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Evaluation of Seed Yield Stability of Wheat Advanced Genotypes in Ardabil, Iran

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Abstract: Eighteen advanced Winter and intermediate cold hardy wheat genotypes and two advanced genotypes of Toos and Alvand as checks to compare their tolerance to the late season drought stress. The experiment was conducted under two different irrigation conditions of (a) normal irrigation and (b) late season drought stress condition where the last two irrigations were cut off after the heading of the wheat. Each of two experiments was conducted in a randomized complete block design with three replications and 20 wheat genotypes. The analysis of variance showed that genotypes×environments×regressions interaction and AMMI component 1 were significant. Results show that 10(5002), 2(4016), 15(5034), 1(4002) and 6(4034) the high seed yield in all of sites and all of environment conditions and two years (2007-2008). These genotypes had the high seed yield in normal and drought stress. The 10, 2, 15, 6, 7 and 11 genotypes have rather good adaptation to a wide range of environments toward other genotypes and selected for stabile genotypes.

Key words: AMMI, stability, drought, stress, wheat, yield

INTRODUCTION

The wheat crop is very sensitive to water stress and available soil water. Moisture deficiency, specially after anthesis, is one of the main constrains of wheat production in most part of Central Asia and the Middle-East including Iran (Ehdaie, 1995). Drought stress can reduce grain yield. Edmeades *et al.* (1995) have estimated the average yield loss of 17 to 70% in grain yield due to drought stress. Drought stress may occur throughout the growing season, early or late season, but its effect on yield reduction is highest when it occurs after anthesis (Blum, 2005). Morphological characters such as root length, tillering, spike number per m^2, kernel number per spike, fertile tillers number per plant, 1000 kernel weight, peduncle length, spike weight, stem weight, awn length, grain weight per spike and etc. affect the wheat tolerance to the moisture shortage in the soil (Lazar *et al.*, 1995; Boyer, 1996; Moustafa *et al.*, 1996; Plaut *et al.*, 2004; Blum, 2005).

Sabaghniaa *et al.* (2006) resulted genotype by environment interactions are important sources of variation in any crop and the term stability is sometimes used to characterize a genotype, which shows a relatively constant yield, independent of changing environmental conditions. On the basis of this idea, genotypes with a minimal variance for yield across different environments are considered stable.

The stability methods can be divided into two major groups: univariate and multivariate stability statistics (Lin *et al.*, 1986). Ebdon and Gauch (2002) showed among multivariate methods, the additive main effect and the multiplicative interaction analysis (AMMI) are widely used for G×E investigation. This method has been shown to be effective because it captures a large portion of the G×E sum of square, it clearly separates main and interaction effects that present agricultural researchers with different kinds of opportunities and the model often provides agronomically meaningful interpretation of the data. Gauch and Zobel (1997) showed that the results of AMMI analysis are useful in supporting breeding program decisions such as specific adaptation and selection of environment. Usually, the results of AMMI analysis shown in common graphs are called biplot. The biplot shows both the genotypes and the environment value and relationships using singulars vectors technique.

The AMMI model has been extensively applied in the statistical analysis of multi-environment cultivar trials (Kempton, 1984; Gauch and Zobel, 1989, 1997; Crossa *et al.*, 1990).

The objective of this study, therefore, was to determine the yield performance and to assess the yield stability of the 20 genotypes of wheat in four environments by using the AMMI statistical model.

MATERIALS AND METHODS

This study was conducted at the Agriculture and Natural Resource Research Center of Ardabil, Iran (48°, 20' N; 38°, 15' E) in 2007-2008. The soil texture at the experimental site is clay-loam. The average minimum, maximum and absolute temperature during the experiment were 1.98, 15.18 and 21.58°C, respectively and the long term average rainfall of the region is 310 mm. The effective soil depth (A+B) is 70 cm and the drainage of the soil is considered to be very suitable and the level of underground water is very deep. Ardabil plain has a typical semi-arid cold climatic condition with a long dry Summer and cold Winter. The soil pH of the experimental site is 7.7 and its EC is one mmos. The P and K concentrations of the soil are 12 and 400 ppm, respectively. Eighteen advanced winter and intermediate cold hardy wheat genotypes and two advanced genotypes of Toos and Alvand as checks to compare their tolerance to the late season drought stress. The experiment was conducted under two different irrigation conditions of (a) normal irrigation, where the plots were irrigated 6 times with an approximately 10 days intervals throughout the growing season started at the end of rainfall season that coincided and (b) late season drought stress condition where the last two irrigations were cut off after the heading of the wheat. Each of two experiments was conducted in a randomized complete block design with three replications and 20 wheat genotypes. Combined analysis of variances were done and comparison of means were done by Duncan test. The G×E interaction was partitioned according to the (AMMI) model. The AMMI analysis combines analysis of variance and principal component analysis into a single model with additive and multiplicative parameters. All analysis were carried out using the CropStat 7.2 software packages.

