University of Birjand

تنش‌های محیطی در علوم زراعی
Environmental Stresses In Crop Sciences
Env. Stresses Crop Sci.
Vol. 15, No. 2, pp. 287-298 (Summer 2022)

http://dx.doi.org/10.22077/escs.2020.3527.1871

Original article

Study of grain yield stability of bread wheat genotypes using non-parametric method and GGE biplot

A.M. Mahdavi[1*], N. Babaeian Jelodar[2], E. Farshadfar[3], N. Bagheri[4]

1. Ph.D student, of Plant Breeding, Sari Agriculture Sciences and Natural Resources University, Iran
2. Professor of Plant Breeding, Sari Agriculture Sciences and Natural Resources University, Iran
3. Professor of Plant Breeding, Razi Agriculture Sciences and Natural Resources University, Iran
4. Associate Professor of Plant Breeding, Sari Agriculture Sciences and Natural Resources University, Iran

Received 5 July 2020; Accepted 15 Nuvember 2020

Extended abstract

Introduction
The necessity of considering wheat production as the staple food of most people in the world reveals the urgent need to produce this strategic product. The most important aspect of producing advanced lines in addition to yield consideration is the stability of the studied traits, especially the stability of grain yield in different environments.

Materials and methods
In this study, 23 bread wheat genotypes with 2 cultivars as control during three cropping years at Razi University of Kermanshah Agricultural Research Field were tested by randomized complete block design with three replications in two irrigated (no stress) and rainfed environments (stress) was implemented. After determining the performance of each genotype, by first performing Bartlett test and proving homogeneity of variance, combined analysis of variance was performed assuming the effect of genotypes and environment (year and location) constant. Non-parametric univariate stability statistics based on Nasser and Huhn's (1987) and Tennarasu's (1995) criteria were used for selection of stable wheat genotypes. Next, the genotype effect + genotype×environment (GGE) biplot suggested by Yan et al. (2007) was used. Other analyzes were performed using SPSS 16 and Genstat 12 software.

Results and discussion
In this analysis, F-test was used to investigate the significant effects of variance components of grain yield based on the model (random effect of year and fixed effects of genotype and location). There was a significant difference between places, years, genotypes, interactions of year × place, year × genotype, place × genotype, year × place × genotype at the statistical probability level of 1%. Therefore, the results showed that the studied wheat genotypes showed different reactions in the studied environments. Also, the years and places studied had different effects on the performance of genotypes The Nonparametric statistics studied for selection of stable genotypes from the studied cultivars were evaluated based on the proposed criteria of Nasser and Hoon (Nasser and Huhn, 1987) and Thennarasu (1995). The results indicated that $Si^{(1)}$ usually had higher mathematical expectation and smaller variance than $Si^{(2)}$ in the Nasser and Huhn (1987) method, so the accuracy of $Si^{(1)}$ in selecting genotypes was higher. Stability can be far greater than $Si^{(2)}$ statistics. In this regard, Kaya and Taner (2003) have described the simplicity of calculating the $Si^{(1)}$ statistic as the reason for its preference over the $Si^{(2)}$ statistic. Graphical analysis was used to study the variety of cultivars, environments and the interaction of genotypes and environments.

*Correspondent author Amir Mohammad Mahdavi; E-Mail: a.mahdavi161@gmail.com.

The results of GGE biplot showed that the first and second principal components accounted for 43.1% and 20.9%, respectively, of 64% of the total variation, indicating the relative validity of the biplot in justifying G + GE changes.

