Department of Genetics and Plant Breeding

School of Agriculture

Heterosis and combining ability analysis for yield and quality traits in Indian mustard (Brassica juncea L.)

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By

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Title:- Heterosis and combining ability analysis for yield and quality traits in Indian mustard (Brassica juncea L.)

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Period of research	**2017-19**

CERTIFICATE

This is certified that this synopsis entitled **"Heterosis and combining ability analysis for yield and quality traits in Indian mustard (Brassica juncea L.)"** submitted in partial fulfillment of requirements for degree – Master of Science in Genetics and Plant Breeding by Sipra Pal, Registration no. 11700212 to Department of Genetics and Plant Breeding, School of Agriculture, Lovely Professional University, has been formulated and finalized by the student herself on the subject.

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DECLARATION

I hereby declare that the project work entitled – **"Heterosis and combiningability analysis for yield and quality traits in Indian mustard (Brassica juncea L.)"** is an authentic record of my work carried at Lovely Professional University as requirements of Project work for the award of degree - Master of Science in Genetics and Plant Breeding, under the guidance of Dr. NidhiDubey, Assistant Professor, School of Agriculture, Lovely Professional University, Phagwara, Punjab.

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1. Introduction:

Rapeseed (Brassica spp.) is one of the most important edible oilseed crops in the World. The group of Rapeseed Mustard is Brassicaceae and also belongs to Cruciferae family. There are many types of species of genus *Brassica* like Brassica nigra (n=8), Brassica oleracea (n=9), Brassica rapa (n=10). Brassica juncea is made by the crosses between Brassica nigra and Brassica rapa. Choromosome no. of Brassica juncea is n=18. Mustard are most highly diversified central and Western Asia. Rapeseed is a latinword means "turnip". Mustard also latin term where "must" denotes for "juice of grapes" and "ardens" means "hot and burning". There are 310 genera and 3500 species in Mustard group. Mustard are the second most important edible oilseed crops of the World after Soybean. It accounts for nearly 25% of the total oilseed production in India. Rapeseed – Mustard production in India was 72.82 lakh tonnes. India is third largest mustard producing country in the World after China and Canada. India accounts for nearly 12% of World production. Mustard seeds are a rich source of oil and protein. The seed has oil as high as 46-48%, and whole seed meal has 43.6% protein. Oil is also used as hair oil and as lubricant. Mustard seeds are known in Hindi, Urdu and Punjabi as sarson(Indian colza, Brassica rapasubspp. Trilocularis, syn. Brassica campestris var. sarson), in Bengali as shorshe. India is one of the largest rapeseed-mustard growing countries in the World occupying the first position in area (20.2%) and second in production (10.7%) after china. Mustard plant is suitable for high alkality but the soils having 7-8 Ph are considered as the best. For Mustard cultivation Alluvial loam soil is the best. Toria, Rai and Mustard is Rabi seasonal crop specially winter season crop are sown in October-November. Harvesting time is February-March. 15* to 25*C temperature is suitable for this crop. Cold temperature, bright sun shine and enough soil moisture increases oil content of seed. Mustard is a crop which required about 31- 40 cms of water. The Mustard and Rapeseed growing areas of India have witnessed a "**YELLOW REVOLUTION**".

Rajasthan is the number one state in terms of Mustard production. In 2014-15 total Mustard production in Rajasthan was 28.96 lakh tonnes which is 43% of the National production. U.P is the second largest state in Mustard producing state with 14% of national production. Madhya Pradesh is the third largest mustard producing state with 11% of national production. Haryana (8%) and West Bengal (6%) in national production. Being an important source of edible oil and feed meal to the country, rapeseed is undoubtedly the focus of Indian oilseed industry.

Yield is a complex quantitative trait and under pleiotropic gene control at the same time it is highly influenced by environment and contributed by many other traits. For effective selection, information on nature and magnitude of variation in population, association of character with yield and among themselves and the extent of environmental influence on the expression of these characters are necessary. High magnitude of variability in a population provides the opportunity for the selection to evolve a variety having desirable characters.

Keeping in view the aforesaid problems, the present investigation has been planned with the following objectives:

Objectives:

1. To study *per se* performance of parents and hybrid.
2. To estimate the magnitude of heterosis for yield and quality traits.
3. To study GCA effects of the parents and SCA effects of the hybrids.
4. To study the nature and magnitude of gene action.

