

Original Research Article

Heterosis Breeding in Indian Mustard (*Brassica juncea* L. Czern & Coss)

ABSTRACT

The heterosis breeding strategy is one of the most successful technological approaches for improving Indian mustard varieties for seed yield quality and quantity, as well as other yield contributing character. The present investigation was undertaken ten genetically diverse parents following diallel mating design excluding reciprocals. The resultant 45 F₁s and all the ten parents were evaluated in randomized block design with three replications under three different environments. Data on quantitative characters were recorded and heterosis and Heterobeltosis were determined that sufficient degree of heterosis and heterobeltiosis were observed for all the attributes. The crosses, RGN-13 x RH-406 for days to 50 per cent flowering, days to maturity, no. of secondary branches per plant, no. of siliquae per plant, 1000-seed weight, oil content, leaf area index and harvest index and RGN-303 x RGN-229 for days to 50 per cent flowering, days to maturity, no. of secondary branches, no. of seed per siliqua, 1000-seed weight Among 45 crosses, RGN-13 x RH-406 emerged as good heterotic as well as heterobeltiotic crosses for seed yield and other contributing characters.

Keyword: Heterosis, heterobeltiosis, attributes, yield, diallel

INTRODUCTION

Brassica is a major angiosperm genus with approximately 3200 species with morphological diversity. Indian mustard (*Brassica juncea*) is an important rabi oilseed crop in India and contributes more than 80% of total rapeseed-mustard production in the country. It is utilised in the production of oil, as well as nourishing vegetables and sauces. India is the world's 4th largest grower and producer of oil-producing crops, accounting for ~19% of worldwide acreage and 2.7% of production. Oilseed crops, just after cereals, play an important role in the Indian agricultural economy. India is the second largest mustard growing country in the world and ranks third next to Canada and China in production. In India, rapeseed-mustard grown in 7.92 mha with production of 9.34 mt with average productivity of 1499 kg ha⁻¹ (Anonymous, 2020). Rajasthan is the largest producer of rapeseed-mustard followed by Uttar Pradesh, Haryana, Madhya Pradesh, West Bengal, Gujarat and Assam. In Rajasthan mustard is cultivated on about 2.71 million hectares with 4.30 mt production and 1586 Kg/ha productivity (Anonymous, 2020).

Domestic demand for edible oils and fats has been proliferating at 6% per year, but domestic output has only increased by 2% per year. The country's significant scarcity of edible oils has been attributed to several issues, including the country's ever-growing population, sudden climate change, rising household income and low

productivity of oilseed crops. Heterosis breeding could be a potential alternative for achieving quantum jumps in production and productivity. Since then, commercial exploitation of heterosis in a variety of crop species has resulted in a significant increase in yield levels. Verma *et al.* (2000) observed significant degree of heterobeltiosis in several varieties of Indian mustard. A wide range of positive heterosis for seed yield and important yield components was also reported by Rawat (1975) and Ram *et al.* (1976). Keeping this in view, the present study was undertaken to identify potential parental material for producing high yielding varieties, following full diallel analysis which helps plant breeders to predict the utility of F1 hybrids and its behavior in subsequent generation.

MATERIALS AND METHODS

Ten genetically diverse parents namely, RGN-303, RGN-13, RGN-229, RGN-298, RGN-236, RH-30, RH-406, RB-50, RLM-619 and PBR-378 were crossed in diallel mating design excluding reciprocals. During Rabi 2019-20, ten parents and their 45 F₁s were evaluated in randomized block design (RBD) under three different environments created by three dates of sowing [1st October (E₁), 15th October (E₂) and 30th October (E₃)] during Rabi 2019-2020 at Research farm, College of Agriculture, SKRAU, Bikaner. Observations were recorded for the characters namely, days to 50% flowering and days to maturity, plant height, no. of primary branches per plant, no. of secondary branches per plant, no. of siliquae per plant, siliqua length, no. of seed per siliqua and leaf area index, 1000 seed weight, oil content, biological yield per plant, harvest index and seed yield per plant. Heterosis is expressed as per cent deviation from mid parent, whereas heterobeltiosis expressed as per cent deviation toward desirable direction over better parent. Heterosis and heterobeltiosis were calculated according to the method suggested by Shull (1908) and Fonseca and Patterson (1968).

$$\text{Heterosis (\%)} = \frac{\bar{F}_1 - \bar{MP}}{\bar{MP}} \times 100$$

Where,

\bar{F}_1 = Mean Value of F₁

\bar{MP} = Mean mid parent value *i.e.* (P₁+P₂)/2

$$\text{Heterobeltiosis} = \frac{(\bar{F}_1 - \bar{BP})}{\bar{BP}}$$

To calculate heterosis and heterobeltiosis parents with higher mean values were considered desirable for all the characters. Lower mean values of days to 50% flowering and days to maturity were considered desirable.