Conclusions

Overall, a closer examination of the results of nonparametric statistics indicated that genotypes 3 and 8 (Vanguard) were identified as the most stable genotypes by the two statistics $Si^{(1)}$ and $Si^{(2)}$. Whereas, $Si^{(3)}$ and $Si^{(6)}$ statistics identified genotypes 15 (pioneer) and 13 as stable genotypes. According to $NPi^{(1)}$ statistics, genotype 12 was the most stable genotype according to $NPi^{(2)}$, $NPi^{(3)}$ and $NPi^{(4)}$ statistics. This suggests that the use of nonparametric methods by Tennarasu (1995) and Nasser and Huhn (1987) may not lead to the selection of high yielding stable genotypes Soughi et al., (2016). In a study by Abdulahi et al. (2007) on the stability of safflower seed yield, they stated that the statistics of $Si^{(1)}$, $Si^{(2)}$ and $Si^{(3)}$ actually represent a static concept of stability and dependence. They were not significant with mean performance. Therefore, the use of multivariate methods of sustainability decomposition that actually discusses the dynamic concept of sustainability can be important. Overall, the results of multivariate stability analysis showed that GGE Biplot is a suitable method for simultaneous selection of stability and yield of cultivars and lines. In this study, GGE biplot results showed that 20, 17, 15 (pioneer), 9, 6 and 20 genotypes with average yield were among the most stable genotypes in terms of grain yield among studied genotypes., 22 and 24 were identified as the most undesirable genotypes for stability and yield.

Acknowledgements

We would like to thank the colleagues of the Department of Agriculture and Plant Breeding, Razi University of Kermanshah, as well as the technicians involved in this research project, who ultimately contributed to providing the facilities needed to carry out this research.

***Keywords*:** Bread wheat, Genotype× environment interaction, GGE biplot, Non-parametric, Yield stability

Table 1. Entry number and code at bread wheat genotypes.

Genotype No.	Genotype code	Origin	Genotype No.	Genotype code	Origin
G1	Wc-4924	Iran	G14	Wc-4994	Iran
G2	Wc-4582	Iran	G15	Pishgam (check2)	Iran
G3	Wc-4592	Iran	G16	Wc-47583	Iran
G4	Wc-47341	Iran	G17	Wc-47522	Iran
G5	Wc-4965	Iran	G18	Wc-47569	Iran
G6	Wc-4840	Iran	G19	Wc-47399	Iran
G7	Wc-4958	Iran	G20	Wc-47638	Iran
G8	Pishtaz (check1)	Iran	G21	Wc-47640	Iran
G9	Wc-4600	Iran	G22	Wc-47467	Iran
G10	Wc-4987	Iran	G23	Wc-4553	Iran
G11	Wc-47615	Iran	G24	Wc-4583	Iran
G12	Wc-4612	Iran	G25	Wc-4554	Iran
G13	Wc-5001	Iran	–	–	

Table2.Geographic and meteorological location of the test site

Longitude	47˚, 9´
Latitude	34˚, 21´
Height (m)	1319 (m)
Mean Rainfall	450-480 (mm)
Average temperature of test years	14.8º (C)
Rainfall in the years of the experiment	330.25 (mm)

Table 3. Combined analysis of variance in for grain yield performance of the 25 wheat genotypes in the 6 testing environments

S.O.V	df	Mean of Square	F
Year	2	3586508.5	952.1**
Environment	1	7854210.2	2085.2**
Environment ×Year	2	743832.1	197.4**
Error1	9	6184.4	1.64
Genotype	24	49170.5	13.05**
Genotype ×Year	48	38316.7	10.17**
Genotype× Environment	24	22290.4	5.9**
Genotype ×Year× Environment	48	17454.3	4.6**
Error2	304	3766.6	-
Total	462	-	-

**: Significant at 1% probability level

Table 4. Mean comparison of grain yield for wheat genotypes across locations and years

Genotype No.	Genotype Code.	Yield	Genotype No.	Genotype Code.	Yield
G1	Wc-4924	3.5735^{a-d}	G14	Wc-4994	4.0133^{a-e}
G2	Wc-4582	4.2822^{c-e}	G15	Pishgam	4.3280^{de}
G3	Wc-4592	3.0206^{a}	G16	Wc-47583	3.7816^{a-e}
G4	Wc-47341	3.3966^{a-d}	G17	Wc-47522	4.2399^{b-e}
G5	Wc-4965	3.5086^{a-d}	G18	Wc-47569	3.9951^{a-e}
G6	Wc-4840	4.2002^{b-e}	G19	Wc-47399	3.8882^{a-e}
G7	Wc-4958	4.1612^{b-e}	G20	Wc-47638	4.0403^{a-e}
G8	pishtaz	3.8949^{a-e}	G21	Wc-47640	4.0681^{a-e}
G9	Wc-4600	3.9061^{a-e}	G22	Wc-47467	3.1068^{a-b}
G10	Wc-4987	4.7866^{d}	G23	Wc-4553	3.2844^{a-d}
G11	Wc-47615	3.7048^{a-e}	G24	Wc-4583	3.1781^{abc}
G12	Wc-4612	3.4126^{a-d}	G25	Wc-4554	4.1133^{a-e}
G13	Wc-5001	4.4063^{de}	–	–	–

