American-Eurasian J. Agric. & Environ. Sci., 9 (5): 465-469, 2010
ISSN 1818-6769

Study of Drought Tolerance in Durum Wheat Genotypes

[1]Roza Gholamin, [2]Mohammad Zaeifizadeh and [1]Majid Khayatnezhad
[1]Shahzad Jamaati-e-Somarin and [1]Roghayyeh Zabihi-e-Mahmoodabad

[1]Young Researchers Club, Islamic Azad University, Ardabil Branch, Ardabil, Iran
[2]Islamic Azad University, Ardabil Branch, Ardabil, Iran

Abstract: Considering the special place of durum wheat in terms of resistance to environmental stress and diseases and shortage of water resources to cultivate the plant so valuable study on drought resistance in plants is important. In this experiment 25 genotypes of durum wheat crop in years 2008-2009 in both normal and drought conditions in the Ardabil region was conducted. Analysis of variance showed that between genotype and the interaction of genotypes in drought conditions in terms of most traits there was a significant difference. Drought tolerance genotype level using average genotype in two conditions were calculated and compared. Genotypes among all sub convar, genotypes number 18 and 22 terms of performance and tolerance index to the highest allocated. Grouped according to genotype tolerance index cluster method performed and genotypes were classified in three groups of the genotypes number 16, 17, 18, 22 and 24 high due to drought tolerance index in terms of grain weight per main spike weight, spike Home, main spike and grain weight were tolerated with most. Cluster results with the results of drought resistance genotypes were consistent.

Key words: Drought tolerance · Durum wheat

INTRODUCTION

Dryness of the most important factor limiting production of crops including wheat in the world and Iran. This Topic is more important in dry and semi-arid regions of the world [1]. Importance of this subject is determined when we know which more than 1/4 part ground is dry and estimated that about 1/3 of the world's cultivable land under water shortage conditions are in range [1]. Wheat production in Mediterranean region is often limited by sub-optimal moisture conditions. Visible syndromes of plant exposure to drought in the vegetative phase are leaf wilting, a decrease in plant height, number and area of leaves and delay in accuracy of buds and flowers [2]. Drought tolerance consists of ability of crop to growth and production under water deficit conditions. A long term drought stress effects on plant metabolic reactions associates with, plant growth stage, water storage capacity of soil and physiological aspects of plant. Drought tolerance in crop plants is different from wild plants. In case crop plant encounters severe water deficit, it dies or seriously loses yield while in wild plants their surviving under this conditions but no yield loss, is taken into consideration. However, because of water deficit in most arid regions, crop plants resistance against drought, has always been of great importance and has taken into account as one of the breeding factors [2]. Achieving a genetic increase in yield under these environments has been recognized to be a difficult challenge for plant breeders while progress in yield grain has been much higher in favorable environments [3]. Thus, drought indices which provide a measure of drought based on yield loss under drought conditions in comparison to normal conditions have been used for screening drought-tolerant genotypes [4]. These indices are either based on drought resistance or susceptibility of genotypes [5]. Drought resistance is defined by Hall [6] as the relative yield of a genotype compared to other genotypes subjected to the same drought stress. Drought susceptibility of a genotype is often measured as a function of the reduction in yield under drought stress [7], whilst the values are confounded with differential yield potential of genotypes [8]. Zaeifizadeh studied the relationship between genotype and environmental conditions (dry and normal) on the amount of chlorophyll content and the amount of super oxide dismutase reported

Corresponding Author: Majid Khayatnezhad, Young Researchers Club, Islamic Azad University, Ardabil Branch, Ardabil, Iran, Tel: +989144521606, E-mail: gholamein@yahoo.com.

that drought-resistant cultivars increase dismutase super oxide stress increases but in susceptible cultivars decreased chlorophyll super oxide dismutase [9]. Also a good variety between the native masses of durum wheat in North-West Iran and Azerbaijan in terms of drought resistance and SRAP (Sequence related amplified polymorphism) but did not found any Significant relationship between coefficient of drought tolerance and SRAP [9]. The present study was undertaken to assess the selection criteria for identifying drought tolerance in durum wheat genotypes, so that suitable genotypes can be recommended for cultivation in the drought prone area of Iran and Ardabil.

MATERIALS AND METHODS

Twenty five durum wheat cultivars (*Triticum durum* Desf.) with Iran and Azerbaijan republic region were chosen for the study based on their reputed differences in yield performance under irrigated and non-irrigated conditions (Table 1).

