STABILITY ANALYSIS FOR GRAIN YIELD AND IT'S CONTRIBUTING TRAITS IN BREAD WHEAT (*TRITICUM AESTIVUM* L.)

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Abstract: The present investigation carried out by to assess the phenotypic stability for grain yield and its contributing traits under three varied environmental conditions using 10 diverse wheat genotypes and 45 F_1S. The mean sum of squares due to genotypes and environments were found to be significant for all the characters, indicating differential effect of environment on the genotypes. G x E interaction was found significant for all the characters except spike length and biological yield per plant. Similarly the pooled analysis of variance showed that the mean squares due to E + (G x E) interaction was partitioned into G x E (linear) and pooled deviation (nonlinear components). Mean sum of squares due to G x E (linear) component and pooled deviation (nonlinear component) was significant for all the characters. The genotypes Raj 3765, Raj 3777, Raj 4238 x WH 1021, Raj 3077 x Raj 3777 had higher yield and were suitable for variable environmental conditions. These genotypes could be utilized as a donor in routine breeding programme to improve grain yield and its contributing traits in bread wheat.

Keywords: Bread wheat, Stability, Grain yield, Genotype x environment interactions

INTRODUCTION

Bread wheat (*Triticum aestium* L.) has covered the most cultivation area and its product is the most widely used products in the world and of primary importance for human nutrition. It is a mandatory food crop and provides as a staple food in different parts of the world. It is a major food grain in India after rice, therefore the primary objective of wheat specialists is to increase the grain yield. Wheat genotypes identification with varied adaptation to dissimilar conditions, multi-location, results in the empirical identification of superior varieties. The adaptability of a variety over diverse environments is usually tested by the degree of its interaction with different environments under which it is grown. A variety or genotype is considered to be more adaptive or stable one, if it has a high mean yield but low degree of fluctuation in yielding ability, when grown over diverse environments. According to Eberhart and Russell (1966) a stable variety should have around unit regression coefficient over environments ($b_i \approx 1$) and minimum deviation from the regression ($S^2 d_i = 0$) in addition to higher seed yield than population mean. The objectives of this study were to identify bread wheat genotypes that have both high mean yield and stable yield performance across different environments and to study the similarities, relationships and dissimilarities among yield - stability statistics carried out to quantify GE interaction effects on yield and to determine stable entries within the genotypic pool used in this study.

MATERIALS AND METHODS

Crosses among the ten genotypes were made in diallel fashion excluding reciprocals, during *Rabi* season 2016-17. A number of plants were randomly selected in a parent crossed with a number of randomly selected plants from other parent. In *Rabi* 2017-18 ten genotypes along with their 45 F_1's progenies were evaluated in three environments created three different dates of sowing 15 Nov. (timely sown), 1 Dec. (late sown) and 15 Dec. (very late sown) with 3 replications at Research Farm, College of Agriculture, Bikaner. Row length was kept 4 meter and plant geometry (Row to row and plant to plant distance) was 22.5 cm and 10 cm, respectively. Stability parameters for grain yield and its contributing traits were worked out as per procedure suggested by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The genotype × environment (GE) interaction is a major challenge to plant breeders. Many stability parameters for genotypes grown in different environments were developed for this purpose and each has its advantages and limitations. In various methods, GE interactions are used to characterize the response of genotypes to changing environments along with mean grain yields. Accordingly, genotypes with a minimal variance for yield across environments were considered stable (Mohammadi, 2012). Improving yield and yield stability is the principal objective of wheat breeding programs (Ram *et al.*, 2007). To study of wheat genotypes with wide

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or specific adaptation to different environments, trails are grown at three different date of sowing. These have resulted to empirical identification of superior cultivars, some of which have been released in several countries (Basford *et al.*, 2004). The environments involve a wide range of photoperiods and temperatures which could cause large genotype (G) × environment (E) interactions (GEI), specifically in the semi-arid regions. Large crossover-type GEI, especially among high yielding lines gives incorrect suggestions to farmers across the all test environments. Quantification of GEI and comprehension its physiological bases are needed to breed effectively for superior environments (Thomason and Phillips, 2006). Most yield trails are used only to determine which cultivars give the highest average grain yield and therefore valuable recommendation for planting by farmers. Understanding the structure and nature of GEI is important in plant breeding programs because a significant GEI can seriously impair efforts in selecting superior genotypes relative to new crop introductions and cultivar improvement programs (Shafii and Price, 1998).The detect of GEI in trials has led to the development of procedures that are generically called stability analyses. The available numerous stability statistics to breeders and to the production agronomist provide different strategies and approaches of dealing with GEI. Stability is an important concept for plant breeders interested in analysing GEI data (Denis *et al.*, 1996; Ayed *et al.*, 2016).

