Journal of Oilseed Brassica, 10 (1) : 33-37, January 2019

Phenotypic stability for seed yield and related traits in Trombay mustard genotypes under North western Himalayas

Vedna Kumari, S Jambhulkar*, HK Chaudhary, BK Sharma, P Sood, SK Guleria, A Bala and S Sanju

CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176062 India
**Bhabha Atomic Research Centre, Trombay, Mumbai-400085 India*
Corresponding author: drvedna@gmail.com
(Received: 28 July 2018; Revised: 16 October 2018; Accepted: 05 November 2018)

Abstract

The present study was conducted to evaluate different Trombay mustard genotypes for their stability in yield performance under varied agro-climatic conditions of the state. Five promising Trombay mustard genotypes viz., TM-136, TM-172, TM-204, TM-215 and TM-224 were evaluated along with three checks viz. Kranti, RL-1359 and RCC-4 under eleven environments spread over different agro-climatic zones of Himachal Pradesh during *Rabi* 2012-13 to 2015-16, for stability parameters with respect to four characters such as plant height (cm), number of siliquae per plant, maturity duration (days) and seed yield (kg/ha). Pooled analysis of variance for stability revealed significant differences among different genotypes for plant height, days to maturity and seed yield indicating that the genotypes selected possessed significant variation for these characters. Significant mean squares due to environments confirmed that the environments selected were variable in nature which influenced the expression of all the characters under study. Significant mean squares for genotype x environment (g x e) interaction revealed the differential response of Trombay mustard genotypes over environments for plant height, days to maturity and seed yield. The partitioning of environment + (genotype x environment) mean squares into different components revealed that the linear component of environment appeared to be highly significant for all the characters under study which indicated large macro-environmental differences in four years for these characters. All the eight genotypes were tested for three stability parameters viz. mean, bi and S^2di. Out of eight genotypes, only one genotype *viz.* TM-224 was identified to be stable for dwarf plant height. The genotypes such as TM-172, Kranti (national check) and RL-1359 (zonal check) exhibited higher siliquae per plant than the overall population mean and stability for this character. The two genotypes viz., TM-136 and Kranti exhibited stability for early maturity while none of the genotypes exhibited stability for seed yield across the varied environments. The check Kranti appeared to be average in performance and stability for seed yield though, the values were slightly lower than the population mean. Thus, these genotypes may be involved in breeding programme to develop high yielding and stable genotypes over different environments or could be recommended for cultivation across the environments.

Key words: *Trombay mustard, G x E interaction, seed yield, stability*

Introduction

Oilseed crops are the second most important contributing factor of agricultural economy being next only to cereals. In India, oilseeds contribute 3% and 10% to gross national products and value of all agricultural products with 14 and 1 million people involved in oilseed cultivation and processing, respectively (Anonyomus, 2015). India is the second largest rapeseed-mustard growing country after China and third in production after China and Canada. Rapeseed-mustard crops in India comprise traditionally grown indigenous species, namely Toria (*Brassica rapa* L. var. Toria), Brown Sarson (*B. rapa* L. var. Brown Sarson), Yellow Sarson (*B. rapa* L. var. Yellow Sarson), Indian mustard (*B. juncea*), black mustard (*B. nigra*) and Taramira (*Eruca sativa*), which have been grown since 3,500 BC along with non-traditional species like Gobhi Sarson (*B. napus*) and Ethiopian mustard/Karan rai (*B. carinata*). In India, rapeseed–mustard is grown in diverse agro-climatic conditions ranging from North-eastern/North-western hills to southern India under irrigated/rainfed, timely/late sown and sole/mixed cropping. Indian mustard accounts for about 75-80% of the 6.6 million hectare area under these crops in the country during 2013-14. In India, rapeseed-mustard is grown over an area of 6.6 million hectare with production of 7.9 million tonnes (Anonymous, 2014-15). Rajasthan is India's top rapeseed-mustard producing state followed by Madhya Pradesh and Haryana contributing about 48.12% of rapeseed-mustard production. In Himachal Pradesh, rapeseed-mustard is grown over an area of 11.37 thousand hectare with total production and productivity of 6.37 thousand tonnes and 590kg/ha, respectively (Anonymous, 2014). The average productivity in the state is much less than national and world average productivity. Climatic change may be the major cause for yield reduction in winter crops. The uncertainty of winter rainfall and inadequacy of irrigation resources are the limiting factors for rapeseed-mustard production in the state.

