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Short Communication

Inheritance of low erucic acid in Indian mustard [*Brassica juncea* (L.) Czern. and Coss.]

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Abstract

Genetics of erucic acid content was studied using six generations *viz*., P_1, P_2, F_1, F_2, B_1 and B_2 derived from the crosses, Varuna × LES-39 and Varuna × LES-1-27. The trait high erucic acid content was partially dominant over low erucic acid content in both the crosses. In both the crosses, adequacy of additive – dominance model suggested absence of non-allelic interactions. The study revealed that selection for low erucic acid would result in isolation of plants with high oleic and linoleic acids and hence, it should be possible to develop high oleic acid lines having low erucic acid content in mustard.

Key words: *Brassica juncea*, erucic acid, oleic acid, inheritance

Brassica juncea (Indian mustard) is one of the most important species in the genus *Brassica* of the family *Brasicaceae* which is predominantly grown in the Indian sub-continent occupying above 80% area of the rapeseed-mustard group of crops. Oil content and oil quality (*viz*., oleic, linoleic and linolenic acid) are strongly influenced by the erucic acid pathway in oilseed Brassicas. Low level of erucic acid in seed oil increases oleic acid, but also increases the linoleic and linolenic acids (Jagannath et al. 2011). Presence of high erucic acid in edible oil is nutritionally undesirable as it is not metabolized and causes myocardial conductance and increased blood cholesterol (Renard and Mcgregor 1992; Mortuza et al. 2005). The erucic acid is negatively correlated with oleic acid, therefore, the genotypes with low erucic acid coupled with high oleic acid can be developed. It is therefore, imperative to breed mustard varieties with low erucic acid (< 2 %) and increased levels of oleic acid to enhance the nutritional quality as well as versatility of mustard oil.

Knowledge of the genetic architecture of quality characters would help breeders to take up its improvement by conventional breeding methods. In general, erucic acid content in the genus *Brassica* varies with the allelic constitution of the genotype, differences in the ploidy level, the genetic background and environmental impact. As per the earlier reports erucic acid in the oil is under the control of embryonic genotype and is governed by one gene in diploid species, *B. rapa* (AA) and two genes in amphidiploid species, *B. napus* (AACC). Kirk and Hurlstone (1983) reported that the genes for erucic acid content in *B. juncea* generally behave in additive mode of inheritance. Series of alleles have been identified in *B. napus* and *B. rapa*, which make it possible to breed strains having different levels of erucic acid ranging from less than one per cent to about 60 per cent of total fatty acids in seed oil. The earlier reports of inheritance are based on the various exotic materials which are either not available in India or non-adaptable to Indian ecological conditions. Several reports dealing with the inheritance of fatty acids in *B. napus* and *B. rapa* are available but such information for erucic and oleic acid contents in *B. juncea* are scanty. Hence, the present study was undertaken to investigate the inheritance of erucic acid in indigenous germplasm for use in future quality improvement programme.

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The experimental material used in the present study consisted of P_1, P_2, F_1, F_1 (reciprocal), F_2, B_1 and B_2 generations of the crosses Varuna × LES-39 and Varuna × LES-1-27 grown during *rabi* 2009-10 at IARI experimental farm, New Delhi. Two rows of parents and F_1, five rows of B_1 and B_2 and ten rows of F_2 were grown with a spacing of 30 cm between rows and 10 cm between plants within row with a row length of 5 meters. Recommended package of practices were followed for raising a good crop. Each plant from all the generations of both the crosses was selfed and selfed seeds were harvested separately. Ten plants each were harvested from parents P_1 and P_2, 20 from F_1, 98-108 each for both backcrosses and 203-205 from each F_2 generation and were analysed for erucic acid (Table 1).