Yield means with the same letters are not significantly at 5% level of probability (Duncan's multiple range test)

Table 5. Non parametric Stability in promising bread wheat genotypes

	Non- Parametric statistics Nasser and Huhn				Non- Parametric Statistics Thennarasu			
Genotype	$S_i^{(1)}$	$S_i^{(2)}$	$S_i^{(3)}$	$S_i^{(6)}$	$NP_i^{(1)}$	$NP_i^{(2)}$	$NP_i^{(3)}$	$NP_i^{(4)}$
G1	6.60	29.90	13.00	2.26	5.00	0.39	0.49	0.57
G2	7.07	35.07	9.92	1.70	7.67	0.39	0.46	0.40
G3	4.27	12.67	11.88	3.38	4.17	1.70	1.04	0.80
G4	7.00	40.97	23.19	3.02	6.00	0.83	0.77	0.79
G5	6.53	33.47	15.69	2.75	5.83	0.73	0.60	0.61
G6	5.80	25.77	7.50	1.32	4.50	0.23	0.34	0.34
G7	5.80	22.70	6.88	1.27	5.17	0.31	0.39	0.35
G8	4.53	15.07	5.26	1.26	4.17	0.22	0.35	0.32
G9	8.67	53.07	17.30	2.17	5.83	0.30	0.44	0.57
G10	9.93	91.37	24.26	2.62	7.83	0.30	0.55	0.53
G11	7.78	56.67	34.00	3.68	6.00	0.83	0.84	0.94
G12	7.33	41.20	25.75	4.00	3.83	1.27	0.58	0.92
G13	5.00	16.57	4.56	1.05	5.67	0.50	0.39	0.28
G14	6.00	26.27	9.61	1.85	5.00	0.32	0.45	0.44
G15	5.07	17.47	4.52	1.03	3.67	0.23	0.25	0.26
G16	11.40	97.77	37.13	3.70	7.00	0.42	0.70	0.87
G17	6.27	28.00	7.78	1.33	4.33	0.31	0.31	0.35
G18	8.73	58.17	21.02	2.80	7.33	0.57	0.62	0.63
G19	11.27	94.97	40.13	4.48	10.00	0.77	0.85	0.95
G20	6.93	35.60	10.47	1.76	7.00	0.97	0.57	0.41
G21	10.00	65.20	27.17	3.17	7.17	0.56	0.69	0.83
G22	5.93	24.70	22.45	4.55	4.83	1.89	1.09	1.08
G23	6.07	24.97	15.94	2.89	3.33	1.31	0.72	0.77
G24	6.13	27.07	21.37	3.89	4.33	1.33	0.93	0.97
G25	5.33	19.47	6.21	1.28	3.83	0.42	0.31	0.34

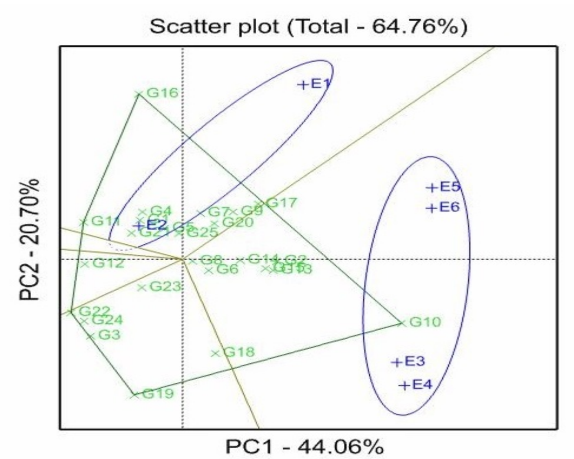

Fig. 1. Graphical demonstration GGE biplot based on which won were/what to identify large nvironments and superior genotype

