INVESTIGATION OF NON-PARAMETRIC STABILITY METHODS IN 28 BREAD WHEAT GENOTYPES IN SOME TROPICAL REGIONS OF IRAN

Mehran Khaki[1], Mahdi Changizi[2]*, Mohsen Esmaeilzadeh Mogadam[3], Shahab Khaghani[4], Masoud Gomarian[2]

[1] Ph.D. Student in Plant Breeding, Islamic Azad University, Arak Branch, Arak, Iran.
[2] Assistant Prof. Faculty of Agriculture Islamic Azad University, Arak Branch, Iran.
[3] Associate Prof. Agriculture and Natural Resources Research and Education Center Karaj, Iran.
[4] Associate Prof. Faculty of Agriculture Islamic Azad University, Arak Branch, Iran.
*Corresponding author (mchangizi47@gmail.com)

Abstract

"This study was conducted to investigate the interaction effects of genotype and environment and environmental effects, adaptation and stability of bread wheat (Triticum aestivum) yield with different genetic structure and selection of stable and productive genotypes in twenty-eight bread wheat genotypes in a randomized complete block design with four replications is evaluated in Ahvaz, Dezful, Darab, Iranshahr, Zabol and Khorramabad stations for two years (94-95 and 95-96), comparison of non-parametric stability methods and the use of non-parametric tests have been the objectives of this study. The results of ANOVA composite analysis of variance at the level of meaningful 1% probability indicate that different genotypes react in different environments. Based on the results of two non-parametric statistics, Nassar and Huhn and, genotypes 16, 25, 27, 15 with low values were selected as the most stable genotypes. In the two stability criteria and, the genotypes with the lowest value are known as the most stable genotypes, genotypes 15, 16, 27 were identified as the most stable genotypes. High correlation of s statistic with grain yield and other non-parametric stability methods do not have a positive correlation with mean yield, which indicates a static concept, Thennarasu (1995) used four stability parameters to analyze the nonparametric stability. Examination of criteria, and show that genotype 27 is introduced as a stable genotype in all four criteria. TOP measurement was associated with high performance Stability, results of PC principal component analysis and correlation analysis Statistical and non-parametric stability performance showed that only ranking methods are useful for simultaneous selection for high performance and stability.

Keywords; Environmental genotype interactions; Bread wheat, stability, nonparametric methods.

Introduction

Non-parametric methods have advantages over parametric stability, deleting a genotype or adding a genotype does not change the results, parametric methods are performed on the assumption of distribution and uniformity of variance, non-parametric methods do not require the initial assumptions of analysis of variance, they are performed on the basis of grading, including ranking methods, not on the basis of measurement data. The distribution of the studied trait or characteristics in the community is clear. Huhn and Nassar proposed four methods of non-parametric stability, the mean of the rank differences is S_i^1, which measures the rank differences, and the rank variance is denoted by S_i^2, which indicates the standard deviation for genotype ranks in the target environment, the selection based on criterion $S_i^{(3)}$, shows the stability and yield of the high cultivars. Criterion $S_i^{(6)}$ is similar to criterion $S_i^{(3)}$, only the method of calculation is different. Kang (1988) used total-rank non-parametric methods, which is a combination of Shukla stability variance (1972) and performance methods, as a selection indicator. In this method, genotypes with the highest yield receive the rank of one and genotypes with the lowest variance of stability receive the rank of one, as the same way, genotypes are ranked and yield and stability variance rankings are added to each genotype, with the lowest total-rank genotypes being selected as the most desirable genotype. Nonparametric criterion, in this ranking method, is based on the performance of genotypes in each location and then is described based on the percentage of genotypes in the upper, middle and lower Fox nonparametric superiority indices with three parameters TOP, MID, LOW (Fox et al.,1990), TOP non-parametric superiority index in which the percentage of superior genotypes among the studied genotypes, whatever the TOP parameter value of a genotype is more, then it is more stable and desirable.

Experimental designs:

This experiment was performed in a randomized complete block design with four replications, by using 28 wheat genotypes, 26 lines with 2 evidences during 2015-16 and 2016-17 in Ahvaz, Darab, Dezful, Iranshahr, Zabol and Khorramabad research farms. After taking notes of preliminary statistical calculations including Bartlett test to evaluate the variance uniformity of experimental errors and composite analysis of variance to determine the main effects (year, place and genotype) of bilateral interactions (year × place, genotype × place) and tripartite interactions (Genotype × year × location) was performed on the data. Grain yield and its components including grain yield, and its components including occasional yield, seeds in spike, biological yield, 1000-seed weight, plant height, spike length and root length were examined. In order to calculate the stability by nonparametric method, the methods of mean rank and standard deviation of rank (Ketata H. 1988), Huhan criteria (1979), Nassar and Huhn (1987), Thennarasu (1995), Kang sum of ranking (1988) and Fox and et al. classification techniques (1990) have been used. The genotypes used are 1-Chamran 2-Pishtaz 3-Attila 4-Kauz / Luco 5-Irina/Babax 6-Becard/Akuri. Introducing superior wheat to farmers requires their acceptance that farmers have superior and more desirable yields than native cultivars with compatibility and stability with the introduced cultivars. Therefore, in the breeding programs of the Agricultural Research Institute, they use figures that are from the native masses of the country and can be presented to different regions. Excell software was used to perform simple calculations on data transfer and for data analysis the SPSS and SAS software are used.

