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Stability analysis for grain yield under different environment in bread wheat (*Triticum aestivum* L.)

Kamini, AP Agrawal, DJ Sharma and Hemkumar

Abstract
The experiment conducted with 12 genotypes of bread wheat by using Eberhart and Russell (1966) model for grain yield under different environment during Rabi- 2019-20 *viz.* 8th Nov. (normal sown), 4th Dec. (late sown) and 24th Dec. (very late sown) at All India Co-ordinated Wheat & Barley Improvement Project, B.T.C. College of Agriculture and Research Station, Bilaspur, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The variances due to genotypes was found significant revealed the presence of genetic variability for grain yield. The genotype Ratan and CG-1029 was stable for all the characters. This is revealing not only the amount of variability that existed among environments but also the presence of genetic variation among the genotypes. Only the genotype CG-1029 having high mean performance, non-significant regression coefficient deviation from unity (bi=1) and non-significant deviation from zero ($S^2d=0$) in term of grain yield per hectare. Hence, in term of grain yield per hectare CG-1029 can be considered the most stable and adopted to all environments compared to other stable genotypes.

Keywords: Stability, grain yield, environment, bread wheat, *Triticum aestivum* L.

1. Introduction

Wheat (*Triticum aestivum* L.) is a self-pollinated crop belonging to Poaceae family. Species *Triticum aestivum* grouped in the 3 ploidy level diploid (2n= 14, tetraploid (2n= 24) and hexaploid (2n= 42). There are 17 diverse species out of 17 species only three species are cultivar all through the world *viz. Triticum aestivum*, *Triticum durum* and *Triticum dicoccum*. The *Triticum aestivum* (common wheat) is the main significant species occupy more than 90% of the total wheat area in India. *Triticum durum* (macaroni wheat) is the second main significant species cover about 10% of the total area in India and *Triticum dicoccum* is grown on a limited scale in Gujarat, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. It is the most important grain food crop of India. In India, wheat is the second very most important food crop behind rice both in terms of area and production. It have been describe as the 'King of cereals' because of the acreage it occupy, high productivity and the prominent situation it holds in the world wide food grain trade.

In India, wheat covers an area of 29.55 million ha, with total production of 101.20 million tonnes per ha and productivity 3424 kg per ha (Anonymous, 2018-19) [3]. In Chhattisgarh wheat covers an area of 101.36 ('000 ha) with 130.65 ('000 tonnes) of production and 1289 kg/ha productivity (Anonymous, 2017-18) [2]. It is known that genotypes, environment and their interaction (G × E) have influence on the phenotype of the various traits in wheat. Some genotypes may perform well in certain environments, but, fail in several others. Environment conditions such as sowing time, sowing date, temperature, humidity, soil *etc.* The basic differences between genotypes and in their yield stability is the wide occurrence of Genotype × Environment (GE) interactions. To overcome this situation it is necessary to develop and identify of good phenotypically stable genotypes, which can significantly perform over a wide range of environment conditions.

Yield is a quantitative character which are controlled by polygenic system and their expression is depend on the genotype and environment interaction and such character are greatly influence by environmental condition. Hence a study of genotype-environment interaction can lead to successful evaluation of wheat cultivars for stability in yield performance across environments. The adaptability of a variety in different environments is usually tested by the degree of its interaction with different environments under which it is grown.

The study of genotype × environment interaction was extremely important in the development and evaluation of plant varieties because they reduce the values of genotypical stability in different environments. A variety or genotypes is considered more adaptive if it has a high mean yield but a low degree of fluctuation in yielding potential when grown in different environments. The present experiment was conduct for normal sown, late sown and very late sown condition in rabi season 2019-2020. Testing the stability of genotypes and estimating the genotype × environment (G × E) interaction Eberhart and Russell (1966) [5] models were used.

Materials and Methods

Field trials: A field experiment consisting of twelve genotypes of wheat was conducted during Rabi- 2019-20 in three different environments *viz.* 8th Nov. (normal sown), 4th Dec. (late sown) and 24th Dec. (very late sown) at All India Co-ordinated Wheat & Barley Improvement Project, B.T.C. College of Agriculture and Research Station, Bilaspur, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. A list of the twelve genotypes are presented in Table 1.

