

Stability analysis for yield and its contributing traits in Indian mustard [*Brassica juncea* (L). Czern & Coss] under variable environments

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Received : 28 August, 2017

ABSTRACT

Stability analysis was carried out with fourteen elite genotypes of Indian mustard [*Brassica juncea* (L). Czern & Coss] including four check viz., NRCHB 506, Kranti (National check) and GM 3, GDM 4 (State check) over five different environments (Sardarkrushinagar, Junagadh, Amreli, Vijapur and Derol) of Gujarat to identify phenotypically stable genotypes that could perform more or less uniformly under different environmental conditions for various economic traits. Analysis of variance revealed that the genotypes exhibited significant genetic variability for all the traits except days to maturity, seeds per siliquae and seed yield per plot. Genotype x Environment interaction was observed to be significant for all the characters. Environment (linear) interaction component was also significant for all the traits studied, while the linear component of environment interaction was significant for length of siliquae and number of siliquae per plant. The variance due to pooled deviation (non-linear) was highly significant for all the traits except number of siliquae per plant which reflect considerable genetic diversity in the material. In the present investigation genotypes SKM 1219 and SKM 1428 were stable for days to flowering as well as maturity. Genotypes, SKM 1414, SKM 1404 and SKM 1219 for length of siliquae; Kranti, SKM 1413 and SKM 1219 for seeds per siliquae; SKM 1428 for test weight were found to be stable under varying environment conditions.

Key words : Mustard, stability, G x E Interaction, seed yield

Rapeseed-mustard is one of the important edible oil plants needed for human consumption. Indian mustard belong to family *cruciferae* and alone covers 70% of the area among the different *Brassica* spp. In India this crop is grown under diverse agroclimatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed, timely/late-sown, saline soils and mixed cropping. Indian mustard is cultivated in the area of 6.70 million ha with 7.96 million tones of production and 1188 kg/ha productivity respectively (AICRPRM, 2014).

Grain yield is a complex quantitative character and is vital influenced by environmental fluctuations. It fluctuates due to sensitivity of genotype to different environments. A Specific genotype does not always exhibit the same phenotypic characteristics under all the environments and different genotypes respond differently to a specific environment. A genotype is considered to be adaptive or stable if it has a high mean yield but a low degree of fluctuation in yielding

ability where grown under diverse environments (Bicer and Sakar, 2006). Among the *rabi* crops Indian mustard is grown as a source of an important edible oilseed crop in India. In Gujarat condition, winter is very short and sometimes the temperature rise early in winter. Therefore, the identification of short duration and stable genotypes of Indian mustard that perform better over a wide range of environments with high yielded is required. Keeping this view, present investigation was carried out to identify the genotypes stable for desirable maximum number of traits across the wide range of environmental conditions.

MATERIALS AND METHODS

Fourteen genetically diverse and promising Indian mustard genotypes viz., SKM 1403, SKM 1404, SKM 1413, SKM 1414, SKM 1423, SKM 1424, SKM 1428, SKM 1305, SKM 1331 and SKM 1219 including four check i.e., NRCHB 506, Kranti (National checks) and GM 3, GDM 4 (State checks) were used for study.

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The experiment was conducted in Randomized Complete Block Design with four replications at five variable locations of Gujarat condition *i.e.*, Sardarkrushinagar, Junagadh, Amreli, Vijapur and Derol in *rabi* 2015-16. Each genotype was accommodated in a plot of eight rows of five meter length, with 45 cm x 10 cm. The recommended packages of practices were followed to raise the good crop. Observations were recorded on eight quantitative traits *viz.*, days to flowering, days to maturity, plant height (cm), length of silique (cm), seed per silique, number of silique per plant, test weight (g) and seed yield per plot (4.6 x 1.8 sq. mt) (kg). The data on days to flowering and maturity were recorded on plot basis. The data were subjected to analysis of variance as per the procedure suggested by Panse and Sukhatme (1978) for Randomized Complete Block Design. Genotype x environment interaction were found to be significant in respect of all the characters studied, hence the data were subjected to stability analysis model proposed by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Analysis of variance on eight characters for individual as well as pooled over the environment was carried out for each environment. The pooled analysis of variances revealed significant differences among the genotypes for all the characters except days to maturity, seed per silique and seed yield per plot (Table 1). This indicated that genotypes interacted strongly with the environments. Significant differences were observed among the environments indicated significant effect of environment was there in the expression of the traits. Similar results has been reported by Dhillon *et al.* (1999) and Brar *et al.* (2007). Environment (linear) component was significant for all the traits, while the linear component of environment interaction was significant for length of silique and number of silique per plant. The variance due to pooled deviation (non-linear) was highly significant for all the traits except number of silique per plant which reflect considerable genetic diversity in the material. These results are akin with the findings of Chattopadhyay *et al.* (2012) and Sah *et al.* (2015). A variety may be said to be stable over different environments if it shows unity or less than unity regression coefficient (b_i) with lowest deviation (non-significant) from linear regression (S^2_{di}). The mean, regression coefficient (b_i) and deviation from regression (S^2_{di}) for seed yield and yield contributing traits are presented in Table 2.

