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Combining Ability Analysis in Linseed (*Linum usitatissimum* L.)

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ABSTRACT: The present research was executed for evaluation of combining ability analysis using 12 lines and 3 testers in a line × tester mating design. The data on mean squares due to the parents and their crosses were highly significant for all nine characters studied *i.e.* days to 50% flowering (on plot basis), days to maturity (on plot basis), plant height (cm), number of branches plant^{-1}, number of capsule plant^{-1}, 1000 seed weight (g), seed yield plant^{-1} (g), bud fly infestation (%), alternaria blight infestation (%) indicating the presence of considerable genetic variation among the parents and their crosses for the characters studied. Means squares due to lines were significant for all the characters except days to 50% flowering and alternaria blight infestation (%) indicating substantial genetic variability for general combining ability among lines. The mean squares due to testers were significant for all the characters except days to 50% flowering, days to maturity, number of branches plant^{-1} and alternaria blight infestation (%) indicating the considerable genetic variability for general combining ability among testers. The line × tester interactions were significant for all the characters except days to 50% maturity indicating genetic variability for specific combining ability among crosses. Among the 36 crosses studied IC0498517 × IC0499191, IC0499201 × IC0499191, Neela × IC0499156 were found most promising as they possessed high mean performance for yield along with negative significant SCA for seed yield plant^{-1}, capsules plant^{-1}, 1000 seed weight and bud fly resistance. Hence the hybrids identified from the present study were exploited further to obtain transgressive segregants for seed yield improvement in Lin seed crop.

Keywords: Linseed, combining ability, GCA, SCA.

INTRODUCTION

Linseed *(Linum usitatissimum* L.*)* is an annual self-pollinated diploid (2x=2n=30) oilseed crop belonging to Linaceae family and it is the earliest domesticated and economically important industrial non edible oilseed crop which is being cultivated for seed and its fibre since centuries (Mahto *et al.*, 2020). To initiate an effective breeding programme, combining ability analysis is a powerful tool to identify parents with better potential to transmit desirable characteristics to the progenies and to identify the best specific crosses for yield parameters. Isolation of parental lines of good combining ability makes the pathway easy towards the success. The concept of combining ability plays a significant role in crop improvement, as it helps the breeder to study and compare the performance of new lines in hybrid combination (Nirala *et al.*, 2018). Tuong *et al.* (2020) studied self-pollination, maintenance and evaluation of combining abilities among maize lines. Combining ability analysis identifies the method of gene action as well as parents with high general combining effects and cross combinations with high specific combining effects (Thakur *et al*., 2023). The selection of the parents for a population breeding or hybridization plan is then aided by this.

MATERIAL AND METHODS

The experimental material comprised of 12 parental lines which were crossed with 3 testers in line × tester mating design to produce 36 crosses during first year. In second year, these 36 crosses (F_1's) along with 15 parents including check were grown in randomized block design in 3 replications with the spacing of 30cm × 5cm during *rabi* at the farm of AICRP on Linseed and Mustard, College of Agriculture, Nagpur. The recommended practices were followed to raise good crop. Five plants which were competitive from each genotype are selected randomly to record observations on nine traits *viz.*, days to 50% flowering (on plot basis), days to maturity (on plot basis), plant height (cm), number of branches plant^{-1}, number of capsules plant^{-1}, seed yield plant^{-1} (g), 1000 seed weight (g), bud fly infestation (%), alternaria blight infestation (%).The combining ability analysis was carried out following the methodology of Kempthorne (1957) with fixed effect model (model-1) and ANOVA as per the methodology suggested by Panse and Sukhatme (1954). The obtained data is subjected for analysis using the software TNAUSTAT.

RESULTS AND DISCUSSION

The mean squares data**(Table.1)** due to the parents and their crosses were highly significant for all characters studied *i.e*. days to 50% flowering (on plot basis), days to maturity (on plot basis), plant height (cm), number of branches plant^{-1}, number of capsules plant^{-1}, seed yield plant^{-1} (g), 1000 seed weight (g), bud fly infestation (%), alternaria blight infestation (%), indicating the presence of considerable genetic variation among the parents and their crosses for the characters studied. Similar results were also observed by Suvarnlata *et al*. (2021); Ghige *et al*. (2021); Mohammed *et al*. (2010).