Analysis of variance for stability for grain yield and its contributing characters in bread wheat were shown in Table 1. The pooled analysis of variance across the environments revealed significant differences among genotypes and environments for grain yield, indicating differential effect of environment on the genotypes. The mean sum of squares due to G x E interaction was found significant for all the characters except spike length and biological yield per plant. Similar findings were also reported by Sharma *et al.* (2003), Arya *et al.* (2004), Jeena *et al.* (2005), Banerjee *et al.* (2006), Singh and Chaudhary (2007), Arain *et al.* (2011), Mohammadi *et al.* (2012), Saleem *et al.* (2015) and Bavandpori *et al.* (2018). The mean sum of squares due to E + (G x E) was also found significantly for all the characters. Similarly the pooled analysis of variance showed that the mean squares due to E + (G x E) interaction was partitioned into G x E (linear) and pooled deviation (nonlinear components). Mean sum of squares due to G x E (linear) component and pooled deviation (nonlinear component) were significant for all the characters which indicated that prediction across the environments was possible for all characters. Similar results were also reported by Ashraf *et al.* (2001), Madariya *et al.* (2001), Khumkar *et al.* (2001), Singh *et al.* (2002), Sharma *et al.* (2003), Arya *et al.* (2004), Najeeb *et al.* (2004),

Jeena *et al.* (2005), Singh and Chaudhary (2007) and Patel *et al.* (2014).

Among the crosses, three best stable crosses for various environments conditions were presented in Table 2. The joint consideration of mean performance of genotypes across the environments and stability parameters revealed that out of 45 genotypes, genotypes namely Raj 1482 x Raj 3777, Raj 4238 x WH 1021 and Raj 3765 x DBW 90 were suitable for harsh environment (mean<population mean, $b_i<1$ and $S^2d_i=0$) while the genotypes Raj 3077 x DBW 90, Raj 1482 x DBW 90 and Raj 3765 x PBW 550 were most suitable for early flowering in average environment (mean<population mean, $b_i=1$ and $S^2d_i=0$). The present finding supported the results obtained by Badhe *et al.* (1998) and Meena *et al.* (2014). For days to maturity the cross combinations Raj 4079 x Raj 3765 and Raj 4079 x Raj 3777 were predictable for better environment. Among 45 genotypes, genotypes namely Raj 4079 x Raj 1482, Raj 3077 x Raj 3777 and Raj 4079 x DBW 90 were suitable for poor environments (mean<population mean, $b_i<1$ and $S^2d_i=0$) while the crosses Raj 3777 x HD 3086, PBW 550 x HD 3086 and Raj 3077 x WH 1021 were most stable and desirable for early maturity. The present finding supported the results obtained by Badhe *et al.* (1998) and Meena *et al.* (2014). Late season heat stress, often occurring during the last phases of spring wheat development, (booting, heading, anthesis and grain filling period) is considered as one of the major environmental limiting factors that drastically reduces grain number per spike, grain weight and final grain yield throughout most of the bread wheat growing areas in the region and other warm and dry regions [Modhej *et al.*, (2008) and Mohammadi *et al.* (2012)]. The crosses WH 1021 x PBW 550, Raj 1482 x Raj 3777 and Raj 3765 x HD 3086 were suitable for rich environment conditions while the crosses namely Raj 1482 x WH 1021 and Raj 4238 x WH 1021 were suitable for varying environment conditions. Taller plants are more likely to lodge quite often. Short stature in wheat is preferred. In the present study, cross combinations Raj 4079 x HD 3086, Raj 3777 x WH 1021 and Raj 3765 x DBW 90 were considered for poor environments (mean<population mean, $b_i<1$ and $S^2d_i=0$). While the crosses namely Raj 3765 x PBW 550 and Raj 3777 x PBW 550 (mean<population mean, $b_i=1$ and $S^2d_i=0$) were considered stable for average environments. Significant GE interaction for plant height was also reported by Sakin *et al.* (2011). Number of effective tillers per plant is important character from the point of view of straw and grain yield, respectively. In the current study, crosses Raj 3765 x Raj 3077, Raj 4079 x Raj 3077 and Raj 1482 x WH 1021 were considered for poor environments (mean>population mean, $b_i<1$ and $S^2d_i=0$). While the crosses namely Raj 4238 x WH 1021, DBW 90 x PBW 550 and Raj 4079 x Raj 3765 were best suited for average

