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Stability Analysis for Grain Yield and Harvest Index in Bread Wheat (*Triticum aestivum* L.)

J M PATEL[1*], S K PATEL[2], C.R.PATEL[3], A.A.PATEL[4], A.S.PATEL[5], M.S.PATEL[6], D. J. JOSHI[7] AND B.C.PATEL[8]

Wheat Research Station,
S. D. Agricultural University, Vijapur-382 870 (Gujarat)

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ABSTRACT

Present study was conducted to assess the genetic diversity and stability for grain yield (GY) and harvest index under three varied environmental locations using 26 diverse wheat genotypes (including five checks i.e., GW 496,GW 322,GW 366,GW 451 and HI 1544) during *Rabi* 2016-2017. Pooled analysis of variance revealed highly significant variance due to environments for both the traits studied indicating differential response of the genotypes. The variance due to Genotype x environment was found highly significant only for harvest index. Genotype VA 2015-34 showed stable performance for harvest index across the environment whereas, VA 2005-26, VA 2015-45 and VA 2015-19 were found suitable for unfavorable environment for harvest index. VA 2015-34 may be further assessed for their genetic distance and diverse parents could be utilized in future wheat hybridization programme as well as a donor parents in multiple traits breeding programme to improve harvest index in wheat.

Key words: Bread wheat, Genotype-environment interactions, Multi-location testing, Harvest index

Wheat (*Triticum aestivum* L.) is the world's most important staple food crop as well as most consumed cereal. It is known as "king of cereals" as its cultivation is easier, ecologically suitable and contain high amount of nutrients. It compares well with other cereals in nutritive value. In India, it is the staple diet in the northern and central regions. It is cultivated on 15.4% of the arable land in the world in almost all countries, except the humid and high-temperature areas in the tropics and high-latitude environments. Accounting for a fifth of humanity's food, wheat is the second only to rice which provides 21% of the food calories and 20% of the protein for more than 4.5 billion people in 94 developing countries (Braun *et al.*, 2010).The harvest index (HI) was defined as ratio of economic yield to total aboveground biomas yield. Donald (1962). This "trait" was chosen because it represents plant efficiency in translocating nutritive matter from vegetative to generative plant part that can serve as useful indicator of productivity. Harvest index has been recommended as selection criterion for increasing yield of cereals (Dalal *et al.*, 1995). One of the possibilities in increasing of grain yield production can be to increase HI up to 0.50 or more at the level of biomass already produced by semidwarf wheat cultivars. When biological yield is more or less constant economic yield is proportional to HI and economic yield is in correlation with biomass yield, while biomass yield and HI are uncorrelated. Cultivars with improved harvest index expressed increase in physiological efficiency of nutrient re-utilisation, capacity to mobilize photosynthates and efficiency of their translocation from leaves and stem into grains . Some genotypes frequently show fluctuations in yield performance in different environments as a result of genotype-environment interactions (GxE).Thus, GxE interactions are of major consequence to the breeders in the process of evaluation of improving genotypes when genotypes are grown at multi-locations for testing their performance. However, their relative rankings do not remain the same; this could cause difficulties in demonstrating significant superiority of any genotype. The information about phenotypic stability could be useful for the selection of desirable genotypes for yield and quality traits as well as for

[1&6]Associate Research Scientist, [2&5]Assistant Research Scientist, [3&7]Agriculture Officer, [4]Research Scientist, S. D. Agricutural University, [8]Associate Research Scientist, Anand Agricutural University, Anand
*Email : dr.jmpatel63@gmail.com

breeding programme. A number of techniques have been used to interpret data from multi-environment trials (Eberhart and Russel, 1966), including GGE bi-plot analysis for effectively identifying mega-environments. Therefore, we need to have research programme which primarily focus to develop cultivars with high yield potential and consistent performance across the environments. Thus, the assessment of the nature and extent of GxE interaction and identification of phenotypically stable genotypes, showing low GxE interaction, becomes important. Therefore, the present study was conducted to identify stable wheat genotype for grain yield and harvest index.

MATERIALS AND METHODS

An experiment was conducted at three locations Wheat research station Vijapur and Sardarkrushinagar representing North Gujarat Agro climatic zone IV and Regional research station Anand representing middle Gujarat Agro climatic zone in rabi crop season 2016-17 using Randomised Complete Block Design with three replications. The material used in the present experiment comprises of twenty one advanced breeding lines along with five standard checks Recommended cultural practices were adopted to raise a good crop. Data were recorded for grain yield and harvest index according to standard procedures. Yield was taken from 4 m^2 plot (5.0 m length and 0.8 m width).

Statistical analysis: The mean values from each replication were subjected to statistical analysis using SAS computer software. The analysis of variance was carried out as per Panse and Sukhatme (1985). Stability parameters, were computed as per Eberhart and Russell (1966), (Singh and Chaudhary ,1985). Estimates of mean performance (X^-), regression coefficient (bi) and deviations from regression (S^2di) were used to draw inferences on stability of genotypes.

RESULTS AND DISCUSSION

The location wise analysis of variance (Table 1) was significant for both the traits in all the locations (Vijapur,Sardarkrushinagar and Anand), suggesting sufficient variability in the present set of materials. The pooled analysis of variance concerning both the traits is presented in (Table 2). The variances due to genotypes were significant for grain yield per hectare, and harvest index indicated differential response of the genotypes selected for the present study. The variance due to environment was significant for both the traits indicated the distinct and differential effects of different environmental conditions. Similar results were also reported by Kumar *et al.,* (2014) for grain yield in wheat. The variance due to genotype x environment interaction was found significant at 5% level of significance for harvest index only sowing differential response of the varieties with different environments, so stability analysis was performed for harvest index only. Similar results were reported earlier by Krupal S. M. *et. al.*, (2018) for harvest index. The mean squares due to environment + (genotype x environment) interaction were significant for harvest index only which showed that genotypes were interacted considerably with environmental conditions that existed over different locations. The significant linear component of GxE interaction was also recorded for harvest index indicating differential response of the genotypes with in different environments (locations). Hence, it would be possible to predict the performance of genotypes over wide range of environments (multilocation) for harvest index only. Charan singh *et al.*, (2018) and Krupal S. M. *et. al.*, (2018) reported similar results for grain yield and harvest index respectively.

