The Pharma Innovation Journal 2022; 11(11): 797-801

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(11): 797-801

www.thepharmajournal.com
Received: 22-08-2022
Accepted: 28-09-2022

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Stability analysis in Indian mustard [*Brassica juncea* (L.)] varieties

Ganesh Lal Kumawat and Shrikant Sharma

Abstract
Thirty-five varieties of Mustard [*Brassica juncea* (L.) Czern & Coss] were evaluated for stability over three different environments created by three different dates of sowing during *rabi* 2017-18. Environment wise analysis of variance revealed that in all three environments significant differences were observed for all the characters. The stability analysis following Eberhart and Russell (1966) model revealed that based on stability parameters Varieties RGN-48, RGN-73, Maya, PCR-7, CS-52 and RH-749 were stable and suitable for growing because these had high mean, regression coefficient equivalent to unity and S^2d were non-significant and near to zero. Thus, these varieties are suitable over wide range of environment conditions. Varieties RGN-13, RGN-229, RGN-236 and RGN-303 also having superior performance and responsive to optimum sowing conditions as they exhibited greater mean with significantly higher regression coefficient. Thus, these varieties namely-RGN-48, RGN-73, Maya, PCR-7, CS-52, RH-749, RGN-13, RGN-229, RGN-236 and RGN-303 and can be used in hybridization programme to produce genetically superior gene pool.

Keywords: Indian mustard, *Brassica juncea* (L.), hybridization programme

Introduction
Rapeseed-mustard is one of the important edible oil crop needed for human consumption. Indian mustard belongs to family Cruciferae and alone covers 70% of the area among the different Brassica spp. India is one of the largest rapeseed-mustard growing countries in the world, occupying the first position in area (20.2%) and second in production (10.7%) after China. About 80% of the 5.96 million hectare (m ha) under these crops in the country during 2017-18 (Anon, 2018) [1]. The oil productivity depends upon the grain yield and percentage of oil in grain. It is well known fact that, expression of such quantitative nature of traits influenced by environmental changes at various degree due to cumulative performance of the genes responsible these traits. Under such situation the genetic potential and buffering capacity of the plants withstand the performance of the genotypes. All the genotypes may not equally perform good in all the environments. Since the interplay environment and genotypes x environments effect, affect the performance of the genotypes. It is therefore, important to screen and identify the phenotypically stable genotypes which could perform more or less uniformly under different environmental conditions. Keeping this view, the present investigation was done to identify the genotypes stable for desirable maximum number of traits across the wide range of environmental conditions.

Materials & Methods
Thirty-five Indian mustard varieties were evaluated in randomized block design with three replications during *Rabi*, 2017-2018 at Research farm, Plant breeding & Genetics, MJRP College of Agriculture & Research, Achrol, Jaipur. In each replication each variety was sown in a plot of two rows, each row consisting with 5meter length maintaining R X P distance 30cm X 10 cm. The sowing was done in three different environments created by sowing in three different dates i.e. Environment- I (21st October, 2018), Environment- II (5th November, 2018) and Environment-III (21st November, 2018). The recommended agronomical practices were adopted to raise a healthy crop.
Observations were recorded on ten randomly selected competitive plants in each replication for various characters *viz*., days to 50% flowering, days to maturity, plant height, primary branches per plant, secondary branches per plant, number of siliquae per plant, length of siliquae, number of seeds per siliquae, seed yield per plant, test weight and oil content. Mean data obtained was statistically analysed and the varieties were assessed for their stability of performance across environments following the method described by Eberhart and Russell (1966) [2].

Results and Discussions

Plant breeder attempts to produce progressively better-adapted populations to the existing or altered environments. Stability parameters have proved to be valuable for assessing the response of various genotypes under variable environmental conditions.

The quantitative characters are highly influenced by the environment. The magnitude of this influence is reflected by G × E interaction. This interaction generally remains confounded with variance and leads to biased estimates of genetic parameters. This bias can be minimized by growing the breeding materials over the environments. The study of G × E interactions was made as per the procedure outlined by Eberhart and Russell (1966) [2].

