on the magnitude of heterosis. This indicates that the cross can be exploited commercially for higher yield potential.

Key Words: Heterosis, Diallel, Sesame

Introduction

Sesame (*Sesamum indicum* L.) belonging to the family Pedaliaceae is one of the ancient indigenous oil seed crop and has been cultivated in India with the highest area, production and export in the world. The crop is grown primarily in the tropics by small landholders, of which

99.9 per cent is produced in developing countries (Ashri, 1994). Sesame oil is used as cooking oil in Southern India. It is also used for anointing the body. The major sesame growing countries are Sudan, Nigeria, Ethiopia, Uganda, Mexico, Venezuela, India, China, Pakistan and Myanmar.

Edible oils play a significant role in human nutrition by providing energy to run the machinery of life. They also serve as a carrier for certain fat soluble vitamins (A, D, E and K) and used in the construction, repair and maintenance of body tissues. Many developing countries of the Asia-pacific region are suffering from a serious edible oil shortage and the governments are forced to allocate scarce and valuable foreign exchange to import such oils. Sesame is one of the edible oilseed crop producing seeds, which contain about 45-58 per cent oil. The oilseed crops are of paramount importance to the Indian economy. In spite of their envious position in the national agricultural economy, the country's indigenous output of oilseeds was lagging far behind the requirements. Hence there is an urgent need to design a proper technique to identify heterotic combination for commercial exploitation.

Shull (1948) explained that heterosis was the genetic expression of beneficial effects of hybridization. Heterosis was first reported in sesame by Pal (1945). The presence of hybrid vigour is an important crieteria for successful production of hybrid varieties. Heterosis works as a basic tool for improved production of crops in the form of F_1 hybrids. The heterotic studies can provide the basis for the exploitation of valuable hybrid combinations in the future breeding programmes and their commercial utilization. Heterosis breeding is one of the methods of plant breeding to develop hybrids with high yield potential. Heterosis is the increased or decreased vigour of F_1 over the mean of parents, better parent and standard of the two or best parent. The manifestation of heterosis and its utilization as a means of maximizing the yield of agricultural crops has been one of the most important techniques in plant breeding. The magnitude of heterosis provides a guide for the choice of desirable parents for developing superior F1 hybrids, so as to exploit hybrid vigour. The investigation aims primarily to study the direction and the extent of relative heterosis, heterobeltiosis and standard heterosis for seed yield and its contributing character through diallel analysis in sesame.

Materials and Methods

The experiment was conducted at Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar during 2012-2013. Six sesame genotypes namely VRI 1, VRI 2, TMV 3, TMV 4, TMV 6 and CO 1 were selected based on the commercial value and varying by pedigree and yield were obtained from Regional Research Station, Vridhachalam. Six parents were crossed in all possible combinations and the resulting thirty cross combinations inclusive of reciprocal crosses along with the parents form an effective complete diallel set for the study. In the crossing block, six parents were raised in rows with a spacing of 30 × 30 cm. In each row ten plants were selected for crossing programme. Separate plots were maintained for crossing and selfing purposes. Thirty hybrids along with six parents were sown in rows with a spacing of 30 × 30 cm. In each cross, 20 plants were maintained. The parents and hybrids were evaluated in a randomized block design with three replications. Border rows were grown all around the experimental block. Recommended fertilizer schedule, cultural operations and plant protection measures were carried out. The observations were recorded on 10 plants in parents and hybrids for the following traits like days to 50 per cent flowering, Plant height at maturity, Number of branches per plant, Number of capsules per plant, Number of seeds per capsule, 1000 seed weight, Seed yield per plant and Oil content. The heterosis analysis was carried out following the procedure suggested by Griffing (1956). Relative heterosis (RH) was calculated over the mean performance of the mid parent. Heterobeltiosis (HB) was calculated over that of the mean performance of better parent and standard heterosis (SH) was calculated over that of mean performance of standard variety CO 1

$$\text{Relative heterosis} = \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100, \text{ where } \overline{MP} = \frac{P_1 + P_2}{2}$$

$$\text{Heterobeltiosis} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$$

$$\text{Standard heterosis} = \frac{\overline{F_1} - \overline{SV}}{\overline{SV}} \times 100$$

The significance of heterosis was tested using the formula as suggested by Wynne *et al.* (1970).

