Journal of Oilseed Brassica, 10 (2) : 80-86, July 2019

Genetic variability, heritability, genetic advance and character association of Indian mustard (*Brassica juncea* L.)

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(*Received: 16 January 2019; Revised: 18 January 2019: Accepted: 4 February 2019*)

Abstract

An investigation was undertaken to study the Genetic variability, heritability, genetic advance and character association of Indian mustard (*Brassica juncea* L.) of twelve characters namely days to 50% flowering, days to maturity, plant height (cm), no. of primary branches per plant, no. of secondary branches per plant, no. of siliquae per plant, no. of seeds per siliqua ,1000- seed weight (g), biological yield per plant (g), harvest index (%), oil content (%) , seed yield per plant (g) in seven Indian mustard germplasm lines. The experiment material was evaluated in a randomized complete block design with three replications. Analysis of variance estimates of all the characters were found highly significant. Coefficient of variation for GCV and PCV were found high for the following traits i.e. primary branches per plant, 1000- seed weight (g), no. of seeds per siliqua and seed yield per plant. All the characters showing higher heritability except biological yield per plant (g). no. of siliquae per plant show higher genetic advance. Correlation study revealed that that seed yield had significant and positive association with no. of siliqua per plant (0.21G & 0.19P), number of Seeds per siliqua (0.35G & 0.13P),1000 seed weight (0.52G&0.45P), harvest index (0.79G & 0.78P) biological yield (0.97G & 0.44P), no. of secondary branches per plant (0.74G & 0.29P), number of primary branches (0.77G & 0.54P) and oil content (0.70G & 0.51P) at genotypic and phenotypic levels.

Keywords: *Indian mustard, GCV, genetic advance, heritability, PCV, variability*

Introduction

Brassica juncea commonly known as Indian mustard [*Brassica juncea* (L) Czern & Coss.] is an amphidiploids species that originated through the interspecific hybridization of *B. rapa* and *B. nigra* (UN, 1935). It is an important rabi season crop extensively gown as rain- fed as well as under irrigated conditions. Among the four oleiferous Brassica species, major area is under *Brassica juncea*, which contributes about 80 per cent of the total rapeseed-mustard production in the country. Among the various oilseed crops grown globally, the estimated area, production and yield of rapeseed-mustard in the world was 36.68 mha, 72.42 mt and1974 kg/ha, respectively, during 2017-18. Globally India account for 19.80% and 9.8% of the total acreage and production. In India estimated area production and productivity of rape seed & mustard was 6.07 mha , 7.92 mt and 1304 kg /ha (Anon. 2017-18).In Uttar Pradesh estimated area , production and Yield was 0.66 mha, 0.84 mt and 1080 kg /ha, respectively (Anon. 2016-17). Yield is complex character which dependent on the various yield contributing characters. Thus the study of correlation between yield and its component is of primary importance in formulating the selection criteria under crop improvement. Selection of any desirable trait is generally performed based on the phenotypic value of the plants, which is partly determined by genotypes, which is heritable, and partly by environment which is non- heritable. Therefore, it is necessary to know the various components of the yield and its mutual correlation with other independent traits. This is because; selection would be more efficient if it is based on some components which are less sensitive to environment. Various components of seed yield very often exhibit varying degree of associations with seed yield as well as among themselves. Analysis of correlation coefficients between characters contributing directly or indirectly towards seed yield is a matter of considerable importance in exercising the selection programme. A study of correlation alone is not enough to provide an exact picture of relative importance of direct and indirect influences of each of the component traits on seed yield.

Materials and Methods

There are seven morphological diverse genotypes / varieties viz., Maya, NRCDR-2, NRCHB-101, RGN-73, Pusa M-21, Urvashi and Pusa Bold, their 21 direct crosses i.e., the F1 populations. All the 28 treatments (7 parents and 21 F1s) were grown in Randomized Complete Block Design with three replications at Oilseed Research Farm, Kalyanpur, C. S. Azad University of Agriculture and Technology, Kanpur (UP) during Rabi 2015-2016. The parents and F1s were grown in single row of five meter length spaced 45 cm apart. The distance of 20 cm between the plants in a row was maintained by thinning. All the recommended agronomic practices were adopted for raising the crop. These genotypes/varieties have been taken on the basis of their differences in days to 50% 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 (gm), biological yield per plant (gm), harvest index (%), oil content (%) and seed yield per plant (gm). The mean data of each plot was used for statistical analysis. These traits were computed on basis of mean data after computing for each character was subjected to standard method of analysis of variance following Panse and Sukhatme (1978), phenotypic and genotypic coefficient of variation, heritability by Allard (1960) & Falconer (1990) and genetic advance as percent of mean were estimated by the formula suggested by Burton (1952) and Johanson *et. al.* (1955) .The genotypic correlation coefficients were estimated according to the formula given by Al-Jibouri *et al.* (1958).