Analysis of Variance

Pooled analysis of variance over three environments showed that the genotypic variance when tested against G X E were significant for most of the traits (Table 1). Partitioning of G X E interaction showed that Environment linear interaction effects were highly significant for all the traits except length of siliqua and (G X E) linear interactions were non-significant for most of the traits except secondary branches per plant, test weight, seed yield per plant and oil content. Further, partitioning of variance i. e. Environment + (Genotype X Environment) interaction was observed to be significant for all the traits except length of siliqua and seed yield per plant. The magnitude of mean square due to Environment + (Genotype X Environment) was also recorded higher as compared to Genotype X Environment (linear) for all the traits.

Stability parameters

The genotypes with higher mean values, regression coefficient value of unity (bi=1) and non-significant deviations from linear regression deviation (S^2d =0) were considered as stable for the traits and adaptable to varied environmental conditions studied in the present investigation. However, genotypes with a higher mean value with non-significant deviations from linear regression and regression coefficient near to unity were considered to be responsive and suitable for favorable environmental conditions.

Further, the genotypes with higher mean values and regression coefficient less than one (unity) or negative and non-significant deviations from linear regression were considered to be responsive and suitable for poor environmental conditions. Accordingly, the genotypes were classified into different classes as suitable for varied environmental condition.

The earliness in flowering in mustard is highly desirable character in the areas where water stress, edaphic or atmospheric adversities prevail during the growing season, particularly in the later parts of the crop growth so that the variety may escape the adversities and mature before occurrence of stress. About 90% varieties showed non-significant S^2d values exhibiting stability for this character. Among all the varieties which were included in the present study, varieties RGN-145, PCR-7, Rohini and RGN-253 had lower mean than general mean and regression coefficient value equivalent to unity (Table 2.), hence these are most desirable.

Similarly, early maturity is also a desirable character like early flowering in mustard to escape the crop from environmental adversities. About 80% varieties showed non-significant s^2d values exhibiting stability for this particular trait. Varieties Nav gold and JMWR-08-3 were most desirable and stable for this trait because these varieties had the mean lower than general mean and regression coefficient close to unity. Varieties RGN-145, RH-30, Kranti and BIO-902 had below average stability as these had higher mean than general mean and regression coefficient significantly higher than unity.

Tallness is desirable because tall plant is expected to bear more siliqua. In the present investigation 90% varieties exhibited non-significant deviation from regression indicating, their general stability for plant height. Pusaagarni and RLM-619 having highest mean and unity regression is most desirable among the varieties evaluated.

97% varieties exhibited non-significant deviation from regression indicating their general stability for primary branches per plant. RGN-236, Maya, NRCDR-2, RH-50 and JMWR-08-3 exhibited below average stability as they had higher mean than general mean with regression coefficient significantly higher than unity. RGN-13, RGN-48, RGN-229 and PCR-7 exhibited above average stability as they had higher mean then general mean with regression coefficient significantly lower than unity.

The S^2d estimates of 85% varieties for secondary branches per plant were non-significant indicating their general stability for this trait. Varieties RGN-13, RGN-73, Laxmi, CS-52, PBR-378, Geeta, varuna, vardan, Rohini and NPJ-113 are suitable for better environment as they had higher mean then general mean and significantly high regression coefficient than unity.

The S^2d estimates of 97% varieties for number of siliquae per plant were non-significant indicating their general stability for this trait. Variety RGN-229 exhibiting average stability is thus, suitable for all environmental condition for this trait as it had high mean than general mean and regression coefficient near to unity.

The S^2d was non-significant for all the varieties for the trait of length of siliqua. Varieties RGN-145 and RH-406 had higher mean than general mean and regression coefficient close to unity exhibited stability making them suitable for all environmental condition for this character.