environments. These results are also similar with the earlier findings of Jaydeep *et al.* (2006). For test weight, the crosses WH 1021 x PBW 550, DBW 90 x PBW 550 and Raj 3777 x HD 3086 were recognized for late sown while the crosses Raj 4238 x WH 1021, Raj 4079 x PBW 550 and Raj 4238 x DBW 90 were responsive for timely sown conditions. The crosses like Raj 3765 x Raj 3077, Raj 3077 x Raj 1482 and Raj 4079 x Raj 3077 were found desirable for wide range of environments.

Meena *et al.* (2014) and Kumar *et al.* (2014) also identified some wheat genotypes which give stable performance for 1000-grains weight across the environment. For flag leaf area, number of grains per spike and harvest index G x E interaction was significant. Similar findings were also reported by Banerjee *et al.* (2006), Singh and Chaudhary (2007), Mohammadi *et al.* (2012), Singh *et al.* (2017) and Bavandpori *et al.* (2018).

Table 1. Analysis of variance for stability for grain yield and its contributing characters in bread wheat

Source	df	Days to Heading	Days to Maturity	Grain filling period	Plant Height	Flag leaf area (cm^2)	Number of effective tillers per plant	Spike Length (cm)	Number of grains per spike	1000-Seed weight (g)	Biological yield per plant (g)	Harvest Index (%)	Grain yield per plant (g)
Repl./Env.	6	1.02	0.85	2.16	4.56	0.83	0.26	1.3	2.91	4.32	13.79*	1.34	1.37
Genotypes	54	15.09**	19.41**	29.99**	44.38**	10.61**	4.11**	5.04**	69.23**	32.5**	124.87**	62.64**	40.94**
Environment	2	2243.58**	8626.69**	2071.61**	3758.03**	896.34**	40.07**	74.17**	1561.85**	1520.68**	1814.14**	798.39**	727.13**
G x E	108	3.03**	6.91**	9.67**	7.54**	4.46**	0.17**	0.3	3.28**	3.22**	2.06	7.69**	1.7**
Env. + (G x E)	110	43.77**	163.64**	47.16**	75.73**	20.68**	0.9**	1.64**	31.62**	30.81**	35.01**	22.07**	14.89**
Env. (linear)	1	4487.17**	17253.39**	4143.21**	7516.06**	1792.68**	80.14**	148.34**	3123.7**	3041.35**	3628.27**	1596.79**	1454.25**
G x E (linear)	54	4.49**	10.4**	14.72**	12.88**	6.41**	0.23**	0.27	4.64**	4.23**	2.93**	12.34**	2.64**
Pooled deviations	55	1.55**	3.36**	4.53**	2.17**	2.46**	0.11*	0.32*	1.89**	2.17**	1.16**	2.99**	0.76**
Pooled error	324	0.71	0.76	1.28	1.32	1.47	0.11	0.36	0.95	2.04	4	2	0.47
Total	1136	11.54	39.03	13.95	21.98	5.84	0.66	0.93	14.79	10.54	21.71	11.91	7.89

Table 2. Best stable crosses for different environments (Ranked on the basis of means)

