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AMMI Stability of Some of Internationally Derived Durum Wheat Varieties in the Southeastern of Anatolia

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Abstract: This study aimed to investigate the stability of some of internationally derived durum wheat varieties in the Southeastern Anatolia. The experimental data, collected from both rain fed and supplementary irrigated conditions in different locations of Southeastern of Anatolia in 1995/96,1996/97 and 1997/98 cropping seasons, were subjected to Additive Main Effects and Multiplicative Interactions (AMMI) stability assessment method. The results, obtained from AMMI analysis indicated that Aydın-93 and Ceylan-95 were the most responsive varieties. Harran-95 and Diyarbakır-81 both seemed to be stabile yielding varieties under both rain fed and supplementary irrigated conditions, while, Fırat-93 was the least responsive variety, adapted to poor environmental conditions. It was concluded that several responsive and stabile yielding varieties have been developed adapting to a wide range of environments in the Southeastern of Anatolia.

Key words: Durum wheat, stability, Southeastern of Anatolia, AMMI

INTRODUCTION

Turkey is the leading durum wheat producer in West Asia and North Africa and produces from 4-6 million tons of durum wheat annually from 2-3 million ha. Total wheat production of Turkey, including durum wheat, varies between 16 and 21 million tons and the total wheat acreage from 9-9.5 mil ha. Fallow occupies an additional 5 mil ha. The average grain yield of 2.0 tons ha^{-1} conceals wide disparities in production potential due to extremely diverse agro-ecological conditions. The 50% of the durum production areas are the Central Anatolia Plateau (CAP) and the Transitional Zones (TZ), 35% Southeastern of Anatolia and 15% in the Mediterranean, Aegean and Southern Marmara region[1]. Although Southeastern of Anatolia produces only 35% of total national production, it is well known to be the durum wheat belt of the country as 85 % of total wheat acreage is devoted for durum wheat[2]. Total wheat acreage is 1.152.500 ha and annual production is 2.045.990 tons[3]. Major growing sites are Şanlıurfa and Diyarbakır provinces.

Average yield can reach to 6.0 tons ha^{-1} under supplementary irrigated condition. The climate of the region is characterized by dry, hot summers and mild to cold, wet winter. Early and late frosts, irregular rainfall distribution pattern, drought and heat stresses in grain filling period are the other characteristics of the climate. Facultative and spring growing habit wheat are grown in Southeastern of Anatolia. Spring type wheat is grown in the southern zone, close to Syrian border.

Fırat-93, Harran-95, Altıntoprak-98 and Sarıçanak-98 were released from International Wheat and Maize Improvement Center (CIMMYT) derived material, received in last 20 years. Similarly Aydın-93 and Ceylan-95 were released, utilizing the material, derived from the International Center for Agricultural research in Dryland Areas (ICARDA). Diyarbakır 81, released in 1986, was derived from a Turkish material and is still widely grown under rain fed conditions. Fırat-93 is in second range in growing acreage. Zenith, Duraking, Svevo and Ege-88 are other leading varieties under supplementary or fully irrigated conditions. The first three are all international derived and the latter is Turkish derived cultivar. Sarıçanak 98 and Altıntoprak-98, which are other international derived cultivars followed them in acreage[4-6].

Under supplementary irrigated conditions as suggested by many researchers[7-9], Diyarbakır-81, Fırat-93, Aydın-93, Ceylan-95 and Harran-95 can be recommended for farmers in the region who practice supplementary irrigation.

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In another study, carried out under supplementary irrigated conditions, Fırat-93, Diyarbakır-81, Aydın-93, employing various stability methods such as regression, rank-sum and Si^3 and Si^6 were found to be high yielding and stabile cultivars[10] and Ozberk and Ozberk[11] investigating the interactions between grain yield and some meteorological parameters, inferred that Diyarbakır-81 and Harran-95 were the most stable varieties under rain fed conditions whereas, Fırat-93 turned out to be less responsive at the same conditions. The results of rank analysis confirmed the above results[12]. In the study, Ceylan-95 and Aydın-93 were found to be most responsive varieties.