Stability analysis and identification of stable genotypes over locations: Eberhart and Russell (1966) emphasized the need of considering both linear (bi) and non-linear regression coefficient, i.e. deviation from regression (S^2di) components of G x E interactions to measure the stability of genotypes. The genotypes with lowest deviation around regression line (S^2di) were considered to be stable and vice-versa. Along with above measures, the highest mean performance was also considered as a requirement for identifying high grain yield and stability of genotypes. Thus, in the present investigation three measures, viz. higher mean performance, regression coefficient (bi=1) and deviation from regression (S^2di=0) were used to identify superior and stable genotypes. The stability analysis showed a wide range of adaptation and resilient performance of genotypes. The mean performance and estimates of stability parameters for both the traits are presented (Table 3). The mean harvest index ranged from 0.42 to 0.37 across the locations (environments). Considering high mean performance than population mean with stability parameters together, only one genotype VA-2015-34 was found desirable and exhibited stable performance across the locations for harvest index. Similar finding was reported by Kumar *et al.,* (2014).

Furthermore, the genotypes VA-2015-11, VA-2015-38 and VA 2015-41 were having higher mean grain yield than population mean and regression coefficient lesser than unity (b<1), hence this genotypes are specifically adapted to poor environmental location. The genotypes VA 2015-26, VA 2015-45 and VA 2015-19 having lower mean grain yield than the population mean also than all the three checks with unit regression (b=1), hence, this genotype are poorly adapted to all the environmental locations. The sensitivity of HI under environmental variation was noticed by Bedak *et al.*, (1999). Eberhart and Russell (1966), Lillimo *et al.* (2004) and Kumar *et al.* (2014) they also emphasized that genotypes with high mean performance and regression coefficient near to unity with non-significant deviations are desirable and gave stable performance across the environments. Based on the mean performance, regression coefficient (bi) values and deviation from regression values, some of the genotypes have been identified to suit with stability of performance under unfavorable environments in respect of harvest index. However, breeders must keep in mind that the assessments of stability depend on the sets of genotypes and environments studied.

Table 1 Location wise analysis of variance (ANOVA) for grain yield and harvest index in bread wheat

Source of variation	DF	Grain yield(Kg/ha)	Harvest Index
		A Location Vijapur	
Replication	2	308791.66	0.001
Treatment	25	577711.53*	0.003**
Error	50	196425.0	0.001
Total	77		
		B Location Sardarkrushinagar	
Replication	2	9075729.16	0.0
Treatment	25	1394132.051*	0.001**
Error	50	348054.16	0.0
Total	77		
		C Location Anand	
Replication	2	144531.54	0.001
Treatment	25	1052377.82*	0.004*
Error	50	348054.16	0.002
Total	77		

* and ** indicates 5 % and 1 % level of significance respectively

Table 2 Pooled analysis of variance (ANOVA) for grain yield and harvest index

Source of variation	D F	Grain yield (Kg/ha)	Harvest Index (%)
Genotypes	25	599047.70*	0.001*
Environments	2	22964874.4**	0.063*
G x E	50	204513.049 NS	0.001*
E+ (G x E)	52	1079911.56	0.004*
Environments(linear)	1	45929748.94**	0.126*
G x E (linear)	25	172574.53 NS	0.001
Pooled deviation	26	227356.966	0.001
Pooled error	150	341006.45	0.001
Total	77		

* and ** indicates 5 % and 1 % level of significance respectively

Table 3 Stability analysis for harvest index in wheat

Sr. No.	Genotype	$\bar{X}$	bi	S^2di
1	VA 2015-09	0.40	-0.02	0.007
2	VA 2015-11	0.41	0.82	0.001
3	VA 2015-14	0.40	0.41	0.002
4	VA 2015-18	0.40	1.60	0.002
5	VA 2015-21	0.41	0.54	0.002
6	VA 2015-25	0.39	1.61	-0.000
7	VA 2015-26	0.40	1.07	-0.000
8	VA 2015-30	0.40	0.94	0.002
9	VA 2015-34	0.42	1.11	-0.000
10	VA 2015-38	0.42	0.67	0.001
11	VA 2015-41	0.41	0.67	0.002
12	VA 2015-43	0.41	0.60	-0.000
13	VA 2015-45	0.38	0.91	0.000
14	VA 2015-46	0.39	0.72	0.000
15	J 15-06	0.38	1.45	0.001
16	J 15-22	0.41	0.68	0.001
17	J 15-27	0.37	1.47	0.002
18	J 15-31	0.39	1.29	0.000
19	J 15-29	0.38	1.03	0.001
20	J 15-45	0.40	1.14	0.002
21	LOK-73	0.40	1.56	0.003
22	GW 496©	0.38	0.90	0.002
23	GW 322©	0.42	1.24	-0.000
24	GW 366 ©	0.38	1.15	-0.000
25	GW 451 ©	0.41	1.02	-0.000
26	HI 1544©	0.40	1.33	-0.000

Pooled Mean = 0.40, S.E of Mean= 0.03, Mean of B=1.00 S.E. of b= 0.55

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