Germplasm diversity and heterosis in oilseed rape (*Brassica napus* L.)

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Abstract

With the success of Ogu-INRA CMS system, the focus of breeding efforts in oilseed rape has shifted decisively towards hybrid breeding. Delineation of germplasm into heterotic gene pools is important as complementation between divergent parents is known to define limits of heterosis. In this communication we present results of our attempts to measure genetic diversity in Indian and Australian *B. napus* germplasm (36) on the basis of variation for twelve morphophysiological traits. Diversity analysis (UPGMA) categorized the test germplasm into five groups with overall dissimilarity coefficient of 0.59 suggesting a narrow genetic base. Group I comprised 13 Australian genotypes with dissimilarity coefficient of 0.30. Group II comprised seven Australian canola, six Indian canola and two Indian non-canola types. Two Australian (Monty and BST-7-2M_2) and one Indian non-canola type were included in Group III. Trilogy was the lone genotype in Group IV, close to Group V comprising two Indian canola types GSC 302 and OCN 3, besides an Australian genotype Tranby. Based on genetic diversity, three sets of hybrids (95) were developed by crossing selected Australian lines as female with Canadian (Ashai), Indian canola (OCN 3 and GSC 5) and Indian non-canola (GSL 1 and Neelam) cultivars as males. These hybrids were evaluated against GSC 5 as a frequent check to estimate standard heterosis. Average heterosis in these three sets respectively, was 0.6, 19.8 and 37.5 per cent, suggesting, in general, an association of standard heterosis with diversity in the test germplasm evaluated. Two canola (Rivette×OCN 3 and Av-Sapphire×GSC 5), and six canola×non-canola combinations (AG-Spectrum×GSL 1, Oscar×Neelam, AV-Sapphire×GSL 1, Surpass 400×Neelam, Monty×Neelam and Oscar×GSL 1) were highly productive.

Key words: Oilseed rape, genetic diversity, heterosis, canola, hybrids.

Introduction

Heterosis, a major force during crop evolution, has proved rewarding for productivity enhancement in a large number of field and vegetable crops. Quantitative genetic explanation for this phenomenon depends directly on existence of dominance and indirectly through interaction involving dominance effect at different loci in hybrids. Assuming heterosis as a function of heterozygosity, it can be considered as a function of parental diversity. Geographic diversity, singly or in combination with other measures of genetic diversity like combining ability analysis has been used in the past to assess parental diversity (Tsaftaris 1995). In spite of the past inconsistent results, documentation of diversity and its association with hybrid performance is critical since it helps in limiting the number of germplasm lines for evaluation in test hybrid combinations. In this communication an attempt has been made to assess genetic diversity in 36 *B. napus* germplasm lines of Indian and Australian origin, using multivariate analysis. In addition, linking hybrid performance of a fairly large number of F_1 combinations with divergence patterns in the germplasm was attempted.

Material and Methods

Experimental material comprised self bred genotypes of *B. napus*, originating from India and Australia, along with a set of 95 hand bred F_1 combinations. The F_1 combinations were developed on the basis of geographic diversity by crossing Australian lines as females with Canadian (Ashai), Indian canola (GSC 5 and OCN 3) and Indian non canola (GSL 1 and Neelam) lines as males. Parental lines and the hybrids (along with commercial check varieties) were raised separately as paired row in a balanced block design with two replications at row to row spacing of 45cm and plant to plant spacing of 10-15cm. Standard agronomic practices were followed throughout the crop season. Data were recorded for ten random plants per genotype/F_1 in each replication and averaged for key morpho-physiological characteristics including yield and its components. Statistical analysis for morphological data was conducted using the software programme NTSYS pc version 2.02e (Rholf 1998). Cluster analysis was conducted on the taxonomic distance matrix with the unweighted pair group method based Arithmetic average (UPGMA). A dendrogram was generated based on genetic distance matrix. Heterosis was estimated as increase or decrease in the mean performance of hybrid over commercial pure line, GSC 5, expressed as per cent.

Results

Mean data for twelve morpho-physiological traits of the parents was subjected to diversity analysis which partitioned the

evaluated 36 germplasm lines into five major groups. The Group I comprised 13 Australian canola types, with dissimilarity coefficient of 0.30. Group II included seven Australian canola, seven Indian canola and two Indian non canola (GSL 1 and Neelam) types. Group III had two Australian (Monty and BST-7-2 M_2) and one Indian non canola type (GSL 2). Australian cv. Trilogy was the lone genotype in Group IV, this group appeared close to Group V which included two Indian canola types (GSC 5 and OCN 3). Last named two groups appeared most distinct with dissimilarity coefficient of 0.59 with respect to the remaining three groups.