Experimental design: The experiment was grown in a randomized blocks design with three replication in three different dates of sowing. Each genotype was grown in a plot size 1.8 X 8.0 meter keeping row to row spacing of 20 cm. for each plot in each replication. All the recommended cultural and management practices were followed to raise a healthy crop.

Statistical analysis and stability parameters: Data from the three environments were subjected to stability analysis using the Eberhart and Russell (1966) [5] model. As per the model, three parameters, *viz.*, mean yield over locations or seasons ($\bar{X}$), regression coefficient (bi), and deviation from regression (S^2di) were estimated. Genotypes that proved to be stable for most stability analysis or at least for the yield then selected as the best. According to this model, a regression coefficient (bi) of approximately one coupled with a deviation from regression coefficient (S^2d) least/zero, it implies average stability over different environments. The hypothesis that any regression coefficient does not differ from unity, it was tested by the t-test using its own standard error for regression. The second stability parameter was mean sum square of the deviation from regression for each genotype.

Table 1: List of twelve diverse wheat genotypes used in experiment

S. No	Genotypes	Notification year	Parentage	Released by	Farming condition
1	HD 2864	2004	DL 509-2/DL 377-8	CVRC	Late sown
2	Chhattisgarh Genhu 3 (CG 1013)	2018	GW 322/ KYZ 0285	SVRC	Timely sown
3	Chhattisgarh Genhu 4 (CG 1015)	2017	NI 908/BL 1986	SVRC	Late sown
4	Chhattisgarh Amber Wheat(CG 1018)	2019	HW 2004/ PBN 1666-2	SVRC	Restricted irrigation
5	Chhattisgarh Hansa Wheat (CG 1023)	Proposed	BOW/VEE/5/ND/VG9144//KAL/B B/3/YACO/4/...../ 3/BAV92	SVRC	Restricted irrigation
6	Ratan (CG 5016)	2009	HUW 325/DL 230-7	SVRC	Restricted irrigation
7	Raj 4238	2013	HW 2021/RAJ 3765	CVRC	Late sown
8	CG 1029	Up-coming	HW 2004/ PHS 725	CVRC	Late sown
9	HI 1634	Up-coming	GW322/PBW498	CVRC	Late sown
10	MP 4010	2003	ANGOSTURA 88	CVRC	Late sown
1 1	HD 2932	2008	KAUZ/STAR//HD2643	CVRC	Late sown
12	MP 3336	2013	HD 2402/GW 173	CVRC	Late sown

Result and Discussion

The pooled analysis across the location revealed significant differences among environments and genotypes for grain yield (Table 2); indicating that the presence of wide variation among environmental conditions and genotypes used for the evaluation of the materials. Thakur *et al.*, 2019 [18], Krupal *et al.*, 2018 [10], Mut *et al.*, 2010 [12] and Singh *et al.*, 2018 [16] had observed similar results. Differences due to Genotypes × Environment (G× E) were also found highly significant for grain yield per hectare (q). Present results are in agreement with those of earlier reports of Patel *et al.*, 2014 [13], Amin *et al.*, 2005 [1], Verman *et al.*, 2015 [19].

Components analysis of the Environment + (Genotype × Environment) interaction (E+ (G× E) was found to be highly significant for this characters.Similar results was reported for grain yield by Singh *et al.*, 2018 [16], Mekuria *et al.*, 2018 [11], Kabir *et al.*, 2009 [9], Gulzar *et al.*, 2015 [6]. Genotype × Environment (linear) variances was also found significant for grain yield.