Therefore, it is essential to breed high yielding varieties which can perform consistently better under varied environmental conditions. Adaptation of a genotype to different environmental conditions is dependent upon its phenotypic stability. Since rapeseed-mustard yields are subjected to considerable environmental fluctuations, growing of its genotypes over years and situations should be an integral part of a plant breeding programme aimed at evolving widely adapted varieties. G x E interaction occurs widely in any breeding programme due to variation in environmental factors such as temperature, soil moisture, soil type and fertility level over the locations/years. A stable genotype is considered as the one that is capable of utilizing the resources available in high yielding environments and has above average performance in all environments (Eberhart and Russell, 1966; Allard and Bradshaw, 1964). Therefore, the present investigation was carried out to evaluate Trombay mustard genotypes for yield and its component characters under multi-environments to identify the most stable and widely adapted genotype for its use in future breeding programme.

Materials and Methods

The experimental material comprising eight diverse genotypes of Trombay mustard including three checks; Kranti, RCC-4 and RL-1359 were evaluated in randomized block design with three replications and spacing of 30 x 10 cm during *rabi* seasons of four consecutive years under eleven environments *viz*., 2012-13 (Kangra, Una and Akrot), 2013-14 (Sundernagar and Palampur), 2014-15 (Akrot, Palampur and Bajaura) and 2015-16 (Akrot, Palampur and Bajaura) spread over different agro-climatic zones of Himachal Pradesh. The sowing was completed during the second fortnight of October to first fortnight of November at all the locations during each year and recommended package of practices were followed to raise the crop.

Observations were recorded on five randomly selected plants from each genotype in each replication with respect to two characters such as plant height (cm) and number of siliquae per plant. The observations on days to 75% maturity and seed yield per hectare (kg/ha) were recorded on plot basis at appropriate stages of crop growth and harvest. The stability parameters for different characters were computed using the regression approach of Eberhart and Russell (1966).

Results and Discussion

The analysis of variance for pooled data revealed significant differences among different genotypes for plant height, days to 75% maturity and seed yield per hectare (kg/ha) indicating that the genotypes selected possessed significant variation for these characters (Table 1). Significant mean squares due to environments for all four characters confirmed that the environments selected were variable in nature which influenced the expression of characters under study. Significant mean squares for genotypes x environments (g x e) interactions revealed the differential response of Trombay mustard genotypes across the environments for plant height, siliquae per plant, days to 75% maturity and seed yield per hectare. Eberhart and Russell (1966) reported that both linear and non-linear components are important for

Table 1: Analysis of variance for seed yield and other components pooled over environments in Trombay mustard genotypes

Source of Variation	d. f.	Plant height (cm)	Siliquae per plant	Days to 75% maturity	Seed yield (kg/ha)
Genotypes	7	1701.39**	3596.59	16.51**	144956.71**
Environments	10	11083.26**	30253.84**	6670.34**	1241236.47**
Genotype x environments	70	211.61**	1978.49**	7.04**	62056.69**
Environments + (genotype x environment)	80	523.52**	1837.64**	279.98**	69818.05**
Environments (linear)	1	36944.19**	100846.13**	22234.46**	4137454.90**
Genotypes x environments (linear)	7	81.18	204.70	6.16**	26097.11
Pooled deviation	72	60.68*	621.28	1.68	17573.74
Pooled error	176	42.45	637.02	1.22	4505.17

*Significant at P≤0.05, **Significant at P≤0.01

Table 2: Stability parameters for seed yield and other components in Trombay mustard genotypes