Varieties which, having more seeds per siliqua are expected to be high yielders. In the present investigations, Rohini, PBR-378, Pusa-agarni and RGN-303 were found to stable with close to unity regression coefficient and high mean then general mean and are therefore, classified desirable.

The similar results for seed yield and its components and quality traits were found by Gazal *et al*., (2013) [3], Sagolsem *et al*., (2013) [6], Sah *et al*., (2015) [7], Priyamedha *et al*., (2017) [5], Shekhawat *et al*., (2020) [8], Gupta *et al*., (2021) [4].

Table 1: Joint regression analysis for seed yield and its components in mustard varieties

Source	d.f	Mean sum of squares										
		Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches / plant	Secondary branches / plant	No. of siliquae / plant	Length of siliqua	No. of seeds / siliqua	Test weight (g)	Seed yield/plant (g)	Oil content (%)
Environment	2	584.156**	5141.69**	4263.457**	1.061**	9.847**	7067.965**	3.743**	33.847**	16.445**	20.014**	38.965**
Rep / Env.	6	92.2	18.69	173.2	0.304*	0.706	1436.615	0.5154	0.4114	0.2135	0.214	0.313
Varieties	34	188.296**	182.08**	664.463**	3.633**	1.243**	1941.815**	1.650**	6.562**	1.939**	22.893**	26.608**
Var. x Env.	68	159.142**	29.18	54.761	0.073	0.453	284.877	0.445	0.640	1.037**	0.182	2.298
Error	204	78.200	23.15	89.630	0.132	0.338	516.590	0.461	0.970	0.366	0.562	4.526

* = Significant at P = 0.05

** = Significant at P = 0.01

Table 2: Mean value and stability parameters (b_i and S^2d) of the mustard varieties for seed yield and its components