- **Methods of Huhn and Nassar (1987):**

The mean of the rank differences $S_i^{(1)}$ measures rank differences and rank variance $S_i^{(2)}$ shows the standard deviation for genotype rankings in the target environment. For calculation $S_i^{(1)}$ and $S_i^{(2)}$, first the values of χ_{ij} , where it is the phenotypic value, must be converted and corrected. because differences between genotypes affect the size of statistical stability, it may cause differences in genotypes.

$$S_i^{(1)} = 2\sum_{j}^{n-1}\sum_{j'=j+1}^{n}\left|r_{ij}^* - r_{ij'}^*\right|/[n(n-1)]$$

$$X_{ijk}^* = X_{ijk} - \left(\bar{X}_{i00} - \bar{X}_{000}\right)$$

$S_i^{(1)}$ has the concept of environmental variance, in fact it measures the difference of rank i on all environments, and similarly shows the biological stability. Rank variance $S_i^{(2)} = \sum_{j=1}^{n}(r_{ij}^* - \bar{r}_{i.}^*)^2/(n-1)$ is a parameter that indicates the standard deviation for the rankings of a genotype.

Statistics test of $S_i^{(1)}$ and $S_i^{(2)}$ has been suggested by Huhn and Nansar (1987) as follows. For all genotypes that have the same stability, the significance test based on normal distribution was used.

$$S^{(m)} = \sum_i^I Z_i^m, \quad m = 1, 2$$

$$Z_i^{(m)} = \frac{\left[S_i^{(m)} - E\left(S_i^m\right)\right]^2}{Var\left[S_i^{(m)}\right]}$$

where Z_i and $S^{(m)}$ have approximate distribution of statistics χ^2 with the degree of freedom of one, $E\left(S_i^m\right)$ is the mean of S_i^m and $Var\left[S_i^{(m)}\right]$ is the variance of $S_i^{(m)}$.

- **Huhn's method (1979):**

In this method we have,

$$S_i^{(3)} = \frac{\sum_{j=1}^{n}(r_{ij} - \bar{r}_{i.})^2}{\bar{r}_{i.}}$$

and

$$S_i^{(6)} = \frac{\sum_{j=1}^{n}|r_{ij} - \bar{r}_{i.}|}{\bar{r}_{i.}}$$

where r_{ij} is the rank of i -th genotype in the i -th environment and $\bar{r}_{i.}$ is the mean of i -th genotype. Selection based on S criterion shows the stability and performance of the above cultivars. Criterion $S_i^{(6)}$ is similar to criterion $S_i^{(3)}$, only the method of calculation is different.

- **Thennarasu's non-parametric criteria**

Thennarasu (1995) used the following four stability parameters to analyze the nonparametric stability.

$$NP_i^{(3)} = \frac{\sqrt{\sum\left(r_{ij}^* - \bar{r}_{i.}^*\right)^2/n}}{\bar{r}_{i.}}$$

$$NP_i^{(2)} = \frac{1}{n}\left[\sum_{J=1}^{n}\left|r_{ij}^* - M_{di}^*\right| / M_{di}\right]$$

$$NP_i^{(1)} = \frac{1}{n}\sum_{J=1}^{n}\left|r_{ij}^* - M_{di}^*\right|$$

where r_{ij}^* is the corrected performance ranking, M_{di}^* and $\overline{r^*}_{i.}$ are the median and mean of the corrected ranks of the i-th genotype, respectively and M_{di} and $\bar{r}_{i.}$ are the median and mean uncorrected ranks of the i-th genotype, respectively.

- **Rank sum test**

These methods are based on the ranking of genotypes in the environment. Rank stability means environmental resistance or genotype ability to remain constant in different environments (Huhn, V. M. 1979). If its rank is the same in different environments, it has stability. The Kang (1988) rank sum criterion is a non-parametric criterion that uses a combination of Shukla stability variance (Shukla, G. K. 1972) and genotype mean performance as the selection index (Kang, M. S. 1991).