Results and Discussion

The analysis of variance was carried out for twelve characters and showing the significant difference amongst all the parents except biological yield, among the F1's except number of secondary branches per plant, no. of seed per siliqua and biological yield per plant, parents vs F1's for all the characters revealed significant difference (Patel *et al*., 2012; Arifullah, 2013). Highly significant differences were recorded among the treatments for all the characters namely, days to (50%) flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, no. of siliquae per plant, number of seeds per siliqua, 1000- seed weight, biological yield per plant, harvest index, oil content and seed yield per plant (Table 1). The perusals of data revealed that phenotypic variance were higher than the corresponding genotypic variance for all the traits studies. Which indicated the influences of environmental factor on these traits? Data presented in (Table 2) showed maximum GCV and PCV was recorded for no. of primary branches per plant (13.1 and 15.6) followed by 1000 seed weight (g) (11.7 and 12.0), no. of seeds per siliqua (4.9 and 7.5), no. of secondary

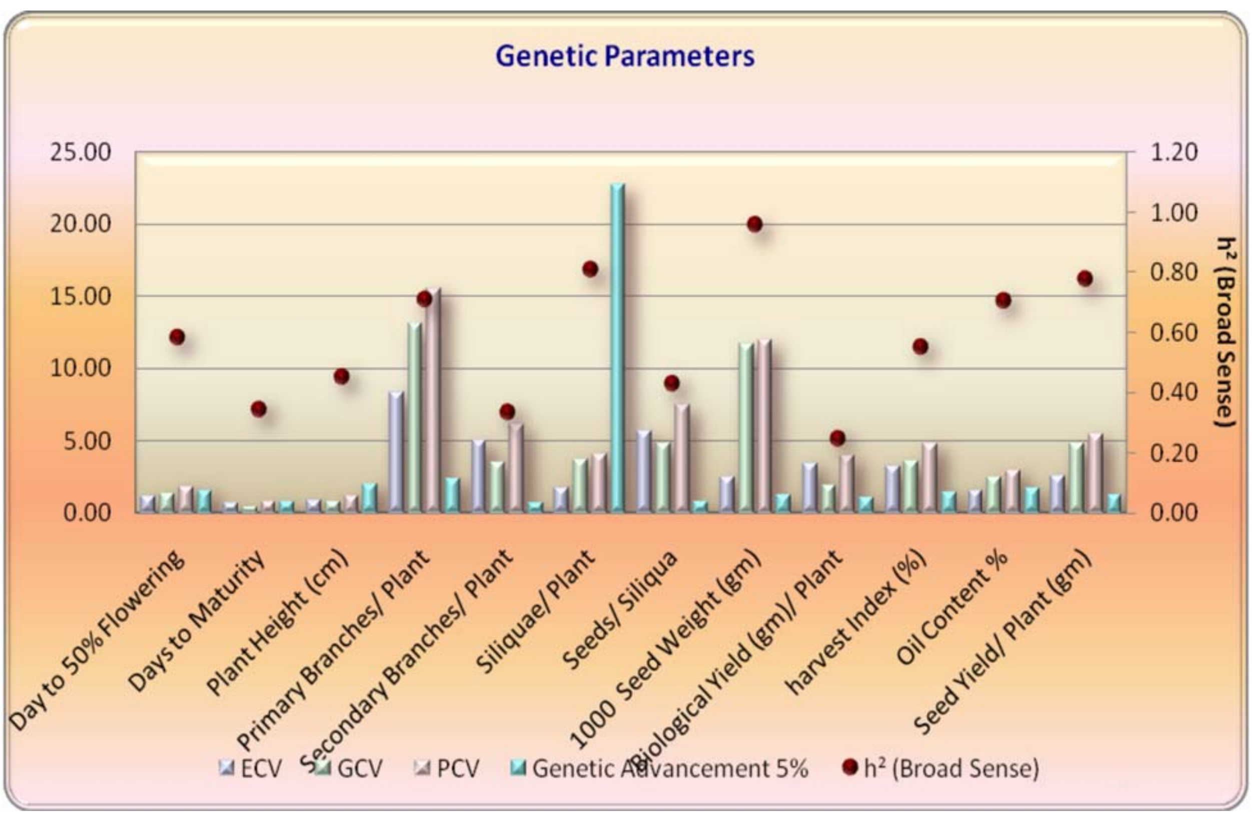

Figure 1

Table1: ANOVA of parents vs F_1's for 12 characters in a 7 x 7 parental diallel cross of Indian mustard: mean sum of squares