S. No.	Varieties	Days to 50 percent flowering					Days to maturity					Plant height (cm)					Primary branches per plant			
		μ	b_i		S^2d		μ	b_i		S^2d		μ	b_i		S^2d		μ	b_i		S^2d
1	RGN-13	61.89	0.989		69.033	*	140.56	1.094	**	-6.483		156.78	0.905	**	-28.603		3.44	-0.423		-0.043
2	RGN-48	62.89	0.989		69.033	*	139.33	0.821	**	-7.023		178.78	0.905	**	-28.603		3.47	5.072		0.102
3	RGN-73	62.22	0.841		43.536		140.56	0.848	**	-6.976		169.67	0.955	**	-29.216		3.30	1.522		-0.031
4	RGN-145	63.00	1.066		5.803		139.89	0.766	**	-7.113		158.56	0.930	**	-28.934		2.57	0.507		-0.043
5	RGN-229	58.56	1.016		0.902		140.33	0.821	**	-7.023		182.00	0.881	**	-28.221		2.54	-0.845		-0.040
6	RGN-236	57.00	0.522		-2.045		144.89	1.423	**	-5.631		179.89	0.709	**	-24.150		2.38	1.183		-0.036
7	Maya	59.22	0.794		-15.469		145.33	1.395	**	-5.710		184.11	0.905	**	-28.603		2.07	0.507		-0.043
8	PCR-7	57.89	0.794		-15.469		143.00	1.149	**	-6.356		185.67	0.955	**	-29.216		2.72	0.338		-0.043
9	RH-30	58.56	0.868		-11.045		143.56	1.094	**	-6.483		156.00	0.955	**	-29.216		2.96	0.338		-0.043
10	Laxmi	58.33	0.769		-16.713		139.56	0.848	**	-6.976		162.00	1.176	**	-29.505		2.16	0.423		-0.043
11	CS-52	58.67	1.565	**	-22.791		140.67	0.821	**	-7.023		163.89	1.373	**	-26.366		3.15	0.254		-0.044
12	Nav gold	58.00	1.962	**	-22.084		142.11	1.204	**	-6.224		167.22	1.151	**	-29.673		3.29	-0.676		-0.042
13	NRCDR-2	58.89	1.191	**	-20.292		138.56	0.694	**	-7.658		169.33	1.028	**	-29.762		3.34	0.051		-0.044
14	RH-50	59.44	0.967		-3.540		143.44	1.107	**	-5.522		169.00	1.028	**	-29.762		3.55	0.186		-0.044
15	JMWR-08-3	61.44	0.967		-3.540		143.11	0.972	**	-7.529		176.22	0.930	**	-28.934		3.21	0.879		-0.004
16	PBR-378	58.22	0.322		-13.145		138.78	0.615	**	-3.790		177.78	1.279	**	-27.235		3.19	2.948	**	-0.021
17	RH-406	56.33	0.074		-22.333		139.22	0.766	**	-7.113		174.44	1.092	**	-27.980		3.09	1.177	**	-0.040