Results and Discussion

Non-parametric methods include the stability analysis of Huhn, Nassar and Huhn, and Thennarasu, the classification rankings of Fox et al., and the Kang ranking set. The studied nonparametric statistics for the selection of stable genotypes are presented in Table 2. The suggested criteria are Huhn (1979), Nassar and Huhn (1989), Thennarasu (1995), ranking method of Fox and et al. and rank sum method of Kang (1993). The sum of Z_1 is equal to 30/492 and Z_2 is equal to 26/439. Due to the fact that the sum of Z_1 and Z_2 is less than the value of χ^2 ($\chi^2 \%5, df\ 28 = 41.3$), so no significant difference in terms of Z_1 and Z_2 was observed in the stability of the studied 28 genotypes.

It was proposed by Han and Nassar (1987) to test the stability of Z_1 and Z_2 individually for each genotype. In the individual study of Z values, it was observed that genotype number 16 is significantly unstable because these genotypes have a higher Z value compared to Table χ^2 ($\chi^2 \%5, df\ 16 = 3.84$). Based on the results of two non-parametric statistics of Nassar and Huhn S_1 and S_2, Table 2, genotypes 16, 25, 27, 15 with low values of S_1 and S_2 and higher yield than the average total yield were selected as the most stable genotype. Since nonparametric statistics are based on the rank of genotypes in all environments, genotypes with less than variable rank are identified as more stable genotypes (Becker, H. C., and Leon, J. 1988). Genotypes 13 and 6 were not recognized as stable genotypes with low S_1 and S_2 values and low yield of average yield. Genotypes that have a high yield of average yield and high values of S_1 have a high susceptibility to environmental changes and as a result have a very high yield in suitable environments, which were 20, 22, 24, 28 genotypes. Genotype No. 2 with high values of S_1 and S_2 and average yield less than the average total yield is not in the group of stable cultivars, considering the mean and variance of S_1 and S_2 statistics, it can be said that genotypes with values less than the average of 9/24; are in the group of stable cultivars and values above the average are in the group of unstable cultivars. Statistics S_1 is more accurate than S_2, by calculating the amount of variance and the mean of these two statistics and their coefficient of variation, we can say that the accuracy of statistics S_1 in choosing a stable genotype is higher than S_2 because mathematical expectation S_1 is greater than S_2 and variance S_1 is smaller than variance S_2, therefore, S_1 is more sensitive and accurate than S_2 and is more likely to be significant. The distribution of genotypes based on the mean S_1 S_2 is shown in Figure 1, four regions are recognizable in the figure (Kaya, Y., and Taner, S. 2003).

1. Genotypes with higher than total mean yields and lower than S_1 values are in the first region.
2. Genotypes with higher than total mean yields and upper than S_1 values are in the second region.
3. Genotypes with higher than total mean yields and upper than S_1 values are in the third region.
4. Genotypes with higher than total mean yields and lower than S_1 values are in the fourth region.

Only genotypes of the first region are recommended as desirable and stable genotypes. The distribution of genotypes S_2 in Figure 1 is similar to the distribution of genotypes S_1. According to the figures, genotypes 15, 19, 1, 25, 16, 27 are the most stable genotypes that are located in the first region. In the second region, which shows the greater sensitivity of genotypes to environmental changes and have a high yield in well-conditioned environments, the genotypes 2, 17, 14, 7, 24, 12, 22, 28, 20, 23 are in this region. Genotypes 18, 9, 10, 3, 4, 21 are in the third region and these genotypes were not in the group of stable cultivars and genotypes 8, 13, 11, 26, 5, 6 are in the fourth region. Two criteria of stability S_3 and S_6 are the genotypes with the lowest value are known as the most stable genotypes (Kaya, Y., and Taner, S. 2003). Genotypes 15, 16, 27 are the most stable genotypes. Genotypes 15, 16, 27 are introduced as the most stable genotypes with the lowest values of S_3 and S_6 statistics by referring to Table 1.