Sources of variance	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/ plant	No. of siliquae/ plant	No. of seeds per siliqua	1000 seed weight (g)	Biological yield/ plant (g)	Harvest index (%)	Oil content (%)	Seed yield/ plant (g)
Replication	2	0.04	0.74	4.30	0.96	0.87	8.05	0.75	0.01	1.92	2.37	0.44	0.38
Treatments	27	4.08**	2.38**	9.27**	6.82**	2.06**	487.9**	1.87**	1.28**	7.56*	3.88**	3.5**	1.81**
Parents	6	5.41**	2.32*	19.21**	7.94**	2.98**	925.2**	2.41**	1.06**	6.38**	2.48*	1.97**	0.71*
F_1s	20	2.88**	1.92*	6.13**	4.06**	0.45	303.9**	0.94	1.17**	2.00	3.06**	2.0**	0.91**
Parents vs F_1s 26.38**	1	20.0**	12.0**	12.4**	55.25**	28.67**	1545.1**	17.29**	4.96**	125.83**	28.91**	43.2**	
Error	54	0.79	0.92	2.67	0.82	0.82	35.78	0.58	0.02	3.77	0.82	0.43	0.16
Total	83	1.84	1.39	4.85	2.77	1.22	182.19	1.00	0.43	4.96	1.86	1.44	0.70

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

Table 2: PCV, GCV, heritability, genetic advance and genetic advance in percent over mean in 12 characters F_1's diallel generation of Indian mustard

Character	GCV	PCV	$\hat{h}^2$(%)	Genetic advance (5%)	Genetic advance in percent over mean
Days to 50% flowering	1.43	1.88	58	1.64	2.26
Days to maturity	0.53	0.89	35	0.84	0.64
Plant height (cm)	0.85	1.26	45	2.05	1.17
Number of primary branches per plant	13.12	15.56	71	2.46	22.77
Number of secondary branches per plant	3.60	6.21	33	0.77	4.29
Number of siliquae per plant	3.75	4.17	81	22.73	6.94
Number of seeds per siliqua	4.92	7.52	43	0.89	6.64
1000-seed weight (g)	11.70	11.97	95	1.31	23.54
Biological yield per plant (g)	2.02	4.03	25	1.16	2.09
Harvest index (%)	3.63	4.88	55	1.55	5.57
Oil content (%)	2.55	3.03	71	1.76	4.41
Seed yield per plant (g)	4.85	5.51	78	1.34	8.81

$\hat{h}^2$(%) = Heritability estimates in percent, GCV =Genotypic coefficient of variance, PCV= Phenotypic coefficient of variance