Results and Discussion

The results of the analysis of variance showed that all the characters studied were significant except 1000 seed weight indicated the genetic diversity of the parents selected for the present study. (Table. 1). Among the 30 hybrids, some crosses showed significant heterosis over better parent and mid parent (Table. 2). Heterosis over better parent for days to 50 percent flowering was estimated over earlier flowering parents of the crosses. Hence, crosses with negative heterosis were considered as desirable attributes. Maximum, negative and significant relative heterosis was recorded by TMV 6 × CO 1 (-10.58 per cent). Three hybrids recorded significant negative values. Heterobeltiosis was negative, significant and maximum in VRI 2 × TMV 4 (-12.05 per cent) and eight hybrid recorded negative and significant valued for this trait. Standard heterosis was negative significant and maximum in TMV 6 × CO 1 (-10.71 per cent). Three hybrids recorded negative and significant standard heterosis. In respect of plant height at maturity Relative heterosis was positive and significant in seven hybrids and it ranged from 11.88 per cent (VRI 2 × TMV 3) to 26.15 per cent (TMV 6 × TMV 3). Heterobeltiosis was also significant and positive in three hybrids. Maximum, significant and positive heterobeltiosis was recorded by TMV 6 × TMV 3 (16.79 per cent). Only two hybrids exhibited positive and significant standard heterosis and maximum positive value was recorded by VRI 1 × TMV 6. In case of number of branches per plant the hybrid TMV 6 × TMV 3 (22.51 per cent) showed maximum significant and positive relative heterosis. Heterobeltiosis was significant but negative in four hybrids. Standard heterosis was negative and significant in four hybrids and positive and significant in three hybrids and was maximum positive and significant in TMV 3 × TMV 6. Regarding number of capsules per plant positive and significant relative heterosis was observed in twenty two hybrids, among them VRI 2 × TMV 3 (28.64 per cent) registered the maximum. Heterobeltiosis was maximum in CO 1 × TMV 6 (26.04 per cent) and fifteen hybrids showed significant, positive value for this character. Sixteen hybrids registered significant and positive values for standard heterosis and the maximum was recorded by CO 1 × TMV 6 (26.04 per cent). Fourteen hybrids displayed significant and positive values in all the three heterosis. In the character number of seeds per capsule twelve hybrids exhibited positive and significant relative heterosis and it was maximum in the hybrid CO 1 × VRI 2 (12.67 per cent). Heterobeltiosis was positive and significant in three hybrids. Significant but positive standard heterosis was observed in the three hybrids and it ranged from 7.87 per cent (VRI 1 × TMV 3) to 22.95 per cent in VRI 1 × TMV 6. With respect to 1000 seed weight four hybrids displayed significant and positive relative heterosis and it was maximum in the hybrid VRI 1 × TMV 6 (10.42 per cent). Heterobeltiosis was positive and significant in three hybrids and maximum positive and significant value was registered by VRI 1 × TMV 6 (8.46 per cent). In the character seed yield per plant, Relative heterosis was maximum, positive and significant in the hybrid VRI 1 × TMV 3 (35.76 per cent). Twenty hybrids recorded positive and significant relative heterosis. Heterobeltiosis was significant and positive in ten hybrids and maximum value was observed in the hybrid VRI 1 × TMV 3 (32.15 per cent). Standard heterosis was significant and positive in eleven hybrids and it ranged from 15.93 per cent (TMV 4 × VRI 1) to 40.46 (TMV 3 × VRI 1). With respect to oil content, Positive and significant relative heterosis was observed in five hybrids and maximum value was registered in the hybrid TMV 6 × TMV 3 (6.60 per cent). Heterobeltiosis was positive and significant in four hybrids. The hybrid TMV 4 × TMV 3 (4.46 per cent) recorded maximum positive and significant heterobeltiosis. Positive and significant standard heterosis was exhibited by three hybrids. Maximum significant and positive standard heterosis was recorded in the hybrid TMV 6 × TMV 3 (4.68 per cent).