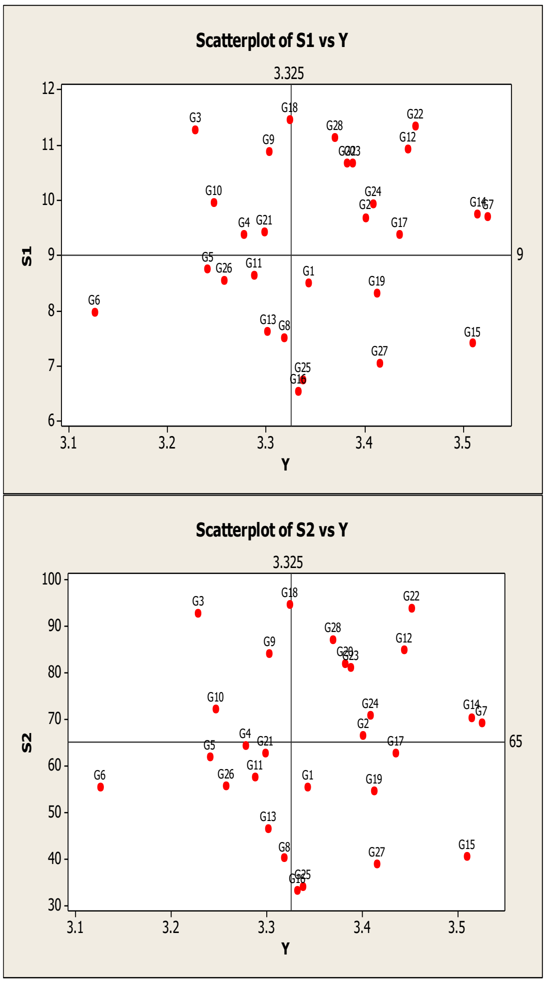

Figure 1. Mean performance distribution diagrams of S_1 and S_2.

According to the table in the criterion NP_1, genotypes 16, 25, 27, 13 were introduced as the most stable genotypes, respectively. The two genotypes 22, 18, 3, 20 were introduced as the most unstable genotypes.

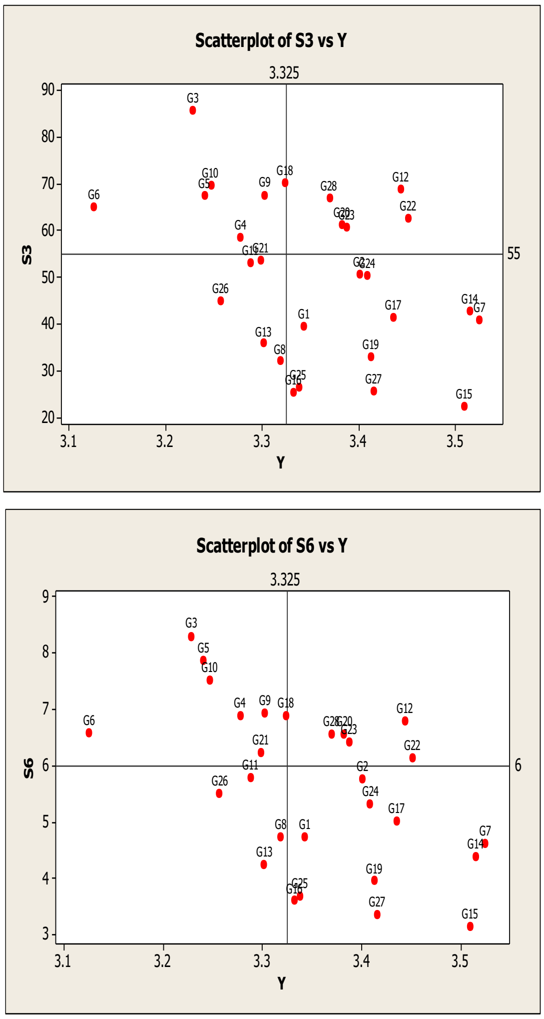

Figure 2. Mean performance distribution diagrams of S_3 and S_6.

In criterion NP_2, genotypes 19, 27, 15, 25 were introduced as the most stable genotypes and genotypes 6, 5, 3, 4 were introduced as the most unstable genotypes. The most stable genotypes 15, 27, 19, 16 and the most unstable genotypes 3, 6, 11, 5 were identified by criterion NP_3. By examining criterion NP_4, genotypes 15, 27, 16, 19 with the lowest values were introduced as the most stable genotypes and genotypes 3, 10, 5, 6 were identified as the most unstable genotypes. Examining the criteria NP_1, NP_2, NP_3 and NP_4 showed that genotype number 27 in all four criteria, genotypes number 15, 27, 18 in three criteria have been introduced as stable genotype and the most unstable genotypes based on four criteria, in all criteria genotype 3 and genotypes 3, 5, 6 were identified as unstable genotypes in three criteria. Genotypes Nos. 22, 16 which had high yield were introduced as unstable genotypes. The distribution of genotypes based on the mean and NP_1, NP_2, NP_3 and NP_4 is shown in Figures 3 and 4.