Erucic acid content was estimated using Gas-Liquid Chromatography (GLC-Perkin Elmer Clarus 600) which is a rapid, cost effective procedure with high reproducibility for fatty acid analysis. The Flame Ionization Detector (FID) was used. Each fatty acid in the seed oil sample was first converted to FAME (*Fatty Acid Methyl Ester*) following the method described by Sujata et al. (2008). Area under each peak is calculated by measuring the peak height and width at half height (Triangulation method) and multiplying them (Burriel-Marty et al. 1968). After computing total peak area for the sample, per cent area under each peak is indicating percentage of respective fatty acid. The plants in the segregating generations were classified in five classes of varying erucic acid content (< 2 %, 2-14 %, 15-27 %, 28-40 % and > 40 %). Chi-square (χ^2) test was employed to test goodness of fit of observed and expected frequency in segregating generations.

Varuna produces very high erucic acid content (> 40 %), while LES-39 and LES-1-27 possess very low erucic acid content (< 2 %). The F_1 plants of both the crosses, Varuna x LES-39 and Varuna x LES-1-27 showed (medium to high) erucic acid content comparable to Varuna indicating that low erucic acid is a recessive character. In earler studies, it was demonstrated that the Indian geographical group of *B. juncea* (with ~50 % erucic acid) contains alleles for high erucic acid at two loci (Kirk and Hurlstone 1983).

The segregation pattern of the erucic acid trait in the F_2 generation of crosses Varuna × LES-39 and Varuna × LES-1-27 fits well in 1:4:6:4:1 theoretical ratio (χ^2 = 2.4 and 3.1, respectively) (Table 1), indicating digenic inheritance of erucic acid trait with additive gene action. This digenic nature of the low erucic acid trait was confirmed from the results of backcross populations as well (B_1: χ^2 = 3.4 and 2.9, respectively; B_2: χ^2 = 3.8 and 2.7, respectively). These results of digenic recessive nature of low erucic acid content are in agreement with the earlier findings in *B. juncea*

Table 1. Inheritance of erucic acid in two crosses of Indian mustard

Generation	Total plants studied	Observed frequency					Expected ratio	df	χ^2 value	P value
		< 2	2-14	15-27	28-40	> 40				
Varuna x LES-39										
P_1	10	-	-	-	7	3	-	-	-	-
P_2	10	10	-	-	-	-	-	-	-	-
F_1	20	-	-	18	2	-	-	-	-	-
F_2	203	9	52	84	46	12	1:4:6:4:1	4	2.4	0.66
B_1	98	-	-	19	58	21	1:2:1	2	3.4	0.18
B_2	108	21	64	23	-	-	1:2:1	2	3.8	0.15
Varuna x LES-1-27										
P_1	10	-	-	-	4	6	-	-	-	-
P_2	10	10	-	-	-	-	-	-	-	-
F_1	20	-	-	12	8	-	-	-	-	-
F_2	205	8	48	81	57	11	1:4:6:4:1	4	3.1	0.54
B_1	100	-	-	23	58	19	1:2:1	2	2.9	0.24
B_2	101	19	58	24	-	-	1:2:1	2	2.7	0.26

(Bhat et al. 2002; Chauhan et al. 2003). The non-significant differences for erucic acid content in the F_1 of both the crosses and their respective reciprocal crosses indicated the absence of maternal influence, which signifies equal contribution of both the parents in the inheritance of erucic acid trait. These results were in accordance with the previous findings reported by Liu and Liu (1989) that fatty acids were genetically governed by genotype of embryo without maternal effect in *B. juncea*. It was also observed that the segregants showing low erucic acid (< 2 %) have also recorded high oleic acid (42-47 %). This clearly indicates that breeding for low erucic acid will offer multiple nutritional benefits by increasing the content of desirable fatty acid like oleic acid.

The study indicated that low erucic acid varieties can be developed through introgression of the two recessive genes through backcross breeding. The digenic recessive mode of inheritance with additive gene effect also suggested that low erucic acid varieties can be developed through pedigree breeding by identifying transgressive segregants in the early segregating generations.

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