One of the important criterion for evaluating the hybrids is the expression of the phenomenon of hybrid vigour. Generally the hybrid vigour could be expressed in the cross whose parents are geographically and genetically diverse. A good hybrid should manifest high amount of heterosis for commercial exploitation. Relative heterosis is of limited importance because it is only the deviation of F_1 from mid parental value (Grakh and Chaudhary, 1985). Heterobeltiosis is a measure of hybrid vigour over the better parent. Swaminathan *et al.* (1972) and Bobby and Nadarajan (1994) stressed the need for computing standard heterosis for commercial exploitation of hybrid vigour. Hence, for the evaluation of hybrids, standard heterosis is to be given more importance rather than the other two.

The hybrids selected based on the magnitude of heterosis, were listed in Table 3. The hybrid VRI 1 × TMV 6 possessed significant positive value for plant height at maturity and 1000 seed weight. Maximum significant positive standard heterosis was observed by the hybrids TMV 6 × CO 1 for number of branches per plant. The hybrid TMV 3 × VRI 1 had significant positive standard heterosis for seed yield per plant. In general, heterosis for days to 50 per cent flowering were required in negative direction, hence the crosses TMV 6 × CO 1 and VRI 1 × CO 1 could be used in future crop improvement programme for development of early maturing varieties. Highest positive and significant standard heterosis was observed by the hybrid CO 1 × TMV 6 for number of capsules per plant.

These findings are in consonance with Karuppaiyan *et al.* (2000); Krishnaiah *et al.* (2002); Kumaresan and Nadarajan (2002); Senthilkumar *et al.* (2003); Patel *et al.* (2005); Thiyagu (2007) ; Jadhav and Mohrir (2013) and Parimala *et al.* (2013). The characters that contributed to vegetative growth such as plant height and number of branches per plant, the maximum positive standard heterosis was observed in the hybrid VRI 1 × TMV 6 and TMV 6 × CO 1 respectively which was in concurrence with the findings of Santha *et al.* (2001); Nijagun *et al.* (2002); Karad *et al.* (2002) ; Tripathi and Mishra (2005) ; Padmasundari and Kamala (2012) and Subashini et al. (2014) Maximum standard heterosis for yield parameters were reported by Tripathi and Mishra (2005) and Thiyagu *et al.* (2007). Grafius (1959) suggested that there could not be any one gene system for yield *per se* and that the yield was an end product of multiplicative interaction between yield components. Hence, from the foregoing discussion it may be concluded that TMV 6 × CO 1, VRI 1 × TMV 6 and TMV 3 × VRI 1 can be rated as best hybrids and the hybrids VRI 1 × CO 1 and VRI 2 × TMV 3 can be rated as better hybrids based on the magnitude of heterosis.

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Table-1
Analysis of variance for seed yield and yield contributing characters in sesame

Source	DF	Mean sum of squares							
		Days to 50 per cent flowering	Plant height at maturity (cm)	Number of branches per plant	Number of capsules per plant	Number of seeds per capsule	1000 seed weight (g)	Seed yield per plant (g)	Oil content (%)
Replication	2	51.07	84.49	24.58	15.18	5.80	0.23	0.73	1.42
Genotypes	35	17.68**	270.63**	3.99**	187.40**	22.41**	0.017	3.11**	11.80*
Error	70	7.11	69.56	1.99	7.22	3.94	0.02	0.43	6.48

** - Significant at 1% level

Table-2

Estimation of Relative heterosis, Heterobeltiosis and Standard heterosis for seed yield and yield contributing characters in sesame

