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RESEARCH ARTICLE

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Genetic analysis of fatty acid profile in cross of Indian Mustard [*Brassica juncea* (L.) Czern and Coss]

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ABSTRACT

Six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of the cross GM 3 x NUDHYJ 3 of Indian mustard [*Brassica juncea* (L) Czern and Coss] were analyzed for palmitic, stearic, oleic, linoleic, linolenic and erucic acid content using gas liquid chromatography during 2005-06 to study their genetic architecture. The F_1 mean for erucic and oleic acid were near to the mid-parental value suggesting partial dominance of gene(s) controlling higher content over low one. F_1 was intermediate between the mean values of both the parents and also significantly differed with both the parents, these finding indicated the additive gene action was governed the expression of oleic and erucic acid, while, F_1 mean were significantly higher than both the parents indicated presence of over dominance for stearic, linoleic and linolenic acid. The significance of scaling tests suggested the presence of epistasis in the genetic control of these fatty acids. Palmitic, stearic and linoleic acid appeared to be controlled by dominance, additive x additive and dominance x dominance interactions, whereas, dominance for oleic, additive x dominance for linolenic and additive x additive for erucic acid were predominant.

KEY WORDS : *Brassica,* Fatty acid, Gene effect and Indian mustard

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INTRODUCTION

Fatty acid profiles determine the quality of Indian mustard [*Brassica juncea* (L.) Czern and Coss] oil, which is an important component of Indian diet. Present available mustard varieties oil having low (about 7%) saturated fatty acids (palmitic + stearic acid), high erucic (about 50%), low oleic (9-18%) and linoleic acid (13-25%). The preferred oil should have low saturated fatty acids (around 4%), low erucic acid (<2%) and appreciable amount of unsaturated fatty acids (oleic and linoleic). Low erucic ($C_2$2:1) and intermediate level of linoleic ($C_1$8:2), an essential fatty acid improve the nutritional quality of the oil and high oleic ($C_1$8:2) imparts thermo stability to the oil and also lowers cholesterol, a major component associated with coronary heart diseases (Grundy, 1986). It is, therefore, imperative to breed Indian mustard varieties with increase level of both oleic (about 50%) and linoleic acid (20-25) and low erucic acid (<2%) to improve its nutritional quality. Genetic enhancement of a character is primarily dependent on its genetic architecture, which is ultimately decides the success of the conventional breeding programme. Therefore, the present investigation was attempted to study genetics of oleic, linoleic and erucic acid in Indian mustard so as to devise appropriate breeding methodology for their improvement.

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MATERIALS AND METHODS

The materials for the present investigation consisted of six generations *viz.,* P_1, P_2, F_1, F_2, BC_1 and BC_2 of the cross GM 3 x NUDHYJ 3 of Indian mustard. GM 3 is a high yielding variety having low linoleic and high erucic acid content and NUDHYJ 3 is a low erucic (<2%), relatively high oleic and linoleic acid strain received from the Main Castor and Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar by hand crossing using standard technique during *Rabi* 2005-2006, this hybrid was selfed and backcrossed to obtain their F_2, BC_1 and BC_2 generations. All the crosses along with their parents *i.e.,* all six generations were grown in the Compact Family Block Design with three replications in *Rabi* 2006-07. Each net plot had one row for parents and F_1, two rows for each of the BC_1 and BC_2 generations and four rows for

F_2 generation. Each row consisted of 20 plants with row to row and plant to plant spacing being 45 and 15 cm, respectively. The recommended agronomic practices were followed to raise the crop. The plants were selfed and selfed seeds were harvested. Fatty acid profiles of the oil were determined in percentage by GAS Liquid Chromatography (NUCON-5765) through the separation of methyl esters on diethylene glycol succinate (DEGS) column as described earlier (Chauhan *et al*., 2002).

Mean and variances were calculated for each generation separately and used for statistical analysis. Adequacy of additive-dominance model was tested using scale given by Hyman and Mather (1955). Gene effects were estimated following Hyman (1958) using six-parameter model. The significance of gene effects was tested by calculating variances, standard errors and "t" values

RESULTS AND DISCUSSION

The results obtained from the present investigation have been discussed in the following sub heads :

Palmitic acid content (%):

The mean values of parents were at par with each other. The F_1 mean was at par with the parent P_2. The mean value of F_2 was significantly lower than the mean value of F_1 indicating the loss of vigour in the F_2 generation. The mean values of BC_1 and BC_2 generations were at par with each other but they were significantly higher than respective recurrent parent.

Barring additive, all other gene effects were significant, where, dominance x dominance, dominance and additive x additive were higher in magnitude followed by additive x dominance.

Stearic content (%):

Results revealed significant difference between the mean values of the parents for this quality trait. The mean value of F_1 was significantly higher than both the parents indicated presence of over dominance. The mean of F_2 significantly lower than the mean value of F_1 indicated the presence of inbreeding depression and involvement of non-additive gene action for this trait. The mean values of BC_1 and BC_2 were significantly differed with F_1 and their respective recurrent parents.

All the gene effects were found significant where in dominance gene effect was highest followed by additive x additive, dominance x dominance and additive x dominance gene effects.

