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Genetic components analysis of F_1 and F_2 generations for seed yield and its component traits in yellow sarson (*Brassica rapa* var. yellow sarson)

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Abstract
The analysis of variance indicated significant differences among the treatments for all the characters. Parents vs. F_1s, parents vs. F_2s and F_1s vs. F_2s also revealed highly significant differences for all the characters except number of primary branches, number of secondary branches, days to maturity and oil content. Average degree of dominance $(\hat{\sigma}^2s/\hat{\sigma}^2g)^{0.5}$ was over dominance type for days to maturity, in both F_1 and F_2 generations.

Keywords: *Brassica*, degree of dominance, genetic components and yellow sarson.

1. Introduction
Indian mustard (*Brassica juncea*) is a naturally autogamous species, yet in this crop frequent out-crossing occurs which varies from 5 to 30% depending upon the environmental conditions and random variation of pollinating insects. Cytologically Indian mustard is an amphidiploid (2n=36), derived from interspecific cross of *Brassica campestris* (2n=20) and *Brassica nigra* (2n=16) followed by natural chromosome doubling. These relationships have been confirmed by the artificial synthesis of amphidiploids species by hybridizing basic diploid species and also by analysis of chloroplast and mitochondrial DNA restriction pattern of basic and amphidiploid species. The improved mustard seeds contain 39-44% oil. In India the estimated area, production and productivity of Rapeseed-mustard is 6.62 lakh ha, 8.25 million tonnes and 1245 kg/ha, respectively during in rabi 2014-15, (GOI 2015-16) **[1].** Rapeseed-mustard plays a major role in the catering edible oil demand of the country. Population of India is increasing rapidly and consequently edible oil demand is also going up day- by-day, hence, it has become necessary to enhance the present production by developing superior varieties of Indian mustard.

2. Materials & Methods
The materials comprised 25 lines namely, YSC-63, YSC-41, B-09, YSK-71, YSKM-11-02, YSC-76, YSKM-10-1, YSKM-11-1, YSC-75, YSKM-10-02, YSK-9-01, YSC-80, K-88, YSC-15, Type-42, YSC-18, YSK-03, YSC-21, YSC-92, YSC-45, YSC-30, YSC-95, YSC-40, YSC-46 and YSC-46 used as female and 4 testers namely, NRCYS-05-02, YSH-401, YST-151 and Pitambari (check) used as male of yellow sarson selected on the basis of variability for days to maturity, plant height and other agronomic characters from the Oilseeds Section, Department of Genetics and Plant Breeding, Chandra Shakher Azad University of Agriculture and Technology, Kanpur. Observation were recorded on fifteen characters viz., days to 50% flowering, days to maturity, plant height (cm), length of main raceme (cm), leaf area index (cm/m^2), number of primary branches per plant, number of secondary branches per plant, number of siliquae per plant, number of seeds per siliqua, biological yield per plant (g), 1000-seed weight (g), harvest index (%), protein content (%), oil content (%) and seed yield per plant (g). All the Twenty five females were crossed with each of four males in line x tester mating deigns to produce sufficient amount of F_0 seeds of 100 crosses during the *Rabi* season 2011-12 to raise the F_1s. The F_1s were selfed in order to obtain F_2s seeds during the *Rabi* season 2012-13. 229 treatments (29 Parents + 100 F_1s and 100 F_2s) were sown at oil seed

research farm, Kalyanpur, Kanpur in Randomized Block Deign (R. B. D.) with three replication. Recommended agronomic package and practices were followed to raise good crop. The parents were also maintained through selfing. Oil content (%) was estimated with the help of NMR method. Line x Tester analysis was analyzed as suggested by O. Kempthorne (1957) [11]. Fisher (1918) [6] divided the component of variance into additive, dominance and epistatic.

3. Results and Discussion

The results of analysis of variance for 29 parents and their 100 F_1s + 100 F_2s was computed for all the seven characters and mean sum of squares are presented table-1. Highly significant differences were observed among the treatments for all the fifteen characters. This indicated the presence of an appreciable amount of variability in the base material as well as in the material generated. These findings were also similar as Aruna chalam (1976) [2], Yadav *et al*. (1993) [22] and Choudhary *et al*. (1997) [3].

Table 1: ANOVA (MSS) for combining ability effects for fifteen characters in line x tester cross analysis of yellow sarson (*Brassica rapa* var. yellow sarson).