Table 2: Combined analysis of variance of grain yield per hectare (q) in twelve wheat genotypes under three different environments

Source	DF	MSS
Genotypes	11	71.17**
Environments	2	461.67**
Genotypes × Environment	22	17.54 **
Env.(Gen.× Env.)	24	18.18**
Environment (linear)	1	307.78**
Genotypes × Env. (linear)	11	8.51*
Pooled deviation	12	2.9181
Pooled error	72	3.2878
Total	35	34.840

The studies on estimate of parameters of stability revealed that all genotypes except for Chhattisgarh Hansa wheat was found stable for grain yield. This is revealing not only the amount of variability that existed among environments but also the presence of genetic variation among the genotypes. It was emphasized that both linear (bi) and non-linear (S^2di) components of G×E interactions are necessary for judging the stability of a genotype. A regression coefficient (bi) of approximately one coupled with a deviation from regression coefficient (S^2d) least/zero, it implies average stability. The value of regression coefficient more than one identify genotype with greater sensitivity to changing environments (below average stability) and higher specificity of adaptability to high yielding environments. A value of regression coefficient less than one contribute a measurement of higher resistance to environmental chances (above average stability) and thus increases the specificity of adaptability to low yielding environments.

Table 3: Stability parameters of 12 wheat genotypes grown in three environments

S.N	Genotypes	Mean	Regression coefficient (bi)	deviation from regression (S^2D)
1	HD 2864	32.00	0.96	0.082
2	Chhattisgarh Genhu 3	33.42	0.66	1.21
3	Chhattisgarh Genhu 4	30.51	0.74	−2.86
4	Chhattisgarh Amber wheat	31.07	1.09	−2.91
5	Chhattisgarh Hansa wheat	32.51	1.04	11.25*
6	Ratan	24.92	−0.22	−2.19
7	Raj 4238	28.14	0.27	−2.31
8	CG 1029	41.51	1.46	−1.26
9	HI 1634	38.39	1.08	−3.28
10	MP 4010	37.53	1.50	1.28
11	HD 2932	39.53	1.71	−1.53
12	MP 3336	34.00	1.66	−1.89
	Grand mean	33.62	0.64	

The grand mean of the experiment is 33.62 qt/ha, five varieties recorded the above average productivity and seven varieties recorded the below average productivity. CG 1029 recorded the highest productivity of 41.51q/ha among the varieties tested. The mean value ranged from 24.92 (Ratan) to 41.51 (CG 1029). HD 2932 recorded the second highest productivity of 39.53 qt/ha followed by HI 1634 (38.39 qt/ha). Value of regression coefficient (bi) ranged from -0.22 (Ratan) to 1.71 (HD 2932). Near to one value for linear regression is recorded for HD 2864 (0.96), Chhattisgarh Amber wheat (1.09), Chhattisgarh Hansa wheat (1.04) and HI 1634 (1.08) indicates their average response under varying climatic conditions. Four varieties *viz*., CG 1029 (1.46), MP 4010 (1.50), HD 2932 (1.71) and MP 3336 (1.66) have higher bi values indicated that a higher productivity can be harvested under favourable environment by theses varieties. Value for deviation from regression (S^2d) ranged from -3.28 (HI-1634) to 11.25* (Chhattisgarh Hansa wheat). All genotypes, except Chhattisgarh Hansa wheat (11.25*) deviated non-significantly from zero (S^2d=0). Hence they are stable.
Similar results were obtained by Pujer *et al*., 2020 [15], Haydar *et al*., 2018, Singh *et al*., 2018 [16], Jhinjer *et al*., 2017 [8], Polat *et al*., 2016 [14], Verman *et al*., 2015 [19], Thakare *et al*., 2014 [17], Zoubeir *et al*., 2014 [20], Patel *et al*., 2014 [13]; Arain *et al*., 2011 [4] and Kabir *et al*., 2009 [9].

Conclusion
Only the genotype CG 1029 having high mean performance, non-significant regression coefficient deviation from unity (bi=1) and non-significant deviation from zero (S^2d=0) in term of grain yield per hectare. Hence, in term of grain yield per hectare CG 1029 can be considered the most stable and adopted to all environments compared to other stable genotypes. Therefore, it could be included in the hybridization program to converge the stability characteristics of grain yield for the development of stable cultivar adapted to a wide range of environments.

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