Journal of Oilseed Brassica, 8 (1) : 37-42, January 2017

Stability for seed yield and component traits in Indian mustard (*Brassica juncea* L.) under Jharkhand condition

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(*Received: 20 June 2016; Revised: 17 July 2016; Accepted: 26 July 2016*)

Abstract

Fifty three genotypes of *Indian mustard [Brassica juncea* (L.) Czern & Coss.] consisting of 13 parents and 40 crosses were sown during *Rabi* 2014-15 under three different dates of sowing *i.e.* 21st October, 06th November and 21st November, with objective to test genotype-environmental (G X E) interaction and phenotypic stability for seed yield and its component traits. The experiment was laid out in randomized complete block design replicated two times. Timely sown (21st October) genotypes showed higher mean for seed yield/plant while late sown (21st November) genotypes showed lower mean due to forced maturity. Sufficient G X E interaction was exhibited by the genotypes for all the characters. All 53 genotypes were tested for 3 stability parameters, *viz*. mean, bi and $S^2_{di.}$ The environment (linear) was highly significant for all the characters, while the linear component of G X E interaction was highly significant for days to maturity only. Pooled deviation differed significantly for plant height, number of siliquae on main shoot, number of seeds/siliqua, total number of siliqua/plant, 1000-seed weight, days to maturity and seed yield/plant, suggesting the genotypes had varying level of stability over the sowing times for these characters. The parents *viz*. NRCDR-02, Pusa Bold and BPR 543-2 as well as the crosses *viz*. Pusa Bold x Pusa Mustard-21, Pusa Bold x RGN-73, Pusa Bold x JN032, Shivani x Heera and Shivani x BPR 543-2 exhibited high mean and showed stable performance for seed yield/plant. Stability parameters indicated that BAUSM-92-1-1 (1000-seed weight and days to maturity), Pusa Bold (seed yield/plant and days to maturity) and BAUM-2007 x JN-032 (total number of siliqua/plant and number of seeds/siliqua) were fairly stable across the environments. These genotypes can be utilized to develop stable strains having wider adaptability for different sowing times.

Key words: *Indian mustard, G X E interaction, seed yield*

Introduction

Rapeseed-mustard (*Brassica* spp) is the second largest oilseed crop in India after soybean, comprising eight cultivated crops of tribe Brassiceae within the family Brassicaceae. Among all the cultivated species, Indian mustard accounts for about 75–80% of the total area and production under rapeseed – mustard crops and nearly 30% of the total oilseeds and 27% to edible oil pool of the country (Sutariya *et al*., 2011). It is because of its wider adaptability and comparative tolerance to biotic and abiotic stresses as compared to other *Brassica* species grown as oilseeds. In India, this crop is grown in diverse agroclimatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed, timely/late-sown, saline soils and mixed cropping. The major mustard producing states include Rajasthan, Uttar Pradesh and Haryana. Indian mustard is cultivated in the area of 6.5 million ha with 8.02 million tones of production and 1262 kg/ha productivity respectively (AICRP-RM 2013). However, production of rapeseed-mustard in Jharkhand is far below the national average. As against national productivity of 1262 kg/ha, the productivity of rapeseed-mustard in Jharkhand had been 690 kg/ha in the year 2013-14 (www.nmoop.gov.in). This poor productivity or yield loss to the tune of 30-40 percent is linked to several biotic and abiotic stresses and poor management mainly due to delayed sowing of the crop. This may be due to lack of time left after harvesting of long-duration rice varieties. Under such a situation, it becomes imperative to identify genotypes which can show a stable performance over different dates of sowing. The genotype x environment interaction as described by the Allard and Bradshaw in 1964 is very important in the development and evaluation of genotypes, since diverse environments can reduce the stability of genotypes (Eberhart and Russell, 1966). The stability is the consistency in performance of genotypes over wide range of environment (Singh and Chaudhary, 1985). Only stable genotypes can guarantee a good yield with decreased risk of losing production and allow the plant breeders to make general recommendations for a range of environments. Keeping these facts in view, the present investigation was carried out by taking different released varieties as well as registered germplasms and their crosses developed in line x tester design, to test stability over the three environments created by changing the dates of sowing through genotype x environment interaction to identify high yielding and stable genotypes.