Mean sum of squares (Table 2) due to lines were significant for all the characters except days to 50% flowering and alternaria blight infestation (%) indicating substantial genetic variability for general combining ability among lines. The mean squares due to testers were significant for all the characters studied except days to 50% flowering, days to maturity, number of branches plant^{-1} and alternaria blight infestation (%) indicating the considerable genetic variability for general combining ability among testers. The line × tester interactions were significant for all the characters except days to 50% maturity indicating genetic variability for specific combining ability among crosses. The significant mean squares for some characters in lines, testers and lines × testers were also observed by Ghige *et al*. (2021); Upadhyay *et al*. (2019); Wadikar *et al*. (2019). Significance of mean squares indicates significant variation among crosses for combining ability hence allows the estimates of gca and sca effects.

Identification of parents on the basis of general combining ability, high mean performance (Table 3). Out of the parents selected in the present study two of the parents namely, IC0499146, IC0498517 possessed positive significant GCA effects for seed yield plant^{-1} (Table 4). But none of these parents possessed high mean performance for seed yield plant^{-1}. Hence, these parents can be used in hybridization programme to get better transgressive segregants. The parent IC0526055 possessed higher mean performance for seed yield plant^{-1} hence can be utilised in varietal development programme. Rajane *et al.* (2022) also confirmed the similar kind of results in sunflower for seed yield plant^{-1}

Among the 36 crosses studied, the cross IC0498517 × IC0499191 showed negative significant SCA effect (-0.37**) for seed yield plant^{-1} with high mean performance and negative non significant SCA effect (-0.13) for number of capsules plant^{-1} with high mean performance, negative significant SCA effect (-0.21*) for 1000-seed weight and negative significant SCA effect (-0.46**) for bud fly resistance (Table 5). Other cross IC0499201 × IC0499191 possessed negative significant SCA (-0.41**) effect for seed yield plant^{-1} with high mean performance, positive significant SCA effect (5.71**) for number of capsule plant^{-1} and positive non significant SCA effect (0.03) for 1000-seed weight, negative non significant SCA effect (-0.14) for bud fly resistance (Table 6). The cross Neela × IC0499156 also exhibited negatively significant SCA effect (-0.43*) for seed yield plant^{-1} and negative non significant SCA effect (-2.00) for number of capsules plant^{-1} and negative non significant SCA effect (-0.08) for 1000 seed weight and positive on significant SCA effect (0.25) for bud fly resistance with high mean performance for all characters.

Table 1: Analysis of variance of parents and their crosses for nine characters.

Source of variation	d.f.	Mean squares								
		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches plant^{-1}	Number of capsules plant^{-1}	1000 seed weight (g)	Seed yield plant^{-1} (g)	Bud fly infestation (%)	Alternaria Blight infestation (%)
Replication	2	6.96	0.34	18.37	0.12	13.44	0.01	0.04	3.67	1.46
Genotypes	51	17.67**	38.34**	256.57**	1.64**	207.62**	1.95**	0.30**	416.43**	50.62**
Error	102	3.66	4.78	7.56	0.27	13.02	0.06	0.05	1.78	3.95

Note: * Significant at 5% level, ** Significant at 1% level

Table 2: Analysis of variance for combining ability in linseed.

Source of variation	d.f	Mean squares								
		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches plant^{-1}	Number of capsules plant^{-1}	1000 seed weight (g)	Seed yield plant^{-1} (g)	Bud fly infestation (%)	Alternaria Blight infestation (%)
Lines	11	4.854	9.38*	235.56**	1.081*	274.21**	2.10**	0.239*	1.19**	18.276
Testers	2	13.46	20.52	1231.34**	3.951	261.39*	3.76**	2.580*	5.34*	15.917
L × T	22	10.55	12.94**	200.26**	1.313*	194.25**	2.51**	0.254*	2.68**	22.755*
Error	70	3.208	1.657	5.318	0.252	11.97	0.02	0.06	0.054	5.914
GCA vs. SCA(Baker, 1978)		0.634	0.697	0.879	0.793	0.733	0.700	0.917	0.709	0.600

Note: * Significant at 5% level, ** Significant at 1% level

Table 3: Mean performance of parents and their crosses for nine quantitative characters.