S. No.	Hybrids	Heterosis	Days to 50 per cent flowering (per cent)		Plant height at maturity (per cent)		Number of branches per plant (per cent)		Number of capsules per plant (per cent)	
			Direct	Reciprocal	Direct	Reciprocal	Direct	Reciprocal	Direct	Reciprocal
1.	VRI 1 × VRI 2	RH	-6.39	-5.50	18.34**	-6.46	-1.82	-10.12	17.74**	5.93**
		HB	-8.22*	-7.35*	3.69	-18.04	-13.45	-20.76	10.77	-0.34
		SH	-7.90	-7.02	11.04	-12.23*	-7.79	-15.58	11.10	-0.04
2.	VRI 1 × TMV 3	RH	1.77	-7.96*	0.29	-10.85*	-2.36	-7.41	19.04**	-3.20**
		HB	1.03	-8.62*	-14.00**	-23.56**	-12.91	-17.42	14.73	-6.70**
		SH	2.87	-6.96	-7.90	-18.14*	-9.66	-14.33	15.08	-6.42
3.	VRI 1 × TMV 4	RH	1.30	-3.74	2.21	-16.55*	-9.09	7.31	1.88**	21.92**
		HB	0.75	-4.27	-3.82	-21.48	-15.00	0.33	-1.00**	18.47**
		SH	2.22**	-2.87	3.01	-15.91*	-20.56	-6.23	-0.70**	18.83**
4.	VRI 1 × TMV 6	RH	-1.14	-8.39*	17.44**	-13.11**	2.55	5.82	-0.55	-0.99
		HB	-1.46	-8.69*	8.01	-15.99	-2.42	0.69	-0.87	-1.30
		SH	-1.11	-8.37*	15.67**	-10.03	-12.15	-9.35	-0.57	-1.00
5.	VRI 1 × CO 1	RH	-0.47	-3.91	8.41	-13.11*	5.15	10.31*	19.89**	12.17**
		HB	-0.64	-4.08	4.82	-15.99	-4.67	0.00	19.71**	12.00**
		SH	-0.29	-3.74	12.26**	-10.03	-4.67	0.02	20.08**	12.34**
6.	VRI 2 ×TMV 3	RH	-1.83	2.18	11.88**	4.19	-2.52	-9.04	28.64**	12.52**
		HB	-4.43	-0.52	9.09*	1.59	-3.80	-10.23	25.45**	9.73**
		SH	-2.69	1.29	-12.09*	-18.14*	2.49	-4.36	16.72**	2.09**
7.	VRI 2 × TMV 4	RH	-9.82	-1.66	1.18	6.27	-23.36**	-28.35**	11.49	-9.30
		HB	-12.05*	-4.09*	-6.26	-1.54	-28.07**	-32.75**	7.83	-12.27
		SH	-10.70*	-2.69	-11.45	-6.99	-23.36**	-28.35*	2.05*	-16.98*
8.	VRI 2 × TMV 6	RH	4.18*	-0.18	6.22	15.45**	-20.76*	-21.08*	9.28*	4.29*

		HB	2.46	-1.82	0.71	9.47	-26.90**	-27.19**	3.12	-1.59
		SH	2.17**	-2.11	-9.46	-1.59	-22.12*	-22.43*	2.77	-1.93
9.	VRI 2 × CO 1	RH	-4.26	6.34*	12.47*	1.51	-10.11	-17.04	27.59**	7.80**
		HB	-5.97	4.45*	1.55	-8.34	-12.87	-19.59	20.20**	1.56**
		SH	-5.97*	4.45**	1.55	-8.34	-7.17	-14.33	21.20**	1.06**
10.	TMV 3 × TMV 4	RH	-6.16	4.26*	3.12	7.35	8.69*	-4.90	17.98**	18.92**
		HB	-6.32*	4.08	-6.65	-2.82	3.30	-9.61	16.99**	17.92**
		SH	-4.62	5.97**	-11.82	-8.21	7.17*	-6.23	10.71**	11.59**
11.	TMV 3 × TMV 6	RH	1.34	-4.82	0.43	26.15**	22.51**	-0.32	-11.39*	23.64*
		HB	0.29	-5.80	-7.02	16.79*	14.41**	-6.91	-14.33	19.54
		SH	2.11	-4.10	-16.41*	5.00	18.69**	-3.43	-14.62	19.13
12.	TMV 3 × CO 1	RH	-5.36	-3.28	-2.26	5.47	-6.12	5.81	-0.73	11.11
		HB	-6.21	-4.14	-13.71*	-6.89	-7.81	3.90	-4.19	7.24
		SH	-4.51	-2.40	-13.71*	-6.89	-4.36	7.79	-4.19	7.24
13.	TMV 4 × TMV 6	RH	0.06	4.36*	4.05	0.79	-1.53	-6.96	17.93**	12.27**
		HB	-0.81	3.46	1.54	-1.64	-3.33	-8.67	14.96**	9.44**
		SH	0.64	4.97*	-4.09	-7.09	-9.66	-14.64	14.57**	9.07**
14.	TMV 4 × CO 1	RH	-1.19	-1.66	14.94**	3.13	1.45	6.28	23.71**	22.36**
		HB	-1.90	-2.36	11.75*	0.27	-1.87	2.80	20.39**	19.08**
		SH	-0.47	-0.94	11.75	0.27	-1.62	2.08	19.08**	20.39**
15.	TMV 6 × CO 1	RH	-10.58*	3.37	2.33	-7.59	20.66*	7.87	9.29**	26.26**
		HB	-10.71*	3.22	-2.84	-12.26*	14.64*	2.49	9.10**	26.04**
		SH	-10.71*	3.22	-2.84	-12.26	13.64*	2.05	9.10**	26.04**