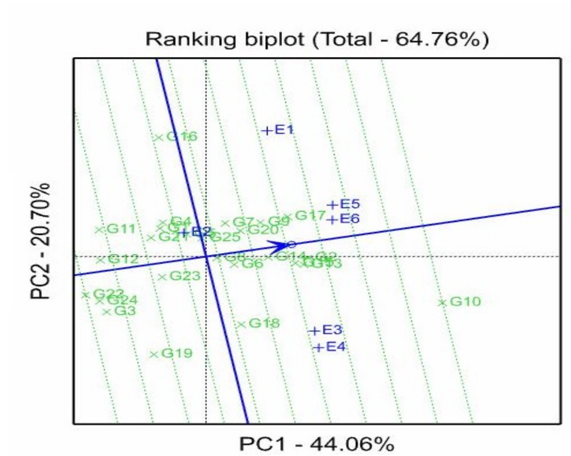

Fig. 2. Biplot of the average- environment coordination (AEC) for simultaneously, selection of yield and stability of bread wheat promising lines in 6 environments. (,* and ns: significant at 1 and 5 percent and non-significant, respectively)**

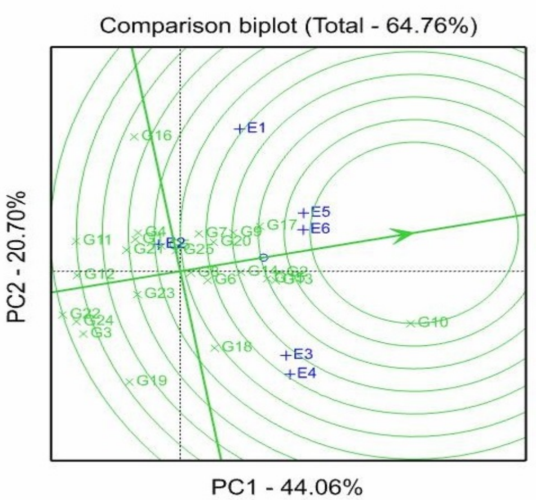

Fig. 3. Biplot of bread wheat lines comparison with ideal genotypes based on yield and stability

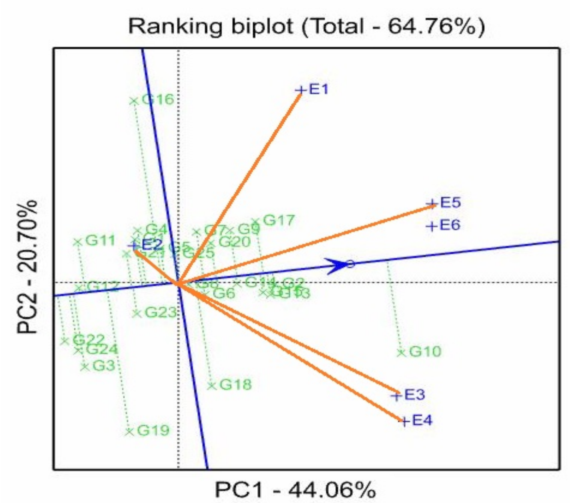

Fig. 4. Biplot which shows the relationship among different environments and discriminative representative of testers

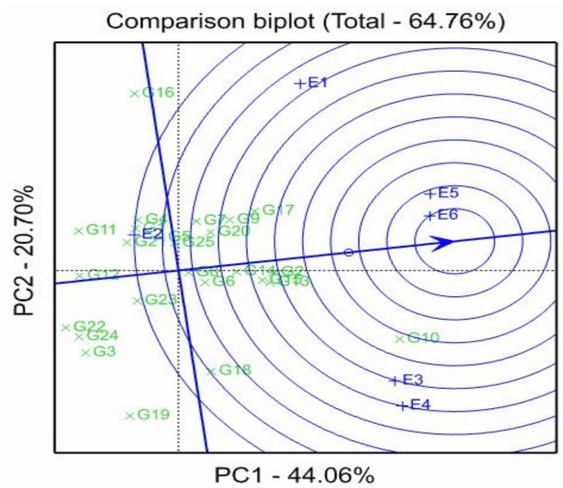

Fig. 5. Biplot for comparison of environment with the ideal based on the discriminating and representivenss ability on the target environment