Sr. No.	Genotypes	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches plant^{-1}	Number of capsules plant^{-1}	Seed Yield plant^{-1} (g)	1000 seed weight(g)	Bud fly infestation (%)	Alternaria Blight infestation (%)
					Lines					
1.	IC0499146	50.67	100.67	37.67	4.20	35.87	1.17	4.35	4.87	10.69
2.	IC0498992	53.67	104.00	38.33	4.20	33.33	1.31	4.55	7.07	12.55
3.	IC0342805	51.67	105.33	36.00	4.13	35.67	0.86	4.53	5.40	15.11
4.	IC0498517	53.33	103.67	46.47	4.07	44.33	1.33	4.51	6.33	12.46
5.	IC0498872	49.00	101.67	62.33	3.67	59.33	0.81	5.18	8.20	14.68
6.	IC0499201	51.67	99.67	41.60	4.13	39.67	1.24	6.28	5.00	13.28
7.	IC0526087	47.33	103.00	36.27	4.87	34.00	1.11	4.42	5.87	9.44
8.	IC0499071	51.67	104.67	46.53	3.73	43.67	1.14	5.74	6.60	21.08
9.	IC0526055	50.00	100.33	29.00	4.60	38.67	1.43	5.07	5.87	12.48
10.	IC0498795	51.33	101.33	38.40	4.93	34.00	1.31	4.72	5.67	15.78
11.	IC0118874	53.67	101.00	39.40	4.33	37.00	1.12	4.91	8.67	18.04
12.	Neela (check)	50.00	104.33	44.93	4.87	42.00	1.20	5.25	4.87	15.28
					Testers					
13.	IC0499191	54.33	104.67	34.60	6.13	32.00	0.79	4.82	26.00	14.85
14.	IC0499156	48.67	100.67	40.87	5.33	38.33	1.22	4.91	29.16	19.66
15.	Neelam(check)	55.33	105.67	39.93	4.53	37.67	1.02	4.63	26.33	20.60
					Crosses					
16.	IC0499146 × IC0499191	49.33	95.33	46.50	4.17	36.83	1.80	4.32	5.17	8.20
17.	IC0498992 ×IC0499191	49.67	94.33	43.17	4.67	41.00	1.05	6.00	4.70	4.41
18.	IC0342805 ×IC0499191	48.33	93.67	42.00	4.43	44.67	1.40	5.17	5.20	7.25
19.	IC0498517 ×IC0499191	47.33	96.00	52.00	4.90	43.33	2.02	5.13	6.01	7.66
20.	IC0498872 × IC0499191	47.33	94.00	48.83	4.37	38.00	1.77	5.24	6.02	4.49
21.	IC0499201 × IC0499191	43.00	93.67	47.33	4.33	31.33	1.20	4.70	5.34	3.14
22.	IC0526087 × IC0499191	47.67	96.00	35.33	4.37	38.17	1.23	4.78	4.27	7.44
23.	IC0499071 × IC0499191	50.00	98.00	18.00	2.83	22.33	0.93	3.37	5.27	9.03
24.	IC0526055 × IC0499191	50.00	95.00	41.67	4.20	40.83	1.70	5.20	3.37	11.14
25.	IC0498795 × IC0499191	45.67	96.00	40.50	3.83	36.83	1.93	4.46	6.10	7.31
26.	IC0118874 × IC0499191	50.00	95.00	40.17	3.37	39.67	1.10	5.17	4.10	9.72
27.	Neela×IC0499191	46.67	96.00	43.50	4.40	52.33	1.70	6.01	5.11	9.51