This study aimed to investigate the stability parameters of some well known varieties through AMMI stability method. Several regional yield trials, carried out both in Diyarbakır and different locations of the region under dry land and supplementary irrigated conditions were subjected to study.

MATERIALS AND METHODS

Pedigrees of varieties under investigation were given in Table 1. All field trials were carried out in Diyarbakır, Mardin and Sanlıurfa locations, employing standard tillage methods for the region. In rain fed conditions, temperate cereals and food legumes in combination with fallow crop rotations were practiced. In supplementary irrigation, wheat and second crop corn were grown in the first year followed by cotton in the second year. Similarly standard crop rotation systems were practiced for supplementary irrigated field trials. Seeding rate was 450 grain m^{-2} for both supplementary and rain fed trials. Plot size was 6 m long x 1.2 m wide in planting and 5 m long x 1.2 m wide in harvest. Plot drill and combine plot harvester were used in planting and harvesting, respectively. 60 kg ha^{-1} pure P_2O_5 + 60 kg ha^{-1} pure nitrogen at base and 60 kg ha^{-1} nitrogen in late joining stage were applied under dry land and 80 kg ha^{-1} nitrogen for supplementary irrigated experiments. Two irrigations were applied at grain filling period. Annual rainfall, received in field trials in Diyarbakır between 1995/96, 1996/97 and 1997/98 crop growing seasons were 557, 343 and 565 mm, respectively. Long term average rainfall in Diyarbakır was 495.7 mm. This ranged from 350 mm to 400 mm in Şanlıurfa and Mardin.

Rain fed conditions: Nine regional yield trials namely DBVD. Dur (3 years x 3 locations) were carried out in Diyarbakır, Mardin (Kızıltepe) and Şanlıurfa (Ceylanpınar) during 1995/96, 1996/97 and 1997/98 cropping seasons, employing a Randomized Complete Block Design (RCBD) with 4 replications. The data was subjected to Additive Main Effects and Multiplicative Interactions (AMMI) analysis by using SAS statistical software. The entry numbers of 5, 10, 15, 20 and 25 were standard durum wheat varieties of Diyarbakır-81, Aydın-93, Fırat-93, Harran-95 and Ceylan-95. In AMMI analysis, average yield of standard varieties (over replications) in each location was considered as one replication of a definite year. In total, 5 varieties x 3 years x 3 replications provided 45 data values were evaluated for both rain fed and supplementary irrigated conditions.

Table 1: Names, pedigrees and the origins of cultivars

Name of cultivar	Pedigree	Origin
Fırat-93	AA'S'/ Vol 'S'// Fg'S'/ Shwa'S'	
	CM:27807-G-1M-2Y-1M-0Y	CIMMYT
Harran-95	Korifla//D:S:15/Geiger	
	CD:523-3Y-1Y-2M-0Y	CIMMYT
Diyarbakır-81	LD 393//Bel 116 E/2*TC/3/CIT 71	
	SE.0364-1S-4S-0S	Turkish
Aydın-93	Omrabia'S'	ICARDA
Ceylan-95	Stork'S'/ Rabi 'S'	
	L.0608.0L-1Ap-2AP-2AP-0AP	ICARDA

AMMI, developed by Gauch[13] which referred widely for assessing genotype x environment interactions. This model includes an analysis of variance for main effects and a principal component analysis for interaction effects[14].

Biplots are useful for summarizing the pattern of response that exists with the original data[15,16]. This involves making a biplot graph scores of sites and genotypes of the first bilinear term against scores of the sites and genotypes of second bilinear term. In this type of graph, the variety and site scores are represented as vector in a two dimensional space. The variety and site vectors are drawn from the origin (=0) to the end points determined by their scores.

The angles less than 90° or larger than 270° between a variety vector and a site vector, indicates that the variety had a positive response to given site. A negative variety response is indicated if the angle is between 90° and 270°. The cosine of angle between two sites (or varieties) approximates the phenotypic correlation of the two sites (or varieties) with an angle of 0° indicating a correlation of '+1', an angle of 90° (or -90°) a correlation of '0' and angle of 180° a correlation of '-1'[17].