18	Geeta	57.33	1.241	**	-18.529		142.11	1.368	**	-5.788		172.89	1.151	**	-29.673		3.40	0.977	**	-0.044
19	Kranti	55.78	0.994	**	-22.749		143.00	0.903	**	-6.877		167.22	1.004	**	-29.630		3.20	0.155		-0.042
20	Varuna	56.33	-0.274		23.336		142.78	0.711	**	-7.196		163.44	1.053	**	-29.844		3.04	0.500	**	-0.044
21	Vardan	57.89	-0.403		19.924		139.44	0.465	**	-7.495		174.67	1.397	**	-25.748		3.32	1.890	**	-0.039
22	RH-749	55.00	0.549	**	-22.827		143.33	1.067	**	-6.544		172.00	1.397	**	-25.748		2.94	2.113		-0.019
23	Rohini	56.11	0.522	**	-22.843		142.67	1.067	**	-6.544		174.89	1.151	**	-29.673		3.19	-0.085		-0.044
24	NPJ-113	54.22	1.043	**	-22.824		141.00	0.903	**	-6.877		177.44	0.979	**	-29.448		3.05	0.727		-0.041
25	RL-1359	50.89	1.866		23.188		148.00	1.724	**	-4.654		179.44	0.979	**	-29.448		3.27	1.636	*	-0.036
26	RGN-253	51.56	2.195		68.616	*	143.11	1.040	**	-6.603		167.56	0.709	**	-24.150		3.71	4.466		0.103
27	RN-393	53.00	1.446		17.836		146.44	1.368	**	-5.788		159.22	0.635	*	-21.656		3.19	1.944		-0.023
28	PBR-357	53.56	2.118		73.416	*	144.00	1.067	**	-6.544		156.22	0.709	**	-24.150		3.56	1.944		-0.023
29	Pusa agarni	72.11	1.780		788.971	**	145.33	1.559	**	-5.210		158.78	1.430	**	-17.314		2.54	0.169		-0.044
30	RGN-303	52.44	2.360		19.046		144.89	1.505	**	-5.383		159.11	0.905	**	-28.603		4.28	1.143	*	-0.039
31	BIO-902	54.56	0.905		9.992		145.11	0.514		17.784		172.11	0.229		10.277		4.03	0.818		0.002
32	Pusa bold	52.33	1.215		50.719		147.67	0.387		28.026		171.11	0.905		1.274		3.39	1.758		0.072
33	GM-3	54.44	0.856		13.252		153.00	0.271		103.023	**	162.56	0.735		877.341	**	4.83	1.014		0.006
34	RGN-281	59.00	0.719		6.163		152.67	0.894		38.449	*	179.33	0.660		7.339		4.54	0.085		0.000
35	RLM-619	59.22	0.173		2.814		160.22	1.751		3.161		177.67	1.814		55.505		4.65	0.304		0.001
	General mean	57.61					143.65					170.20					3.27			
	S.Em±	4.04					1.48					3.12					0.07			
	S.E. b_i		4.947					1.812					3.815					0.090		

Cont..