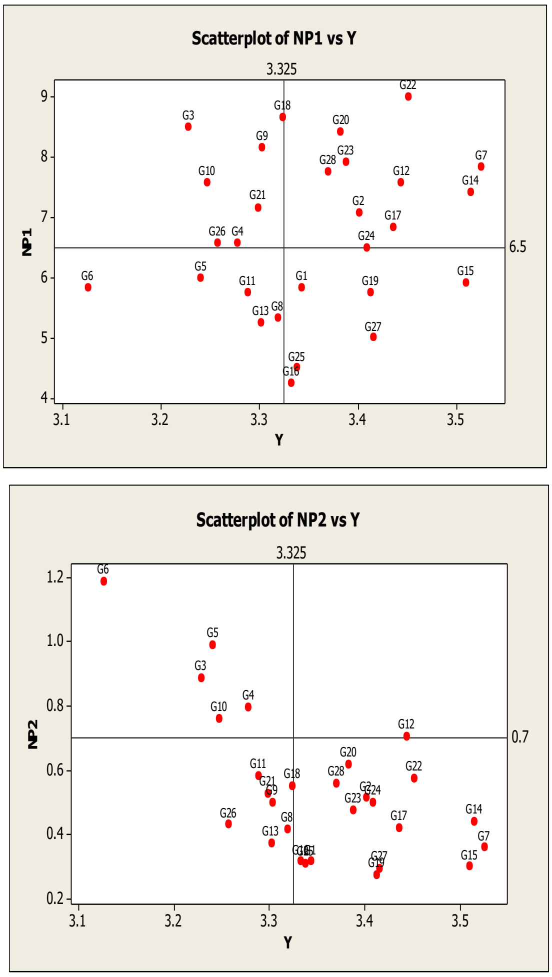

Figure 3. Mean performance distribution diagrams of NP_1 and NP_2

Non-parametric Fox superiority indices have three parameters TOP, MID, LOW and Kang ranking set which are shown in Table 2. TOP non-parametric superiority index in which the percentage of superior genotypes among the studied genotypes, genotypes 5, 6 and 8 have the most stable genotypes among the studied genotypes, because, whatever the TOP parameter of a genotype is higher, then its stability and desirability are also higher. Genotypes 19, 14 and 15 were the most unstable genotypes studied according to TOP non-parametric statistics.

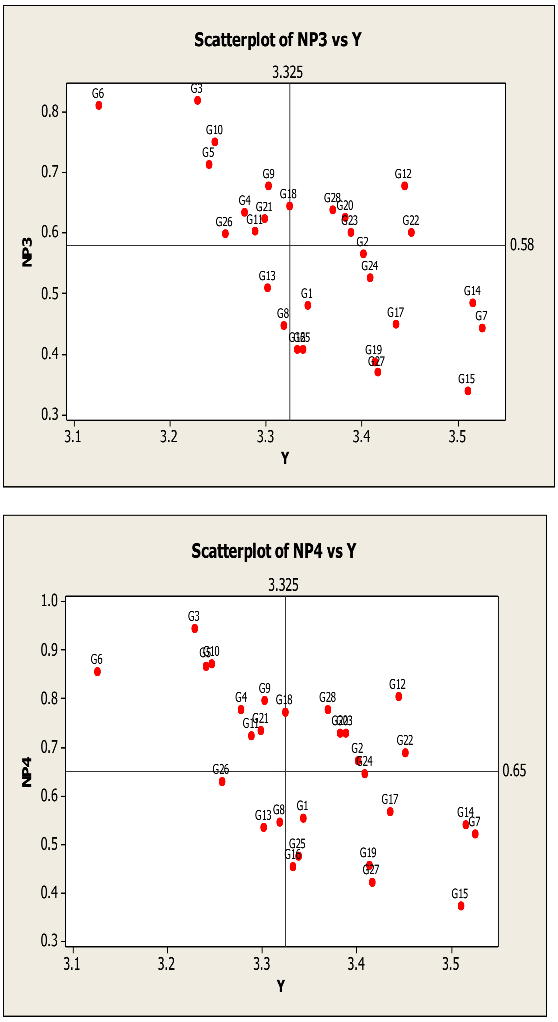

Figure 4. Mean performance distribution diagrams of NP_3 and NP_4

In the above study, TOP statistics, a positive and significant correlation at the level of one percent of the average yield, showed that according to non-parametric MID statistics, according to Table 2, genotypes 3, 6, 10 and 20 were the most stable genotypes, which has been observed in some studies. Stability genotypes were introduced in nonparametric statistics (Fox et al., 1990). Our results were in line with the results of a large number of researchers, including Kang and Pham. In their studies, they observed that the standard methods of total rank and superiority index of Linand Binns were correlated with each other and had a positive and high relationship with the mean performance based on Kang sum statistics, stable genotypes have the lowest total rank value, where genotypes 7, 15 and 27 with the lowest rank being introduced as stable genotypes and the most unstable genotypes are 3, 6 and 10 with the highest rank.

