when infected leaves were buried in soil with the disintegration of leaves The sudden loss of viability of the pathogen observed in the present study in manure heap may also be due to the presence of antagonistic organism and or due to the high temperature developed in such heaps.

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https://doi.org/10.29321/MAJ.10.A02278

Madras Agric. J. 73(6) : 328-333 June, 1986

HETEROSIS AND GENETIC ARCHITECTURE OF OIL CONTENT IN CASTOR (*Ricinus communis* L.)

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Heterosis and genetic architecture of oil-content in castor (*Ricinus communis* L.) was studied in a complete diallel set of 11 parents excluding reciprocals. Twenty-five and thirteen crosses, respectively, exhibited significant heterosis over mid parent and better parents. The analysis of variance for combining ability indicated the importance of both additive and non-additive gene-action, however, non-additive gene action was predominant, for the inheritance of this trait. The varieties *viz*, 2-73-11, T-4, 1-21 and Mesalio were the better general combiners. The crosses *viz*, "Aruna x HC-8", "Aruna x VI-9", "Aruna x Masalio", "279 x 2-73-11", "279 x Masalio", "Ho x HC-8", "Ho x 2-73-11", "Ho x T-4", "413A x VI-9", "413A x Masalio", "1-21 x 2-73-11", "1-21 x T-4", "2-73-11 x VI-9" and "VI-9 x Masalio" possessed higher mean values, significant heterosis, and higher and significant positive SCA effects which can best be exploited for developing higher oil-varieties in castor through further breeding.

The castor (*Ricinua communis* L.) is an important cash crop of India in general and North Gujarat in particular. The major produce of castor is utiliseJ

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for oil-extraction, about 98 per cent of which is used for various industrial uses. Thus, the crop has become one of the most important industrial raw material Therefore, the oil-content is of prime importance alongwith seed yield in castor. Inspite of its importance. the basic genetic information needed for sound scientific breeding are very scanty though few such information on yield and yield components are available (Giriraj *et al*, 1974; Kandaswami, 1977; Singh and Srivastava, 1982, and Singh and Yadava, 1981). The present investigation was, therefore undertaken to know the magnitude and nature of heterosis, and genetic architecture for oil content through combining ability analysis in order to formulate effective quality breeding programme in *Ricinus communis* L.

MATERIALS AND METHODS

The materials for the present investigation consisted of 11 diverse castor varieties and 55 single cross F 1 resulting from crossing these varieties in all possible combinations in a diallel fashion excluding reciprocals. These materials were planted in a randomized block design with three replications at Regional Research Station, Gujarat Agricultural University, Sardarkrishinagar, during kharif, 1978-80. The plot size consisted of single row of 9 m length and the spacing followed was 120 cm between rows and 60 cm between plants within row. The oil content was estimated from the bulk sample for each treatment in each replication using Soxhlet apparatus.

The combining ability analysis was based on the procedure outlined by Griffing (1956 a) using method 2 and model I. Heterosis was calculated as per cent of F1 over the mid parent and better parent.

RESULTS AND DISCUSSION

The results obtained under the present investigation are presented in Tables 1 to 3. There were significant differences for oil-content among the genotypes tested.

It was observed that the Oil-content ranged from 48.10 to 55.23 percent among the parents. The genotype 1-21 recorded the maximum oil-content followed by 2-73-11 and T-4, whereas 413/A showed the lowest oil-content. The estimates of heterosis indicated that 25 crosses had significant positive heterosis over mid parent (H1) where as 13 crosses expressed significant positive hererosis over better parent (H2). It is noticeable that the crosses which had higher oil content involved either both or atleast one superior parent with respect to mean oil-content. It was further observed that many of the crosses which did not involve highest oil-varieties, gave very high oil-content. This might be due to the presence of different genes or gene groups separately in both the parents and when they were brought together they nicked well and gave higher oil-content. 'This can also by due to the presence of non-allelic interactions.