28.	IC0499146 ×IC0499156	47.33	95.67	31.67	3.17	28.67	1.13	4.27	4.32	6.89
29.	IC0498992 ×IC0499156	44.67	94.67	33.33	3.07	44.00	0.87	4.34	5.13	6.30
30.	IC0342805 ×IC0499156	49.00	92.00	35.00	4.00	48.83	1.10	6.02	4.78	8.41
31.	IC0498517 ×IC0499156	49.67	97.67	47.00	4.77	44.17	0.93	4.13	4.46	6.49
32.	IC0498872 ×IC0499156	46.67	97.33	42.17	4.50	37.67	0.93	4.20	4.27	6.21
33.	IC0499201 ×IC0499156	46.00	96.00	38.00	4.20	47.17	1.27	5.34	4.13	8.65
34.	IC0526087 × IC0499156	47.33	96.00	31.67	3.27	36.00	0.90	5.11	5.11	6.01
35.	IC0499071 ×IC0499156	47.33	95.67	31.00	4.93	31.00	1.33	4.10	4.02	6.63
36.	IC0526055 ×IC0499156	48.67	95.33	18.00	3.50	38.67	1.07	4.27	5.28	8.64
37.	IC0498795 ×IC0499156	50.67	96.00	33.50	3.43	35.17	1.43	4.02	4.13	10.23
38.	IC0118874 × IC0499156	47.00	100.00	27.00	2.83	26.00	0.93	3.10	5.99	9.95
39.	Neela×IC0499156	48.00	97.00	40.17	3.27	47.00	1.03	5.27	3.17	8.37
40.	IC0499146 × Neelam	47.67	95.67	36.00	4.40	42.00	1.20	5.28	6.00	8.31
41.	IC0498992 × Neelam	48.00	96.00	30.33	4.00	39.67	1.07	4.73	5.24	12.04
42.	IC0342805 × Neelam	50.00	99.00	20.00	2.83	23.67	0.70	3.37	3.37	10.08
43.	IC0498517 × Neelam	48.00	94.00	37.00	3.83	40.83	1.27	4.13	5.17	8.96
44.	IC0498872 × Neelam	50.67	99.67	22.00	3.17	25.00	0.60	3.10	4.34	7.30
45.	IC0499201 × Neelam	49.67	97.00	37.33	3.67	41.33	1.30	6.10	4.20	6.20
46.	IC0526087 × Neelam	50.00	99.33	17.33	2.73	19.00	0.70	3.10	4.10	9.26
47.	IC0499071 × Neelam	47.67	95.67	40.50	3.43	37.83	1.18	5.99	3.10	8.47
48.	IC0526055 × Neelam	47.00	96.33	32.33	4.17	39.00	1.13	4.10	4.73	7.93
49.	IC0498795 × Neelam	50.00	100.00	17.00	2.33	14.33	0.53	3.17	3.10	8.52
50.	IC0118874 × Neelam	48.33	95.67	42.00	4.00	44.17	1.00	4.29	5.99	6.63
51.	Neela× Neelam	49.17	95.00	29.00	3.50	47.00	1.10	5.11	4.29	6.91
	Mean	**49.15**	**98.27**	**36.93**	**4.02**	**37.26**	**1.17**	**4.71**	**8.09**	**10.10**
	S.E. ± (m)	**1.10**	**1.26**	**1.59**	**0.27**	**2.08**	**0.13**	**0.15**	**0.77**	**1.15**
	S.E. ± (d)	**1.56**	**1.79**	**2.25**	**0.38**	**2.94**	**0.19**	**0.21**	**1.09**	**1.62**
	C.D. 5%	**3.10**	**3.54**	**4.45**	**0.76**	**5.84**	**0.37**	**0.41**	**2.16**	**3.22**
	C. V. %	**3.89**	**2.22**	**7.45**	**11.64**	**9.68**	**19.35**	**5.39**	**16.50**	**19.67**

