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Analysis of genetic variability, heritability and genetic advance for seed yield and its contributing traits in Indian mustard [*Brassica juncea* (L.) Czern and Coss.] Under timely and late sown conditions

Govind Mishra, Shiva Nath and Tarkeshwar

Abstract
The experiment consisting of 57 treatments (45 F_1's along with their 10 parents with two standard varieties) were carried out in a RBD with three replications during *Rabi* 2021-22 at Students Instructional Farm (SIF), Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The observations were recorded on twelve metric traits. The analysis of variance, significant differences were observed among the treatments (parents, F_1's and checks) for all the twelve attributes under study. The mean squares due to treatments were highly significant for all the twelve characters in both environments *i.e*., E1 (timely sown) and E2 (late sown) reflecting variability in these attributes in subsequent generations. High heritability and high genetic advance were observed for number of silique on main raceme followed by 1000 seed weight in E1 and E2. While high heritability coupled with moderate genetic advance in per cent of mean was recorded for number of primary branches, number of secondary branches, harvest index and seed yield per plant in both environments E1 and E2. The high estimates of phenotypic and genotypic coefficient of variation were recorded for number of numbers of silique on main raceme in only E2 environment and in E1 it possessed moderate GCV and PCV.

Keywords: Heritability, genetic variability, genetic advance, GCV, PCV

Introduction
Indian mustard [*Brassica juncea* (L.) Czern & Coss.] is one of the major commercial oil yielding crops of India. Selection for better adaptable types have been practiced in different agroclimatic regions of temperate and subtropical zones from the dawn of civilization and thereby, revealing the polymorphic nature of this crop. Further its ability of out crossing with its wild and cultivated relatives has resulted in the release of tremendous variability.
Indian mustard (*Brassica juncea* L.) is a natural amphidiploid (2n=36) of *B. rapa* (2n=20) and *B. nigra* (2n=16). Indian mustard (*B. juncea* L.) popularly known as rai or raya is one of the most important oilseed crops of the country and it occupies considerably large acreage among the *Brassica* group of oil seed crops (Kaur *et al*., 2019) [6].
Indian mustard being a prime oil seed crop of the country contains oil in different forms ranging from 30 to 48 per cent (Vikram, 1979) [15]. During the last eight years, there has been a considerable increase in productivity from 1840 kg/ha in 2010-11 to 1980 kg/ha in 2018-19 and production has also increased from 61.64 m t in 2010-11 to 72.42 m t in 2018-19. Rapeseed–mustard crops in India are grown in diverse agro climatic conditions ranging from north-eastern / north western hills to down south under irrigated/rainfed, timely/late sown, saline soils and mixed cropping. Indian mustard accounts for about 75-80% of the 6.23 m ha under these crops in the country during 2018-19 crop season (ICAR-DRMR Report, 2019) [1].
Enhancement of crop productivity demands, in turn breeding for wide genetic base for characters related to yield and its components and inherent competence to wide adaptability. Yield in Brassica crops, is a complex character and is the end product of a number of components, each of which is under polygenic control. All changes in yield must be accompanied by changes in one or more of its component traits (Grafius, 1964) [3].

Materials and Methods
Soil and weather
The investigation was carried out at Students Instructional Farm (SIF) of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya.

Geographically this place is located in between 26.470N latitude, 82.120E longitude and at an altitude of 113 meters above from mean sea level. This area falls in sub-tropical zone (Indo-gangatic plain) and the soil texture is characterized by silty loam in nature having 0.40% organic carbon 2.21dSm-1 EC, and 45 ESP, 9.2 pH. The climate of district Faizabad is semi-arid with hot summer and cold winter.

Experimental materials and methodology

The basic material in the present investigation comprised of ten varieties/ strains of Indian mustard namely, RH-749-12-18-19, UJM-11, CS-54, KMR-15-5, KMR-19-3, KMR-850, KMR-17-5, UJM-8, SAURAVEE and RH-819 along with two checks *viz*., Kranti and NDR-8501 were taken from the germplasm maintained at Oilseed Section, Department of Genetics and Plant Breeding, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya.

Ten genetically diverse genotypes of Indian mustard were subjected to diallel fashion mating design (excluding reciprocals) was attempted during *Rabi* 2020 – 2021.

The experimental material comprising of 57 treatments *viz.*, (10 parents + 45 F_1's and 2 checks/standard variety) was evaluated in RBD with three replications during *Rabi* 2021-2022 under varying environment i.e., timely sown (E1) and late sown (E2) conditions. Each parent and F_1's planted in one row of 5m long 45cm apart; plant to plant distance was maintained 15cm by thinning. All the recommended agronomic practices were adopted for raising a good crop.

