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RESEARCH PAPER

Genetics of agronomic characters in Indian mustard [*Brassica juncea* (L.) Czern & Coss.] under normal and late shown conditions

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Abstract : Analysis of generation means *viz*., P_1, P_2, F_1, F_2, BC_1 and BC_2 of eight crosses of *B. juncea* (L) Czern & Coss. was performed under normal and late sown conditions to determine the nature of gene action governing seven agronomic traits *viz*., days to 50% flowering, days to maturity, plant height (cm), primary branches per plant, secondary branches per plant, number of siliquae on main raceme and length of main raceme. Types of gene action varied with the plant traits, crosses and treatments. Additive as well as dominance effects were significant in inheritance of agronomic characters but prevalence of additive x additive interaction coupled with additive effects in the present study implied that selection for desirable agronomic characters would be effective in early segregating generations. Dominance effect and additive x additive type of epistatic gene action were found important in controlling inheritance of all these traits. Despite high magnitude of dominance gene effect, the dominance would not be exploitable because of duplicate type of epistsis found for these traits. However, additive x additive gene effect can offer only limited possibility of genetic improvement through simple selection procedures. The direction of fixable and non fixable gene action and of duplicate epistasis implies the use of biparental mating approach/intermating in early segregating generations.

Key Words : Indian mustard, *B. juncea,* Generation mean analysis, Epistasis

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INTRODUCTION

India is the third largest rapeseed-mustard producer in the world after China and Canada with 12 per cent of world's total production. India holds a premier position in rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production, respectively. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop. Due to the gap between availability and actual consumption of edible oils, India has to resort to import of edible oils with a projected demand for edible oils at more than 20 m t in 2014-15. About 6.51 m ha was occupied under rapeseed- mustard during 2010-11. A great deal of variability is present in the breeding material, its response to drought and genotype x environment interaction. Rishipal and Kumar (1993) reported that environment and crosses in *Brassica juncea* considerably influenced the gene effects. Additive and non-additive effects governed the expression of number of primary branches, seeds/siliqua, 1000-seed weight and seed yield, the latter being the most important. A duplicate type of epistasis was observed for most of the traits. Dominance and epistatic effects of the gene action for days to 50% flower, plant height, siliquae/ plant and yield/plant were found in different generations by Singh and Singh (1994) where as non-additive gene action appeared to be predominant for all traits except days to maturity, which was governed by additive gene action (Patel *et al*., 1996). In Indian mustard (*B. juncea)* preponderance

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of non-additive gene action was found for most of the traits including oil content (Sheikh and Singh, 1998) and additive genetic variance was more important for plant height. Presence of both additive and non-additive gene effects in controlling the expression of various traits and preponderance of non-additive gene action was found to control the yield *in B. juncea* (Khulbe *et al.*, 1998). The presence of duplicate gene action is indicative of the possibility of improvement through heterosis breeding (Celine and Sirohi, 1998). Plant height in *Brassica* displayed low genetic advance irrespective of their high heritability estimates, probably due to non-additive gene effects *i.e.*, dominance and epistasis (Larik and Rajput, 2000). On the basis of selection indices, it could be concluded that branches per plant and siliquae per plant had been the most important yield components. Days to 50% flowering was predominantly governed by non-additive gene action in Indian mustard (*B. juncea*). However, both additive and non-additive gene action were important in the inheritance of most of the traits studied (Tak and Khan, 2000). Predominant role of non-additive gene action along with over dominance was observed for number of days to flowering and maturity, length of main raceme, number of secondary branches, yield per plant, test weight and oil content. Non -additive gene effects controlled the yield per plant (Prasad *et al.*, 2001).

A predominance of non-additive component for a majority of the yield contributing traits including plant height in *B. juncea* is suggested by Rao and Gulati (2001). Ghosh *et al.* (2002) were of the opinion that for most of the major traits including seed yield had both additive and non-additive gene action of prime importance in Indian mustard. Such variability of results indicated clearly that the inheritance patterns of plant traits imparting sowing situation and yield varies with the genetic material and the climatic vagaries that suggested exploring the genetic information about the present material before performing selection.

MATERIAL AND METHODS

A field experiment was conducted with a set of six generations *viz*., P_1, P_2, F_1, F_2, BC_1 and BC_2 of each of these crosses planted in Compact Family Block Design with three replications under normal and late shown conditions during *Rabi* 2006 – 07. The experimental material comprised of 8 cross combinations derived from 7 parents of Indian mustards. The cross combination were NDR-190 x NDRE-4[C1], NDR-190 x NDYR-8 [C2], NDR-8208 x NDRE–4 [C3], NDR-8208 x PHR-1 [C4], Urvashi x PHR-1 [C5], Urvashi x Vardan [C6], Vardan x NDRE-4 [C7] and NDYR-8 x PHR-1 [C8]. Each non-segregating generation including back crosses were sown in four rows and F_2 were sown in six rows. Five randomly selected plants each of P_1, P_2, and F_1, 20 plants of F_2 and 15 plants each of BC_1 and BC_2 generations per replication were utilized for recording observations on days to 50% flowering (DFF), days to maturity (DM), plant height (PH) (cm), primary branches per plant (PBP), secondary branches per plant (SBP), number of siliquae on main raceme (NSMR) and length of main raceme (LMR). The data were subjected to scaling tests (Mather, 1949) to detect the presence of epistasis. In case of significance of simple scaling tests, data were then subjected to the estimation of various genetic components (Hayman, 1958). More precise estimates of three parameters were then obtained by using weighted joint scaling tests (Cavalli, 1952). In the event of the scaling test being non- significant (*i.e.* absence of non-allelic interactions), the three parameter model was used , which is based on to estimate main effect (m), (d) and (h). The significance of the parameters was tested against their corresponding standard errors.