2. Review of Literature:

Singh *et al*., (2017). Half diallel analysis of eight parents was carried out to identify the high heterotic crosses and their relationship in terms of general and specific combining ability (gca&sca) in *Brassica juncea*L. Czern and Coss.Mean squares due to parent v/s crosses were also significant for all the traits which depicted presence of heterosis for all the traits, except for days to maturity, plant height, siliquae on main shoot, number of seeds/siliqua, siliqua length and oil content in timely sown condition and for plant height, number of primary branches per plant, siliqua on main shoot and 1000 seed weight in late sown condition.

Akabari *et al*., (2014). A set of 8×8 diallel crosses (excluding reciprocals) of Indian mustard along with their parents were evaluated to identify heterotic crosses and estimate general and specific combining ability of parents and crosses, respectively. Observations were recorded on 13 economically important characters. Best hybrids were selected on the basis of estimates of mid parent heterosis, better parent heterosis and standard heterosis. Among the 28 hybrids, three hybrids viz., HYOLA 401 × GM-1, PM 67 × ZEM-1 and GM-2 × GM-3 exhibited superior performance for yield and its component traits as they registered significant and positive estimates for midparent, better parent and standard heterosis. Genetic variance components indicated the involvement of non-additive gene action for the inheritance of all the characters under study. Parents viz., GM-3, ZEM-1, Varuna and PM-67 were good general combiner for yield per plant, while HYOLA 401 and HNS 0004 were good general combiner for earliness and dwarfness and oil and protein content respectively. Based on sca effects, the high ranking crosses for yield and its component traits were HYOLA 401 × GM-1, PM 67 × ZEM-1 and GM-2 × GM-3. For oil content, the superior crosses were HYOLA 401 × HNS 0004 and HNS 0004 × ZEM-1.

Patel *et al*., (2012). A study was made to estimate combining ability, heterosis over mid parents (MP) and better parent (BP) with ten diverse parents and their 45 F1 s in half diallel mating design in Indian mustard for nine quantitative and quality traits were made to derive the information on the extent of heterosis over economic parent and relative magnitude of general and specific combining ability effects. On the basis of mean values, the hybrid RK 9501 x GM 2 and the parent RK 9501 were having most outstanding performance for seed yield per plant. A considerable degree of desirable and significant heterosis over mid parent (MP) and better parent (BP) was noted for crosses GM 1 x GM 3 and GM 3 x SKM 139 respectively for seed yield per plant. Significant differences were observed for both general combining ability (gca) and specific combining ability (sca) for almost all the traits studied.

Gupta *et al.,* (2011). Half diallel analysis of eight parents was canied out to identify the high heterotic crosses and their relationship in terms of general and specific combimng ability

(GCA & SCA) in Brassicajuncea L. Czem and Coss at LARI, New Delhi during 2007-08 and 2008-09. The relative heterosis and heterobeltiosis was obsewed to be highest with respect to seed yield per 100 siliquae and days to 50% flowering case of cross IC-19971 5X IC-199714, EC-2896C)2 X Prakash for number of primary branches per plant and hawest index: Agra Local X PusaBahar for length of main axis, Poorbijaya X Agra Local for number of siliquae on mam axis: EC-289602 X PusaBahar for biological yield per plant and seed yield per plant. It was found that different cross combinations exhibit maximum value for better and mid-parent heterosis for the remal_nl_ng traits viz. days to maturity, number of secondary branches per plant, plant height and 1000 seed weight. GCA and SCA variances were significant for all the characters. Variance for gca (0^2g) was observed to be higher for days to flowering, days to maturity, plant height and 1000 seed weight, whereas variance for sca (0^2 s) was higher for seed yield and other parameters.

Akber *et al.* (2008). Evaluated 5 x 5 diallel cross of (*Brassica napus*) using combining ability analysis. Mean Squares for all the traits except for 1000-seed weight were found highly significant for all the characters. RBN 96040 proved good general combiner for all the traits studied. KS-75 proved good general combiner for all the traits except plant height and primary branches per plant. The cross "RBN 96040/RBN 96038" was the best specific combiner for all the traits studied followed by "RBN 96038//DGL/SHIRALEE" which proved good specific combiner for most of the traits including seed yield per plant.