Experiments were conducted at the experimental field of Islamic Azad University of Ardabil, in Ardabil province (Northwest of Iran) in 2008-2009. Seeds were hand drilled and each genotype was sown in five rows of 1.5 m, with row to row distance of 0.2 0 m. The experiment was laid out in randomized complete block design (RCBD) with two replications. Two levels of stress treatments including:

- Full irrigation (100 percent water based on plant needs wheat cultivars at different growth stages).
- Limited irrigation (Supply plant water needs until pollination stage and then Format water until the end of wheat growth and development).

Every line in 5 rows and 20 cm intervals and 150 cm in width were planted. Immediately after planting the field was irrigated to soil moisture profiles in root development and saturated and identical for all treatments in addition to the germination easily is done. Irrigation was done with leaking method. After harvest to evaluate the factors affecting the performance traits, plant height, tiller number total , fertile tillers, number of internodes, peduncle length, length of main spike, spike original weight, awn length, total dry weight , number of seeds per main spike, main spike grain weight, harvest index, 1000 grain seed weight, yield and yield performance were measured.

In order to determine the sensitivity and resistance

Lines Evaluated under Drought Indicators Were Used: Stress Tolerance Index (STI):

STI = $(Ypi*Ysi)/Yp^2$ (Fernandez, 1992)
Ysi = Yield of cultivar in stress condition,
Ypi = Yield of cultivar in normal condition
Yp = Total yield mean in normal condition

Data were analyzed using SPSS16 for analysis of variance and Duncan's multiple range tests was employed for the mean comparisons.

RESULTS

The results of analyses of variance for grain yield and other related traits in both stress and non-stress environments are given in Table 2. There was a significant difference among stress conditions for grain yield and other traits. Except as total number of tillers and fertile tillers remaining traits were significant in 0.01 percent

Table 1: Origin and taxonomy of durum wheat landraces tasted.

No	Genotype	No	Genotype
1	Hordeiforme (Miyaneh)	14	Albiprovincial
2	Africanum Sanandaj)	15	Murceinse (Naxivan)
3	(Omrabi15)	16	Africanum (11017)
4	Hordeiforme (Maragheh)	17	Leucurum (Barakatly)
5	Leucurum (Tabriz)	18	Hordeiforme (Shamxi)
6	Melanopus (Cheiltoxom)	19	Niloticum (Ardabil)
7	Leucurum (Germi)	20	Africanum (Naxivan)
8	Reichenbachi	21	Boeuffi (Ardabil)
9	Hordeiforme (Shargh)	22	Leucumelan (Langan)
10	Apulicum (Gili bagh)	23	Apulicum (11010)
11	Boeuffi (Shaxi)	24	Erythromelan (Mirage)
12	Leucumelan (Naxjavan)	25	Barakatly-95
13	Melanopus (Naxivan)	-	-

Table 2: Results of Analysis of variance for studied traits

		MS					
S.O.V	df	Plant height	Total tillers	Fertile tillers	Peduncle length	Main spike length	Main spike weight
Rep	1	739.96**	2.13	0.031	649.80**	1.77*	0.012
Condition	1	7040.78**	0.13	1.65	2465.03**	10.09**	3.64**
Genotype	21	713.54**	3.041	4.15*	179.01**	1.71**	0.406**
CxG	21	278.74**	3.78*	2.906	150.54**	0.36	0.07
Error	43	113.36	2.205	2.46	37.63	0.61	0.15

		MS					
S.O.V	df	Total plant weight	Grains per main spike	Grain weight per main spike	1000 grains weight	Yield	Harvest index
Rep	1	77.4	1.11	0.013	50.16	15.72	64.96
Condition	1	747.17**	120.11**	4.11**	217.54**	1216.901**	647.09**
Genotype	21	71.84	15.44	0.23**	32.41**	1516.86**	45.35*
CxG	21	58.17	12.72	0.05	23.13	953.4*	46.48*
Error	43	64.36	17.16	0.07	18.63	474.41	27.84