Sources of variation	d.f.	G	Days to 50% flowering	Days to maturity	Plant height (cm)	Length of main raceme (cm)	Leaf area index (cm/m^2)	Number of primary branches per plant	Number of secondary branches per plant
Replicates	2	F_1	1.34	6.97**	1.33	0.16	0.02	4.24	1.96
		F_2	1.12	0.81	1.65	0.56	0.20**	3.10	0.90
Lines	24	F_1	6.87	4.34	3.35	5.34	2.15	0.47	1.68
		F_2	2.62	3.07	4.38	4.54	2.16	0.77	0.58
Testers	3	F_1	6.27	8.51	6.79	13.23	0.04	0.53	6.10
		F_2	0.15	1.35	0.69	1.37	0.29	0.41	2.72
Line x Tester	72	F_1	7.32**	5.11**	3.75**	12.67**	1.99**	0.77	2.12*
		F_2	3.85**	2.80**	5.70**	4.26**	1.38**	1.02	1.53
Crosses	99	F_1	7.18**	5.03**	3.74**	10.91**	1.97**	0.69	2.13
		F_2	3.44*	2.82**	5.23**	4.24**	1.54**	0.94	1.33
Error	198	F_1	1.25	1.35	1.51	1.80	0.01	1.72	1.39
		F_2	2.35	1.59	1.43	2.15	0.03	2.03	1.50
Total	299	F_1	3.21	2.61	2.25	4.80	0.66	1.39	1.64
		F_2	2.70	1.99	2.69	2.83	0.53	1.67	1.44

Table 1: Continue…….

Source of variation	d.f.	G	Number of siliquae per plant	Number of seeds per siliqua	Biological yield per plant (g)	Harvest index (%)	1000-seed weight (g)	Oil content (%)	Protein content (%)	Seed yield per plant (g)
Replicates	2	F_1	12.49**	6.33	0.09	0.67	0.04	1.83	0.12	0.01
		F_2	5.49*	6.84	4.33	0.41	0.05*	1.69	0.04	0.01
Lines	24	F_1	14.49	6.13	23.36	4.86	0.05	1.17	2.59	0.41
		F_2	8.83	3.14	0.50	1.33	1.47	1.62	2.11	0.70
Testers	3	F_1	53.77*	9.00	21.77	4.86	0.05	1.17	2.59	0.41
		F_2	160.44**	5.44	4.00	39.85**	1.36	11.76**	9.27	0.24
Line x Tester	72	F_1	14.29**	7.43**	12.87**	4.40**	0.11**	1.87*	3.17**	1.73**
		F_2	31.64**	6.45**	1.90	5.93**	1.32**	2.62**	3.40**	1.88**
Crosses	99	F_1	15.54**	7.16**	15.69**	5.10**	0.51**	2.60**	3.17**	1.36**
		F_2	30.02**	5.62**	1.60	5.84**	1.36**	2.65**	3.27**	1.54**
Error	198	F_1	1.75	2.86	2.65	1.31	0.01	1.30	0.05	0.01
		F_2	1.79	2.42	1.64	1.30	0.01	1.31	0.02	0.02
Total	299	F_1	6.39	4.31	6.95	2.56	0.18	1.73	1.08	0.45
		F_2	11.16	3.51	1.65	2.80	0.46	1.76	1.10	0.53

*, ** significant at 5 and 1 per cent level, respectively.

The results of analysis of components of variances are presented in Table-2. The estimates of components of variance viz.; variances and $\hat{\sigma}^2 g$ and $\hat{\sigma}^2 s$ were calculated from the variances of all the fifteen characters. Analysis of variances revealed that highly significant differences were found for all the characters. Highly significant differences were recorded among all the treatments for all the fifteen characters except for number of primary branches per plant. Highly significant variability were found in the base materials as well as F_1 hybrids These findings were also reported by Khulbe *et al*. (2000), Kumar and Srivastava (2000) [13], Ghosh and Gulati (2001) and Ghosh *et al*. (2002) [9]. Significant differences were also noted among parents vs. F_1s for all the characters. Significant differences were also noted among parents vs. F_2s for all the characters, except days to maturity, number of siliquae per plant and biological yield per plant. Similar results were also observed by Singh *et al*. (2013) [18] and Shekhawat *et al*. (2014) [16]. Significant differences among F_1s vs. F_2s for all the characters except for length of main raceme, leaf area index, number of primary branches per plant, harvest index and oil content**.** These findings were also observed by Singh and Sachan (2003), Sheikh and Singh (2004) [15],

Goswami and Behl (2005) [10]. The estimate of $\hat{\sigma}^2 g$ were lower than $\hat{\sigma}^2 s$ for all the characters except number of secondary branches per plant and biological yield per plant, in both the generations. These finding were also suggested by Singh *et al*. (2007) [17], Chauhan *et al*. (2008) [4], Upadhyay *et al*. (2009) [20], Sohan Ram and Nutan Verma (2010) [19], Lal *et al*. (2011) [14] and Yadav *et al*. (2012) [21].