RESULTS AND DISCUSSION

Additive effect was most important for days to 50% flowering of crosses and in positive direction in both NS and LS (Table 1). Among the interactions, additive x additive (i) and dominance x dominance (l) were relatively more important because of their higher magnitude and positive direction. Scaling test (Mather, 1949) *i.e.* estimation of deviation from zero revealed that epistasis had a predominant role in expression of most of the characters. Simple and joint scaling tests indicated presence of epistatic interaction and fitness of digenic interaction model for all the seven characters in the eight crosses under both the environments. This means that consistent absence of epistasis in C3 for days to 50% flowering, primary branches per plant, length of main raceme under normal sown condition, while in C5 for secondary branches per plant under late sown condition by the two type of scaling tests. Both simple and joint scaling tests led to similar inferences in respect of presence or absence of epistasis in majority of cases for the seven characters of eight crosses under normal and late sown conditions. Singh and Singh (1994) and Rao and Gulati, 2001 concluded similar findings as those in present studies that plant height is under the control of dominance. Larik and Rajput (2000) studied *B. juncea* and *B. napus* together and reported the involvement of additive effects in the phenotypic expression of the plant height, which is in corroboration with the present studies.

The generation mean analysis revealed importance of additive (d) and/or dominance (h) gene effects as well as one or more of the epistatic gene interactions, (i, j, l) for all the seven characters in most of the crosses under normal and late sown conditions. However, nature and magnitude of gene effects and epistatic interactions for a character exhibited considerable variation across the eight crosses and seasons. The significance of additive gene effects for most of the traits in eight crosses under two situations suggests that substantial improvement in yield status can still be

achieved in Indian mustard by using breeding procedures exploiting fixable components of genetic variance leading to development of pure line varieties in Indian mustard for normal and late sown conditions. Significance of dominance gene effects and epistatic interactions for most of the traits in eight crosses under two conditions indicated that exploitation of heterosis through development of hybrid varieties may be explored as potential alternative in future. In absence of exploitation of heterosis through commercial hybrids, non-additive gene effects may be utilized for facilitating development of pure line cultivars by involving population improvement methods. The results are supported by the findings of Khulbe *et al*. (2000), (Rao and Gulati, 2001) and Prasad *et al*. (2002) and contrary results were found by Patel (1996) and Hooda *et al*. (2000).

Duplicate type of epistasis was detected for plant height, number of siliquae on main raceme and secondary branches per plant in C1; days to 50% flowering, days to maturity, plant height, secondary branches per plant, number of siliquae on main raceme and length of main raceme in C2; days to maturity, secondary branches per plant and number of siliquae on main raceme in C3; plant height and length of main raceme in C4; days to 50% flowering, plant height and length of main raceme in C5; plant height, number of siliquae on main raceme and length of main raceme in C6; primary branches per plant and length of main raceme in C7 and days to maturity, plant height, number of siliquae on main raceme and length of main raceme in C8, while complementary type of epistasis was detected for primary branches per plant in C2; secondary branches per plant in C4; secondary branches per plant in C5 and C6 and days to 50% flowering in C7 under normal sown condition. Under late sown condition, duplicate type of epistasis was detected for length of main raceme and oil content in C1; days to 50% flowering and plant height in C2; days to 50% flowering, plant height, primary branches per plant, secondary branches per plant, number of siliquae on main raceme and length of main raceme in C3; days to 50% flowering, days to maturity, plant height and secondary branches per plant in C4; number of siliquae on main raceme and length of main raceme in C5; days to maturity in C6; days to maturity, secondary branches per plant, number of siliquae on main raceme and length of main raceme in C7 and days to 50% flowering, days to maturity, plant height, secondary braches per plant and number of siliquae on main raceme in C8, while complementary type of epistasis was observed for plant height and secondary branches per plant in C1; number of siliquae on main raceme in C4; plant height in C5; secondary branches per plant in C6 and primary branches per plant in C8. Duplicate type of epistasis slow down the selection procedure of additive or non-additive genetic variance, while complementary type of epistasis will aid in improving the efficiency of additive or non additive gene action. Singh and Singh (1994), Celine and Sirohi (1998), Khulbe *et al.*(1998), Sheikh and Singh (1998), Rao and Gulati (2001), and Prasad *et al*. (2002) supported the results of present studies.

Conclusion :

It is concluded from the present studies that with the change in environment (normal or late sown) gene effects for different traits contributing to yield or yield itself changes. So for different environment one has to opt for different selection criteria for the improvement in agronomical characters along with the yield. For those traits that are controlled by additive gene action, simple selection in early generation is suggested, whereas for those traits controlled by non-additive gene action selection in later generation would be more effective.

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