

## COMBINING ABILITY STUDIES IN MUSTARD

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### ABSTRACT

The experimental material consisted 6 parents *viz.*, RLC-3, NUDH-18, NUDH YJ-6, PM-31, DRMRQ-1-5 and LES-39 which were crossed in full diallel fashion during the year 2021-2022 in *rabi* season. The crosses, two checks Kranti and TAM 108-1 along with their parents were planted in randomized block design in three replications at research field of AICRP on Linseed and Mustard, College of Agriculture, Nagpur in *rabi* 2022-2023. The parents, crosses and checks were grown in randomized block design replicated thrice and eleven observations *viz.*, days to first flower, days to maturity, plant height at maturity, number of branches plant<sup>-1</sup> at maturity, point to first siliqua, siliqua length, number of seeds siliqua<sup>-1</sup>, number of siliquae plant<sup>-1</sup>, siliqua density on main branch, 1000 seed weight and seed yield plant<sup>-1</sup> were taken. The predictability ratio was found 0.25 for siliqua length to 0.86 for 1000 seed weight. Parents NUDH-18 and DRMRQ-1-5 were recorded as good general combiners for seed yield and its contributing characters. The best specific cross combinations for yield and its attributing traits were crosses PM-31 x NUDH-18, NUDH YJ-6 x NUDH-18, NUDH-18 x DRMRQ-1-5, DRMRQ-1-5 x LES-39 and NUDH-18 x LES-39. These crosses also recorded significant performance for seed yield plant<sup>-1</sup> and some yield contributing characters. The presence of negative SCA/RCA effects for several yield components in the above crosses indicates the predominant role of additive gene action for yield components, which is a general situation observed in self-pollinated crop. These five crosses were select as a best crosses which can be forwarded to the subsequent generations.

(Key words: Mustard, specific combining ability, general combining ability, reciprocal combining ability full diallel)

### INTRODUCTION

Indian mustard is a significant oilseed crop in the Indian subcontinent. It is the country's second largest oilseed crop, accounting for roughly 26% of the country's edible oil production. In mustard, yield is one of the most important economic characters and is product of multiplicative interaction of contributing characters (Kant and Gulati, 2001).

The major purpose of mustard enhancement is to generate high-yield potential variants. Concurrent aims include developing novel cultivars with increased adaptability, early maturity, disease resistance and high oil content, while keeping high production potential. Combining ability analysis is one of the powerful tools to test the value of parental lines to produce superior hybrids and valuable recombinants (Singh *et al.*, 2013). The principle of combining ability contributes an important role in determining the existence of parents and the development of superior lines or hybrids. Therefore, the present

investigation was undertaken with an objective to identify the potential F<sub>1</sub> crosses.

### MATERIALS AND METHODS

The experimental material consisted 6 parents *viz.*, RLC-3, NUDH-18, NUDH YJ-6, PM-31, DRMRQ-1-5 and LES-39 which were crossed in full diallel fashion during the year 2021-2022 in *rabi* season. The 30 crosses, two checks (Kranti and TAM 108-1) along with their parents were planted in randomized block design in three replications at research field of AICRP on Linseed and Mustard, College of Agriculture, Nagpur in *rabi* 2022-2023. Each genotype was grown in five rows with spacing 45 x 15 cm<sup>2</sup> for row to row and plant to plant respectively. Observations were recorded on 11 quantitative characters *viz.*, days to first flower, days to maturity, plant height, number of branches plant<sup>-1</sup>, point to first siliqua, siliqua length, number of seeds siliqua<sup>-1</sup>, number of siliquae plant<sup>-1</sup>, siliqua density on main branch, 1000 seed weight and seed yield plant<sup>-1</sup>. The combining ability analysis was carried out by Diallel method-1 and model-1 given by Griffing (1956).

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## RESULTS AND DISCUSSION

Analysis of variance for combining ability for eleven traits are presented in Table 1. The variation among the crosses was partitioned into different components representing due to GCA, SCA, and RCA. The mean sum of squares due to general combining ability were significant for all characters under study except days to first flower and siliqua length. The mean sum of squares due to specific combining ability was significant for ten traits except days to maturity and reciprocal combining ability were significant for the all characters except siliqua density on main branch. The range of predictability ratio was noted from 0.25 for siliqua length to 0.86 for 1000 seed weight. For all the characters studied except siliqua length the predictability ratio was greater than 0.50 but not closer to unity. From the above observations it is to state that both GCA effects of parents and SCA effects can be exploited to restore transgressive segregates. The ratio of variance due to GCA and SCA was below one for all the characters under study were reported by Aghao *et al.* (2010), Saha *et al.* (2017) Sapkal *et al.* (2023) which is in accordance with the present study.

