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Genetic components analysis for seed yield and its contributing traits in Indian mustard (*Brassica juncea* (L.) Czern & Coss)

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Abstract
Analysis of variances revealed highly significant differences for all the traits. The orthogonal components like parents, females, males, females vs males and parents vs hybrid's were also significant for all the traits except parents for 1000-seed weight, females for 1000-seed weight, males for number of primary branches and 1000-seed weight, females vs males for number of primary branches and number of seeds per siliqua, hybrid's for 1000-seed weight. Parents vs hybrid's was found significant for all the characters. A wide range of variability for all traits was observed among parents and F_1. 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 12 characters. The ratio of $\hat{\sigma}^2$ g and & $\hat{\sigma}^2$ s [$\hat{\sigma}^2$ g /$\hat{\sigma}^2$ s] and average degree of dominance expressed as [$\hat{\sigma}^2$ s/ $\hat{\sigma}^2$ g]$^{0.5}$ were also worked out The ratio of 1 : 1 between $\hat{\sigma}^2$ g and $\hat{\sigma}^2$ s indicated an equal importance of both the additive and non-additive genetic variability for expression of the characters while the deviation from 1:1 ratio indicated more importance of either $\hat{\sigma}^2$ g or $\hat{\sigma}^2$ s depending upon the magnitude of the ratio. The estimates of $\hat{\sigma}^2$ g were lower than $\hat{\sigma}^2$ s for all the characters except oil days to maturity. The ratio of $\hat{\sigma}^2$ g/ $\hat{\sigma}^2$ s was less than 1.0 in all the attributes except days to maturity which the ratio of $\hat{\sigma}^2$ g/ $\hat{\sigma}^2$ s was greater than unity. The average degree of dominance ($\hat{\sigma}^2$ s/ $\hat{\sigma}^2$ g) was more than unity for eleven characters *viz;* days to flowering, plant height, number of primary branches, number of secondary branches, number of siliquae per plant, number of seeds per siliqua, biological yield, harvest index, 1000-seed weight, oil content and seed yield per plant showing over dominant in these attributes. This parameter was less than unity for days to maturity reflecting the nature of dominance as partial.

Keywords: additive variance, average degree of dominance, non-additive variance, variability

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. For International acceptance, erucic acid content should be <2%. Seed quality, Seed yield and other yield related parameters of *Brassica* oil seed crop has been tried to improve by several researchers (Rakow, 1995 and Singh, 2003) [20, 22]. 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 2013-14, (GOI 2013-14) [21]. 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.

Material & Methods

The present investigation comprised twenty lines namely; Varuna, Maya, Urvashi, Basanti, Rohini, Pusa Bold, Kranti, NDR-8501, Pusa Bahar, Pusa Barani, Pusa Jai Kisan, Vaibhav, Durgamani, Ashirwad, KR-5610, B-85, Vardan, Nav-gold, RH-30, RLM-198 used as female and four teters namely; Pusa Agrani, RK-9807, RK-9808 and Mathura Rai used as males of Indian mustard [*Brassica juncea* (L.) Czern & Coss]. 104 treatments (20 lines + 4 testers + 80 F_1's) were shown in three replications at the Oilseed. Research Farm of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur during rabi 2010-2011. Each treatment was planted in two rows of 5 m length and 45 cm apart, plant to plant distance was maintained at 15 cm by thinning. All recommended agronomic practices were adopted for raising a good crop. Data were recorded for twelve qualitative and quantitative traits namely; days to flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of siliquae per plant, number of seeds per siliqua, 1000-seed weight (g), biological yield per plant (g), harvest index (%), oil content (%) and seed yield per plant (g). Oil content (%) was estimated with the help of NMR method. Line x Tester analysis was analyzed as suggested by O. Kempthorne (1957) [6]. Fisher (1918) [2] divided the component of variance into additive, dominance and epistatic.

Results and Discussion

The analysis of variance for 24 parents and their 80 F_1s was computed for all the 12 characters and mean sum of squares are presented table-1. Highly significant differences were observed among the treatments for all the 12 characters under the study. This indicated the presence of an appreciable amount of variability in the base material as well as in the material generated (Table-1). These findings were also similar as Aruna chalam (1976) [1], Yadav *et al*. (1993) [10] and Choudhary *et al*. (1997). 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 12 characters. The ratio of $\hat{\sigma}^2 g$ and $\hat{\sigma}^2 s$, [$\hat{\sigma}^2 g / \hat{\sigma}^2 s$] and average degree of dominance expressed as [$\hat{\sigma}^2 s / \hat{\sigma}^2 g$]$^{0.5}$ were also worked out. The ratio of 1:1 between $\hat{\sigma}^2 g$ and $\hat{\sigma}^2 s$ indicated an equal importance of both the additive and non-additive genetic variability for expression of the characters while the deviation from 1:1 ratio indicated more importance of either $\hat{\sigma}^2 g$ or $\hat{\sigma}^2 s$ depending upon the magnitude of the ratio. The estimate of the genetic components, variance, their ratio and the average degree of dominance are presented in Table-2. The estimates of $\hat{\sigma}^2 g$ were lower than $\hat{\sigma}^2 s$ for all the characters except days to maturity. The ratio of $\hat{\sigma}^2 g / \hat{\sigma}^2 s$ was less than 1.0 in all the attributes except days to maturity. In which the ratio of $\hat{\sigma}^2 g / \hat{\sigma}^2 s$ was greater than unity. The average degree of dominance [$\hat{\sigma}^2 s / \hat{\sigma}^2 g$]$^{0.5}$ was more than unity for eleven characters viz; days to flower, number of primary branches, number of secondary branches, number of siliquae per plant, number of seed/ siliquae, oil content (%), seed yield/plant (g), plant height (cm), biological yield (g), 1000-seed weight (g) and harvest index (%) showing over dominance in these attributes. This parameter was less than unity for days to maturity reflecting the nature of dominance as partial. The finding were also suggested by Khulbe *et al*. (2000) [7], Kumar and Srivastava (2000) [8], Ghosh and Gulati (2001) [], Ghosh *et al*. (2002) [4], Singh and Sachan (2003) [22], Sheikh and Singh (2004) [9], Goswami and Behl (2005) [5], Singh *et al*. (2007) [15], Chauhan *et al*. (2008) [14], Upadhyay *et al*. (2009) [18], Sohan Ram and Nutan Verma (2010) [16], Lal *et al*. (2011) [17], Yadav *et al*. (2012) [13], Singh *et al*. (2013) [11] and Shekhawat *et al*. (2014) [12].