Materials and Methods

The experiment was carried out during *Rabi* 2014-15 at Crop Research Centre of Birsa Agricultural University, Ranchi, under three environments created by changing the dates of sowing *i.e.* 21st October, 06th November and 21st November. The material for present study consisted of 53 genotypes of *B. juncea* having 8 lines (NRCHB-101, NRCDR-02, Kranti, Pusa Bold, Shivani, Pusa Mustard-25, BAUSM-92-1-1 and BAUM 2007), 5 testers (Pusa Mustard-21, Heera, JN032, RGN -73 and BPR 543-2) and their 40 crosses developed in line x tester design. The trial was laid out in randomized complete block design with 2 replications in single row of 3 meter length. The row to row and plant to plant distances were kept 30 cm and 10 cm, respectively. All the recommended cultural practices were adopted to raise a good crop. The data was recorded on 8 characters *viz.* plant height (cm), main shoot length (cm), number of siliquae on main shoot, number of seeds/siliqua, total number of siliqua/plant, 1000-seed weight (g), days to maturity and seed yield/plant (g). Except for days to maturity, where data was recorded on row basis, the data on other morphological characters was recorded on randomly selected five competitive plants from each of the two replications. The mean values of 5 samples, except for characters recorded on row basis, were used for detailed statistical analysis. The data were subjected to analysis of variance as per the procedure suggested by Panse and Sukhatme (1978) for randomized complete block design. Genotype-environment interactions were found to be significant in respect of all the characters studied, hence the data were subjected to stability analysis (Eberhart and Russel, 1966) to assess the stability of different genotypes. A genotype with higher mean value than population mean except for plant height and days to maturity, where the genotypes having mean value lower to population mean was considered, were coupled with regression coefficient (bi) equal or close to unity and the deviation (S^2_{di}) not significantly different from zero was taken to be a stable genotype.

Results and Discussion

Breeding and development of superior genotypes with wide adaptability has long been universal goal among the plant breeders. To achieve this goal, growing breeding line over time and space has become an integral part of any plant breeding programme. Thirteen parents and their 40 F_1's tested in three environments (created by changing dates of sowing), were subjected to stability analysis for eight characters *viz.* plant height, main shoot length, number of siliquae on main shoot, number of seeds/siliqua, total number of siliqua/plant, 1000 seed weight, days to maturity and seed yield/plant as per stability model given by Eberhart and Russell (1966).

Analysis of variance (ANOVA)

For each environment, analysis of variance on 8 characters was carried out individually as well as pooled over the environments. The pooled analysis of variance revealed significant differences amongst genotypes for all the observed characters in each of the 3 environments (Table 1). Pooled analysis of variance for genotype x environment interaction indicated highly significant difference for genotype, environment and genotype x environment for all the characters studied. This revealed significant variation among genotypes and among environments.

Table 1: Pooled ANOVA showing G x E interaction for seed yield and attributing traits

Sources	D.F.	Plant height (cm)	Main shoot length (cm)	Number of siliquae on main shoot	Number of seeds /siliqua	Total number of siliqua /plant	1000 seed weight (g)	Days to maturity	Seed yield /plant (g)
Genotypes	52	317.40**	90.73**	97.22**	0.63**	2318.02**	0.94**	10.70**	1.75
Env.+(Gen.xEnv.)	106	81.76	29.57	41.41	0.44*	872.82	0.25**	65.98**	1.81*
Environments	2	434.20**	86.71	658.54**	8.54**	6878.52**	5.38**	3299.72**	35.93**
Gen. x Env.	104	74.98**	28.47	29.55	0.29**	757.33**	0.15**	3.79**	1.16**
Environments (Lin.)	1	868.40**	173.42*	1317.08**	17.09**	13757.04**	10.76**	6599.45**	71.87**
Gen. x Env.(Lin.)	52	76.67	27.02	16.24	0.29	600.64	0.17	5.82**	1.15
Pooled Deviation	53	71.91*	29.35	42.05**	0.28*	896.77**	0.12**	1.73**	1.14**
Pooled Error	156	47.82	26.10	18.22	0.17	312.34	0.01	0.79	0.45
Total	158	159.31	49.70	59.78	0.51	1348.46	0.47	47.79	1.79

* and ** Significant at P = 0.05 and P = 0.01, respectively.