Table 4: General combining ability effects of the parents for different characters.

Sr. No.	Genotypes	Days to maturity	Plant height (cm)	Number of branches plant^{-1}	Number of capsules plant^{-1}	1000 Seed weight (g)	Seed Yield plant^{-1} (g)	Bud fly infestation (%)
				Lines				
1.	IC0499146	-0.94*	2.82**	0.11	-1.35	-0.02	0.20*	0.55**
2.	IC0498992	-1.06*	0.38	0.11	4.38**	0.39**	-0.19*	0.41**
3.	IC0342805	-0.83	-2.90**	-0.04	1.88	0.19**	-0.12	-0.17*
4.	IC0498517	-1.39**	10.10**	0.70**	5.60**	-0.14**	0.22**	0.60**
5.	IC0498872	1.17**	2.44**	0.21	-3.63**	-0.40**	0.03	0.26**
6.	IC0499201	-0.17	5.66**	0.27	2.76*	0.78**	-0.04	-0.06
7.	IC0526087	1.06*	-7.12**	-0.37*	-6.13**	-0.37**	-0.24**	-0.12
8.	IC0499071	0.72	-5.40**	-0.07	-6.79**	-0.10*	-0.03	-0.49**
9.	IC0526055	-0.94*	-4.56**	0.16	2.32*	-0.07	0.12	-0.15
10.	IC0498795	1.61**	-4.90**	-0.60**	-8.40**	-0.74**	-0.02	-0.17*
11.	IC0118874	0.50	1.16	-0.40*	-0.57	-0.39**	-0.17*	-0.22**
12.	Neela (check)	0.28	2.32**	-0.80	9.93**	0.86**	0.23**	-0.43**
	SE(g_i)	**0.42**	**0.76**	**0.16**	**1.15**	**0.07**	**0.81**	**0.14**
				Testers				
13.	IC0499191	-	-1.19**	-	1.51**	-0.10**	-0.10*	-0.29**
14.	IC0499156	-	-5.16**	-	-3.11**	-0.26**	-0.20**	-0.15**
15.	Neelam(check)	-	6.35**	-	1.60	0.36**	0.30**	
	SE(g_j)	**-**	**0.38**	**-**	**0.57**	**0.03**	**0.40**	

Note: * Significant at 5% level, ** Significant at 1% level

Note:- GCA effect of parents for days to 50% flowering, alternaria blight infestation was not estimated as mean square due to lines and testers was non significant and in case of testers days to maturity and number of branches plant^{-1} were not estimated as mean squares due to testers was not significant.

Table 5: Specific combining ability effects of crosses for different characters.