Oleic acid (%):

Significant difference was observed between the mean values of the parents. The F_1 mean between the parental mean values differed significantly from either of its parents, which suggested that additive gene action was involved in the expression of this trait. The F_2 mean was significantly lower than the F_1. The BC_1 mean value was in between with the mean of F_1 and P_1, while, BC_2 was at par with P_2 parent.

All the gene effects *viz.,* additive, dominance and epistatic were found to be significant, where, in dominance was greater in magnitude, next in order being additive x additive and dominance x dominance gene effects.

Linoleic content(%) :

The mean of parents, P_1 and P_2 were not significantly differed with each other. The F_1 mean showed significantly higher than both the parents indicated the presence of over dominance. The F_2 mean was significantly lower than F_1 mean. The BC_1 mean was significantly higher than F_1 and P_1. The mean of BC_2 was in between the mean of F_1 and parent P_2.

All the gene effects were significant where, additive x additive, dominance and additive x dominance were greater in magnitude.

Linolenic content (%):

Parents P_1 and P_2 differed significantly, the F_1 mean was higher than both the parents but at par with parent P_2 indicated the role of non-additive gene action in the expression of this trait. The F_2 mean was significantly

Table 1: Mean values of fatty acids (%) in different generations in cross GM 3 x NUDHYJ 3 of Indian mustard

Fatty acid	Generations						S.E. (±)	C.D. (P=0.05)
	P_1	P_2	F_1	F_2	BC_1	BC_2		
Palmitic (%)	01.08	01.40	01.55	01.07	01.48	01.51	00.036	0.34
Stearic (%)	10.48	18.20	19.41	10.82	16.13	16.62	00.230	0.87
Oleic (%)	17.82	31.77	27.73	17.87	21.74	26.27	05.426	4.23
Linoleic (%)	09.97	09.79	12.12	10.13	17.28	11.58	00.199	0.81
Linolenic (%)	05.38	09.08	09.47	06.51	06.76	08.16	00.269	0.94
Erucic (%)	42.15	01.07	25.78	46.33	31.02	22.12	13.360	6.64

Table 2 : Scaling test and estimation gene effects for fatty acids content in cross GM 3 x NUDH YJ 3 of Indian mustard

Parameter	Palmitic (%)	Stearic(%)	Oleic(%)	Linoleic (%)	Linolenic (%)	Erucic (%)
A	0.32**	2.37**	-2.08	12.46**	-1.33**	-5.88**
B	0.07	-4.37**	-6.95**	01.26**	2.23**	17.38**
C	-1.31**	-24.24**	-33.58**	-3.49**	-7.37**	90.52**
D	-0.85**	-11.12**	-12.27**	-8.61**	-1.90**	39.51**
[m]	1.07**	10.82**	17.87**	10.13**	6.51**	46.33**
[d]	-0.03	-0.49**	-4.54**	05.69**	-1.40**	08.90**
[h]	2.02**	27.31**	27.48**	19.46**	6.05**	-74.85**
[i]	1.71**	22.23**	24.55**	17.22**	3.80**	-79.02**
[j]	0.13**	3.37**	2.44**	05.61**	0.45**	-11.63**
[l]	2.11**	-20.22**	-15.52**	-30.94**	-0.24**	67.52**

* and ** indicate significance of values at P=0.01 and 0.05, respectively

lower than the mean of F_1 generation. The BC_1 mean was the intermediate with the mean value of F_1 and its recurrent parent P_1. The BC_2 mean was lower than both F_1 and its recurrent parent P_2.

Barring dominance gene effect all other gene effects were significant where, dominance x dominance was the highest followed by additive x dominance and additive gene effects in that order.

Erucic content (%) :

The mean values of parents (P_1 and P_2) was differed significantly and also the mean value of F_1 was intermediate between the mean values of both the parents and also significantly differed with both the parents, these finding indicated the additive gene action was governed the expression of this important quality trait. The F_2 mean values were significantly higher. The mean value of BC_1 and BC_2 was differed significantly with each other. The mean value of BC_1 was significantly lower than its recurrent parent P_1. The mean value of BC_2 was at par with F_1 mean value. These finding indicated both additive and non-additive gene action governed this trait.

All the gene effects were found highly significant, where, additive x additive was the highest magnitude followed by dominance, dominance x dominance and additive x dominance gene effects.

Above results summarized that, the entire gene effects were found highly significant, where, additive x additive was the highest magnitude followed by dominance, dominance x dominance and additive x dominance gene effects. The results revealed that both additive and non-additive gene effects responsible for inheritance of these traits. The opposite signs of dominance and dominance x dominance suggested that the interaction were balanced and mainly of duplicate epistasis. This type of gene action responsible for the inheritance of this trait revealed that homozygous recombinants along with high linolenic acid content could be developed by following reciprocal recurrent selection on *inter se* crossing of desired segregates keeping adequate population size.

This results was akin with the results obtained by Chauhan *et al.* (2002) and Singh *et al.* (1995), they reported the additive and additive x additive gene action governed erucic acid content. Kumar and Thakral (2003) reported that the exotic material content low erucic acid and in present study also indicated NUDHYJ 3 content low erucic acid.

The involvement of predominance of non-additive and additive gene action for palmitic acid content and dominance x dominance epistatic gene action higher in most of characters suggested the recurrent selection of superior plants in segregating material for improvement of these quality traits.

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