Supplementary irrigated conditions: Nine regional yield trials namely SBVD. Dur (3 years x 3 locations) were carried out Diyarbakır, Mardin (Kızıltepe) and Şanlıurfa (Akçakale) in 1995/96, 1996/97 and 1997/98 cropping seasons, using a Randomized Complete Block Design with 4 replications, which were subjected to Additive Main Effects and Multiplicative Interactions (AMMI) analysis. The entry numbers of 5, 10, 15, 20 and 25 were standard

durum wheat varieties of Diyarbakır-81, Aydın-93, Fırat-93, Harran-95 and Ceylan-95. In AMMI analysis, average yield of standard varieties (over replications) in each location was considered as one replication of a definite year. In total 5 varieties x 3 years x 3 replications provided 45 data values were evaluated for both rain fed and supplementary irrigated conditions

RESULTS

Rain fed conditions: The results, obtained from AMMI variance analysis showed that replications (actually locations) and environments (actually years) were found to be significant statistically, giving F= 23.39^{***} and 13.10^{***} values, indicating the presence of variation among locations and years. Some genotypes however were found to be non-significant, indicating absence of genetic variance among varieties in response to various environments. The coefficient of determination (R^2%) was found to be 73.9%, which described the variation of genotype x environment interaction adequately. Coefficient of variation (Cv %) was found to be 15.8%, indicating the reliability of experiments. Average yield under rain fed conditions was 4.0 tons ha^{-1} with the highest yielding variety was Aydın-93 (4.28 tons ha^{-1}). Figure 1 indicated that there was no similar response among experimental years. Aydın-93, Ceylan-95 and Fırat-93 seemed to be most responsive varieties to environments. Harran-95 and Diyarbakır-81 were found to be less responsive and stabile. Taking into account of G x E interaction, Fırat-93 had a positive response in 1996 while Diyarbakır-81 and Aydın-93 gave positive responses in 1997. Harran-95 and Ceylan-95 seemed to be better responsive variety than the others in 1998.

Supplementary irrigated conditions: The results, obtained from AMMI variance analysis showed that replications (actually locations) was found to be statistically significant (F= 14.86^{***}), whereas environments (actually years) were not found to be significant statistically, indicating some similarities in experimental years. The results also indicated that there were no statistically significant differences among varieties, indicating the absences of genuine genetic differences in response to environments. The coefficient of determination (R^2%) was found to be 57%, which could not explain G x E interactions adequately. The Cv(%) was also quite high (27.38%), indicating the presence of some questions about reliability of experiments. Average yield was found to be 4.96 tons ha^{-1}. Ceylan-95 was the highest yielding variety (5.12 tons ha^{-1}).

Figure 2 indicated that there were no similarities among experimental years. Ceylan-95, Fırat-93, Aydın-93 and Diyarbakır-81 were found to be most responsive varieties, whereas, Harran-95 seemed to be stable. Considering G x E interactions, Ceylan-95 and Diyarbakır-81 seemed to be responsive varieties in 1996, while Harran-95 and Fırat-93 the most responsive in 1997 and Aydın-93 in 1998.