The analysis of variance for combining ability indicated that the variances due to both general combining ability (GCA) and specific combining ability (SCA) were significant (Table 2) The data thus indicated that for oil content both GCA and SCA vari-

Table 1 : Heterosis (upper diagonal), heterobeltiosis (lower diagonal) and *per se* performance of the parents (diagonal) for oil-contet in castor.

Parents	Aruna	279	Ho	HC 8	413/A	411-JI	1-21	2-73-11	T-4	VI-9	Masalio
Aruna	*51.61*	−0.76	−0.35	0.76	−2.44*	−4.18**	−4.14**	2.10	2.85**	3.84**	4.16**
279	−2.83	*49.48*	2.13	1.09	−0.59	−10.60**	−0.32	12.12**	1.67**	3.28**	8.38**
Ho	−0.68	0.59	*51.00*	4.99**	2.76**	−6.08**	1.32	10.19**	4.52**	3.53**	1.27
HC 8	1.53	−0.06	4.61**	*50.62*	2.47	−0.97	−3.42**	3.42**	0.99	3.14**	3.61**
413/A	−4.76**	−1.96	−0.02	−0.08	*48.10*	−6.46	−1.35	9.28**	−1.23	7.71**	11.63**
411-JI	−7.13**	−15.11**	−8.53	−4.89**	12.31**	*49.34*	−4.41**	3.26**	−6.87**	−1.87	0.82
1-21	−7.28**	−5.52**	−2.55	−7.44**	−7.71**	−4.62	*55.23*	7.63**	2.41*	−1.69	−4.43**
2-73-11	−0.14	11.99**	8.39**	2.15	7.90**	−2.04	1.90	*54.99*	6.08**	13.11**	9.44**
T-4	−5.45**	−2.88*	1.05	−2.62	−7.04**	−7.26**	1.75	1.05	*54.53*	−0.37**	8.12**
VI-9	2.13**	2.83	2.41	2.41	5.77**	−6.40**	−6.43**	12.48**	−5.10**	*49.90*	7.08**
Masalio	3.54**	6.45**	0.41	2.94**	8.17**	−1.15**	−7.64**	7.37**	5.64**	5.64**	*51.28*

*, ** Significant at 5% and 1% levels of significance, respectively. Diagonal figures indicate the *per se* performance of parents.

ances appeared to be important and hence revealed the role of both additive and non-additive type of gene action for the inheritance of this quality trait

Table 2. Analysis of variance (m. s.) for combining ability for oil-content in castor.

Source	D. F.	*Oil content* m. s.
GCA	10	10.80**
SCA	35	3.36**
Error	130	0.38
Variance component		
σ^2gca	—	0.57
σ^2sca	—	2.98
σ^2sca/σ^2gca	—	5.23

in castor. However, the component of variance revealed predominant role of SCA which was five times larger than GCA. This suggested that the non-additive component of genetic variance was more important for the inheritance of this trait. The predominant role of non-additive gene action obtained under the present study suggested that heterosis breeding may profitably be used to improve oil-content in castor. However, selection in segregating materials followed by the hybridization among high oil-lines can best be utilized to develop high oil purelines in castor, in view of the significant role of both additive and non-additive gene actions.

The estimates of gca effects of parents (Table 3) indicated that 1-21, 2-73-11, T-4 and Masalio showed significant positive gca effects and, thus, appeared to be the best general combiners for oil-content. The significant gca effects observed for these parents indicated that they contributed larger number of favourable genes for oil-content and can best be utilized for the improvement of this trait in castor. It is significant to mention that the parents *viz*, 1-21, 2-73-11 and T-4 which had higher mean oil-content also exhibited highly significant gca effects indicating the *per se* performance of the lines as one of the criteria for the selection of parents to be utilized in hybridization programme to improve the oil content in castor.