Table 1. Stability nonparametric statistics for grain yield of bread wheat genotypes studied in six environments

Genotype	Mean yield	Huhn and Nassar's, Huhn's Statistics						Thennarasu's Statistics				Fox and et al. Classification			Kang's rank sum
		$S_i^{(1)}$	$Z_i^{(1)}$	$S_i^{(2)}$	$Z_i^{(2)}$	$S_i^{(3)}$	$S_i^{(6)}$	$NP_1^{(1)}$	$NP_1^{(2)}$	$NP_1^{(3)}$	$NP_1^{(4)}$	TOP	MID	LOW	RS
1	3.3435	8.4848	0/36486	55.1515	0/29367	39.6662	4.73913	6.89333	0.31429	0.48023	0.55336	14	6	8	12
2	3.4013	9.6118	0.06585	66.4470	0.00413	50.6994	5.75723	7.08333	0.51235	0.56455	0.67157	8	23	19	15
3	3.2266	11.25576	1.90073	92.6288	2.15862	85.5035	8.29371	8.50000	0.88596	0.81886	0.94469	8	27	23	28
4	3.2780	9.3788	0.00167	64.2662	0.00279	58.5034	6.88276	6.68333	0.79630	0.63339	0.77617	14	23	23	13
5	3.2407	8.7424	0.16998	61.7197	0.03589	67.3306	7.86777	6.0000	0.98810	0.71323	0.86701	26	14	27	24
6	3.1261	7.9697	0.92645	55.1515	0.29367	65.0000	6.57143	5.83333	1.18750	0.81048	0.85389	26	27	28	26
7	3.5252	9.6970	0.07151	69.1515	0.04383	40.7500	4.60714	7.83333	0.35833	0.44140	0.51948	2	14	6	1
8	3.3187	7.5000	1.68216	40.0227	1.83268	32.0182	4.72727	5.33333	0.41667	0.44684	0.54545	26	6	19	10
9	3.3030	10.8788	1.22976	83.8788	0.99935	67.5122	6.92683	8.16667	0.50000	0.67647	0.79600	8	14	15	22
10	3.2471	9.9545	0.20324	72.0833	0.13447	69.4526	7.51825	7.58333	0.75833	0.74934	0.87193	14	23	23	27
11	3.28863	8.6212	0.24860	57.3561	0.17945	62.9441	5.77622	5.75000	0.58333	0.60265	0.72345	20	14	23	17
12	3.44408	10.9242	1.30259	84.8106	1.10118	68.6810	6.78528	7.58333	0.70290	0.67682	0.80423	14	14	19	15
13	3.30198	7.6212	1.46572	46.3864	1.02470	35.8070	4.24561	5.25000	0.37097	0.50964	0.53482	20	1	3	18
14	3.51504	9.7424	0.08987	70.2552	0.07243	42.7419	4.36866	7.41667	0.44017	0.48338	0.53875	2	10	3	8
15	3.50983	7.3939	1.88376	40.3333	1.78783	22.3697	3.14286	5.91667	0.29845	0.33914	0.37280	2	6	1	1
16	3.33260	6.5303	3.95004	33.1742	2.95279	25.3121	3.59538	4.25000	0.31481	0.40688	0.45296	20	3	8	6
17	3.43575	9.3788	0.00167	62.4470	0.02263	41.4221	5.00503	6.83333	0.41919	0.44946	0.55555	5	10	6	4
18	3.32417	11.4545	2.30713	94.5152	2.46632	70.0899	6.87640	8.66667	0.54839	0.64389	0.77221	5	14	8	22
19	3.41294	8.3030	0.52587	54.5152	0.33185	33.0092	3.94495	5.75000	0.27381	0.38627	0.45704	1	24	3	9
20	3.38271	10.6667	0.91757	81.6970	0.77897	61.2727	6.54545	8.41667	0.61538	0.62559	0.72727	8	23	19	10
21	3.29894	9.4242	0.00536	62.5152	0.02154	53.5844	6.23377	7.16667	0.52564	0.62324	0.73435	20	6	15	14
22	3.45162	11.3333	2.05238	93.7273	2.33531	62.4848	6.12121	9.0000	0.57471	0.60090	0.68686	5	14	8	6
23	3.38802	10.6667	0.91757	80.9697	0.71160	60.7273	6.40909	7.91667	0.47475	0.59966	0.72727	8	14	15	19
24	3.40875	9.9242	0.18425	70.6288	0.08331	50.3946	5.30811	6.50000	0.50000	0.52485	0.64373	8	10	8	21
25	3.33804	6.7273	3.41220	33.9697	2.81766	26.3765	3.67059	4.50000	0.30952	0.40737	0.47486	20	3	8	5
26	3.25733	8.5303	0.31735	55.5379	0.27163	44.9755	44.9755	5.49693	6.58333	0.42929	0.59843	20	3	8	24
27	3.41590	7.0303	2.66159	38.7879	2.01649	25.6000	3.36000	5.00000	0.29412	0.36864	0.42181	14	1	1	3
28	3.36990	11.1212	1.64242	86.9697	1.35848	66.7442	6.55814	7.75000	0.55952	0.63696	0.77589	14	10	15	19
sum						30.492		26.439							

Table 2. Rankings for grain yield of bread wheat genotypes studied in six environments