S. No.	Varieties	Secondary branches/plant					Number of siliquae/plant					Length of siliqua					Seeds per siliqua			
		μ	b_i		S^2d		μ	b_i		S^2d		μ	b_i		S^2d		μ	b_i		S^2d
1	RGN-13	4.13	0.298		-0.102		167.56	1.221	**	-167.176		4.04	0.989	**	-0.149		12.64	0.903		-0.181
2	RGN-48	4.38	0.050		-0.112		187.00	1.066	**	-169.513		4.36	-0.396		-0.153		12.00	0.602		-0.260
3	RGN-73	4.51	0.198		-0.108		182.78	1.241	**	-172.169		4.51	0.396	**	-0.153		9.96	-0.060		-0.323
4	RGN-145	4.56	0.582	*	-0.102		152.22	1.085	**	-171.604		4.72	0.495	**	-0.153		9.41	0.030		-0.323
5	RGN-229	4.69	0.397		-0.095		167.22	0.685	**	-166.815		4.57	-0.297		-0.153		10.38	0.030		-0.323
6	RGN-236	4.22	1.078	**	-0.108		161.22	1.206	**	-172.159		4.27	0.495	**	-0.153		11.12	0.600		-0.260
7	Maya	5.00	2.156	**	-0.096		170.11	1.241	**	-172.169		4.76	0.791	**	-0.151		11.81	1.196	**	-0.272
8	PCR-7	4.13	1.078	**	-0.108		188.78	1.241	**	-172.169		4.02	1.979	**	-0.136		11.82	0.887	**	-0.312
9	RH-30	4.91	0.496		-0.085		147.89	2.006	*	-53.980		3.91	0.989	**	-0.149		11.04	1.185	**	-0.270
10	Laxmi	4.64	0.198		-0.108		153.89	0.568	**	-171.987		4.18	0.989	**	-0.149		11.78	2.035	**	-0.282

11	CS-52	4.43	0.149		-0.110		143.78	1.001	**	-171.478		3.84	0.989	**	-0.149		11.50	1.451	**	-0.287
12	Nav gold	5.19	2.154	*	0.031		174.78	1.136	**	-171.358		4.93	2.543		0.274		13.01	0.891		-0.184
13	NRCDR-2	4.42	1.363	**	-0.093		170.78	0.643	**	-172.197		4.04	2.261		0.001		11.74	0.583		-0.264
14	RH-50	4.38	0.198		-0.108		166.89	0.952	**	-170.541		4.22	0.282		-0.085		11.93	0.394		-0.296
15	JMWR-08-3	5.06	0.248		-0.106		168.00	1.194	**	-164.166		4.67	0.846		0.462	*	12.55	0.299		-0.308
16	PBR-378	4.44	0.198		-0.108		170.22	0.755	**	-169.374		4.37	-0.297		-0.153		11.89	-0.070		-0.322
17	RH-406	4.27	1.747	*	-0.018		153.67	0.668	**	-165.526		4.31	0.396	**	-0.153		12.32	0.300		-0.308
18	Geeta	5.09	-0.496		-0.085		173.33	1.194	**	-164.166		4.24	0.396	**	-0.153		12.51	1.201		-0.071
19	Kranti	4.69	1.980	*	0.009		165.22	1.282	**	-158.234		4.14	0.693	**	-0.152		10.77	1.173	**	-0.322
20	Varuna	4.56	-0.496		-0.085		155.78	0.710	**	-172.129		4.22	-0.564		0.120		10.22	0.872	**	-0.296
21	Vardan	4.23	-0.149		-0.110		156.78	0.843	**	-171.593		4.04	0.989	**	-0.149		12.12	1.052	**	-0.315
22	RH-749	4.16	0.397		-0.095		175.11	0.843	**	-171.593		3.84	0.989	**	-0.149		11.79	1.581	**	-0.305
23	Rohini	4.53	1.190		0.048		175.33	0.668	**	-165.526		3.82	1.553		0.193		11.13	1.191	**	-0.318
24	NPJ-113	4.72	-0.347		-0.099		186.33	0.668	**	-165.526		4.41	0.989	**	-0.149		11.25	1.745	**	-0.213
25	RL-1359	4.53	1.488		0.139		185.00	0.668	**	-165.526		4.24	0.989	**	-0.149		11.54	1.442	*	-0.114
26	RGN-253	4.78	1.164	*	-0.071		131.78	-0.969		2420.013	**	4.78	0.139		0.808	*	10.79	1.444	*	-0.112
27	RN-393	5.11	3.232	**	0.026		155.00	4.648	**	-125.088		3.84	0.143		0.363		12.05	2.320	**	0.065
28	PBR-357	4.49	0.992		-0.001		157.11	1.370	**	-150.672		4.16	1.558		1.081	**	10.41	1.711	*	0.050
29	Pusa agarni	4.60	1.488		0.139		146.33	0.668	**	-165.526		4.09	1.727		0.757	*	11.09	1.830	*	-0.007
30	RGN-303	4.45	0.893		-0.022		157.33	1.194	**	-164.166		4.17	1.700		1.821	**	11.09	2.268	**	0.092
31	BIO-902	4.53	2.083		0.493	*	163.89	1.019		1.058		3.29	3.760		0.008		10.31	1.445		0.210
32	Pusa bold	5.06	2.329		0.168		164.89	0.737		289.921		2.91	2.856		0.061		10.30	1.204		0.254
33	GM-3	5.16	2.588		1.485	**	187.22	1.019		1.058		3.19	2.147		0.210		10.53	0.360		1.475
34	RGN-281	5.24	2.911		0.262		189.78	0.264		45.367		4.20	0.000		0.000		10.66	0.302		0.016
35	RLM-619	5.71	1.164		0.042		141.89	0.268		403.291		3.97	1.484		0.010		10.71	0.601		0.063
	General mean	4.66					165.57					4.15					11.32			
	S.Em±	0.20					5.87					0.27					0.22			
	S.E. b_i		0.242					7.184					0.335					0.269		