GA = Genetic advance, GA (%) = Genetic advance in percent over mean of the character branches per plant (3.6 and 6.2) and seed yield per plant (g) (4.9 and 5.5). Mondal & Khajuria (2000) reported high values for PCV and GCV for the seed yield per plant. These traits suggested the possibility of yield improvement through selection. No. of siliquae per plant , as well as harvest index (%) , oil content (%) and biological yield per plant (g) show moderate estimates of coefficient of variance respectively (3.8 and 4.2), (3.6 and 4.9), (2.6 and 3.0) and (2.0 and 4.0). The minimum estimates of coefficient of variation recorded in these following traits days to maturity (0.53 and 0.89), plant height (0.85 and 1.26) and days to 50% flowering (1.43 and 1.88). According to Dabholkar (1992) generally classified heritability estimates as low (5-10%), medium (10-30%) and high (30-60%). High heritability (Fig-1 and table 2) was observed for 1000 seed weight (95%) followed by no. of siliqua per plant (81%), seed yield per plant (78%), oil content (%) (71%) and no. of primary branches per plant (71%), days to 50 % flowering (58%), harvest index (55%), plant height (45%), number of seeds per siliqua (43%), days to maturity (35%), no. of secondary branches per plant (33%). Moderate estimates of heritability recorded in biological yield per plant (25%). High heritability estimates were also obtained for plant height and grain yield by Major and Singh (1996). Similarly, high heritability estimates for days to flowering and maturity reported by Dhagate *et al.* (1972). Understanding of heritability of a trait guides a plant breeder to predict performance of succeeding generations and helps to predict the response to selection Larik *et al.* (1989) and Dabholkar (1992) explained that heritability of a character refers to a particular population under particular environmental conditions where the experiment was conducted. Moderate heritability estimates suggest that selection should be late to more advance generations for this character. GCV along with heritability estimate gave the precise picture of genetic gain to be exploited through selection as suggested by Burton (1952). High values of GCV coupled with heritability were observed for no. of primary branches per plant and 1000 seed weight suggesting that additive gene action might play major role in the expression of these characters and selection would be rewarding in further improvement of these characters. High magnitude of genetic advance (Table 2) estimated only for no. of silique per plant (22.7) and other characters showed low magnitude of genetic advance. Estimates of genetic advance as percent of mean at 5% selection intensity ranged from (0.64) for Days to maturity to (23.5) for 1000 seed weight. Moderately highest genetic advance as percent of mean was observed for no. of primary branches per plant (22.8), seed yield per plant (8.8), no. of siliqua per plant (6.9) , no. of seeds per siliquae (6.6) and harvest index (5.6) however the minimum genetic advance as percent of mean was observed for characters days to 50% flowering, days to maturity ,plant height, no. of secondary branches per plant and oil content. A low GCV and low genetic advance as percent of mean observed these characters indicated that the characters were under high environmental influence, and that selection based on these characters would be less effective. According to Johnson *et al.* (1995) high heritability estimates along with the high genetic advance is usually more helpful in predicting increase under selection than heritability estimates alone. The present study showed that high heritability coupled with high expected genetic advance as percent of mean for no. of primary branches per plant, no. of siliqua per plant, 1000-seed weight, harvest index, oil content and seed yield per plant. Therefore, these characters could be improved more easily than other characters measured in this study. At the present most of the characters in these genotypes had shown high heritability and very low genetic advance as percent of the mean, this makes the improvement program of important traits or characters of Indian mustard makes complicated. These characters indicated that the genetic advance as percent of mean earlier reported by which indicated that improvement in this trait could be done through selection for breeding programme. The association analysis revealed that, in general, the values of genotypic correlations were higher than their phenotypic correlations indicating the inherent association among the traits. Similar findings were also reported by Singh *et al.* (2003) and Joshi *et al.* (2009). Correlation coefficient analysis revealed (Table-3) that seed yield had significant and positive association with no. of siliqua per plant (0.21G & 0.19P),number of Seeds per siliqua (0.35G & 0.13P),1000 seed weight (0.52G & 0.45P), harvest index (0.79G & 0.78P) biological yield (0.97G & 0.44P), no. of secondary branches per plant (0.74G &0.29P), number of primary branches (0.77G & 0.54P) and oil content (0.70G & 0.51P) at genotypic and phenotypic levels. Thus, these above said attributes can serve as marker characters for seed yield improvement in mustard. Such positive interrelationships between seed yield and these attributes have also been reported in mustard by Sirohi *et al.* (2004), Kardam and Singh (2005). Negative and significance correlation with days to 50% flowering (-0.32G & -0.27P) and plant height (-0.23G & -0.28P), these two traits useful in seed yield improvement. Similar findings have been given by the Shekhawat *et al.* (2014) Days to 50% flowering had significant and positive association with days to maturity (0.6 G & 0.45P), no. of siliqua per (0.34G & 0.21 P), no. of seed per siliqua (0.0.34G & 0.14P),1000 seed weight (0.23G & 0.14P), harvest index

Table 3: Genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficient among 12 attributes in 7 x 7 parental & F_1 of a diallel cross in Indian mustard

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches per plant	No. of secondary branches per plant	No. of siliquae per plant	No. of seeds per siliqua	1000 seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%) (g)	Seed yield per plant
Days to 50% flowering	G		0.611**	0.012	-0.373**	-0.447*	0.342*	0.347*	0.238*	-0.198	0.477*	0.447*	-0.329*
	P		0.4524*	0.085	-0.124**	-0.132	0.213*	0.148	0.140	0.035	0.392*	-0.2231*	0.273*
Days to maturity	G			0.643*	0.081	0.062	0.602**	0.003	-0.139	-0.595*	0.077	0.319*	-0.189
	P			0.356*	0.074	-0.036	0.286*	0.067	-0.081	-0.023	0.270	-0.087	0.233*
Plant height (cm)	G				0.187	-0.279*	0.739**	0.419*	-0.345*	-0.886**	0.082	0.094	-0.235*
	P				0.061	0.112	0.421*	0.409**	-0.230*	-0.289*	0.123	-0.015	0.289*
Number of primary branches per plant	G					0.757**	0.029	0.498*	0.658**	0.505*	0.893**	0.656*	0.770**
	P					0.247*	0.031	0.27*	0.525**	0.259*	0.508**	0.392*	0.545**
Number of secondary branches per plant	G						0.300*	0.780**	0.285*	1.12**	0.427*	0.702**	0.743**
	P						0.195	0.424*	0.183	0.384*	0.079	0.369*	0.298*
Number of siliquae per plant	G							0.170	-0.144	0.451*	0.036	0.582**	0.216*
	P							0.102	-0.141	0.270*	0.042	0.433*	0.193
Number of seeds per siliqua	G								0.104	0.456*	0.359*	0.472*	0.356*
	P								0.083	0.093	0.141	0.210*	0.137
1000-seed weight (g)	G									0.667**	0.458*	0.047	0.522**
	P									0.314*	0.347*	0.045	0.451*
Biological yield per plant (g)	G										0.480*	0.674**	0.976**
	P										0.131	0.321*	0.447*
Harvest index (%)	G											0.655**	0.793**
	P											0.368*	0.789**
Oil content (%)	G												0.702**
	P												0.511*
Seed yield per plant (g)	G												
	P												