Genotype	Mean yield	Huhn and Nassar's, Huhn's Statistics						Thennarasu's Statistics				Fox and et al. Classification			Kang's rank sum
		$S_i^{(1)}$	$Z_i^{(1)}$	$S_i^{(2)}$	$Z_i^{(2)}$	$S_i^{(3)}$	$S_i^{(6)}$	$NP_1^{(1)}$	$NP_1^{(2)}$	$NP_1^{(3)}$	$NP_1^{(4)}$	TOP	MID	LOW	RS
1	15	9	12	8	12	8	10	8	5	9	10	14	6	8	12
2	19	16	4	16	2	14	14	16	16	13	14	8	23	19	15
3	2	26	23	26	24	28	28	26	26	28	28	8	27	23	28
4	6	13.5	1	15	1	17	24	13	25	20	22	14	23	23	13
5	3	12	7	12	5	23	27	11	27	25	26	26	14	27	24

6	1	7	16	9	13	21	21	9	28	27	25	26	27	28	26
7	28	17	5	17	6	9	8	22	7	6	6	2	14	6	1
8	11	5	21	4	22	5	9	5	9	7	9	26	6	19	10
9	10	23	17	23	17	24	25	24	14	23	23	8	14	15	22
10	4	20	9	20	9	26	26	19	24	26	27	14	23	23	27
11	7	11	10	11	10	15	15	6	21	17	16	20	14	23	17
12	24	24	18	24	19	25	22	20	23	24	24	14	14	19	15
13	9	6	19	6	18	7	6	4	8	11	7	20	1	3	18
14	27	18	6	18	7	11	7	18	12	10	8	2	10	3	8
15	26	4	22	5	21	1	1	10	4	1	1	2	6	1	1
16	13	1	28	1	28	2	3	1	6	4	3	20	3	8	6
17	23	13.5	2	13	4	10	11	15	10	8	11	5	10	6	4
18	12	28	25	28	26	27	23	27	18	22	20	5	14	8	22
19	21	8	13	7	14	6	5	7	1	3	4	1	14	3	9
20	17	21.5	14	22	16	19	19	25	22	19	17	8	23	19	10
21	8	15	3	14	3	16	17	17	17	18	19	20	6	15	14
22	25	27	24	27	25	20	16	28	20	16	15	5	14	8	6
23	18	15.5	15	21	15	18	18	23	13	15	18	8	14	15	19
24	20	19	8	19	8	13	12	12	15	12	13	8	10	8	21
25	14	2	27	2	27	4	4	2	4	5	5	20	3	8	5
26	5	10	11	10	11	12	13	14	11	14	12	20	3	8	24
27	22	3	26	3	23	3	2	33	2	2	2	14	1	1	3
28	16	25	20	25	20	22	20	2	19	21	21	14	10	15	19

Table 3. Spearman's rank correlation of nonparametric statistics of stability with mean yield in 28 wheat genotypes

	Y	$S_i^{(1)}$	$S_i^{(2)}$	$S_i^{(3)}$	$S_i^{(6)}$	$NP_1^{(1)}$	$NP_1^{(2)}$	$NP_1^{(3)}$	$NP_1^{(4)}$	LOW	MID	TOP	RS
Y	1												
$S_i^{(1)}$	-0.09	1											
$S_i^{(2)}$	-0.078	.997**	1										
$S_i^{(3)}$	0.403*	0.821**	0.833**	1									
$S_i^{(6)}$	0.552**	0.698**	0.713**	0.957**	1								
$NP_1^{(1)}$	0.128	0.942**	0.944**	0.744**	0.683**	1							
$NP_1^{(2)}$	0.552**	0.580**	0.609**	0.870**	0.896**	0.504**	1						
$NP_1^{(3)}$	0.601**	0.672**	0.667**	0.955**	0.962**	0.507**	0.831**	1					
$NP_1^{(4)}$	0.578**	0.652**	0.668**	0.949**	0.984**	0.573**	0.923**	0.982**	1				
LOW	0.672**	0.283	0.301	0.672**	0.794**	0.213	0.846**	0.792**	0.828**	1			
MID	0.224	0.575**	0.601**	0.719**	0.728**	0.576**	0.749**	0.682**	0.708**	0.672**	1		
TOP	0.701**	-0.444*	-0.440*	-0.005	0.136	-0.520**	0.241	0.273	0.216	0.503**	-0.238	1	
RS	0.740**	0/408*	0.416*	0.740**	0.762**	0.289	0.667**	0.815**	0.788**	0.642**	0/432	0/349	1

ns *** Significant at the level of 0.01 and 0.05 and non-significant, respectively.