Characters	Better environment	Poor environment	Average environment
Days to heading	1. Raj 4079 x Raj 3765 2. Raj 4079 x Raj 3777	1. Raj 1482 x Raj 3777 2. Raj 4238 x WH 1021 3. Raj 3765 x DBW 90	1. Raj 3077 x DBW 90 2. Raj 1482 x DBW 90 3. Raj 3765 x PBW 550
Days to maturity	1. Raj 3777 x HD 3086 2. PBW 550 x HD 3086 3. Raj 3077 x WH 1021	1. Raj 4079 x Raj 1482 2. Raj 3077 x Raj 3777 3. Raj 4079 x DBW 90	1. DBW 90 x PBW 550 2. Raj 3077 x Raj 1482 3. Raj 3765 x Raj 3077
Grain filling period	1. WH 1021 x PBW 550 2. Raj 1482 x Raj 3777 3. Raj 3765 x HD 3086	1. Raj 4079 x Raj 3765 2. Raj 3765 x DBW 90 3. Raj 3765 x PBW 550	1. Raj 1482 x WH 1021 2. Raj 4238 x WH 1021
Plant height	1. Raj 3077 x WH 1021 2. Raj 1482 x WH 1021 3. PBW 550 x HD 3086	1. Raj 4079 x HD 3086 2. Raj 3777 x WH 1021 3. Raj 3765 x DBW 90	1. Raj 3765 x PBW 550 2. Raj 3777 x PBW 550 3.
Flag leaf area	1. Raj 4079 x WH 1021 2. Raj 3765 x Raj 3777 3. DBW 90 x HD 3086	1. Raj 4238 x DBW 90 2. Raj 3777 x PBW 550 3. Raj 3765 x PBW 550	_
No. Of effective tillers per plant	1. WH 1021 x PBW 550 2. Raj 3765 x HD 3086 3. Raj 3777 x HD 3086	1. Raj 3765 x Raj 3077 2. Raj 4079 x Raj 3077 3. Raj 1482 x WH 1021	1. Raj 4238 x WH 1021 2. DBW 90 x PBW 550 3. Raj 4079 x Raj 3765
No. of grains per spike	1. WH 1021 x PBW 550 2. Raj 3765 x HD 3086 3. Raj 3777 x HD 3086	1. Raj 3765 x Raj 3077 2. DBW 90 x PBW 550 3. Raj 3077 x Raj 3777	1. Raj 4238 x WH 1021 2. Raj 3077 x Raj 1482 3. WH 1021 x DBW 90
1000-seed weight	1. Raj 4238 x WH 1021 2. Raj 4079 x PBW 550 3. Raj 4238 x DBW 90	1. WH 1021 x PBW 550 2. DBW 90 x PBW 550 3. Raj 3777 x HD 3086	1. Raj 3765 x Raj 3077 2. Raj 3077 x Raj 1482 3. Raj 4079 x Raj 3077
Harvest index	1. DBW 90 x PBW 550 2. Raj 3777 x HD 3086 3. Raj 1482 x PBW 550	1. WH 1021 x PBW 550 2. Raj 3765 x Raj 3077 3. Raj 3765 x DBW 90	1. Raj 3077 x Raj 3777
Grain yield per plant	1. Raj 3765 x Raj 3077 2. WH 1021 x PBW 550 3. Raj 3765 x HD 3086	1. Raj 3765 x DBW 90 2. Raj 4238 x Raj 4079 3. Raj 4079 x PBW 550	1. Raj 4238 x WH 1021 2. Raj 3077 x Raj 3777

Better environment (Below average stability): mean > μ , bi >1 and S^{2}di = 0
Poor environment (Above average stability): mean > μ , bi <1 and S^{2}di = 0
Average environment (Average stability): mean > μ, bi = 1 and S^{2}di = 0

Grain yield is a complex character and the analysis of individual yield component can lead to simplification

in explaining the stability for grain yield. The joint consideration of mean performance of genotypes

across the environments and stability parameters revealed that out of 45 genotypes, genotypes namely Raj 3765 x DBW 90, Raj 4238 x Raj 4079 and Raj 4079 x PBW 550 were suitable for harsh environment (mean>population mean, $b_i<1$ and $S^2d_i=0$) while the genotypes Raj 4238 x WH 1021 and Raj 3077 x Raj 3777 was most suitable for high grain yield in all types of environment (mean>population mean, $b_i=1$ and $S^2d_i=0$). Similar results for harsh environments were reported by Hassaan (2003), Rane *et al*. (2007), Bhoite *et al*. (2011), Arain *et al*. (2011) and Maeng (2019). For varying environments conditions similar findings were obtained by Ranjana and Kumar (2013), Patel *et al*. (2014), Singh *et al*.(2017) and Bavandpori *et al*. (2018). The cross combinations Raj 3765 x Raj 3077, WH 1021 x PBW 550 and Raj 3765 x HD 3086 were favourable for better environment. The present results were also confirmed by Mondal and Khajuria (2002), Hassaan (2003), Arya *et al*. (2004), Mishra (2007) and Bhoite *et al*. (2011).