Table 1: ANOVA for12 characters involving parents and F_1's in Indian mustard: mean sum of squares.

Sources Of variation	d.f.	Days to flower	Days to maturity	Number of primary branches	Number of secondary branches	Number of siliquae per plant	Plant height	Number of seeds Per siliqua e	Biological Yield per plant	100-seed weight	Harvest index	Oil content	Seed Yield Per plant
Replications	2	17.97**	128.82**	0.66	16.70**	170.66**	34.87**	0.15	1.28	0.086	2.37	4.10	8.05**
Treatments	103	17.37**	146.86**	3.25**	12.27**	3457.22**	54.34**	2.99**	11.38**	1.09**	28.75**	1.69	17.98**
Parents	23	124.00**	171.60**	1.87**	13.64**	675.91**	280.57**	2.28**	43.08**	0.76	50.68**	3.38**	41.62**
Females	19	58.18**	68.71**	2.20**	114.69**	539.16**	126.89**	2.37**	29.52**	0.72	52.81**	3.35**	37.94**
Males	3	14.52**	79.55**	0.30	6.77**	4.22**	343.99**	2.33**	3.22**	0.96	41.19**	4.33**	27.19**
Female vs males	1	1703.02**	2402.50**	0.27	75.62**	5289.81**	3010.34**	0.54	420.33**	1.66**	38.67**	1.16**	154.70**
Hybrid's	79	17.37**	146.86**	3.25**	12.27**	3457.19**	54.35**	2.99**	11.38**	1.09	28.75**	1.69**	17.98**
Parents vs hybrid's	1	138.87**	2560.75**	1102.23**	833.42**	528.00**	670.50**	579.51**	1486.34**	3.57**	13.71**	25.79**	603.64**
Error	206	2.76	2.87	0.78	1.55	329.11	16.18	0.80	8.27	0.030	2.53	0.44	2.82

*Significan at p =0.05; **Significant at p =0.01

Table 2: Estimation of genetic components, their ratios [$\hat{\sigma}^2 g / \hat{\sigma}^2 s$] and degree of dominance [$\hat{\sigma}^2 s / \hat{\sigma}^2 g$]$^{0.5}$.

Character	Days to flower	Days to maturity	No. of primary branches	No. of secondary branches	No. of siliqua/ plant	Plant height	No. of seeds/ siliquae	Biological yield/ plant	1000-Seed weight	Harvest index	Oil content	Seed yield/ plant
$\hat{\sigma}^2$ f	0.51	23.02	0.07	1.27	708.23	1.05	0.37	0.54	0.06	2.18	0.22	1.53
$\hat{\sigma}^2$ m	-0.18	16.61	0.02	-0.06	-24.11	-0.51	-0.03	-0.06	0.05	0.10	0.00	-0.03
$\hat{\sigma}^2$ mf	4.38	13.57	0.76	2.42	382.70	13.08	0.42	0.44	0.27	6.68	0.20	3.72
$\hat{\sigma}^2$ A	-0.12	35.36	0.05	0.33	195.89	-0.50	0.07	0.08	0.10	0.90	0.07	0.46
$\hat{\sigma}^2$ D	4.38	13.57	0.76	2.42	382.70	13.08	0.42	0.44	0.27	6.68	0.20	3.72
[$\hat{\sigma}^2 g / \hat{\sigma}^2 s$]	-0.02	2.60	0.06	0.13	0.51	0.47	0.16	0.18	0.37	0.13	0.35	0.12
[$\hat{\sigma}^2 s / \hat{\sigma}^2 g$]$^{0.5}$	2.06	0.61	3.89	2.70	1.39	3.54	2.44	2.34	1.64	2.72	1.69	2.84

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

Conclusion

The final results concluded that analysis of variances revealed highly significant differences for all the traits. The orthogonal components like parents, females, males, females vs males and parents vs hybrid's were also significant for all the traits. Parents vs hybrid's was found significant for all the characters. A wide range of variability for all traits was observed among parents and F_1. The estimates of $\hat{\sigma}^2$ g were lower than $\hat{\sigma}^2$ s for all the characters except oil days to maturity. The ratio of $\hat{\sigma}^2$ g/ $\hat{\sigma}^2$ s was less than 1.0 in all the attributes except days to maturity which the ratio of $\hat{\sigma}^2$ g/ $\hat{\sigma}^2$ s was greater than unity. The average degree of dominance ($\hat{\sigma}^2$s/ $\hat{\sigma}^2$g) was more than unity for eleven characters *viz;* days to flowering, plant height, number of primary branches, number of secondary branches, number of siliquae per plant, number of seeds per siliqua, biological yield, harvest index, 1000-seed weight, oil content and seed yield per plant showing over dominant in these attributes. This parameter was less than unity for days to maturity reflecting the nature of dominance as partial.

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