Y , ($S_i^{(1)}$, $S_i^{(2)}$, $S_i^{(3)}$, $S_i^{(6)}$), ($NP_1^{(1)}$, $NP_1^{(2)}$, $NP_1^{(3)}$, $NP_1^{(4)}$), (TOP, MID, LOW), RS, respectively they are mean yield, Huhn and Nassar, Huhn statistics, Thennarasu's statistics, Fox and et al. classification techniques and Kang ranking set.

Relationships between nonparametric statistics of stability and mean performance

Spearman correlation analysis method is performed and its results are shown in Table ...., the mean performance showed a positive and significant correlation with $S_i^{(6)}$, $NP_1^{(2)}$, $NP_1^{(3)}$, $NP_1^{(4)}$, LOW, TOP and RS statistics at 1% level and with $S_i^{(3)}$ statistics at 5% level.

The correlation of $S_i^{(1)}$ statistic with $S_i^{(2)}$, $S_i^{(3)}$, $S_i^{(6)}$, $NP_1^{(1)}$, $NP_1^{(2)}$, $NP_1^{(3)}$, $NP_1^{(4)}$, MID statistics is significant at the level of one percent and with the statistic of RS at the level of five percent and has a negative and significant correlation with the statistic TOP at the level of five percent probability.

The correlation of $S_i^{(2)}$ statistic with $S_i^{(3)}$, $S_i^{(6)}$, $NP_1^{(1)}$, $NP_1^{(2)}$, $NP_1^{(3)}$, $NP_1^{(4)}$, MID statistics is significant at the level of one percent and with the statistic of RS at the level of five percent and has a negative and significant correlation with the statistic TOP at the level of five percent probability.

The correlation of $S_i^{(3)}$ statistic with $S_i^{(6)}$, $NP_1^{(1)}$, $NP_1^{(2)}$, $NP_1^{(3)}$, $NP_1^{(4)}$, LOW, MID and RS statistics is significant at the level of one percent.

The correlation of the $S_i^{(3)}$ statistic is shown at the level of one percent probability with the $S_i^{(6)}$, $NP_1^{(1)}$, $NP_1^{(2)}$, $NP_1^{(3)}$, $NP_1^{(4)}$, LOW, MID and RS statistics.

The correlation of the $S_i^{(6)}$ statistic is shown at the level of one percent probability with the $NP_1^{(1)}$, $NP_1^{(2)}$, $NP_1^{(3)}$, $NP_1^{(4)}$, LOW, MID and RS statistics.

Statistical $NP_1^{(1)}$ showed a positive and significant correlation at the level of one percent probability with the statistics of $NP_1^{(2)}$, $NP_1^{(3)}$, $NP_1^{(4)}$ and MID with the statistic TOP showed a negative and significant correlation at the level of one percent.

Showed a positive and significant correlation of $NP_1^{(2)}$ statistic at the level of one percent with $NP_1^{(3)}$, $NP_1^{(4)}$, LOW, MID and RS.

Statistics $NP_1^{(3)}$ showed a positive and significant correlation at the level of one percent with $NP_1^{(4)}$, LOW, MID and RS.

Statistics $NP_1^{(4)}$ showed a positive and significant correlation at the level of one percent with LOW, MID and RS. Statistics $NP_1^{(3)}$ showed a positive and significant correlation at the level of one percent with $NP_1^{(4)}$, LOW, MID and RS.

Mean yield (Y) correlation did not have a significant load rank for many nonparametric statistics, including $S_i^{(1)}$ and $S_i^{(2)}$, indicating that stable genotypes selected based on $S_i^{(1)}$ and $S_i^{(2)}$ statistics did not have high performance.

The mean of correlation yield was positive and significant with MR, TOP and RS at the level of 1% probability (Table 3), which indicates the high potential of statistics for selection of stable genotype with high yield. Also, similar results by Mohammadi et al. (2007) Solomon et al. (2006) reported a significant correlation between mean and performance of TOP and RS. (Mohammadi et al., 2007 and Sabaghia et al., 2006).

Summarize the results

The results of analysis of variance showed that there is a significant difference between genotypes, environment and interaction. Which shows the different reaction of genotypes in different places and years and is the main changes related to the environment. Based on the mean rank of genotype 5 has the lowest and genotype 15 has the highest rank and in terms of genotype performance, in the first year, in the city of Ahvaz, genotype 22 showed the lowest, and genotype 7 showed the highest yield. In other cities: Zabol, genotype 6 and 3, Darab 9 and 14, Dezful 3 and 12, Khorramabad 3 and 2, Iranshahr 10 and 24, respectively. In the second year, Ahvaz showed 12 and 22, Zabol 24 and 12, Darab 24 and 5, Dezful 9 and 15, Khorramabad 13 and 11, Iranshahr 28 and 14, respectively. Genotypes 15, 16, 25, 27 have been shown to be stable genotypes in most nonparametric methods.

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