RESULT AND DISCUSSION

Heterosis has extensively been explored and utilized for boosting various quality traits in *Brassica* and other crops (Hassan *et al.*, 2006). According to Pal and Sikka, (1956) heterosis is a quick, cheap and easy method for increasing crop production. The mean square of parents and crosses were highly significant for most of the characteristics in different environments and over environments in the current study, indicating that there was enough heterosis. Thus, parent study has been done to determine the best cross combinations that should be used for further segregation generation selection. Sufficient degree of heterosis and heterobeltiosis were observed for all the attributes. From Table 1, the performance point of view best hybrids namely, RGN-13x RH-406, RH-30x RB-50, RGN-303x RGN-229, RGN-236x RB-50, RGN-229x RGN-236, RGN-303xRGN236 and RGN-236x PBR-378 for heterosis and RGN-13x RH-406, RH-30x RB-50, RGN-236x RB-50, RGN-303x RGN-229, RGN-13x RB-50 and RGN-298x PBR-378 for heterobeltiosis have been reported to have high significant effect for seed yield and other related traits in desirable direction. These crosses were considered promising for their use for yield improvement in mustard.

Assessment of Table 2 described an interesting relation between heterosis and heterobeltiosis of seed yield and other yield attributing traits. The crosses, RGN-13 x RH-406 for days to 50 per cent flowering, days to maturity, no. of secondary branches per plant, no. of siliquae per plant, 1000-seed weight, oil content, leaf area index and harvest index and RGN-303 x RGN-229 for days to 50 per cent flowering, days to maturity, no. of secondary branches, no. of seed per siliqua, 1000-seed weight and harvest index showed desirable heterosis and heterobeltiosis for seed yield per plant and also yield attributing traits. The results of this study backed up Grafius (1959) asserted that there could be no separate gene system for yield *per se* because yield is the result of multiplicative interactions among its various contributing attributes. The crosses that showed heterotic expression for seed yield per plant, on the other hand, were not heterotic for all of the characters. It was also noted that the expression of

heterosis and heterobeltiosis was influenced by the environments for almost all the characters. This was because of significant G x E interaction. The results are in harmony with Patel *et al.* (2010), Vaghela *et al.*(2011), Gami and Chauhan(2013), Dholu *et al.* (2014), Adhikari *et al.* (2017), Barupal *et al.* (2017) and Bhinda *et al.* (2020).

Conclusion

The crosses, RGN-13 x RH-406 and RGN-236 x RB-50 were best crosses for seed yield per plant in all the environments and combined environments, with desirable heterosis and heterobeltiosis for one or more characters along with positive significant SCA effect. These crosses could be frequently advanced to obtain high frequency of transgressive segregants, which reveals good scope for isolation of pure line from the progenies of heterotic F₁ and commercial exploitation of heterosis in Indian mustard.

Table 1: Best three heterotic and heterobeltiotic crosses for seed yield per plant and *per se* performance in different environments

Environments	Heterotic crosses	Heterosis	<i>Per se</i> performance (g)	Heterobeltiotic crosses	Heterobeltiosis	<i>Per se</i> performance (g)
E ₁	RGN-13x RH-406	76.18**	44.96	RGN-13x RH-406	72.92**	44.96
	RH-30x RB-50	59.19**	46.36	RH-30x RB-50	49.55**	46.36
	RGN-303x RGN-229	56.79**	50.7	RGN-236x RB-50	48.67**	40.51
E ₂	RGN-13x RH-406	54.71**	56.75	RGN-13x RH-406	53.39**	56.75
	RGN-236x RB-50	52.93**	50.96	RGN-236x RB-50	47.1**	50.96
	RGN-229x RGN-236	47.7**	56.3	RGN-303x RGN-229	44.79**	63.71
E ₃	RGN-236x RB-50	46.64**	65.87	RGN-236x RB-50	40.64**	65.87
	RGN-13x RH-406	36.54**	64.11	RGN-13x RH-406	36.4**	64.11
	RGN-303xRGN236	36.09**	65.9	RGN-13x RB-50	34.06**	63.01
Pooled	RGN-303x RGN-229	50.75 **	59.83	RGN-13x RH-406	47.65	55.27
	RGN-13x RH-406	48.18 **	55.27	RGN-303x RGN-229	42.92 **	59.83
	RGN-236x PBR-378	41.26 **	53.79	RGN-298x PBR-378	35.38 **	62.81