Table 1. Grouping of test germplasm.

Group	Germplasm
I	Rainbow, AG spectrum, RR 013, RR 001, RR 005, RQ 011, RR 009, Oscar, Skipton, Rivette, Lantern, Purlar, AG Sapphire
II	Surpass 400, TQ 0055-02W_2, BCN 17, AG-Outback, RQ 001, BCN 15, BCN 33, BCN 41, GSL 1, Charlton, RR 002, BCN 37, Neelam, BCN 5, Mystic, BCN 19
III	Monty, BST 7, GSL 2
IV	Trilogy
V	Tranby, OCN 3, GSC 5

Based on genetic diversity, three sets of F_1 combinations were developed by crossing selected Australian lines as female with Canadian (Ashai), Indian canola (OCN 3, GCS 5) and Indian non canola (GSL 1, Neelam) as males. These hybrids were evaluated against commercial canola cultivar, GSC 5. Average heterosis in these sets was 0.6, 19.8 and 37.5 per cent, respectively. Apparently, hybrids involving Australian germplasm and Indian non canola types were most productive. Intragroup hybrids generally showed negative heterosis. Notable exceptions from this trend were Charlton×GSL 1, Mystic×GSL 1 and Surpass×Neelam. Hybrid combinations (29) showing positive heterosis (>0) are presented in Table 2. It was observed that Group I Australian germplasm showed high heterosis following hybridization with Indian non canola (Group II) and canola (Group V) rapeseed cultivars.

Table 2. Hybrid combinations showing positive heterosis for yield

Group Combination	Extent of Commercial Heterosis		
	0-10%	10-30%	>30%
I×II	-	Rivette×Neelam	RR 001×GSL 1 RR 005×GSL 1 Oscar×GSL 1 Oscar×Neelam Spectrum×GSL 1 Sapphire×GSL 1
I×IV	Skipton×GSL 1 RR 013×OCN 3	Lantern×GSC 5 RR 013×GSC 5 Sapphire×OCN 3	Lantern×OCN 3 Rainbow×GSC 5 Rivette×OCN 3 Oscar×GSC 5 RG 001-02M_2×GSC 5 Sapphire×GSC 5
II×II	-	Mystic×GSL 1	Charlton×GSL 1 Surpass 400×Neelam
II×III	-	-	Monty×Neelam
II×V	Mystic×OCN 3	Mystic×GSC 5	Surpass 400×GSC 5 Surpass 400×OCN 3 Outback×OCN 3 RR 002×OCN 3
III×V	-	Monty×OCN 3	-

Discussion

Success of the commercial hybrid breeding programme is primarily determined by the extent of heterosis for productivity traits. As heterosis is considered to be an outcome of genetic complementation between divergent parents, several measures of genetic diversity have been used for predicting hybrid performance. These include geographic diversity (Lefort-Buson *et al* 1987) as well as the genetic distance between the parents involved in the hybrids (Griffing and Linstorm 1954). Present study constitutes an important step to delineate genetic diversity in a fairly diverse sample of rapeseed germplasm with an aim to associate genetic diversity with standard heterosis. Diversity analysis allowed clustering of the test germplasm into five distinct groups. These were largely in accordance with known originating sources as well as available pedigree records. Australian germplasm largely clustered in two related groups, suggesting a narrow germplasm base. Group II was interesting as it comprised both Australian and several Indian canola types as well as non canola types. Most of the Indian canola/non canola rapeseed types have Canadian germplasm in their pedigree. Same may be true for Australian germplasm. Group IV and V were very distinct indeed. Analysis of combinations showing high heterosis clearly underlined the benefits of such diversity analysis in choice of parents for hybrid combinations. Intragroup hybrids largely showed negative heterosis. Group I Australian lines produced productive F_1 hybrids in combination with group V Indian canola types (OCN 3, GSC 5). The study

underlined the importance of international collaborative research to delineate rapeseed germplasm into distinctive hybrid breeding oriented gene pools.

Conclusions

Clustering of germplasm on the basis of morpho-physiological traits was largely consistent with known originating sources and available pedigree records. Crosses between Australian and Indian germplasm lines appear very productive and may find use in commercial hybrid breeding.

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