In the present investigation the magnitude of regression coefficient (b_i) and deviation from regression varied from genotype to genotype. The first group consisting the genotypes which have high mean value, b_i is equals to unity and S^2_{di} is nearly zero were considered as stable genotype for all the environments studied. The genotypes SKM 1219 and SKM 1428 were stable for days to flowering as well as maturity. Genotypes *viz.*, SKM 1414, NRCHB 506, SKM 1404 and SKM 1219 were found stable for length of silique. For the trait seeds per silique the promising genotypes were Kranti, SKM 1413, GDM 4 and SKM 1219, while the genotypes GDM 4 and SKM 1428 were observed stable for test weight. The genotypes namely SKM 1424, SKM 1413 and SKM 1219 were found stable for seed yield per plot. Further the genotype SKM 1219 was observed to be desirable and stable for other yield contributing characters like days to flowering, days to maturity, length of silique and seeds per silique. In addition to that the genotype SKM 1305 was having high seed yield, $S^2_{di} = 0$ and $b_i > 1$ indicating that this genotypes would perform better in favourable under environmental conditions.

The genotypes which are showing high mean value than over all mean but exhibiting above average stability with $b_i > 1$ comes under the second group, indicated that they were highly sensitive to environment conditions. The genotypes performed well under favourable environmental conditions.

The third groups consisting the genotypes, which are showing high mean value than the population mean and exhibiting below average stability with $b_i < 1$, indicating that these genotypes were least sensitive to environmental conditions. It revealed that the genotypes specifically adapted to poor environmental conditions. These findings were in agreement with the results of Dhillon *et al.* (1999), Brar *et al.* (2007), Yadava *et al.* (2010), Chauhan *et al.* (2010) and Sah *et al.* (2015).

CONCLUSION

Overall, it can be concluded that the genotypes *viz.*, SKM 1219, SKM 1413 and SKM 1424 were exhibited higher mean and stable performance over the environments for most of the yield components as well as for seed yield per plot. Thus, these genotypes can be utilized in future breeding programme for development of stable strains having wider adaptability.

Table 1 Analysis of variance for stability parameters for different characters in Indian mustard

Source of variation	d.f.	Days to flowering	Days to maturity	Plant height (cm)	Length of siliquae (cm)	Seeds / siliquae	Test wt (g)	No. of siliquae/Pl.	Seed yield / plot
Rep within Env.	10	5.375*	3.744	103.754	0.013	0.165	0.014	4249.125*	0.013
Varieties	13	5.981*	1.903	184.300*	0.156**	0.523	0.398**	3795.067*	0.022
Env. +(Var.* Env.)	56	73.496**	45.535**	163.111**	0.499**	1.308**	2.069**	15283.120**	0.125**
Environments	4	996.814**	605.448**	1073.108**	6.204**	11.833**	27.853**	181052.100**	1.327**
Var.* Env.	52	2.472	2.465	93.112	0.060*	0.498	0.086	2531.663	0.033
Environments (Lin.)	1	3987.254**	2421.794**	4292.434**	24.815**	47.333**	111.410**	724208.400**	5.307**
Var.* Env. (Lin.)	13	1.821	2.911	139.704	0.127**	0.233	0.107	4175.632*	0.033
Pooled Deviation	42	2.497**	2.151**	72.039**	0.035**	0.544**	0.073**	1841.983	0.030**
Pooled Error	130	0.6	0.556	18.11	0.01	0.115	0.011	1802.636	0.014
Total	69	60.776	37.314	167.103	0.434	1.16	1.754	13118.71	0.106

*, ** Significant at 5 % and 1 % levels, respectively.