### General combining ability

From Table 3 among the six parents, NUDH-18 was found to be the best general combiner as it recorded a highly significant positive GCA effect for seed yield plant<sup>-1</sup>, plant height at maturity, number of branches plant<sup>-1</sup> at maturity, 1000 seed weight and number of seeds siliqua<sup>-1</sup>. The parent DRMRQ-1-5 exhibited highly significant positive GCA effects for seed yield plant<sup>-1</sup>, number of siliquae plant<sup>-1</sup>, siliqua length, point to first siliqua and days to maturity. Therefore, two parents NUDH-18 and DRMRQ-1-5 were identified as best general combiners for yield and other yield-contributing characters. Earlier worker Meena *et al.* (2017) and Yadav *et al.* (2024) identified as good general combiners on the basis of significant GCA effects for yield and yield contributing characteristics which supported the present findings. These two parents NUDH-18 and DRMRQ-1-5 were identified as good general combiners and can be used in crossing program for seed yield plant<sup>-1</sup>.

### Specific / Reciprocal combining ability

Estimation of SCA/RCA effects of 30 crosses for yield and its component traits are given in Table 3. For the character days to first flowering, four cross combinations showed negative significant SCA/RCA effect in which NUDH YJ-6 x RLC-3 was recorded as highest negative significant reciprocal combining effect. Similar effects also observed for days to maturity in one cross and point to first siliqua in five crosses. For number of branches plant<sup>-1</sup> four cross combinations exhibited positive significant specific combining ability effect. Siliqua length is also the character where positive significance is desirable, among 30 crosses five crosses exhibited positive significant SCA/RCA effect. For the trait number of seeds siliqua<sup>-1</sup>, 3 hybrids showed positive significant specific / reciprocal combining ability effect. Similar effects also found for character number of

siliquae plant<sup>-1</sup> in 9 crosses in which LES-39 x NUDH YJ-6 had highest positive significant specific combining ability effect. Three cross combinations *viz.*, NUDH 18 x LES-39, LES-39 x DRMRQ-1-5 and RLC-3 x DRMRQ-1-5 expressed positive significant SCA/RCA effect for the character siliquae density on main branch. Out of 30 crosses, five cross combinations recorded the positive significant effect for 1000 seed weight. For the trait seed yield plant<sup>-1</sup> positive significance is desirable. Nine cross combinations showed positive significant SCA/RCA for seed yield plant<sup>-1</sup> in which cross NUDH-18 x PM-31 showed highest positive significant specific combining ability effect.

On the basis of high mean performance, high GCA of one or both the parents involved in the cross and with negative SCA effects decided the potential of the cross to be forward in next generation. Based on above criteria, promising crosses and their selected *per se* performance are given in Table 2. Out of the 30 crosses studied, the cross PM-31 x NUDH-18 showed negative highly significant SCA/RCA effects for seed yield plant<sup>-1</sup>, number of siliquae plant<sup>-1</sup>, siliqua density on main branch and 1000 seed weight. The same cross was significantly superior over the best check for seed yield plant<sup>-1</sup> and *at par* over the mean of the best check for number of branches plant<sup>-1</sup> and number of siliquae plant<sup>-1</sup>. The GCA effect of parents involved in the cross possessed low x high GCA effects for seed yield plant<sup>-1</sup> and 1000 seed weight medium x low GCA effects for siliqua density on main branch, low x high GCA effect for 1000 seed weight and medium x medium GCA effect for number of siliqua plant<sup>-1</sup>.

The cross NUDH YJ-6 x NUDH-18 recorded negative significant SCA/RCA effect for seed yield plant<sup>-1</sup>, number of siliqua plant<sup>-1</sup>, number of branches plant<sup>-1</sup>, plant height, siliqua length and number of seeds siliqua<sup>-1</sup>. The same was found to be significantly superior over best check for seed yield plant<sup>-1</sup>, 1000 seed weight and *at par* over the mean of best check for number of siliqua plant<sup>-1</sup>, number of branches plant<sup>-1</sup> and siliqua density on main branch. The GCA of parents involved in this was medium x high GCA for seed yield plant<sup>-1</sup>, medium x medium for number of siliquae plant<sup>-1</sup> and medium x low GCA effect for siliqua length.