Genotypes	Plant height (cm)			Siliquae per plant			Days to 75% maturity			Seed yield (kg/ha)		
	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d	Mean	bi	S^2d
TM-136	149.2	0.99	16.37	172.1	1.13	697.20*	157.1	1.04	-0.34	996.1	1.18	11799.72**
TM-172	153.3	1.05	-22.23	179.8	1.13	106.88	157.5	0.99	-0.83	1128.8	1.33	4604.49*
TM-204	146.8	1.20	70.92**	160.6	0.97	-317.18	158.5	0.98	-0.03	1000.2	1.13	14624.67**
TM-215	134.5	0.84	46.04*	163.8	0.79	-282.59	156.3	1.04	1.38*	949.0	1.01	15177.87**
TM-224	142.6	1.17	-10.23	158.8	0.93	-4.43	157.9	1.05	1.92*	920.5	0.64	10794.63**
Kranti	150.8	0.94	8.22	177.5	1.14	-44.37	156.5	1.00	0.50	1004.4	0.98	3386.67
RCC-4	155.7	0.85	61.32**	166.6	0.89	-170.33	157.1	0.90	1.25*	985.9	0.99	8912.73**
RL-1359	155.5	0.95	-24.51	188.7	1.02	-111.15	157.4	0.98	-0.16	1073.7	0.74	35247.83**
Population mean (µ)	148.6	-	-	171.0	-	-	157.3	-	-	1007.3	-	-

*Significant at $P \leq 0.05$, **Significant at $P \leq 0.01$

determining the differential genotypic response to different environmental conditions. The partitioning of environments + (genotypes x environments) mean squares into different components revealed that both linear and non-linear components played an important role in total genotypes x environments interaction for different characters. Significant variance due to the linear component of environments for all characters studied indicated the presence of large macro-environmental differences over four years and their predominant effects on these characters. This could be due to variations in weather and soil conditions over different locations. Significant variance due to genotype x environments (linear) for days to 75% maturity indicated the more predictability of performance of Trombay mustard genotypes and their linear response over the environments for this character. The importance of genotype x environment interaction has also been observed by Gunasekara *et al*. (2006) and Kumar *et al.*, (2012) in Indian mustard and canola (*B. napus*) for seed yield. Their study further revealed that mustard was generally more adapted to low rainfall and high temperature environments than canola types. Sufficient genotype x environment interaction for seed yield and its components was also observed by Mahto and Haider (2000) and Dhillon *et al*. (2001) in Indian mustard and Kumari *et al*. (2010) in Ethiopian mustard. Similar results have been reported by Chauhan *et al*. (2010), Patel and Arha (2012), Muralia *et al*. (2013), Bibi *et al*. (2016) and Priyamedha *et al*. (2017) in Indian mustard. Significant pooled deviation (non-linear component) for plant height suggested that the deviation from linear regression also contributed substantially towards the differences in stability of genotypes thereby indicating difficulty in predicting the performance of genotypes over environments for this character.

According to Eberhart and Russell model (1966), an ideal genotype may be characterized as having high mean performance with unit regression coefficient (b=1) and minimum (non-significant) deviation from regression ($s^2di=0$). Accordingly, the mean and deviation from regression (s^2di) are considered as measures of stability and linear regression (bi) is used for evaluating the genotypic response. The genotypes possessing regression values above 1.0 (b>1) will have below average stability and such genotypes will be highly sensitive to environmental changes and suitable only for high yielding environments. Regression coefficient below 1.0 (b<1) will categorize the genotypes having above average stability and such genotypes will show resistance to environmental changes and suitable for growing in low yielding environments only.

The stability parameters were worked out for all characters *viz*., plant height, siliquae per plant, days to 75% maturity and seed yield per hectare as genotype x environment interactions were significant for these characters. Based on stability parameters (Table 2), two genotype *viz*. TM-172 and RL-1359 in order of their merit, exhibited higher seed yield than population mean and were average in their performance. However, none of these were stable as their deviations from regression (S^2di) were significant. Only one genotype Kranti (national check) having unit regression and non-significant deviation from regression, could be considered a stable genotype over years though, exhibited slightly lower yield than the population mean. For plant height, three genotypes *viz*., TM-215, TM-224 and TM-204 in order of their merit, exhibited dwarf plant height and average performance over years but, only the genotype TM-224 was identified to be stable for this character. Three genotypes; RL-1359, TM-172 and Kranti in order of their merit, exhibited higher siliquae per plant than population mean with unit regression and non-significant deviations from regression and hence, stability for this character. The two out of four genotypes; Kranti and TM-136 in order of their merit, exhibited average performance and stability for earliness over the years. As evident from the study, the stability for seed yield may not necessarily be associated with stability of other yield components. The results are in agreement with the findings of Patel *et al*. (1997), Kumar *et al*. (2012), Bibi *et al*. (2016) and Priyamedha *et al.* (2017) in Indian mustard and Kumari *et al*. (2010) in Ethiopian mustard.