Significant differences observed among the environments indicated significant effect of environment was there in the expression of the traits. Similar findings have been reported by Dhillon *et al.* (1999) and Brar *et al.* (2007), which confirm the findings of present investigation. The G x E interaction and environment (linear) components were highly significant for all the characters. This suggested that performance of genotypes over environments could be predicted reasonably for these traits. Significant G x E (linear) for different traits have also been reported by Chaudhary *et al.* (2004) and Yadava *et al.* (2010) which supported our findings. The mean sum of square due to pooled deviations were found to be significant for all of the traits except main shoot length, which suggested that prediction of genotypes over environments based on regression analysis for these traits might not be very reliable and similar findings have also been reported by Chattopadhyay *et al.* (2012) and Sah *et al.* (2015).

Stability Parameters

In the present study, genotypes were tested for 3 parameters of stability for all the observed characters. In order to classify the genotypes into various categories with respect to stability and suitability for particular environments, all 53 genotypes were tested for 3 stability parameters, *viz.* mean, bi and S^2_{di}. The genotypes showing superiority and stability for different traits have been summarized in Table 2. The genotype, 'Pusa Bold' besides having stable and high performance for seed yield/plant, was also having stable performance for days to maturity. Likewise, 'BAUSM-92-1-1' has stable and high performance for plant height and days to maturity. In addition to superiority and stability for number of siliquae on main shoot, 'BAUM-2007' also showed stability for 1000-seed weight. Similarly, 'Kranti' was having superior performance for main shoot length and total number of siliqua/plant. Genotypes, NRCHB 101 showed stable and superior performance for main shoot length. Similarly, 'BPR 543-2' and 'NRCDR-02' showed superiority and stability for seed yield/plant. The genotypes, 'Shivani' and 'Pusa Mustard-21'were showing superior as well as stable performance for number of seeds/siliqua and 1000-seed weight respectively. Likewise, 'JN032' and 'RGN-73' showed superiority and stability for number of siliquae on main shoot and days to maturity. Dhillon *et al.* (1999), Ali *et al.* (2002), Brar *et al.* (2007), Ali *et al.* (2009), Yadava *et al*. (2010) and Sah *et al.* (2015) have also reported stability of the genotypes over environments, that can be used successfully for developing stable strains having wider adaptability.

The hybrids showing superior performance over the population mean and stability for seed yield/plant were, Pusa Bold x Pusa Mustard-21, Pusa Bold x RGN-73, Pusa Bold x JN-032, Shivani x Heera,

Table 2: Genotypes of Indian mustard showing stability for various characters (Eberhart and Russell 1966)

Genotypes	Traits for which genotypes showed superiority and stability on the basis of 3 parameters of stability
NRCHB-101	Seed yield/plant, Main shoot length
NRCDR-02	Seed yield/plant, 1000 – seed weight
PUSA BOLD	Seed yield/plant, Days to maturity
SHIVANI	Number of seeds/siliqua
KRANTI	Days to maturity, Main shoot length, Total number of siliqua/plant
BAUSM-92-1-1	Days to maturity, 1000 – seed weight
BAUM-2007	1000 – seed weight
PUSA M-21	1000 – seed weight
RGN-73	Days to maturity, Number of seeds/siliqua
BPR 543-2	Seed yield/plant
JN 032 (T5)	Number of seeds/siliqua
NRCHB-101 x PUSA M-21	Days to maturity
NRCHB-101 x HEERA	Main shoot length, Number of siliquae on main shoot
NRCHB-101 x RGN-73	Days to maturity
NRCHB-101 x BPR 543-2	1000 – seed weight, Number of seeds/siliqua
NRCHB-101 x JN-032	Days to maturity, Number of seeds/siliqua
NRCDR-02 x PUSA M-21	Days to maturity, 1000 – seed weight
NRCDR-02 x HEERA	Number of seeds/siliqua, Main shoot length, Number of siliquae on main shoot
NRCDR-02 x RGN-73	Number of seeds/siliqua
NRCDR-02 x BPR 543-2	Number of seeds/siliqua
NRCDR-02 x JN-032	Days to maturity
PUSA BOLD x PUSA M-21	Seed yield/plant, Total number of siliqua/plant, Number of seeds/siliqua
PUSA BOLD x HEERA	Main shoot length, Number of siliquae on main shoot
PUSA BOLD x RGN-73	Seed yield/plant, Number of siliquae on main shoot
PUSA BOLD x BPR 543-2	Days to maturity, Number of seeds/siliqua
PUSA BOLD x JN-032	Seed yield/plant
SHIVANI x PUSA M-21	Days to maturity,
SHIVANI x HEERA	Seed yield/plant, Days to maturity, Number of siliquae on main shoot
SHIVANI x RGN-73	Number of seeds/siliqua, Number of siliquae on main shoot
SHIVANI x BPR 543-2	Seed yield/plant, Days to maturity, 1000 – seed weight, Number of seeds/siliqua, Number of siliquae on main shoot
SHIVANI x JN-032	Days to maturity, Number of siliquae on main shoot
PUSA M-25 x PUSA M-21	Days to maturity, Number of seeds/siliqua
PUSA M-25 x HEERA	Seed yield/plant, Days to maturity
PUSA M-25 x BPR 543-2	Days to maturity, Number of seeds/siliqua
PUSA M-25 x JN-032	Number of seeds/siliqua, Plant height
KRANTI x PUSA M-21	Days to maturity, Number of seeds/siliqua
KRANTI x HEERA	Days to maturity, Number of seeds/siliqua, Number of siliquae on main shoot
KRANTI x RGN-73	Days to maturity, Number of seeds/siliqua, Number of siliquae on main shoot
KRANTI x JN-032	Days to maturity, Plant height , Main shoot length
BAUSM92-1-1 x PUSA M-21	Number of seeds/siliqua