RESULTS AND DISCUSSION

Combined analysis of variance showed that were significant differences between location (L), year (Y), genotypes (A) and their interaction on tuber yield. Because of their interaction significant differences for tuber yield, the below mentioned AMMI analysis were used to estimate the highest stable cultivars.

The analysis of variance for the AMMI model of seed yield showed that genotypes×environments×regressions interaction (Table 1) and AMMI component 1 (Table 2) were significant.

Table 1: Analysis of variance with site regressions on tuber yield

Sources	df	SS	MS
Cultivars (Cul.)	19	16.001	0.84
Environments (Env.)	3	46.22	15.41
Cul.×Env.	57	20.33	0.36
Cul.×Env.×Reg.	19	4.16	0.22*
Deviations	38	16.17	0.43
Total	79	82.55	

*Significant interaction

Table 2: Analysis of variance for the AMMI model

Sources	df	SS	MS
Cultivars (Cul.)	19	16.001	0.84
Environments (Env.)	3	46.22	15.41
Cult.×Env.	57	20.33	0.36
AMMI Component 1	21	12.47	0.59**
AMMI Component 2	17	4.14	0.22
Total	79	82.55	

**Significant component 1

Table 3: Stability regressions of seed yield for each genotype on means of yield at each environment

Cultivars	Mean	Slope	SE	MS-TXL	MS-REG	MS-DEV
C-85 D1 (4002)	4.01	1.053	0.207	0.07	0.01	0.10
C-85 D2 (4016)	4.11	1.173	0.504	0.41	0.07	0.59
C-85 D3 (4025)	3.04	1.201	0.427	0.31	0.09	0.42
C-85 D4 (4032)	3.20	0.551	0.253	0.25	0.47	0.15
C-85 D5 (4033)	3.46	0.710	0.283	0.19	0.19	0.18
C-85 D6 (4034)	3.97	0.802	0.449	0.34	0.09	0.47
C-85 D7 (4041)	3.97	1.560	0.402	0.49	0.72	0.37
C-85 D8 (4062)	2.73	0.765	0.590	0.58	0.13	0.81
C-85 D9 (4083)	3.62	0.614	0.257	0.22	0.34	0.15
C-85 D10 (5002)	4.27	0.933	0.460	0.33	0.01	0.49
C-85 D11 (5012)	3.83	1.163	0.369	0.23	0.06	0.31
C-85 D12 (5014)	2.99	0.956	0.312	0.15	0.00	0.22
C-85 D13 (5015)	3.23	0.538	0.287	0.29	0.49	0.19
C-85 D14 (5024)	2.84	0.823	0.735	0.86	0.07	1.25
C-85 D15 (5034)	4.03	1.138	0.407	0.27	0.04	0.38
C-85 D16 (5037)	3.82	1.456*	0.033	0.16	0.48	0.00
C-85 D17 (5041)	3.31	0.760	0.081	0.05	0.13	0.01
C-85 D18 (5046)	3.63	1.165	0.319	0.18	0.06	0.23
Toos (control)	3.82	1.532	0.366	0.42	0.65	0.31
Alvand (control)	3.21	1.105	0.790	0.97	0.03	1.44

Slope: Slopes of regressions of cultivar means on environment index. *Slope significantly different from the slope for the overall regressions which is 1.00. MS-TXL: Contribution of each cultivar to interaction MS. MS-REG: Contribution of each cultivar to the regression component of the treatment by location interaction. MS-DEV: Deviations from regression component of interaction. R^2: Squared correlation between residuals from the main effects model and the site index. Cultivar yield was site index with overall mean 1.278

Results show that 10(5002), 2(4016), 15(5034), 1(4002) and 6(4034) the high seed yield in all of sites (Table 3) and all of environment conditions and two years (2007-2008). These genotypes had the high seed yield in normal and drought stress.