* - Significant at 5% level RH- Relative heterosis HB – Heterobeltiosis SH- Standard heterosis
** - Significant at 1% level

CO 1 - Standard variety

Table-2. Contd…

S. No.	Hybrids	Heterosis	Number of seeds per capsule (per cent)		1000 seed weight (per cent)		Seed yield per plant (per cent)		Oil content (per cent)	
			Direct	Reciprocal	Direct	Reciprocal	Direct	Reciprocal	Direct	Reciprocal
1.	VRI 1 × VRI 2	RH	-1.46	-0.56	5.28*	-1.53	31.68**	18.87**	2.06	-5.53
		HB	-2.50	-1.60	3.41*	-3.27	29.33*	16.74*	-2.40	-9.66
		SH	-19.14**	-18.39**	-0.39	-6.83	16.23**	24.38**	-1.57	-8.89
2.	VRI 1 × TMV 3	RH	5.30	-6.06	6.09*	-2.45	35.76**	-10.59	2.07	-2.35
		HB	0.09	-10.71	4.99*	-3.46	32.15*	-12.97	-0.06	-4.39
		SH	7.87**	-17.81**	-0.39	-8.41**	-9.59**	40.46**	-4.02	-8.17
3.	VRI 1 × TMV 4	RH	3.83	4.12	1.84	2.69	9.05*	27.45*	1.17	-4.27
		HB	2.03	2.31	1.70	2.55	7.11	25.18*	-2.01	-7.28
		SH	-12.34**	-12.10**	-5.52**	-2.50	28.06**	15.93**	-3.77	-8.94
4.	VRI 1 × TMV 6	RH	-12.10*	-4.06*	10.42*	0.97	19.45*	-3.31	5.38**	-0.66
		HB	-16.59**	-8.97**	8.46*	-0.82	7.00	-13.39	1.01	-4.78
		SH	22.95**	15.91**	4.47**	-8.41**	-12.44**	29.12**	1.37	-4.44
5.	VRI 1 × CO 1	RH	3.26	1.54	3.13	1.09	22.99*	4.35*	-1.38	1.57
		HB	-5.55	-7.13	-0.53	-2.50	1.33	-14.03	-5.30	-2.48
		SH	-5.55	-7.13	-0.53	-1.31	1.33	-14.03	-5.30	-2.48
6.	VRI 2 ×TMV 3	RH	8.85*	10.86*	-1.99	-1.31	32.72**	19.27**	5.53*	-0.04
		HB	2.43	4.32	-2.73	-2.05	26.94*	14.08*	3.02	-2.42
		SH	-5.72	-3.98	-6.31	-3.02	-13.16**	21.96**	3.90*	0.38
7.	VRI 2 × TMV 4	RH	9.47*	9.77*	-0.56	0.56	20.19**	-6.09	1.61	-2.71
		HB	6.46	6.75*	-2.46	-1.36	15.98**	-9.37	0.27	-3.98
		SH	-8.83*	-8.29*	-6.04	-4.73	22.11**	39.14**	1.13	4.68*
8.	VRI 2 × TMV 6	RH	6.92*	8.35*	3.27	-4.91	18.11**	-1.18	0.98	-0.22