The cross NUDH-18 x DRMRQ-1-5 showed highly negative significant SCA/RCA effect for seed yield plant<sup>-1</sup> and also significant negative SCA/RCA effect for siliqua length, number of siliqua plant<sup>-1</sup>, 1000 seed weight and point to first siliqua. Same cross also had negative non-significant SCA/RCA effect for plant height, siliqua density on main branch and number of seeds siliqua<sup>-1</sup>. Likewise, same cross was significantly superior over best check for seed yield plant<sup>-1</sup> and *at par* over the mean of best check for 1000 seed weight and plant height. The GCA effects of parents of the cross exhibited high x high GCA effects for seed yield plant<sup>-1</sup>, low x high for siliqua length and high x medium for 1000 seed weight.

The hybrid DRMRQ-1-5 x LES-39 exhibited negative significant SCA/RCA effect for seed yield plant<sup>-1</sup> and number of seeds siliqua<sup>-1</sup>. The cross also had negative

Table 1. Analysis of variance for combining ability in mustard

Source of Variation	Degree of freedom	Mean sum of squares										
		Days to first Flower	Days to maturity	Plant Manager	Points to first Sillique	Number of branches plant <sup>-1</sup>	Silliqua length	Number of seeds silliqua <sup>-1</sup>	Number of silliqua plant <sup>-1</sup>	Silliqua density on main branch	Seed yield plant <sup>-1</sup>	1000 seed weight
<b>GCA</b>	5	10.53	28.26*	336.28**	198.29*	0.33*	0.14	6.70**	2883.68**	0.02**	11.53**	2.60**
<b>SCA</b>	15	18.73**	12.68	350.13**	161.27**	0.82**	0.81**	4.73**	3191.27**	0.01**	17.51**	0.83**
<b>RCA</b>	15	20.59**	23.87**	899.11**	261.48**	0.61**	0.33**	7.31**	2314.93**	0.006	6.00**	1.73**
<b>Error</b>	70	6.1	7.74	82.06	72.78	0.13	0.082	1.043	166.91	0.003	0.38	0.177
<b>Predictability ratio</b>	-	0.52	0.81	0.65	0.71	0.44	0.25	0.73	0.64	0.80	0.56	0.86

\* , \*\* = significance at 5% level and at 1% level

**Table 2. Potential crosses identified on the basis of mean performance, GCA effect of parents and SCA/RCA effect of crosses for yield and other traits**

Sr. No.	Crosses	Characters	Mean	SCA/RCA effect	GCA effect	
					P1	P2
1	PM31 x NUDH-18	Yield	12.20	-1.55**	-0.74**	0.63**
		SD	0.61	-0.05*	0.016	-0.032**
		1000 sw	4.49	-0.37*	-0.28**	0.39**
		NOSPP	195.63	-32.95**	-1.77	-3.39
2	NUDHYJ-6 x NUDH 18	Yield	12.37	-1.28**	-0.07	0.63**
		SL	3.82	-0.38**	0.02	-0.09*
		PH	175.40	-12.47**	2.02	3.37*
		NOB	3.47	-0.52*	-0.02	0.15*
		NOSPP	191.73	-28.23**	-5.52	-3.39
		NOSPS	10.17	-2.17**	1.83	0.39**
3	NUDH-18 x DRMRQ-1-5	Yield	13.57	-0.68*	0.63**	0.64**
		SL	3.51	-0.48**	-0.09*	0.10*
		PTFS	78.30	-11.67**	-1.82	3.53*
		NOSPP	230.13	-12.67**	-3.39	10.21*
		1000 sw	3.91	-0.93**	0.39**	-0.29
4	NUDH 18 x LES-39	Yield	12.27	-0.62*	0.63**	-0.49**
		PH	174.40	-9.22**	3.37*	-1.92
		1000 sw	4.37	-0.67**	0.39**	-0.02
5	DRMRQ-1-5 x LES-39	Yield	12.03	-0.55*	0.64**	-0.49**
		PH	169.67	-10.35*	3.87*	-1.92
		NOSPS	10.87	-1.58**	0.80	-0.52**

SD = Siliqua density on main branch, 1000 sw = 1000 seed weight, NOSPP = Number of siliquae plant<sup>-1</sup>, SL= Siliqua length, PH= Plant height, NOB = Number of branches plant<sup>-1</sup>, NOSPS= Number of seeds siliqua<sup>-1</sup>, PTFS= Point to first siliqua