BAUSM-92-1-1 x HEERA	Days to maturity
BAUSM-92-1-1 x RGN-73	Seed yield/plant, Total number of siliqua/plant, Number of siliquae on main shoot
BAUSM-92-1-1 x BPR 543-2	Days to maturity, Main shoot length
BAUSM-92-1-1 x JN-032	1000 – seed weight,
BAUM-2007 x PUSA M-21	Days to maturity, Number of seeds/siliqua, Main shoot length, Number of siliquae on main shoot
BAUM-2007 x RGN-73	Number of seeds/siliqua, Number of siliquae on main shoot
BAUM-2007 x BPR 543-2	Days to maturity, Plant height, Main shoot length
BAUM-2007 x JN-032	Total number of siliqua/plant, Number of seeds/siliqua

Shivani x BPR 543-2, Pusa Mustard-25 x Heera and BAUSM-92-1-1 x RGN-73. For plant height only three hybrids *viz*. Pusa Mustard-25 x JN-032, Kranti x JN-032 and BAUM-2007 x BPR 543-2 showed mean lower than population mean along with stability over the environments. The hybrids, NRCDR-02 x Heera, Shivani x RGN-73, Shivani x BPR 543-2, Kranti x Heera, Kranti x RGN-73, BAUM-2007 x Pusa Mustard-21and BAUM-2007 x RGN-73 showed stability and superior performance for number of siliquae on main shoot and number of seeds/siliqua. For 1000-seed weight four hybrids *viz.* NRCHB101 x BPR 543-2, NRCDR-02 x Pusa Mustard-21, Shivani x BPR 543-2 and BAUSM-92-1-1 x JN-032 showed high mean and stability over the environments. The hybrids showing stability and superior performance for total number of siliqua/ plant included Pusa Bold x Pusa Mustard-21, BAUSM-92-1-1 x RGN-73 and BAUM-2007 x JN-032. For main shoot length the hybrids *viz*. NRCHB101 x Heera, Pusa Bold x Heera, Kranti x JN-032, BAUSM-92-1-1 x BPR 543-2, BAUM-2007 x Pusa Mustard-21 and BAUM-2007 x BPR 543-2 showed stability and superior performance. A total of eighteen hybrids showed maturity earlier than the average days of maturity and stability over the environments. These results are in agreement with those of Badwal and Labana (1989) and Mahto and Haider (2012), where various F_1 hybrids are showing stability for 1 or more characters and that can be used as stable and desirable crosses.

Conclusion

The genotypes; NRCHB 101, NRCDR-02, Pusa Bold, Kranti, BAUSM 92-1-1, NRCDR-02 x Heera, Pusa Bold x Pusa Mustard-21, Shivani x Heera, Shivani x BPR 543-2, Kranti x Heera, Kranti x RGN-73, BAUSM-92-1-1 x RGN-73 and BAUM-2007 x Pusa Mustard-21exhibited higher mean and showed stable performance over environments for most of the yield components as well as for seed yield/ plant. Thus, these genotypes can be utilized to develop stable strains having wider adaptability for different sowing times.

Acknowledgement

The authors are grateful to the Director, ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur (Rajasthan), India for providing seeds of some of the genotypes under study.

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