** And * significant at the 0.01 and 0.05 levels, respectively

Table 3: Values based on measured parameters for traits Fernandez

Genotypes	Yield in normal	Yield in stress	Total tillers	Fertile tillers	Plant height	Internodes	Peduncle	Awn length	Main spike	Main spike length number	Main spike grain	Main spike weight weight	1000 grain grain	Harvest index weight	Yield	Plant performance
1	100.95	87	1.45	1.55	0.54	0.87	0.48	1.06	1.11	0.97	0.91	0.73	0.95	1.57	0.88	1.39
2	97.85	79.55	1.57	1.35	0.51	0.77	0.53	0.77	0.87	0.9	0.84	0.71	0.96	1.46	0.78	1.04
3	104	56.5	0.91	1.11	0.41	0.76	0.38	0.91	0.95	0.82	0.72	0.62	0.81	1.82	0.59	0.92
4	62.45	64	1.22	1.02	0.6	0.78	0.63	0.83	1.06	0.84	0.84	0.73	1.08	1.26	0.4	0.92
5	105.55	95.65	0.71	0.87	0.6	0.93	0.42	1.1	1.06	1	1.15	0.71	0.9	1.2	1.01	1.69
6	83.55	94.3	1.52	1.5	0.47	0.78	0.55	0.68	0.7	0.77	0.58	0.7	1.1	0.89	0.79	0.64
7	91	61.5	1.04	1.46	0.5	0.7	0.56	0.63	0.6	0.81	0.54	0.6	0.76	1.86	0.56	1.07
8	135.6	82.2	1.39	1.96	0.54	0.81	0.61	0.72	0.69	0.66	0.61	0.59	0.92	1.38	1.11	0.69
9	144.7	54.9	0.79	0.63	0.67	1.18	0.67	0.86	0.83	1.09	1.53	0.97	1.5	1.22	0.79	1.17
10	156.55	86.4	0.94	1.02	1.19	1.02	1.27	1.02	1.21	0.9	1.06	0.7	0.93	0.74	1.35	1.02
11	73.45	71.75	0.6	0.55	0.4	0.92	0.37	1.27	1.27	1.34	1.53	0.92	1.09	1.07	0.53	1.58
12	74	77.5	0.87	0.96	1.23	1.17	1.04	1.21	1.29	0.88	1.13	0.7	0.98	0.7	0.57	0.79
13	98.4	96	1.07	1.26	0.88	1.14	0.62	1.5	0.93	1.17	1.66	0.94	1.28	1.17	0.94	1.55
14	71.55	69	0.74	0.52	0.89	1.01	0.77	0.97	0.92	0.75	0.82	0.69	1.1	0.63	0.49	0.35
15	68.95	72.9	0.52	0.55	1.22	1.06	1.1	0.83	1.34	0.56	0.85	0.67	1.35	0.6	0.5	0.47
16	119.45	115.3	0.69	0.89	1.14	1.14	0.94	0.82	0.8	1.09	1.03	0.76	0.89	1.39	1.37	0.99
17	145.3	89.5	1.18	1.11	1	0.95	1.05	1.1	1.05	1.08	1.01	0.73	0.84	0.91	1.3	1.04
18	128.45	125.05	1.51	1.52	0.96	1.14	0.73	0.87	0.87	1.37	1.18	0.84	0.89	1.12	1.6	1.9
19	129.55	84.68	1.25	1.44	1.14	1.1	0.52	0.72	0.68	0.99	0.56	0.55	0.5	0.53	1.1	0.59
20	100.15	96.5	0.66	0.76	1.06	0.96	1.04	0.75	1.05	1.17	1.26	0.84	1.07	0.89	0.96	0.71
21	96.1	78.2	0.66	0.52	0.86	1.09	1.12	0.97	1.16	1.15	1.37	0.79	0.96	1.03	0.75	0.44
22	107.7	106.1	1.05	1.32	0.93	1.2	0.78	1.43	0.97	1.4	1.81	1.01	1.26	1.48	1.14	2.33
23	67.7	59.1	0.83	0.76	1.35	1.14	1.3	1.07	1.04	1.03	1.35	0.79	1.06	0.59	0.4	0.73
24	116.45	127.75	0.9	1.09	0.96	1.05	0.89	1.44	1.12	1.23	1.7	0.97	1.3	1.26	1.48	1.53
25	74.7	82	1.18	1.22	0.45	0.83	0.39	0.9	0.75	0.75	0.55	0.51	0.61	1.1	0.61	0.65