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

(0.47G & 0.39P) at genotypic and phenotypic levels and oil content (0.44G) at genotypic level other characters showing negative and significance association with primary branches per plant (-0.37G &-0.12P), secondary branches per plant (-0.44G &-0.13P) at genotypic and phenotypic level and seed yield per plant at genotypic level only. Days to maturity was positively and significantly associated with Plant height (0.64G & 0.35P), no. of siliqua per plant (0.60G & 0.28P) reported by Hasan *et al.* (2014) and negative and significant correlation with biological yield (-0.59G & -0.02P) and one character seed yield showing (-0.18G & 0.23P) at genotypic & phenotypic level. plant height was positively and significantly associated with days to maturity(0.64G & 0.35P),no. of siliqua per plant(0.73G & 0.42P), no. of seed per siliqua (0.41G & 0.40P) and negative and significance association with 1000 seed weight (-0.34G & -0.23P), biological yield per plant (-0.88G & -0.28P) and seed yield per plant (-0.23G & -0.28P) at phenotypic and genotypic level . No. of primary branches was positively and significantly association with secondary branches per plant (0.75G & 0.24P), no. of seeds per siliqua (0.49G & 0.27P),1000 seed weight (0.65G & 0.52P), biological yield (0.50G & 0.25P), harvest index (0.89G & 0.50P), oil content (0.65G & 0.39P) , seed yield per plant (0.77G & 0.54P) and negatively significant correlation with days to 50% flowering at phenotypic and genotypic level. No. of secondary branches per plant was positively and significantly association with majority of characters except the characters days to 50% flowering (-0.44G & -0.13P) showing negative significant correlation at phenotypic and genotypic level. No. of siliqua per plant was positive and significant association with all the characters except primary branches per plant (0.02G & 0.03P) at phenotypic and genotypic level. Significant and positive association between number of siliquae per plant and biological yield per plant has reported by Joshi *et al.* (2009). No. of seed per siliqua was positive and significant association with eight characters except no. of siliqua per plant (0.17G & 0.10P), days to maturity (0.003G & 0.06P) and 1000 seed weight (0.10G & 0.08P) at phenotypic and genotypic level. 1000-seed weight was positive and significant correlation with eight characters except no. of seed per siliqua (0.10G & 0.08P), no. of siliqua per plant (-0.14G & -0.14P) and days to maturity (-0.13G &-0.08P) at phenotypic and genotypic level. Biological yield was positive and significant correlation with majority of the characters at phenotypic and genotypic level except days to 50% flowering at (-0.19G) showing negative significant at genotypic level only. Harvest index was positive and significant correlation with majority of characters at phenotypic and genotypic level except days to maturity (0.07G & 0.27P), plant height (0.08G & 0.12P) and no. of siliqua per plant (0.03G&0.04P) at phenotypic and genotypic level. Oil content was positive and significant correlation with eight characters at phenotypic and genotypic level and days to 50% flowering (0.47G) significant at genotypic level.

Conclusion

From the present investigation, it can be concluded seed yield had significant and positive association with no. of siliqua per plant (0.21G & 0.19P), number of Seeds per siliqua (0.35G & 0.13P), 1000 seed weight (0.52G & 0.45P), harvest index (0.79G & 0.78P) biological yield (0.97G & 0.44P), no. of secondary branches per plant (0.74G & 0.29P), number of primary branches (0.77G & 0.54) and oil content (0.70G & 0.51P) at genotypic and phenotypic levels. Thus, these above said attributes can serve as marker characters for seed yield improvement in mustard. Therefore, more emphasis should be given to these components while making selection for higher seed yield in mustard. However, a study of correlation alone is not enough to provide an exact picture of relative importance of direct and indirect influences of each of the component traits on seed yield.

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