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S. No.	Varieties	Test weight per plant (g)					Seed yield per plant (g)				Oil yield (%)			
		μ	b_i		S^2d		μ	b_i		S^2d	μ	b_i		S^2d
1	RGN-13	4.24	0.470	**	-0.117		5.29	0.669	**	-0.180	38.66	-1.604		-1.211
2	RGN-48	4.54	0.470	**	-0.117		7.03	0.713	**	-0.179	40.96	0.588	*	-1.469
3	RGN-73	4.18	0.470	**	-0.117		8.58	1.145	**	-0.166	40.31	0.495	*	-1.394
4	RGN-145	4.86	0.470	**	-0.117		4.67	0.713	**	-0.179	37.89	0.247		-1.480
5	RGN-229	4.58	0.470	**	-0.117		9.84	1.145	**	-0.166	39.56	0.588	*	-1.469
6	RGN-236	3.91	0.470	**	-0.117		6.10	0.713	**	-0.179	38.89	0.588	*	-1.469
7	Maya	4.31	0.470	**	-0.117		8.50	0.713	**	-0.179	37.66	0.588	*	-1.469
8	PCR-7	4.73	0.470	**	-0.117		7.71	1.005	**	-0.174	39.51	1.175	*	-1.349
9	RH-30	5.42	-0.470		-0.117		7.40	1.589		0.085	36.89	-1.175		-1.349
10	Laxmi	4.58	-0.125		-0.053		7.17	0.713	**	-0.179	35.56	0.247		-1.480
11	CS-52	4.71	3.337	*	0.625	*	6.00	0.713	**	-0.179	37.78	1.237		-0.793
12	Nav gold	4.24	0.470	**	-0.117		4.75	0.713	**	-0.179	37.33	0.742		-1.251
13	NRCDR-2	5.04	0.470	**	-0.117		5.38	0.713	**	-0.179	39.33	2.366	**	-0.997
14	RH-50	4.51	0.470	**	-0.117		5.13	0.713	**	-0.179	38.89	1.469	*	-1.259
15	JMWR-08-3	4.91	0.470	**	-0.117		4.83	0.713	**	-0.179	38.22	0.588	*	-1.469
16	PBR-378	4.78	0.470	**	-0.117		8.21	2.698	**	0.154	36.56	0.588	*	-1.469
17	RH-406	4.76	-0.188		-0.121		7.99	1.577	**	-0.148	35.56	0.588	*	-1.469
18	Geeta	4.23	-0.141		-0.122		4.19	1.145	**	-0.166	37.44	0.294	*	-1.499
19	Kranti	4.43	-0.141		-0.122		5.13	0.713	**	-0.179	38.89	0.588	*	-1.469
20	Varuna	3.89	0.094	**	-0.122		3.57	0.713	**	-0.179	35.22	-0.294		-1.499
21	Vardan	4.69	-0.188		-0.121		5.73	1.437	**	-0.184	35.44	1.175	*	-1.349
22	RH-749	4.16	0.344		-0.085		6.34	1.145	**	-0.166	37.56	1.469	*	-1.259
23	Rohini	4.33	0.814	**	-0.107		4.78	1.145	**	-0.166	38.22	0.588	*	-1.469
24	NPJ-113	4.80	3.819	**	0.039		5.10	0.713	**	-0.179	38.00	2.644	*	-0.699
25	RL-1359	4.93	2.817	**	0.058		4.13	0.713	**	-0.179	38.00	2.644	*	-0.699
26	RGN-253	3.15	4.226	**	0.283		4.53	0.713	**	-0.179	37.89	0.588	*	-1.469
27	RN-393	4.34	0.344		-0.085		4.24	1.297	*	-0.086	33.56	3.155	**	-0.599
28	PBR-357	4.36	0.344		-0.085		5.55	1.589		0.085	35.67	1.485		-0.478
29	Pusa agarni	4.61	0.688		0.026		5.82	1.729	**	-0.118	34.89	3.155	**	-0.599
30	RGN-303	4.18	1.299		0.928	**	5.23	1.433	*	-0.017	35.78	-0.588		-1.469
31	BIO-902	5.42	-0.470		0.005		4.78	0.713		0.008	37.22	1.732		1.403
32	Pusa bold	4.70	2.817		0.180		4.25	0.713		0.008	36.67	0.000		0.000
33	GM-3	5.07	2.817		0.180		3.98	0.713		0.008	35.00	0.000		0.000
34	RGN-281	4.60	3.099		0.218		3.53	0.713		0.008	35.00	2.644		0.810
35	RLM-619	3.56	3.757		0.320		4.40	0.713		0.008	36.67	4.407		2.250
	General mean	4.51					5.71				37.33			
	S.Em±	0.19					0.12				0.34			
	S.E. b_i		0.235					0.149				0.420		