**Table 3. GCA effects of parents, SCA effects of direct crosses and RCA effect of reciprocal crosses for seed yield and its contributing traits in mustard**

Sr. No.	GCA/RCA/SCA effects	Days to first flower	Days to maturity	Plant height	Number of branches plant <sup>-1</sup>	Points to first silliqua	Silliqua length	Number of seeds silliqua	Number of silliqua plant <sup>-1</sup>	Silliqua density on main branch	1000		Seed yield		
											seed weight	branch	seed weight	plant <sup>-1</sup>	
1	RLC-3	-0.86*	-0.71	2.70	0.04	-3.22*	-0.01	0.33*	11.43*	0.034**	0.21**	0.03			
2	LES-39	-0.35	-0.17	-1.92	-0.09	1.16	0.021	-0.52**	-0.97	0.008	-0.02	-0.49**			
3	DRMRQ-1-5	0.23	1.08*	-3.87*	0.03	3.53*	0.095*	0.08	10.21*	-0.014	-0.29	0.64**			
4	NUDH 18	-0.02	-1.28	3.37*	0.15*	-1.82	-0.093*	0.39**	-3.39	-0.036**	0.39**	0.63**			
5	NUDH YJ-6	0.65	0.49	2.02	-0.02	0.28	0.019	0.28	-5.52	-0.009	-0.01	-0.07			
6	PM-31	0.35	0.59	-2.30	-0.12*	0.06	-0.032	-0.56**	-1.77	0.017	-0.28**	-0.74**			
<b>Direct crosses</b>															
7	RLC-3 x LES-39	-0.74	-1.82	5.79	0.31	-4.63	0.202*	-0.29	-7.94	0.004	0.28	-0.44			
8	RLC-3 x DRMRQ-1-5	0.23	0.93	-5.09	-0.21	6.44*	0.126	0.40	15.16**	0.046*	-0.04	1.27**			
9	RLC-3 x NUDH 18	-1.97*	1.29	1.90	-0.14	-3.86	-0.056	0.33	2.49	0.006	-0.20	-1.23**			
10	RLC-3 x NUDH YJ-6	-2.36*	0.85	-4.00	-0.22	-1.01	0.195	0.64	-23.55**	-0.015	-0.42**	1.07**			
11	RLC-3 x PM-31	0.85	0.58	4.12	0.54	0.27	-0.049	0.44	21.29	-0.04*	0.60**	-0.21			
12	LES-39 x DRMRQ-1-5	-1.23	1.56	7.26*	-0.08	-5.36	0.267	0.28	3.13	0.056*	0.13	0.69**			
13	LES-39 x NUDH 18	-1.58	1.75	3.62	-0.36**	-2.06	-0.11	0.21	-4.17	-0.014	-0.24	1.01**			
14	LES-39 x NUDH YJ-6	1.07	1.31	-2.36	0.27*	-6.26*	-0.239*	-0.03	35.73**	0.011	0.28	2.08**			
15	LES-39 x PM-31	-1.62	0.55	-2.42	0.31*	8.44**	0.623	0.15	-0.98	-0.01	0.12	-1.46**			
16	DRMRQ-1-5 x NUDH 18	-0.24	-0.83	14.74**	0.51**	3.35	-0.004	1.49	23.09	0.03	-0.18	1.24**			
17	DRMRQ-1-5 x NUDH YJ-6	1.02	0.23	-2.06	0.07	-3.20	0.176	-0.21	9.01	0.038	-0.22	-0.32			
18	DRMRQ-1-5 x PM-31	1.31	0.63	2.50	0.20	-7.13*	0.347**	-0.03	-27.61**	-0.004	0.05	-1.23**			
19	NUDH 18 x NUDH YJ-6	2.17*	-0.75	3.93	0.29*	2.09	0.278*	-0.96*	15.99**	0.02	0.88**	1.35**			
20	NUDH 18 x PM-31	1.40	-0.02	-11.54**	-0.14	-1.72	-0.072	-0.38	20.85**	0.035	-0.17	2.12**			
21	NUDH YJ-6 x PM-31	-1.10	-1.96	3.69	0.05	3.37	-0.034	1.50**	3.50	0.019	-0.27	-0.80**			
<b>Reciprocal crosses</b>															
22	LES-39 x RLC-3	0.38	0.33	-2.65	0.43	3.07	0.198	-0.17	-7.93	-0.028	0.44*	-0.63*			
23	DRMRQ-1-5 x RLC-3	0.67	-1.67	-11.55**	-0.10	8.19*	0.153	0.45	15.48**	-0.008	-0.17	1.95**			
24	NUDH 18 x RLC-3	-1.62	0.00	1.62	0.25	-4.08	0.163	-0.43	15.28**	-0.02	-0.74**	-1.03**			
25	NUDH YJ-6 x RLC-3	-3.03**	-2.33	-7.00	-0.23	2.25	0.347**	-0.40	-23.05**	-0.03	-0.50**	-0.60*			
26	PM-31 x RLC-3	-0.70	-1.83	4.73	0.07	8.44*	0.018	0.38	-13.37*	-0.023	0.58**	0.38			
27	DRMRQ-1-5 x LES-39	-1.55	-1.83	-10.35*	-0.17	1.71	0.345**	-1.58**	25.85*	0.037	0.45*	-0.55*			
28	NUDH 18 x LES-39	2.55*	-1.33	-9.22*	0.01	-1.33	0.01	-0.83	12.68*	0.065**	-0.67**	-0.62*			
29	NUDH YJ-6 x LES-39	2.50*	2.00	-17.82*	-0.47**	-6.95	-0.21	2.05**	19.38*	-0.033	-0.88**	1.37**			
30	PM-31 x LES-39	3.18*	0.33	-7.24	-0.13	-9.67*	0.17	-1.82**	-0.97	-0.015	0.32	-0.12			
31	NUDH 18 x DRMRQ-1-5	2.67*	2.67*	-5.02	0.18	-11.67**	-0.48**	-0.47	-12.67**	-0.017	-0.93**	-0.68*			
32	NUDH YJ-6 x DRMRQ-1-5	-0.73	1.17	-26.43**	-0.38*	-9.58*	-0.115	-0.23	-34.85**	-0.008	-0.36*	0.60*			
33	PM-31 x DRMRQ-1-5	-0.35	-0.33	-24.33**	0.08	-0.23	0.185	0.90*	-2.55	0.005	-0.27	-0.82**			
34	NUDH YJ-6 x NUDH 18	1.13	4.17**	-12.47**	-0.52*	8.81*	-0.38**	-2.17**	-28.23**	0.002	-0.12	-1.28**			
35	PM-31 x NUDH 18	0.63	-1.67	0.00	-0.28	5.64	0.032	0.73	-32.95**	-0.055*	-0.37*	-1.55**			
36	PM-31 x NUDH YJ-6	-2.23*	-3.17*	0.25	-0.65**	-0.72	-0.085	-0.73	-8.43	0.033	-0.28	-1.07**			