* and ** indicates significance of values at P< 0.05 and 0.01, respectively

Table 2: Crosses possessing high heterosis and heterobeltiosis for seed yield per plant along with desirable (+) heterotic expression for other characters in different environments

Particulars	Environments	Crosses	Per se performance for seed yield per plant	Magnitude of heterosis or heterobeltiosis in per cent	Days to 50% flowering	Days to maturity	Plant height	No. of primary branches per plant	No. of secondary branches per plant	Number of siliquae per plant	Siliqua length	Number of seeds per siliqua	1000-Seed weight	Biological yield per plant	Oil content	Leaf area index	Harvest index	
+Heterosis	E₁	RGN-13x RH-406	44.96	76.18**	+	+	-	+	+	-	-	-	+	+	+	+	+	
		RH-30x RB-50	46.36	59.19**	+	+	-	-	+	-	-	-	-	-	-	-	-	+
		RGN-303x RGN-229	50.7	56.79**	-	-	+	+	+	+	-	-	+	+	+	-	-	+
	E₂	RGN-13x RH-406	56.75	54.71**	+	+	-	+	+	+	-	-	+	+	-	-	+	+
		RGN-236x RB-50	50.96	52.93**	+	-	-	-	-	-	-	-	-	-	-	-	-	+
		RGN-229x RGN-236	56.3	47.7**	-	-	-	+	+	+	-	-	+	+	-	-	-	+
	E₃	RGN-236x RB-50	65.87	46.64**	-	-	+	-	-	-	-	-	-	-	-	-	-	+
		RGN-13x RH-406	64.11	36.54**	+	+	-	-	+	+	-	-	+	+	-	+	+	+
		RGN-303xRGN-236	65.9	36.09**	+	+	+	-	-	-	-	-	+	+	+	-	+	+
	Pooled	RGN-303x RGN-229	59.83	50.75 **	+	-	+	-	+	+	-	-	+	+	-	-	-	+
RGN-13x RH-406		55.27	48.18 **	+	+	-	+	+	+	+	+	+	+	-	+	+	+	
RGN-236x PBR-378		53.79	41.26 **	-	-	+	+	+	-	-	-	+	+	-	-	+	+	
Heterobeltiosis	E₁	RGN-13x RH-406	44.96	72.92**	+	+	-	-	+	-	-	-	+	-	+	+	+	
		RH-30x RB-50	46.36	49.55**	+	+	-	-	+	-	-	-	-	-	-	-	-	+
		RGN-236x RB-50	40.51	48.67**	+	-	+	-	-	-	-	+	-	-	+	-	-	+
	E₂	RGN-13x RH-406	56.75	53.39**	+	+	-	-	+	+	-	-	+	+	-	-	+	+
		RGN-236x RB-50	50.96	47.1**	+	-	-	-	-	-	-	-	-	-	-	-	-	+
		RGN-303x RGN-229	63.71	44.79**	+	+	-	+	+	+	-	+	-	-	-	-	-	+
	E₃	RGN-236x RB-50	65.87	40.64**	-	-	+	-	-	-	-	-	-	-	-	-	-	+
		RGN-13x RH-406	64.11	36.4**	+	+	-	-	+	+	-	-	+	+	-	-	+	+
		RGN-13x RB-50	63.01	34.06**	+	+	-	+	+	+	-	-	-	-	-	-	+	+
	Pooled	RGN-13x RH-406	55.27	47.65	+	+	-	-	+	+	-	-	+	+	-	-	+	+
RGN-303x RGN-229		59.83	42.92 **	+	+	-	-	+	+	-	+	+	+	-	-	-	+	
RGN-298x PBR-378		62.81	35.38 **	-	-	-	-	-	-	-	-	-	-	-	-	-	+	

* and ** indicates significance of values at P< 0.05 and 0.01, respectively

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