Annals of Arid Zone 34(1) : 35–38, 1995

Varietal Diallel Analysis for Yield and Yield Traits in Taramira (*Eruca sativa* L.)

M. R. Nehra* and E. V. D. Sastry
Department of Plant Breeding and Genetics, SKN College of Agriculture, Rajasthan Agricultural University, Jobner 303 329, India

Abstract : A varietal diallel performed in taramira, indicated complex inheritance for seed yield and its component traits. The heterosis component accounted for more than 70% of the total sum of squares, and among the heterosis components, the SCA component accounted for more than 70% to the total heterosis sum of squares. Trend between the *per se* performance and the varietal heterotic effects were reverse. The crosses involving RTM-465 or RTM-314 were the best for mean seed yield including yield traits and the SCA effects.

Key words : *Eruca sativa,* seed yield, varietal diallel, heterosis, taramira.

Taramira (*Eruca sativa*) known, as 'rocket' in Europe, is an important oilseed of the arid regions of western India. Being a crop of the marginal land, improvement and the genetic studies are almost negligible. At present, only 'ITSA' and 'T-27' are available for general cultivation and even these were released more than 15 years ago (Tunwar and Singh, 1985). The present work was undertaken to study the genetics of yield, so that the generated information could be used for designing breeding programs. Taramira is cross pollinated having sporophytic self incompatibility with complex inheritance. Gardener and Eberhart (1966) suggested varietal diallel and gave a statistical genetic model which should serve as a guide to plant breeders in the design and analysis of their experiments, so that maximum amount of useful genetic information, concerning a fixed set of random mating varieties, are generated. Here, the term "variety" represents an allogamous population. Hence, a varietal diallel was used in the present investigation to obtain information on the genetics of yield and its traits.

Materials and Methods

Experimental material comprised of crosses made between nine varieties (allogamous populations) of *E. sativa* namely, JOB-TC- 2, RTM-2(I), T-27, ITSA, RTM-112, RTM-314, RTM-465, RTM-521 and RTM-523, excluding reciprocals. The parents and F_1s were sown in RBD with three replications. Each parent and F_1 was sown in 4 and 2 rows, respectively. The rows were 4 m long and spaced 30 cm apart and the plant to plant distance, within each row, was 15 cm. Data on morphological traits were collected on 10 randomly selected plants at maturity and analysed according to model-II of Gardener and Eberhart (1966). This model assumes that parents used are a set of fixed set of random mating varieties with no epistasis and diverse gene frequencies. The genetic effects are defined as functions of gene frequencies and additive and dominance effects for individual loci. When parents and their diallel crosses are grown together, the additive effect (A) and dominance effect (D) are confounded, and must therefore be estimated jointly. Under such conditions, depending upon the presence or absence of heterosis and its components, 4 models are suggested. They are:

1. $Y_{ii'} = \mu_v + \frac{1}{2}(v_i + v_{i'})$

2. $Y_{ii'} = \mu_v + \frac{1}{2}(v_i + v_{i'}) + \delta \bar{h}$

3. $Y_{ii'} = \mu_v + \frac{1}{2}(v_i + v_{i'}) + \delta\bar{h} + \delta(h_i + h_{i'})$

* Present Address: Agricultural Research Station, Sri Ganga Nagar 335 001, India.

4. $Y_{ii'} = \mu_v + \frac{1}{2}(v_i + v_{i'}) + \delta\,(\bar{h} + h_i + h_{i'} + s_{ii'})$

where ,

$Y_{ii'}$ = mean of a cross between i and i′

μ_v = mean of all parental varieties included

v = the variety effect when parent varieties are included in the analysis

$\bar{h}$ = average heterosis, h_i and h_j refers to varietal heterosis, and $s_{ii'}$ refers to the specific combining ability of the cross between i and i′

δ = 0, where, i = i′, and 1, where, i = i′

Results and Discussion

The analysis of variance indicated significant differences between the parents and F_1s revealing the existence of variability for all the characters studied among parents and their progeny as well. The parent Vs F_1 interaction was also significant indicating existence of heterosis. This is also supported by the results obtained from the partitioning of the entries sums into varieties and heterosis (Table 1). The heterosis sum of squares accounted for 70% and above of the entries sum of squares indicating that additive, dominance and epistatic components controlled the inheritance of all the characters, in other words the inheritance was complex (Bailey *et al.,* 1980). Further partitioning of the overall heterosis sum of squares indicated that contribution of SCA was the highest (Table 2). This suggests that data should fit to the model 4. The data did fit to the model supporting the observation of complex inheritance. Because of the confounding effect, each of the genetic components namely additive, dominance and epistatic components in the model II (Gardener and Eberhart, 1966) can not be estimated separately.

Seed yield, a complex character, is controlled by a number of component traits (Grafius, 1964). Nehra *et al.* (1989) and Sodani *et al.* (1989) reported that siliquae per plant, siliqua length, plant height and number of secondary branches are the most important yield determinants in taramira. *Per se* RTM-314, RTM- 2(I) and RTM-523 were found to be the top yielders (Table

Table 1. The mean sum of squares for different characters

Character	Source of variation: Variety (V_i) (8)	Heterosis ($h_{ii'}$) (36)	Error (88)	Heterosis as percent of total sum of squares
Day to 50% flowering	1.81**	5.27**	0.57	92.93
Days to maturity	5.93**	3.05**	1.42	69.90
Plant height (cm)	152.81**	42.15	28.20	55.38@
Fruiting branches/plant (No.)	34.27**	30.04**	1.78	79.77
Siliqua/plant (No.)	2774.25**	2141.28**	96.06	77.64
Siliqua length (cm)	0.04**	0.10**	0.004	92.98
Seeds/siliqua (No.)	17.92**	12.86**	1.44	76.36
Test weight of seed (g)	0.48**	0.23**	0.03	67.21
Seed yield/plant (g)	1.42**	1.19**	0.08	79.16
Oil content (%)	2.53**	10.46	0.69	94.88

Figures in parenthesis represent df.