Stability regressions of seed yield for each genotype on means of seed yield at each environment showed that 10(5002), 2(4016), 15(5034) and 1(4002) genotypes had the less slop (Slopes of regressions of cultivar means on environment index) and 15(5034) and 1(4002) genotypes S.E., MS-TXL (Contribution of each cultivar to interaction MS), MS-REG (Contribution of each cultivar to the regression component of the treatment by location interaction) and MS-DEV (Deviations from regression component of interaction) among other genotypes and was the most stable genotypes (Table 3).

Eight genotype posed in quadrant 1 show that it is stabile genotype with low yield but was more adapted to stress condition. The 10, 2, 15, 6, 7 and 11 genotypes posed in

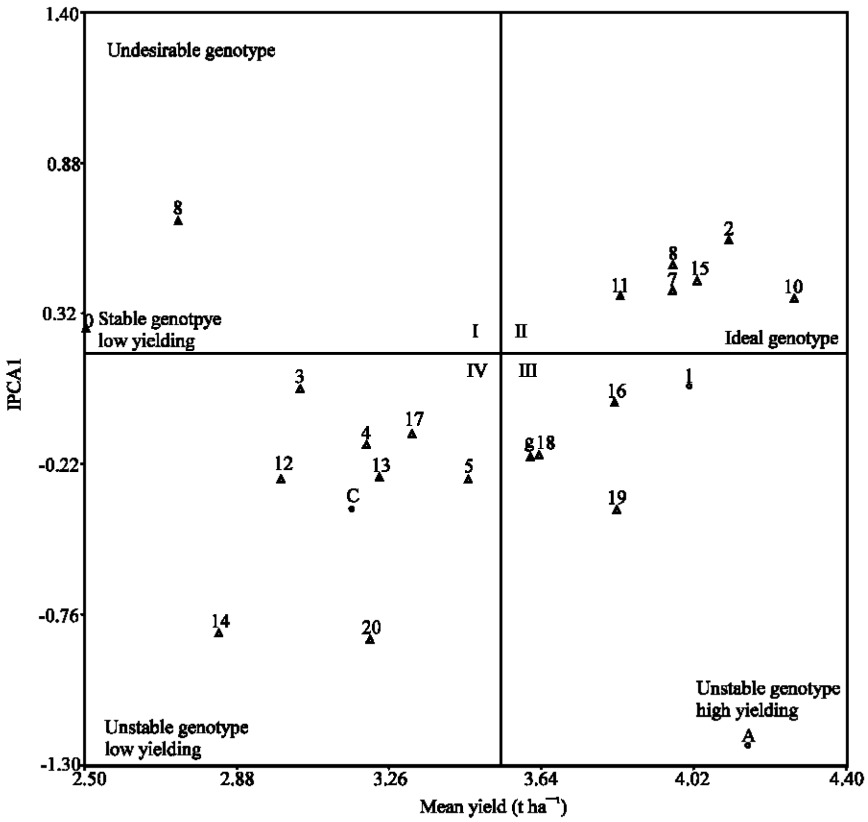

Fig. 1: AMMI1 biplot of interactions of cultivars×locations×years

quadrant 2 show that they have rather good adaptation to a wide range of environments toward other genotypes. The 19, 18, 9, 16 and 1 genotypes posed in quadrant 3 show that they are unstable genotype with high yield. The 5, 17, 13, 4, 3, 12, 20 and 14 genotypes posed in quadrant 4 show that they are unstable genotype with low yield but were more adapted to stress condition (Fig. 1).

The AMMI analysis should provide (1) an enhanced understanding of G×E in METs, (2) increasingly accurate yield estimates using means for multiplicative interaction effects and (3) the increased probability of identifying the next royalty paying genotype. The interaction of the 20 genotypes with four environments was best predicted by the first 2 principal components of genotypes and environments. Consequently, biplots generated using genotypic and environmental scores of the AMMI components can help breeders have an overall picture of the behavior of the genotypes, the environments and G×E (Manrique and Hermann, 2000; Kaya *et al*., 2002; Tarakanovas and Ruzgas, 2006).

CONCLUSION

The analysis of variance for the AMMI model of seed yield showed that genotypes×environments×regressions interaction and AMMI component1 were significant. Results show that 10(5002), 2(4016), 15(5034), 1(4002) and 6(4034) the high seed yield in all of sites and all of environment conditions and two years (2007-2008). These genotypes had the high seed yield in normal and drought stress. The 10, 2, 15, 6, 7 and 11 genotypes have rather good adaptation to a wide range of environments toward other genotypes.

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