Sr. No.	Crosses	Days to maturity	Plant height (cm)	Number of branches plant^{-1}	1000 seed weight (g)	Number of capsules plant^{-1}	Seed yield plant^{-1} (g)	Bud fly infestation (%)	Alternaria blight infestation (%)
1	IC0499146 × IC0499191	1.08	-5.20**	-0.69*	-0.32**	-8.68**	-0.14	-0.55**	-1.13
2	IC0499146 × IC0499156	-2.28**	3.11*	0.79**	0.81**	9.28**	0.02	0.99**	-0.00
3	IC0499146 × Neelam	1.19	2.09	-0.10	-0.49**	-0.60	0.12	-0.43**	1.13
4	IC0498992 × IC0499191	0.19	-1.09	-0.79**	-0.69**	0.93	-0.02	0.40**	-1.65
5	IC0498992 × IC0499156	-0.50	-0.12	0.39	0.02	1.22	0.27	0.36**	5.57**
6	IC0498992 × Neelam	0.31	1.20	0.40	0.67**	-2.15	-0.25	-0.76**	-3.92**
7	IC0342805 × IC0499191	-2.69**	3.86**	0.30	1.35**	8.26**	0.14	0.62**	-0.08
8	IC0342805 × IC0499156	3.28**	-7.17**	-0.62*	-1.38**	-12.28**	-0.17	-0.94**	1.39
9	IC0342805 × Neelam	-0.58	3.31*	0.32	0.03	4.01*	0.03	0.31*	-1.31
10	IC0498517 × IC0499191	-1.14	2.86*	0.32	-0.21*	-0.13	-0.37**	-0.46**	-1.56
11	IC0498517 × IC0499156	-1.17	-3.17*	-0.37	-0.05	1.17	0.06	0.11	1.04
12	IC0498517 × Neelam	2.31**	0.31	0.04	0.26**	-1.04	0.31*	0.36*	0.52
13	IC0498872 × IC0499191	0.31	5.69**	0.54	0.13	2.60	0.16	-0.32*	0.45
14	IC0498872 × IC0499156	1.94*	-10.50**	-0.54	-0.82**	-5.44**	-0.11	-0.39**	1.11
15	IC0498872 × Neelam	-2.25**	4.81**	-0.00	0.69**	2.85	0.25	0.71**	-1.57
16	IC0499201 × IC0499191	0.64	-1.70	0.19	0.03	5.71**	-0.41**	-0.14	3.91**
17	IC0499201 × IC0499156	0.6	1.61	-1.10	1.00**	4.50*	0.36*	-0.21	0.45
18	IC0499201 × Neelam	-1.25	0.09	-0.09	-1.02**	-10.21**	-0.25	0.34*	-3.47*
19	IC0526087 × IC0499191	-1.58*	4.75**	-0.11	1.00**	3.43	0.06	0.91**	-2.04
20	IC0526087 × IC0499156	1.72*	-5.62**	-0.47	-1.06**	-8.94**	-0.04	-0.25	1.66
21	IC0526087 × Neelam	-0.14*	0.87	0.58*	0.06	5.51**	-0.02	-0.66**	0.38
22	IC0499071 × IC0499191	-0.58	2.36	1.26**	-0.28**	-0.90	0.29*	0.18	-1.85
23	IC0499071 × IC0499156	-1.61*	15.83**	-0.00	1.76**	10.56**	0.23	-0.88**	-0.12
24	IC0499071 × Neelam	2.19**	-18.19**	-1.26**	-1.48**	-9.65**	0.52**	0.70**	1.97
25	IC0526055 × IC0499191	-0.25	-11.48**	-0.40	-0.18*	-2.35	-0.13	1.11**	-0.68
26	IC0526055 × IC0499156	-0.61	6.83**	0.51	-0.15	2.61	0.03	0.42**	-2.57
27	IC0526055 × Neelam	0.86	4.65**	-1.11	0.33**	-0.26	0.10	-1.53**	3.26*
28	IC0498795 × IC0499191	-1.14	4.36**	0.29	0.28**	4.88**	-0.03	-0.02	2.34
29	IC0498795 × IC0499156	1.83*	-8.17**	-0.57	-0.42**	-11.33**	-0.11	-1.20**	-0.97
30	IC0498795 × Neelam	-0.69	3.81**	0.28	0.13	6.46**	0.46**	1.22**	-1.38
31	IC0118874 × IC0499191	3.97**	-8.20**	-0.51	-0.98**	-12.13**	0.03	-1.00**	1.84
32	IC0118874 × IC0499156	-1.39	10.77**	0.90**	0.36**	10.67**	0.19	1.74**	-3.76**
33	IC0118874 × Neelam	-2.58**	-2.57	-0.39	0.62**	1.46	-0.22	-0.73**	1.92
34	Neela × IC0499191	1.19	3.80**	-0.40	-0.12	-1.62	0.13	-0.73**	0.44
35	Neela × IC0499156	-1.83*	-3.39*	0.08	-0.08	-2.00	-0.43*	0.25	-2.91*
36	Neela × Neelam	0.64	-0.41	0.32	0.20*	3.63	-0.22	0.48**	2.47
	SE(s_{ij})	**0.74**	**1.33**	**0.28**	**0.13**	**1.99**	**1.40**	**0.24**	**0.14**

Note: * Significant at 5% level, ** Significant at 1% level

Note:- SCA effect of crosses for Days to 50% flowering was not estimated as mean square due to Line × Tester was non significant

Table 6: Potential crosses identified.

Sr. No.	Crosses	characters	Mean	SCA effects	GCAeffects	
					P1	P2
1.	**IC0498517 × IC0499191**	Yield	2.02	-0.37**	0.22**	-0.10*
		Capsule plant^{-1}	43.33	-0.13	5.60**	1.51**
		1000 seed weight	5.13	-0.21*	-0.14**	-0.10**
		Bud fly resistance	6.01	-0.46**	0.60**	-0.29**
2.	**IC0499201 × IC0499191**	Yield	1.20	-0.41**	-0.04	-0.10*
		Capsule plant^{-1}	31.33	5.71**	2.76*	1.51**
		1000 seed weight	4.70	0.03	0.78**	-0.10**
		Bud fly resistance	5.34	-0.14	-0.06	-0.29**
3.	**Neela × IC0499156**	Yield	1.03	-0.43*	0.23**	-0.20**
		Capsule plant^{-1}	47.0	-2.00	9.93**	-3.11**
		1000 seed weight	5.27	-0.08	0.86**	-0.26**
		Bud fly resistance	3.17	0.25	-0.43**	-0.15**