REFERENCES

Arain, M.A., Siali, M.A., Rajputi, M.A. and Mirbahar, A.A. (2011). Yield stability in bread wheat genotypes. *Pak. J. Bot.,* **43**(4): 2071-2074, 2011.

Arya, V. D.; Pawar, I. S. and Lamba, R. (2004). Phenotypic stability for yield, its components and quality traits in bread wheat. *Natnl. J. Pl. Improv*., **6**: 9-13.

Ashraf, M., Qureshi, A.S., Ghafoor, A. and Khan, N.A. (2001). Genotype by environment interactions in wheat. *Asian J. Biol. Sci*., **1** : 356 – 357.

Ayed, S., Othmani, A., Chaieb, N., Bechrif, B., Rezgui, M, and Younes, M.B. (2016). Assessment of adaptability and stability of six Tunisian cereal genotypes under rainfed conditions and at two semi-arid environments. *Eur. Sci. J*., **12**(6): 1857 – 7881.

Badhe, P. L., Bhavsar, V.V. and Pawar, B. B. (1998). Stability parameter in wheat (*Triticum* spp.). *Ann. Agric. Res*. **19**: 125-129.

Banerjee, J., Rawat, R. S. and Verma, J. S. (2006). Stability analysis in bread wheat (*Triticum aestivum* L. em. Thell) and durum (*T. durum* L.) genotypes. *Indian J. Genet*., **66**: 145-147.

Basford, K.E., Federer, WT. and Delacy, IH. (2004): Mixed model formulations for Multi-environment trails. *Agron. J.,* **96**: 143-147.

Bavandpori, F., Ahmadi, J. and Hossaini, S. M. (2018). Stability analysis of bread wheat landraces and lines using biometrical genetic models. *Genetika*. Vol **50**, No.2, 449-464.

Bhoite, K.D., Rasal, P.N. and Gavhase, V.N. (2011). Stability of grain yield in rainfed wheat. *New Agriculturist*, **22**(1) : 19-21.

Denis, J.B., Piepho, H.P. and Vaneeuwijk F.A. (1996): Mixed models for genotype by environment tables with an emphasis on heteroscedasticity.

Technology de Biometrie, Laboratory de Biometrie, Institut Nationale de Research Agronomique, Versailles, France.

Eberhart, S. A. and Russell, W. A. (1966). Stability parameter for comparing vaieties. *Crop Sci*., **6**: 26-40.

Hassaan, R. K. (2003). Effect of drought stress on yield and yield components of some wheat and triticale genotypes. *Annals Agril. Res*.,**48**: 117-129.

Jaydeep, B., Rawat, R. S. and Verma, J. S. (2006). Stability analysis in bread wheat (*Triticum aestivum* L. em. Thell) and durum wheat (*T. durum* Desf.) genotypes. *Indian J. Genet.*, **66**: 145-146.

Jeena, S. N., Muduli, K. C. and Tripathy, S. (2005). Genotype × Environment interaction and stability analysis in wheat. *Indian Agricul.*, **49**: 183-188.

Khumkar, M. S., Chandrashekaran, S. and Chaudhary, H. B. (2001). Genotype × environment interaction and stability studies in late sown bread wheat (*Triticum aestivum* L. em. Thell). *Indian J. Pl. Genet. Res.*, **14**: 373-377.

Kumar, V., Tyagi, B.S., Verma, A. and Sharma, I. (2014). Stability analysis for grain yield and its components under different moisture regimes in bread wheat (*Triticum aestivum*). *Indian Journal of Agricultural Sciences*, **84**(8): 931-6.

Madariya, R. B., Poshiya, V. K. and Kavani, R. H. (2001). Phenotypic stability of yield and its contributing characters in bread wheat (*Triticum aestivum* L. em. Thell). *Madras Agric. J.* **88**: 648-650.

Maeng, D.J. (2019) Studies of yield and yield components in hybrid winter wheat (*Triticum aestivum* l.) Article.

Meena, H. S., Kumar D., Srivastava, T. K. and Prasad, S. R. (2014). Stability for grain yield and its contributing traits in bread wheat (*Triticum aestivum* L.). *Indian J. Agri. Sci*., **84**: 1486-1495.