Table 2 Mean and stability parameters for yield and its components in Indian mustard

Genotype	Days to flowering			Days to maturity			Plant height (cm)			Length of siliquae (cm)		
	Mean	bi	σ^2_{di}	Mean	bi	σ^2_{di}	Mean	bi	σ^2_{di}	Mean	bi	di
SKM 1403	50	0.95	0.52	114.467	1.04	-0.54	182.193	1.45	20.97	4.453	0.97	0.02*
SKM 1404	49.733	1.07	0.97	114.267	1.07	1.36*	179.62	1.04	15.12	4.513	0.85	0.00
SKM 1413	50	1.03	2.03*	114.733	0.81	0.76	181.033	0.2	85.53**	4.633	0.8	0.02*
SKM 1414	49.067	0.98	3.06**	114.4	1.00	1.93*	164.74	0.15	126.43**	4.52	0.98	0.00
SKM 1423	48	1.01	-0.71	114.2	1.02	0.01	180.573	0.64	-10.08	4.713	1.21	0.01
SKM 1424	48.8	0.94	4.01**	113.8	1.00	5.06**	183.493	2.11	46.3*	4.44	0.9	0.03*
SKM 1428	50.733	0.95	-0.1	115.267	1.03	-0.5	183.753	1.81	65.9*	4.267	0.39*	0.04**
SKM 1305	50.267	1.02	2.63*	115.133	0.91	1.96*	181.373	0.86	22.13	4.107	1.03	0.07**
SKM 1331	50.533	0.86	2.1*	114.867	1.07	1.81*	183.353	1.68	86.86*	4.62	1.35*	-0.01
SKM 1219	52.533	1.09	-0.17	116.067	1.11	0.58	175.633	0.24	179.42**	4.167	0.93	0.04
NRCB 506 (C ₁)	49.6	1.04	4.09**	114.4	0.76	2.3**	189.14	0.44*	-16.15	4.52	0.89	0.01
KRANTI (C ₂)	48.867	0.91	0.27	113.933	0.92	2.97**	188.313	1.85*	-12.58	4.607	0.95	0.05**
GM-3 (C ₃)	50.667	1.18	2.98**	114.6	1.29*	0.27	187.78	1.04	-19.95	4.54	1.41	0.05**
GDM-4 (C ₄)	50.2	0.96	0.09	113.867	0.98	1.16	183.16	0.49	79.48**	4.44	1.35*	0.00
Population Mean		49.929		114.571			181.726			4.467		

bi *, ** = Regression coefficient significantly different from unity at P = 0.05 and P = 0.01, respectively.

 σ^2_{di} *, ** = Deviation from regression significantly different from zero at P = 0.05 and P = 0.01, respectively.



Table 2 cont.

Genotype	Seeds per siliquae			Test weight (g)			Number of siliquae per plant			Seed yield per plot		
	Mean	bi	σ^2_{di}	Mean	bi	σ^2_{di}	Mean	bi	σ^2_{di}	Mean	bi	σ^2_{di}
SKM 1403	12.80	0.96	0.05	4.325	0.99	0.07**	365.867	0.84	-1147.37	1.770	0.84	0.02*
SKM 1404	13.387	0.71	0.01	4.547	1.05	0.09**	352.200	1.11	2723.43	1.650	1.21	0.03*
SKM 1413	13.107	1.05	0.04	4.779	1.22*	0.02*	365.000	1.32	-1124.56	1.682	0.94	0.00
SKM 1414	12.86	1.06	0.19	4.195	0.92	0.08**	376.733	1.43	1661.44	1.717	1.79	0.03*
SKM 1423	13.46	0.50	1.11**	4.108	0.86	0.22**	358.467	1.04	-102.32	1.695	1.03	0.05**
SKM 1424	12.367	1.33	1.57**	4.46	1.08	0.04**	399.133	1.22	339.89	1.856	0.96	-0.01
SKM 1428	12.553	1.49	0.03	4.075	0.95	-0.01	318.867	0.67*	-1877.89	1.623	0.42	0.03*
SKM 1305	12.693	1.14	0.28*	4.381	1.13	0.01	372.533	1.04	-953.48	1.699	1.18	0.01
SKM 1331	13.02	0.85	1.50*	4.144	1.13	0.15**	318.800	0.31*	-858.48	1.601	1.02	0.05**
SKM 1219	12.753	0.95	-0.01	3.973	0.99	0.06**	337.200	0.78	-913.74	1.679	1.02	0.02
NRCHB 506 (C ₁)	13.053	1.33	0.69**	4.10	0.96	-0.01	360.933	0.96	-835.65	1.716	0.77	0.02
KRANTI (C ₂)	13.42	0.78	-0.03	3.601	0.78	0.09**	409.800	1.04	3734.46*	1.736	0.97	0.00
GM-3 (C ₃)	12.92	0.94	0.54**	4.125	1.01	0.05**	338.933	1.03	-1040.11	1.684	1.01	-0.01
GDM-4 (C ₄)	13.073	0.92	0.00	4.089	0.93	0.00	391.467	1.2	-1501.28	1.787	0.85	-0.01
Population Mean		12.962			4.207			361.852			1.707	

bi *, ** = Regression coefficient significantly different from unity at P = 0.05 and P = 0.01, respectively.

 σ^2_{di} *, ** = Deviation from regression significantly different from zero at P = 0.05 and P = 0.01, respectively.

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