Table 3: Superior varieties having stability for seed yield and its components

Varieties	'bi' for seed yield	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	primary branches / plant	secondary branches / plant	No. of siliquae / plant	length of siliqua	No. of seeds / siliqua	Test weight (g)	Seed yield /plant(g)	Oil content (%)
RGN-48	bi = 1	55.78	154.33	183.99	5.94	9.38	203.44	4.39	12.02	4.68	9.54	40.03
RGN-73	bi = 1	52.89	154	179.44	6.56	12.5	202	4.5	10.29	5.11	10.3	39.57
CS-52	bi = 1	51.44	154.56	170.22	5.4	9.57	167.67	3.83	10.11	5.34	8.61	41.53
RH-749	bi = 1	55.89	156.33	182.56	5.3	8.79	82.67	4.1	11.11	6.66	7	38.12
RGN-303	bi = 1	55.89	154.89	170.89	5.11	8.56	105.33	3.88	11.34	5.38	7.66	42.03
Maya	bi = 1	57.11	156.56	172.93	6.39	9.6	176.33	3.87	9.63	5.39	8.64	39.5
RGN-229	bi > 1	59	152.22	183.1	5.54	9.39	170.89	3.78	9.68	4.64	12.87	40.1
RGN-236	bi > 1	54.89	156	182.92	6.31	10.03	164.33	3.98	10.61	6	9.89	39.2
RGN-13	bi > 1	57.33	150.56	182.07	6.12	7.12	165.61	4.67	9	5.42	9.13	38.13
PCR-7	bi < 1	53.33	156.89	183.67	5.99	9.49	179.44	4.14	10.02	5.83	8.8	36.7
NPJ-113	bi < 1	42.67	147.33	170	4.93	10.46	115	4.08	10.42	6.52	9.99	38.21
RGN-253	bi < 1	51.78	155.33	145.78	5.41	10.1	132.56	4.04	11.08	6.06	7.3	39.93
RH-30	bi < 1	53	155.11	193.8	5.34	8.44	176.89	4.2	9.53	4.88	9.04	39.57
Laxmi	bi < 1	56.67	156.22	177.28	5.21	9.82	164	3.82	10.22	4.83	11.39	39.67
RH-50	bi < 1	53.67	151.56	167.22	6.26	9.66	131.44	4.23	12.8	6.27	7.33	38.1
JMWR-08-3	bi < 1	56.89	152.22	183.89	6.36	9.97	124.56	4.48	10.89	6.53	6.92	37.6
General mean		54.48	154.2	174	5.53	9.36	134.4	4.17	10.9	5.69	6.89	39.0

Varieties	bi	Character
RGN-48	bi = 1	Seed yield per plant, days to maturity and primary branches per plant
RGN-73	bi = 1	Seed yield per plant, days to maturity, primary branches per plant per plant, number of seeds per siliqua and test weight
CS-52	bi = 1	Seed yield per plant, days to maturity, primary branches per plant, Secondary branches per plant and siliqua length
RH-749	bi = 1	Seed yield per plant, days to 50 per cent flowering, days to maturity and primary branches per plant,
RGN-303	bi = 1	Seed yield per plant, days to 50 per cent flowering, days to maturity, primary branches per plant and number of seeds per siliqua
Maya	bi = 1	Seed yield per plant, days to maturity, primary branches per plant and test weight
RGN-229	bi > 1	Seed yield per plant, plant height, number of siliquae per plant, test weight and oil content
RGN-236	bi > 1	Seed yield per plant, plant height, primary branches per plant and number of seeds per siliqua
RGN-13	bi > 1	Seed yield per plant, days to 50 per cent flowering plant height, Secondary branches per plant, siliqua length, Number of seeds per siliqua and oil content
PCR-7	bi < 1	Seed yield per plant, days to maturity, secondary branches per plant, siliqua length, Number of seeds per siliqua and test weight
NPJ-113	bi < 1	Seed yield per plant, days to maturity, primary branches per plant and test weight
RGN-253	bi < 1	Seed yield per plant, days to maturity, primary branches per plant, siliqua length, number of seeds per siliqua and oil content
RH-30	bi < 1	Seed yield per plant, secondary branches per plant, siliqua length, number of seeds per siliqua and test weight
Laxmi	bi < 1	Seed yield per plant, siliqua length, number of seeds per siliqua, test weight and oil content
RH-50	bi < 1	Seed yield per plant, secondary branches per plant and siliqua length
JMWR-08-3	bi < 1	Seed yield per plant, secondary branches per plant, siliqua length and test weight

Conclusion

The varieties which had higher mean for seed yield and bi = 1 are RGN-48, RGN-73, Maya, PCR-7, CS-52 and RH-749 (Table 3 & 4.). These varieties can be used as stable varieties over the environments. Varieties RGN-13, RGN-229, RGN-236 and RGN-303 also having superior performance and responsive to optimum sowing conditions as they are having greater mean with significantly higher regression coefficient. Thus, varieties namely- RGN-48, RGN-73, Maya, PCR-7, CS-52, RH-749, RGN-13, RGN-229, RGN-236 and RGN-303 should be used in hybridization programme to generate superior gene pool.

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