Mishra, B. (2007). Challenges and preparendness for increasing wheat production in India. *Journal of Wheat Research* (**1 and 2**): 1-12.

Modhej, A., Naderi, A., Emam, Y., Aynehband, A. and Normohamadi, GH. (2008). Effects of post-anthesis heat stress and nitrogen levels on grain yield in wheat (*T. durum* and *T. aestivum*) genotypes. *Int. J. Plant Prod.* **2**, 254-267.

Mohammadi, M., Karimizadeh, R., Sabaghnia, N. and Shefazadeh, M. K. (2012). Genotype × Environment interaction and yield stability analysis of new improved bread wheat genotypes. *Turkish Journal of Field Crops,* **17**(1): 67-73.

Mondal, S. K. and Khajuria, M. R. (2002). Stability analysis in bread wheat (*Triticum aestivum* L. em. Thell). *Environ. Ecol*., **20**: 620-624.

Najeeb, S., Wani, S. A. and Jeena, A. S. (2004). Stability analysis for yield and its component characters in wheat (*Triticum aestivum* L. em. Thell) under cold arid conditions of Ladakh. *Natl. J. Pl. Improv*., **6**: 86-88.

Patel, B. C., Rojasara, Y. M., Akbari V. R. and Patel, J. A. (2014). Stability analysis for grain yield in bread wheat (*Triticum aestivum* L.) for irrigated ecosystems *Journal of Wheat Research* **6**(2):160-162.

Ram, C., Sharma, G., Ferrara, O., Crossa, J., Bhatta, M.R. and Sufian, M.A. (2007). What grain yield and stability assessed through regional trials in the Eastern Gangetic Plains of Sought Asia. *Euphytica*, **157**: 457-464.

Rane, J., Pannu, R.K., Saini, R.S. and Joshi, A.K. (2007). Performance of yield and stability of advanced wheat genotypes under heat stress enviornments of the Indo – Gangetic plains. *Crop Sci.*, **47** (4) : 1561 – 1573.

Ranjana and Kumar, S. (2013). Genotype × Environment interaction over extended dates of sowing for grain yield and its attributing traits in wheat (*Triticum aestivum* L.). *Annals Bio. Res.*, **4**: 238-241.

Sakin, M. A., Akinci, C., Duzdemir, O. and Donmez, E. (2011). Assessment of genotype × environment interaction on yield and yield components of durum wheat genotypes by multivariate analysis. *African J. Biotech.*, **10**: 2875-2885.

Saleem, N., Ahmad, M., Wani, S.A. and Dar, Z.A. (2015). Genotype x environment interaction and stability analysis in wheat for protien and gluten contents. *Scientific Research and Essays*, **10** (7) : 260-265.

Shafii, B. and W.J. Price (1998): Analysis of genotype-by-environment interaction using the Additive Main Effects and Multiplicative Interaction model and stability estimates. *J. Agric. Biol. Environ. Stat.*, **3**: 335-345.

Sharma, A. K., Garg, D. K. and Brijender, K. (2003). Phenotypic stability in bread wheat (*Triticum aestivum* L.) under normal and saline environment. *Annals Agril. Res.*,**24**: 181-183.

Singh, G. P. and Chaudhary, R. V. (2007). Stability of wheat genotypes for yield and moisture stress tolerance traits. *Indian J. Genet.*, **67**: 145-148.

Singh, M., Srivastava, R. L. and Dixit, R. K. (2002). Stability analysis for certain advanced lines of bread wheat under rainfed condition. *Advances pl. Sci.* **15**: 295-300.

Singh, B., Mavi, G.S., Malhotra, A., Sood, N., Jhinjer, R.K., Kaur, B., Bhagat, I., Kumar, V. and Sohu, V.S. (2017) Stability Performance of Bread Wheat Genotype for Grain Yield, Zinc and Iron Concentrations. *IJAEB*: **10**(4): 407-413.

Thamson, W.E. and S.B. Philips (2006): Methods to evaluate wheat cultivar testing environment and improve cultivar selection protocols. *Field Crops Res.*, **99**: 87-95.

486   SOHAN LAL KAJLA, ANIL KUMAR SHARMA, HOSHIYAR SINGH, MUKESH BHAKAL, BHAGWATI BARANDA, NEELU KUMARI AND MOTI RAM NATWARIA