The oil-content of the hybrids ranged from 46.41 to 56 28 percent. Majority of the crosses exhibited oil-content higher than 50 per cent. It was further noticed that a higher degree of correspondence between oil-content of the crosses and their sca effects exist. The crosses *viz*. "Aruna X HC-8", "Aruna X VI-9", "Aruna X Masalio", "279 x 2-73-11", "Ho x T-4", "413A X VI-9", "413A X Masalio", "1-21 x 2-73-11", "1-21 X T-4", "2-73-11 X VI-9" and "VI-9 X Masalio" showed significant and positive s.c.a. effects These crosses involved high x high, high x low and also low x low general combiners. The crosses which involved both high combiners indicated additive, whereas those crosses involving high x low general combiners suggested the additive x dominance type of gene interaction. It can further be mentioned that the crosses involving low x low combiners producing high sca effects suggestedthe epistatic type of gene action which may be due to genetic diversity in the form of heterozygous loci. These crosses can best be utilized for the improvement of oil con.

Table 3 : General combining ability effects (diagonal), specific combining ability effects (upper diagonal) and performance of crosses (lower diagonal) for oil content in castor.

Parents	Aruna	279	Ho	HC 8	413/A	411-JI	1-21	2-73-11	T-4	VI-9	Masalio
Aruna	*−0.63***	−0.35	−0.31	1.25*	−0.90	−0.02	−1.21*	−1.26*	−1.06	1.25*	2.13**
279	50.15	*−1.04***	0.14	−0.15	−1.16*	−4.00	0.17	3.01**	0.74	0.26	3.54**
Ho	51.26	51.30	*0.03*	1.54**	0.21	−1.46**	0.74	1.83**	1.82**	−0.79	−0.33
HC 8	52.40	50.59	53.35	*−0.39**	0.29	0.96	−1.53**	−1.32**	0.23	0.14	0.14
413/A	49.15	48.49	50.92	50.58	*−1.49***	−2.02**	−0.59	1.31*	−1.07	2.18**	3.93**
411-JI	51.07	46.68	50.30	52.30	−48.22	*−0.45***	0.07	0.90	−1.81*	−0.15	0.12
1−21	51.21	52.18	53.82	51.13	50.97	52.63	*0.88***	1.98**	2.06**	−1.29**	−3.01**
2−73−11	51.40	55.39	55.28	51.71	53.24	53.87	56.28	*1.24***	0.60	2.80**	0.78
T−4	51.56	52.96	55.10	53.10	50.69	51.00	56.20	55.10	*1.08***	−1.42*	−0.47
VI−9	*52.71*	51.31	51.33	51.84	52.78	51.49	51.68	56.13	51.75	*−0.08*	1.22*
Masalio	*53.59*	54.59	51.79	52.79	55.47	52.71	50.90	55.06	*53.65*	54.17	*0.86***

*, **, Significant at 5% and 1% levels of significance respectively.

The diagonal figures indicate the GCA effects.

tent by effecting single plant selections in segregating generations as they seem to have good potential to throw off favourable recombinants in segre gating generations for oil content.

The over-all results revealed that in view of the significance of both additive and non-additive gene action, selection in segregating generations followed by hybidization involving the high oil-lines *viz*.. 1-21, 2-73-11 and T4, which also possessed highly significant gca effects, would be the best breeding method to improve the oil-content in castor. The presence of highly significant heterosis over mid parent and over better parents indicated that there is sufficent scope fo the improvement of oil-content in the present material. The correspondence between the mean performance of the parents and their gca effects and the mean performance of the crosses and their sca effects suggested the importance of *per-se* performance in the breeding programme for oil improvement in castor. The evaluation of large number of plant samples in the early segregating generations is however, time consuming and expensive process, which could be overcome by developing certain quick and cheap method of oil analysis.

The authors are thankful to the Director of Research, Gujarat Agricultural University for providing facilities and the Indian Council of Agricultural Research, New Delhi, for financial assistance to carry out the present investigation.

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