Note: *, ** = Significant at 5% and 1% level respectively

CONCLUSIONS

The presence of negative SCA effects for yield components in the above crosses table 6 indicates the presence of predominant role of additive gene action for yield components which is general situation observed in autogamous crops. These crosses therefore found to be the best crosses which could be exploited to the next generation for their use in varietal breeding programme in linseed.

FUTURE SCOPE

Combining ability studies in linseed germplasm has future scope to identify better potential parents to transmit desirable characteristics to the progenies and to identify the best specific crosses for yield parameters and for Isolation of parental lines of good combining ability.

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REFERENCES

Baker, R. J. (1978). Issues in diallel analysis. *Crop Sciences, 18*(4), 533-536.

Ghige, A. B., Nair, B. M., Shah, K. M., Dadas, N. D. and Jambulwar, A. P. (2021). Combining ability analysis in linseed (*Linum usitatissimum* L.). *Journal of Soils and Crops*, *31*(1), 121-126.

Kempthorne, O. (1957). An Introduction to general statistics. John Wiley and Sons. Inc. New York. Chapman and Hall Ltd. London, pp: 468-470.

Mahto, D., Singh, P. K. and Marker, S. (2020). Half diallel analysis for estimation of heterosis for phenological traits in linseed (*Linum usitatissimum* L.). *Int. J. Curr. Microbiol. App. Sci*, *9*(2), 2451-2474.

Mohammadi, A. A., Saeidi, G. and Arzani, A. (2010). Genetic analysis of some agronomic traits in flax (*Linum usitatissimum* L.). *Australian J. Crop Sci*, *4*(5), 343-352.

Nirala, R., Rani, N., Acharya, S., Vishwakarma, R., Ranjan, T., Prasad, B. D. and Pal, A. K. (2018). Combining ability analysis for grain yield and its component traits in linseed (*Linum usitatissimum* L.). *Int. Curr. J. App. Sci*, *31*(4), 1-12.

Panse, V. G. and Sukatme, P. V. (1954). Statistical methods for agricultural workers. ICAR. Publication. New Delhi. 63-66.

Rajane, A. R., Satish S. Nichal, Sangita U. Fhatak, E. R. Vaidya, Pallavi R. Sasane and S. H. Karvar (2022). Combining Ability Assessment in Sunflower through Line × Tester Analysis. *Biological Forum–An International Journal*, *14*(2a), 255-260.

Suvarnlata, D. S., Nair, B. M., Chougule P. S., Kshama, M. S., Ingole, H. P. (2021). Combining Ability Analysis for Yield and Yield Contributing Traits in Linseed (*Linum usitasissimum* L.). *Int. J Curr. Microbiol. App. Sci.*, *10*(7), 386-392.

Thakur, K., Abhinav Sao, Deepak Gauraha, Sunil Nair and Krishna Tandekar (2023). Estimation of Combining Ability using Line × Tester Analysis for Yield and its Contributing Traits in Aromatic rice (*Oryza sativa* L.). *Biological Forum – An International Journal*, *15*(7), 01-09.

Tuong, L. Q., Tung, L. Q., Khoi, N. T., Vladimirovna, N. O., & Thinh, B. B. (2020). QT68: A new single cross maize hybrid for the North Central Provinces of Vietnam. *International Journal on Emerging Technologies*, *11*(2), 266-270.

Upadhyay, D. Y., Manapure, P. R., Anasane, A. V., Navghare, A. V., Kankal, G. A. and Rahangdale, P. Z. (2019). Combining ability analysis in linseed. *J. Soil and crops, 29*(1), 158-163.

Wadikar, P. B., Magar, M. R. and Dhare, S. L. (2019). Combining ability and gene action studies for yield and yield contributing traits in linseed (*Linum usitatissimum* L.). *Bull. Env. Pharmacol. Life Sci*, *8*(7), 18-22.

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