		HB	0.45	1.79	3.27	-4.91**	4.12	-12.88	0.73	-0.47
		SH	-7.21	-5.97	-0.53	-4.47	-14.79**	28.71**	1.59	1.57
9.	VRI 2 × CO 1	RH	5.53*	12.67*	2.95	-1.07	20.40*	6.30*	-4.95	1.74
		HB	-4.39	2.07	1.05	-2.89	-2.20	-13.65	-5.35	1.31
		SH	-4.39	2.07	1.05	-5.65**	-2.20	-13.65	-4.54	2.18
10.	TMV 3 × TMV 4	RH	4.56*	8.47*	3.43	1.19	24.70**	27.27**	4.25**	5.62**
		HB	1.08	4.86*	2.22	-0.03	23.56**	26.11**	3.10*	4.46*
		SH	-6.96	-3.48	-3.02	-4.99	-15.47*	-13.73*	1.25	2.58
11.	TMV 3 × TMV 6	RH	-0.99	2.96	-3.37	3.23	12.97**	25.24**	-2.45	6.60**
		HB	-1.17	2.78	-4.09	2.46	3.71	14.97*	-4.55	4.31*
		SH	-8.70	-5.05	-7.62	-2.89	-15.13	-5.92	-4.21	4.68*
12.	TMV 3 × CO 1	RH	0.95	8.54*	-0.74	-0.61	4.12	11.64**	3.32	2.60
		HB	-3.07	4.23	-3.29	-3.15	-12.12	-5.99	1.28	0.57
		SH	-3.07	4.23	-3.29	-5.12	-12.32	-5.99	1.28	0.46
13.	TMV 4 × TMV 6	RH	-2.23	-1.30	-2.09	4.31*	15.14**	7.05	2.86	2.28
		HB	-5.65	-4.75	-3.96	2.32	4.82	-2.55	1.76	1.18
		SH	-12.84**	-12.01**	-7.49*	-3.15	-14.22**	-20.25**	2.12	1.54
14.	TMV 4 × CO 1	RH	3.12	1.16	2.18	0.68	14.61	9.53	3.62	2.49
		HB	-4.14	-5.97	-1.58	-3.02	-4.21	-8.46	2.69	1.57
		SH	-4.19	-5.68	-1.58	-1.45	-4.81	-8.86	2.69	1.43
15.	TMV 6 × CO 1	RH	10.25*	3.70	0.67	-2.14	9.91	4.44	2.80	3.38
		HB	6.05*	-0.25	-1.18	-3.94	-0.08	-5.04	2.61	1.57
		SH	6.05	-0.25	-1.18	-3.65	-0.08	-5.04	2.98	3.56*

* - Significant at 5% level RH- Relative heterosis HB – Heterobeltiosis SH- Standard heterosis
** - Significant at 1% level

CO 1 - Standard variety

Table-3
Superior hybrids selected based on standard heterosis

S. No.	Characters	Standard heterosis (d_{iii})
1.	Days to 50 per cent flowering (days)	TMV 6 × CO 1, VRI 2 × TMV 4
2.	Plant height at maturity (cm)	VRI 1 × TMV 6, VRI 1 × CO 1
3.	Number of branches per plant	TMV 3 × TMV 6, TMV 6 × CO 1
4.	Number of capsules per plant	CO 1 × TMV 6, TMV 4 × CO 1
5.	Number of seeds per capsule	VRI 1 × TMV 6, TMV 6 × VRI 1
6.	1000 seed weight (g)	VRI 1 × TMV 6
7.	Seed yield per plant (g)	TMV 3 × VRI 1, TMV 4 × VRI 2
8.	Oil content (%)	TMV 6 × TMV 3, VRI 2 × TMV 3