Observations recorded

Five plants in parents and F_1's were taken randomly for each treatment in each replication and tagged for recording observations for twelve metric characters *viz.*, days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, length of main raceme (cm), number of siliquae on main raceme, number of seeds per siliqua, biological yield per plant (g), harvest index (%), 1000-seed weight (g) and seed yield per plant (g).

Statistical analyses: This data was undertaken to assess genetic variability, heritability and genetic advance as suggested by Panse and Shukhatme (1967), Hanson (1963) and Johnson *et al*. (1955a) respectively.

Results and Discussion

Analysis of variance

The analysis of variance was carried out with respect to all the characters to test the significance of differences among various treatments *viz*., ten lines, 45 F_1s and two checks is depicted in Table 1. The mean squares due to treatments were highly significant for all the twelve characters in both environments *i.e*., E1 (timely sown) and E2 (late sown). The variance due to replications were emerged non-significant for all the traits in both the environments *viz*., E1 and E2.

Table 1: Analysis of variance for 12 characters in Indian mustard in E1 and E2

Source of variation	DF	Env.	Days to 50% flowering	Days to maturity	Plant height (cm)	Length of main raceme (cm)	Number of primary branches/plant	Number of secondary branches/plant	Number of siliquae on main raceme	Number of seeds/siliqua	1000-seed weight (g)	Biological yield/plant (g)	Harvest index (%)	Seed yield/plant (g)
Repl/	2	E1	3.59	14.24	75.32	23.10	0.18	1.06	9.99	0.51	0.24	3.61	3.14	2.15
		E2	1.52	0.78	20.06	9.58	0.04	0.36	8.23	1.20	0.04	14.39	1.02	0.24
Treatment	56	E1	20.50**	42.82**	196.63**	50.10**	2.87**	6.41**	266.74**	2.43**	1.72**	22.38**	13.37**	8.65**
		E2	18.65**	24.20**	204.41**	49.92**	2.15**	6.91**	266.10**	2.40**	1.75**	17.24**	24.83**	7.51**
Error	112	E1	3.46	7.67	37.25	6.54	0.06	0.42	2.92	0.27	0.03	3.37	2.51	0.35
		E2	1.31	7.31	19.10	3.92	0.03	0.20	2.56	0.17	0.02	2.71	1.27	0.19

*, ** significant at 5% and 1% level, respectively

Note: E1 = Timely sown, E2 = Late sown

Coefficient of variation, Heritability and Genetic Advance

The existence of genetic variability in the population provides ample opportunities for selection of genotypes with desired characters. The pool of genotypes was, therefore, assessed for variability analysis.

The phenotypic and genotypic coefficients of variability in E1 and E2 for all the twelve characters have been given in Table 2. In general, the magnitude of phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the traits in both conditions i.e., E1 and E2. The high estimates of phenotypic and genotypic coefficient of variation (>20%) were recorded for number of numbers of silique on main raceme in only E2 environment and in E1 it possessed moderate (10-20%) GCV and PCV. The characters which exhibited moderate estimates (10-20%) of PCV and GCV were number of primary branches per plant, 1000 seeds weight, in both environments while harvest index and seed yield per plant only in E2. Rest traits showed low estimates (<10%) of PCV and GCV in E1 and E2.

Heritability in broad sense, genetic advance and genetic advance in per cent of mean were estimated for all the characters and are presented in Table 2.

High estimates of broad sense heritability (>75%) were recorded for number of primary branches per plant, number of secondary branches per plant, numbers of silique on main raceme, number of seeds per siliqua, 1000-seed weight and seed yield per plant in both the environments E1 and E2. Days to 50% flowering, plant height, length of main raceme and harvest index showed high estimates of broad sense heritability only in late sown conditions (E2).

The moderate estimates of heritability (50-75%) were recorded for days to 50% flowering in E1, days to maturity in E1 and E2, plant height in E1, length of main raceme in E1, biological yield per plant in E1 and E2 and harvest in E1 only.

High genetic advance in per cent of mean (>20%) was recorded for number of silique on main raceme (33.31 and 42.24 respectively) and 1000 seeds weight (31.29 and 34.14) in both environments E1 and E2. Number of primary branches, number of secondary branches, harvest index and seed yield per plant showed moderate estimates (10-20%) of

heritability in both E1 and E2 environment. Days to 50% flowering in E2 and length of main raceme in E2 showed moderate estimates of heritability. Rest traits were possessed low (<10%) estimates of heritability in both the environments E1 and E2.

High heritability coupled with high genetic advance in per cent of mean was recorded for number of siliques on main raceme followed by 1000 seed weight in E1 and E2. While high heritability coupled with moderate genetic advance in per cent of mean was recorded for number of primary branches, number of secondary branches, harvest index and seed yield per plant in both environments E1 and E2. High heritability coupled with low genetic advance in per cent of mean was recorded for remaining traits.