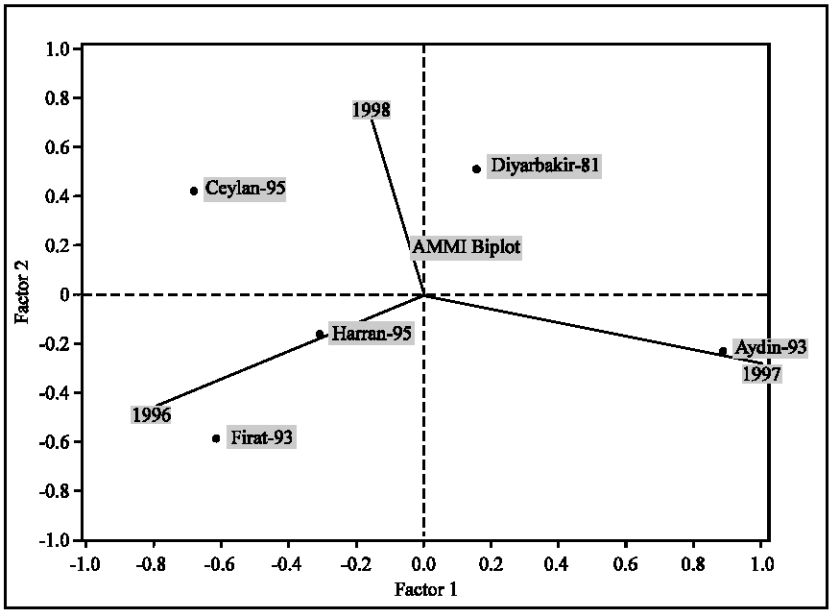

Fig. 1: Biplot of 5 genotypes and 3 years using all information (rain fed)

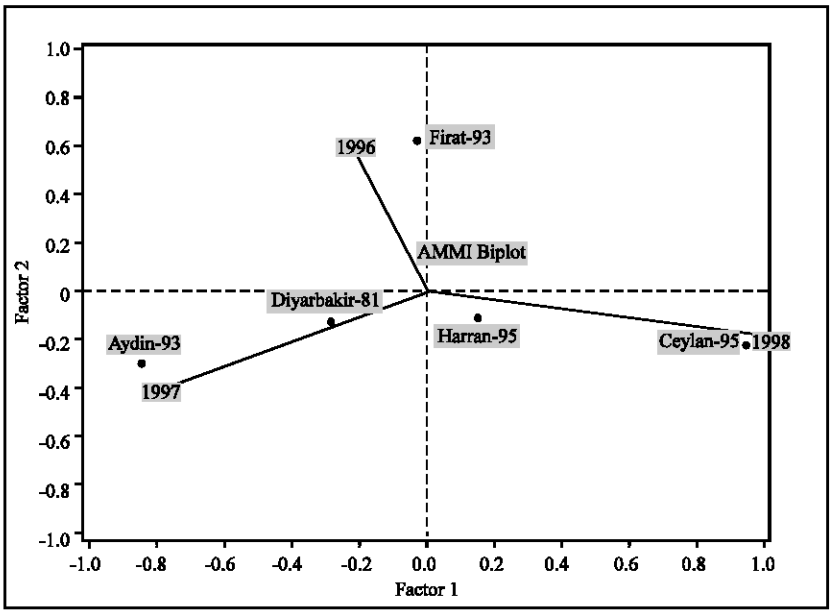

Fig. 2: Biplot of 5 genotypes and 3 years, using al information (supplementary irrigation)

DISCUSSION

The performance of varieties in this study was investigated using several field trials and location in the Southeastern of Anatolia region. The research findings of this study confirm by those of Ozberk and Ozberk[7,10,12,18]. The performance and yield stability of cultivars under study were tested in various studies, cited above in last decade. Regression[11,19] and rank stability analysis[20,21] gave similar results, confirming each other. In above studies, Diyarbakır-81 and Harran-95 were found to be stable under both rain fed and supplementary irrigated conditions. Aydın-93 and Ceylan-95 turned out to be as responsive cultivars under favorable environments. Fırat-93 did not respond well to improving environmental conditions. It was found to be well fit for poor environments. It was understood that both regression and rank stability methods were found to be appropriate testing methods for stability. But rank analysis was found to be suitable for a limited number of entries under testing. AMMI analysis, confirming the results of those two methods, showed the reliability of method. The partitioning of GxE interactions through AMMI analysis allow for clear conclusions to be drawn about the performance of varieties.

It was concluded that Diyarbakır-81 and Harran-95 were more stabile than Fırat-93 under both conditions, whereas Fırat-93 was suitable for poor conditions. Ceylan-95 and Aydın-93 were found to be most responsive varieties to varying environments.

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