Table 2: Estimation of genetic components, their ratios [$\hat{\sigma}^2 g / \hat{\sigma}^2 s$] and degree of dominance [$\hat{\sigma}^2 s / \hat{\sigma}^2 g$]$^{0.5}$ for fifteen different characters in line x tester analysis of F_1s and F_2s generations in yellow sarson (*Brassica rapa* var. yellow sarson).

Characters	G	$\hat{\sigma}^2 f$	$\hat{\sigma}^2 m$	$\hat{\sigma}^2 mf$	$\hat{\sigma}^2 A$	$\hat{\sigma}^2 D$	$[\hat{\sigma}^2 g / \hat{\sigma}^2 s]$	$[\hat{\sigma}^2 s / \hat{\sigma}^2 g]^{0.5}$
Days to 50% flowering	F_1	0.46	0.06	2.00**	0.24	2.00	0.12	2.88
	F_2	0.03	-0.02	0.56**	-0.03	0.56	-0.06	3.95
Days to maturity	F_1	0.24	0.09	1.23**	0.23	123	0.18	2.31
	F_2	0.12	-0.00	0.40**	0.02	0.40	0.07	3.74
Plant height (cm)	F_1	0.14	0.06	0.72**	0.16	0.72	0.22	2.12
	F_2	0.24	-0.01	1.40**	0.04	1.40	0.03	5.40
Length of main raceme (cm)	F_1	0.29	0.15	3.65**	0.34	3.65	0.09	3.24
	F_2	0.20	-0.00	0.73**	0.04	0.73	0.05	4.19
Leaf area index (cm/m^2)	F_1	0.17	0.00	0.66**	0.04	0.66	0.07	3.64
	F_2	0.17	0.00	0.45**	0.05	0.45	0.12	2.86
Number of primary branches per plant	F_1	-0.09	-0.01	-0.29	-0.05	-0.29	0.18	2.35
	F_2	-0.09	-0.01	-0.28	-0.05	-0.28	0.20	2.19
Number of secondary branches per plant	F_1	0.01	0.06*	0.22*	0.11	0.22	0.50	1.40
	F_2	-0.08	0.01	-0.00	0.00	-0.00	-1.10	0.95
Number of siliquae per plant	F_1	1.04	0.69*	4.10**	1.47	4.10	0.36	1.66
	F_2	0.57	2.11**	9.89**	3.80	9.89	0.38	1.61
Number of seeds per siliqua	F_1	0.26	0.08	1.51**	0.21	1.51	0.14	2.65
	F_2	0.04	0.00	1.28**	0.07	1.28	0.06	4.04
Biological yield per plant (g)	F_1	1.71*	0.25	3.36**	0.90	3.36	0.27	1.92
	F_2	-0.12	0.02	-0.03	0.01	-0.03	-0.39	1.59
Harvest index (%)	F_1	0.29	0.30**	1.03**	0.60	1.03	0.58	1.31
	F_2	0.00	0.51**	1.54**	0.88	1.54	0.57	1.31
1000-seed weight (g)	F_1	0.00	0.18**	0.03**	0.31	0.03	10.10	0.31
	F_2	0.12	0.01	0.43**	0.06	0.43	0.14	2.59
Oil content (%)	F_1	-0.00	0.40**	0.20*	0.69	0.20	3.44	0.53
	F_2	0.02	0.13**	0.44**	0.24	0.44	0.55	1.34
Protein content (%)	F_1	0.21	0.10	1.04**	0.23	1.04	0.22	2.11
	F_2	0.17	0.12	1.12**	0.26	1.12	0.23	2.07
Seed yield per plant (g)	F_1	0.00	0.00	0.57**	0.01	0.57	0.02	6.75
	F_2	0.05	0.00	0.61**	0.02	0.61	0.03	5.48

$\hat{\sigma}^2 g$ and $\hat{\sigma}^2 s$ are the variance components due to general and specific combining ability, respectively

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