In earlier studies, high genetic advance in per cent of mean coupled with high heritability have also been reported for seed yield per plant by Tripathi *et al.* (2013) [14], Lodhi *et al.* (2014) [7], Samahegn and Tesfaye (2016) [12], Prasad and Patil (2017) [9], Singh *et al.* (2017) [13], Raut *et al.* (2018) [10], Rout *et al.* (2019) [11] and Gadi *et al.* (2020) [2].

Table 2: Mean, range, coefficient of variation, heritability and genetic advance for 12 characters in Indian mustard in E1 and E2

Genotypes	Env.	Mean	Min	Max	var (g)	var (p)	Heritability (%)	GA	GA% mean	GA 1%	GA mean 1%	GCV (%)	PCV (%)	ECV (%)
Days to 50% flowering	E1	51.90	47.00	57.33	5.68	9.14	62.13	3.87	7.45	4.96	9.55	4.59	5.83	3.58
	E2	42.69	38.00	47.33	5.78	7.09	81.55	4.47	10.48	5.73	13.43	5.63	6.24	2.68
Days to maturity	E1	122.55	117.00	135.67	11.71	19.39	60.42	5.48	4.47	7.02	5.73	2.79	3.59	2.26
	E2	109.71	104.67	118.00	5.63	12.94	43.53	3.23	2.94	4.13	3.77	2.16	3.28	2.46
Plant height (cm)	E1	189.66	172.35	203.38	53.13	90.38	58.78	11.51	6.07	14.75	7.78	3.84	5.01	3.22
	E2	166.20	147.35	183.41	61.77	80.87	76.38	14.15	8.51	18.13	10.91	4.73	5.41	2.63
Length of main raceme (cm)	E1	81.84	72.95	89.20	14.52	21.06	68.93	6.52	7.96	8.35	10.21	4.66	5.61	3.13
	E2	64.09	55.29	71.53	15.34	19.25	79.66	7.20	11.23	9.23	14.40	6.11	6.85	3.09
No of primary branches/plant	E1	8.44	5.78	10.66	0.94	0.99	94.10	1.93	22.91	2.48	29.36	11.47	11.82	2.87
	E2	5.78	4.28	7.60	0.70	0.74	95.50	1.69	29.26	2.17	37.50	14.53	14.87	3.16
No of secondary branches/plant	E1	20.46	16.98	23.05	1.99	2.42	82.51	2.64	12.92	3.39	16.56	6.90	7.60	3.18
	E2	14.53	10.98	17.05	2.23	2.44	91.72	2.95	20.29	3.78	26.01	10.29	10.74	3.09
No of siliquae on main raceme	E1	57.05	35.24	75.35	87.94	90.86	96.79	19.01	33.31	24.36	42.69	16.44	16.71	2.99
	E2	45.05	23.24	63.35	87.85	90.41	97.17	19.03	42.24	24.39	54.14	20.80	21.10	3.55
Number of seeds/siliqua	E1	16.49	14.51	18.29	0.72	0.99	73.02	1.50	9.07	1.92	11.63	5.15	6.03	3.13
	E2	11.55	9.54	13.29	0.74	0.91	81.17	1.60	13.85	2.05	17.74	7.46	8.28	3.59
1000-seed weight (g)	E1	4.82	3.37	6.12	0.56	0.59	95.20	1.51	31.29	1.93	40.10	15.57	15.96	3.49
	E2	4.48	3.02	5.77	0.58	0.60	96.00	1.53	34.14	1.96	43.75	16.91	17.26	3.45
Biological yield/plant (g)	E1	61.10	51.55	65.02	6.34	9.71	65.26	4.19	6.86	5.37	8.79	4.12	5.10	3.01
	E2	45.28	36.12	49.02	4.85	7.55	64.18	3.63	8.02	4.66	10.28	4.86	6.07	3.63
Harvest index (%)	E1	28.65	24.55	34.16	3.62	6.13	59.11	3.01	10.52	3.86	13.49	6.64	8.64	5.53
	E2	27.86	22.94	33.87	7.85	9.12	86.09	5.36	19.22	6.86	24.64	10.06	10.84	4.04
Seed yield/plant (g)	E1	17.50	12.65	20.87	2.77	3.11	88.82	3.23	18.45	4.14	23.65	9.50	10.08	3.37
	E2	12.62	8.85	15.87	2.44	2.63	92.94	3.10	24.59	3.98	31.51	12.38	12.84	3.41

Note: E1 = Timely sown, E2 = Late sown

Conclusion

In the present study, number of primary branches per plant, number of secondary branches per plant, numbers of silique on main raceme, number of seeds per siliqua, 1000-seed weight and seed yield per plant in both the environments E1 and E2. Days to 50% flowering, plant height, length of main raceme and harvest index showed high estimates of broad sense heritability only in late sown conditions (E2).

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