non-significant SCA/RCA effect for days to first flower and days to maturity. Same hybrid was significantly superior over superior check for seed yield plant<sup>-1</sup>, plant height, siliqua length, number of siliqua plant<sup>-1</sup> and siliqua density on main branch.

Highly negative significant SCA/ RCA effect for seed yield plant<sup>-1</sup> was observed in the cross NUDH-18 x LES-39 also had negative significant SCA/RCA effect for 1000 seed weight and plant height and negative non-significant effect for days to maturity, number of seeds siliqua<sup>-1</sup> and point to first siliqua. Same cross also showed significantly superiority over best check for seed yield plant<sup>-1</sup> and number of siliqua plant<sup>-1</sup>. The parents of this cross had high x low GCA effect for seed yield plant<sup>-1</sup>, high x medium for plant height and high x medium for 1000 seed weight.

Out of thirty crosses studied, the cross combinations PM-31 x NUDH-18, NUDH YJ-6 x NUDH-18, NUDH-18 x DRMRQ-1-5, DRMRQ-1-5 x LES-39 and NUDH-18 x LES-39 involved one of the parents with highly significant or non-significant positive GCA effect for yield plant<sup>-1</sup> and some yield contributing characters. These crosses also recorded significant performance for seed yield plant<sup>-1</sup> and some yield contributing characters. The presence of negative SCA/RCA effects for several yield components in the above crosses indicates the predominant role of additive gene action for yield components, which is a general situation observed in self-pollinated crop. These five crosses were select as a best crosses which can be forwarded to the subsequent generations. Saha *et al.* (2017), Kumar *et al.* (2020) and Sapkal *et al.* 2023 identified the superior crosses based on SCA and *per se* performance.

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