Acharya and Swain (2004). Based on combining ability analysis in 9 x 9 half-diallel set of Indian mustard studied for nine traits revealed the pre-ponderance of additive gene effects for seed yield, secondary branches per plant, siliquae on main stem, siliqua length, seeds per siliqua and 1000-seed weight. PusaBahar was the best general combiner for seed yield and yield components except days to maturity. Majority of crosses showing high *per se* performance involved parents of high x high or high x low gca effects. Pusa bold x PusaBahar, BM 20-~2-3 x JC 26 and PusaBahar x JC 26 were promising cross combinations which exhibited high sca effects and high mean performance.

Sarkar and Singh (2001). Studied combining ability for 13 traits using 10 Indian mustard cultivars. Results revealed the presence of significant general (gca) and specific combining ability (sca) variances for seed yield per plant, days to 50% flowering, days to maturity, early vigour, plant height, number of primary branches, number of secondary branches, length of main axis, number of siliques on main axis, length of silique, seeds per silique, oil content and 1000-seed weight. There was a significant positive correlation between per se performance of the parents and gca of the parents for days to 50% flowering, plant height, seed yield per plant and 1000-seed weight.

Kumhalkar*et al.* (1999). Identified better parents on the basis of their combining ability and to isolate superior crosses for study in further generations. The parents, ACN-9, PKV-NU-2, Seeta and RW-351 were identified, based on mean performance and GCA effects, as the best combiners for utilization in a breeding programme. The cross RW 351 x PKV NU-2 was identified as a promising cross for yield/plant.

Kumar *et al.* (1990). Evaluated thirteen inbred lines/varieties which were crossed with the varieties RH30, Varuna and Parkash in line X tester fashion; the 16 parents and 39 F1 were evaluated for six traits. Crosses processing positive heterosis for seed yield had positive heterosis for primary branches, secondary branches, siliqua length and seeds per siliqua. Highest positive heterosis for seed yield was observed in the cross RLM198 X RH30, followed by the crosses RLM514 X Varuna, RL18 X Varuna and RS64 X Varuna. RLM198 X RH30 also recorded highest heterobeltiosis for secondary branches.

3. MATERIAL AND METHOD:

(Including location, place of work and facility available)

The experimental material of present study comprised of 21 hybrids developed from half diallel mating design (7x7). The crosses were made during rabi season 2017-18 by half diallel mating design which will be evaluated during rabi season 2018-19 along with parents at field of Lovely Professional University, Phagwara, India.

3.1 Experimental detail:

1st Season (crossing- 2017-18)

Crop Name	Mustard
Mating Design	Half diallel design
Genotype	Different Indian mustard genotypes
Number of Parents	7
Experimental year	2017-18
Row to Row distance	50 cm
Cropping Season	*Rabi*

2nd Season (Evolution 2018-19)

Number of Genotypes	28 (hybrids- 21, Parent- 7)
Design	RBD (Randomized Block Design)
Replication	3

3.2 Genotype details

Sr.No.	Name of Genotype	Source
1.	Pusa Mustard 24	Directorate of Rapeseed Mustard Research, Bharatpur
2.	Gujrat Mustard 3	Directorate of Rapeseed Mustard Research Bharatpur
3.	PB – 50	Directorate of Rapeseed Mustard Research, Bharatpur
4.	GSL – 2	Directorate of Rapeseed Mustard Research, Bharatpur
5.	Pusa Jai Kishan	Directorate of Rapeseed Mustard Research, Bharatpur
6.	Jhumka	Directorate of Rapeseed Mustard Research, Bharatpur
7.	Urvashi	Directorate of Rapeseed Mustard Research, Bharatpur

Statistical Analysis:

1. Analysis of variance (Panse and Sukhatme, 1952)
2. Estimation of heterosis (Fonseca and Patterson, 1968)
3. Combining ability analysis (Griffing's Method)
4. Gene action (Hill, 1982, Lynch 1991)

Observations:

A	Quantitative Traits	B	Qualitative Traits
1	Days to 50 % flowering	**15**	Oil content
2	Days of maturity		
3	Plant height		
4	No. of primary branches of plant		
5	Length of main raceme		
6	No. of seeds per siliqua		
7	1000 seed weight		
8	Harvest index (%)		
9	Biological yield		
10	Siliqua on main raceme		
11	Siliqua length		
12	Seed yield per hector		
13	No. of secondary branch of plant		
14	Siliqua size		

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