Conclusion

Based on the results, it appeared that no genotype could be found stable simultaneously for all characters across the locations. Each genotype was stable for one or the other yield component. Thus, it is concluded that while selecting for stability in yield, various yield components should also be taken into account. In the present investigation, only one genotype Kranti having average stability with similar mean performance could be considered an ideal genotype for seed yield per hectare. Three genotypes; RL-1359, TM-172 and Kranti were observed to be ideal genotypes for siliquae per plant. Two genotypes; Kranti and TM-136 exhibited average performance and stability for earliness over the years. Thus, these desirable genotypes can be involved in breeding programme to develop high yielding and stable genotypes having wider adaptability for different sowing times or could be recommended for cultivation across the environments.

Acknowledgement

The senior author is grateful to Bhabha Atomic Research Centre (BARC), Trombay, Mumbai for providing financial assistance in the form of an ad-hoc research project for the present study.

References

Allard RW and Bradshaw AD. 1964. Implications of genotype-environmental interactions in applied plant breeding. *Crop Sci* **4**: 503–508.

Anonymous. 2014. Statistical Outline of Himachal Pradesh. Department of Economics and Statistics, Govt. of Himachal Pradesh, India.

Anonymous. 2014-15. http://faostat3.fao.org. [9th February, 2017] FAO Production year book, Rome, Italy: FAOSTAT.

Anonymous. 2015. Vision 2050. Directorate of Rapeseed-Mustard Research. Indian Council of Agricultural Research, New Delhi. p.1.

Bibi T, Rauf S, Mustafa HSB, Mahmood T and Salah-ud-Din. 2016. Selection of stable mustard (*B. juncea* L.) genotypes through genotype × environment interaction and stability analysis suitable for Punjab, Pakistan. *J Agric and Basic Sci* **1**: 14-17.

Chauhan JS, Meena SS, Singh M and Singh KH. 2010. Estimating genotype x environment interaction and stability parameters for oil and seed meal quality, seed yield and its contributing characters in Indian mustard [*B. juncea* (L.) Czern & Coss.]. *Indian J Agric Sci* **80**: 172-180.

Dhillon SS, Brar KS, Singh K and Raheja RK. 2001. G x E interaction and stability of elite strains in Indian mustard. *Crop Improv* **28**: 89-94.

Eberhart SA and Russell WA. 1966. Stability parameters for comparing varieties. *Crop Sci* **6**:36-40.

Gunasekera CP, Martin LD, Siddique KHM and Walton GH. 2006. Genotype x environment interaction of Indian mustard (*B. juncea* L.) and canola (*B. napus* L.) in Mediterranean-type environments. 1. Crop growth and seed yield. *Eur J Agron* **25**:1-12.

Kumar A, Sah RP, Haider ZA, Ghosh J, Kumar R, Mahato CS, Lakara RK, Akhatar J and Kumar R. 2012. G x E interaction for seed yield and its components in Indian mustard. Proceedings of 1st National Brassica Conference on production barriers and technological options in oilseed brassica held at CCS Haryana Agricultural University, Hisar, p.56.

Kumari V, Sood BC, Kalia R and Jai Dev. 2010. Phenotypic stability for seed yield and component characters in Ethiopian mustard (*B. carinata* A. Braun). *Crop Res* **39**: 103-106.

Mahto JL and Haider ZA. 2000. Stability and environment interaction in Indian mustard (*B. juncea* L.) at higher altitude. *Indian J Agric Sci* **70**: 554-558.

Muralia S, Sharma LK, and Kulkarni GU. 2013. Phenotypic stability for seed yield in Indian mustard (*B. juncea* L.). *Prog Res* **8**: 248-250.

Patel KM, Raika BR and Sharma GS. 1997. Phenotypic stability of performance in Indian mustard. *J Oilseeds Res* **14**: 88-92.

Patel AM and Arha MD. 2012. Genotype x environment interactions and stability parameters in Indian mustard (*B. juncea*). Proceedings of 1st National Brassica Conference on production barriers and technological options in oilseed brassica held at CCS Haryana Agricultural University, Hisar, p53.

Priyamedha, Kumar A and Haider ZA. 2017. Stability for seed yield and components traits in Indian mustard (*B. juncea* L.) under Jharkhand conditions. *J Oilseed Brassica* **8**: 37-42.