** Significant at p=0.01.

@ Mean square not significant at p=0.05.

Table 2. Mean sum of squares due to heterosis components for different characters

Character	Average (V_i) 1	Variety (h_i) 8	SCA (s_{ii}') 27
Day to 50% flowering	136.00** (71.68)	2.46** (10.37)	1.27** (18.07)
Days to maturity	37.87** (34.49)	3.27** (23.83)	1.69 (18.07)
Plant height	169.34** (11.16)	67.28** (35.44)	30.00** (53.77)
Fruiting branches/plant	14.21** (1.31)	55.40** (40.98)	23.11** (57.70)
Siliquae/plant	1253.00** (1.63)	2940.00** (30.51)	1937.53** (67.86)
Siliqua length	1.22** (33.83)	0.09** (20.00)	0.06** (45.00)
Seed/siliqua	0.00 (0.00)@	22.76** (39.33)	10.40** (60.65)
Test weight	2.33** (28.14)	0.28** (27.05)	0.14** (45.65)
Seed yield/plant	13.78** (32.17)	0.48** (8.03)	0.95** (59.87)
Oil content	274.49** (72.89)	3.70** (7.86)	2.68** (20.51)

** Significant at $p=0.01$.
@ Mean square not significant at $p=0.05$.
Figures in parenthesis represent the percentage of the h_{ii}' mean squares.

3). The mean ranking for other morphological traits was very close to the *per se* performance of yield supporting the reports of Sodani *et al.* (1989). Comparison of h_i values and mean values of the parents indicated an inverse relation between the two for seed yield (Table 3). Dudley *et al.* (1977) reported such a relation in corn. The sign of $\bar{h}$ effects is generally dependent h_i and the distribution of genes in the parents and the difference between the heterozygotes and the mid parental value at any given locus. The direction of the $\bar{h}$ for seed yield was found to be high and undesirable and this may be the reason that the h_i effects were non-significant.

The crosses RTM-465 X RTM-521 followed by RTM-2(I) X T 27 were the best having desirable and significant s_{ii} effects for seed yield per plant. The *per se* performance of RTM-465 X RTM-521 was also the best among the crosses. Examination of SCA effects for other morphological traits indicated that none of the crosses exhibited significant effects for days to maturity and plant height at both the locations, while only one cross exhibited significant SCA effects (though undesirable) for days to flowering. Only few crosses exhibited significant SCA effects (most of them undesirable) for oil content. Close examination of SCA effects also revealed that in general, the hybrids with significant SCA effects had parents which differed in the magnitude and direction of h_i effects. The best hybrids for other characters in general had RTM-465 as one of the parents followed by RTM-314.

When the inheritance is complex (additive, dominance and epistatic effects) as observed in *E. sativa*, ample progress could be expected if

Table 3. The mean and rank of the parents for the seed yield along with the mean rank over different characters, varietal effect and the heterotic effect

Parent	Seed yield (g plant^{-1})	Rank	Mean rank	Varietal effect (V_i)	Heterotic effect (h_i)
Job−TC−2	3.94	7	4.89	−0.361	−0.334
RTM−2(I)	4.74	2	5.33	0.439	−0.143
T−27	3.88	8	6.67	−0.421	0.012
ITSA	4.04	5	4.11	−0.261	0.092
RTM−112	3.98	6	6.11	−0.321	0.324
RTM−314	5.24	1	4.78	0.939**	−0.366
RTM−465	4.49	4	3.56	0.193	0.045
RTM−521	3.85	9	5.11	−0.447	0.224
RTM−523	4.54	3	3.56	0.239	0.147
Mean				4.301(μ_V)	−0.799
SE				±0.236	±0.167

** Significant at p=0.01.

population improvement methods like mass selection, recurrent selection or production of composites were used. If inbred lines could be generated, there is a great scope for the production of hybrids. Nevertheless, development of inbred lines will be complicated due to the presence of self-incompatibility. Bud pollinations are routinely followed to overcome this problem in germplasm maintenance.

References

Bailey, T.B., Qualset Jr, C.O. and Cox, D.F. 1980. Predicting heterosis in wheat. *Crop Science* **20** : 339-342.

Dudley, J.W., Lambert, R.J. and de La Roche, I.A. 1977. Genetic analysis of crosses among corn strains divergently selected for percent oil and protein. *Crop Science* **17** : 111-117.

Gardener, C.O. and Eberhart, S.A. 1966. Analysis and interpretation of the variety cross diallel and related populations. *Biometrics* **22** : 439-452.

Grafius, J.E. 1964. A geometry for plant breeding. *Crop Science* **4** : 241-246.

Nehra, M.R., Sodani, S.N. and Sastry, E.V.D. 1989. Correlation and path analysis in taramira. *Transactions of Indian Society of Desert Technology* **14** : 149-159.

Sodani S.N., Sastry, E.V.D. and Nehra, M.R. 1989. Divergence analysis in taramira. *Indian Journal of Genetics and Plant Breeding* **50** : 9-12.

Tunwar, N.S. and Singh, S.V. 1985. *Handbook of Cultivars*. Published by the Central Seed Committee, Department of Agriculture & Cooperation, Ministry of Agriculture & Rural Development, New Delhi, pp. 263-274.