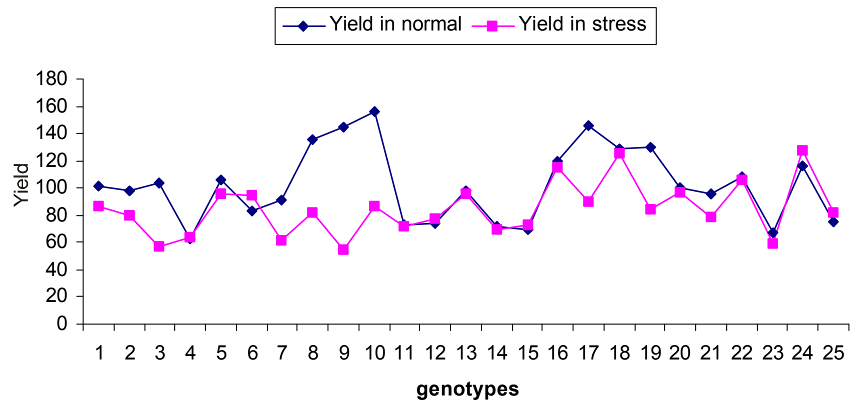

Fig. 1: Mean of genotype yields in normal and stress condition

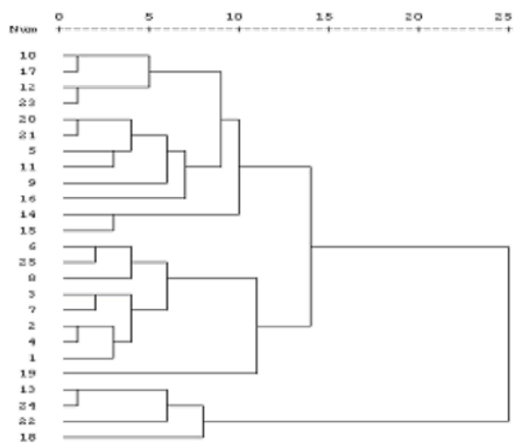

Fig. 2: Cluster scheme based on tolerance index (STI) for traits

probability level. The genotypes showed significant differences in grain yield and other traits. Total number of tillers, total plant weight and seed number per main spike were non-significant, traits of fertile tillers and harvest index 0.05 percent level and other traits were significant in 0.01 percent level. Thus, indirect selection for a drought-prone environment based on the results of optimum conditions will not be efficient. These results are in agreement with those of Sio-Se Mardeh *et al.* [10] and Bruckner and Frohberg [11]. For drought tolerance genotypes and select the best value performance indicators based on tolerance for the genotypes studied and calculated in Table 3.

Fernandez [5] in study the yield of genotypes in two environments and without drought stress than plants in two environments appears to be divided into four groups:

- The genotypes that have high yield in stress and non stress environments (group A).
- The genotypes that have high yield only in non stress environments (group B).
- The genotypes that have high yield in stress environments (group C).
- The genotypes that have weak yield in stress and non stress environments (group D).

Fernandez opinion appropriate selection criterion for stress group A criterion that can recognize from other groups. How much higher STI value represents higher drought tolerance of specific genotypes that cause this rise in yield potential is higher than its genotype. These index genotypes of group A group B and C are separated. Selected based on selection index SSI caused some genotypes with low yield but high yield under normal environmental conditions are stressful. The major drawback of this index is able to identify group A, group C is not.

Genotypes 10 and 17 in rain fed conditions dry conditions than most of the water conditions were the product if the average performance of genotypes in water conditions significantly higher than the dry conditions (Fig. 1). Genotypes with the most stress, but decreased performance genotypes in warm, 18, 22 and 24 growing trend that is causing the interaction. To evaluate drought tolerance genotypes using the average performance of genotypes and traits in the two conditions Fernandez calculation method in 1992 and is listed in a table. Langan masses and flower gardens to the highest tolerance index allocated, this genotype based on tolerance index Fernandez (STI) cluster method performed in three groups of genotypes were classified by the sub convar

13, 24, 22 and 18 high due to drought tolerance index of the main spike grain weight, main spike weight, main spike and grain weight have most were tolerated. Cluster results with the results of drought resistance genotypes was consistent (Fig. 2). Farshadfar and Sutka [12], Sio-Se Mardeh *et al.* [10] and Golabadi *et al.* [13] obtained similar results in multivariate analysis of drought tolerance in different crops. Also Gholamin *et al.* [14] in similar study reported that, the genotypes including more 1000 grain weight, the main spike grain weight, main spike weight, main spike and grain weight have most tolerated for drought conditions

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