Advances in Environmental Biology, 5(7): 1934-1940, 2011
ISSN 1995-0756

This is a refereed journal and all articles are professionally screened and reviewed

ORIGINAL ARTICLE

Morphological Diversity and Interrelationships Traits in Durum Wheat Landraces under Normal Irrigation and Drought Stress Conditions

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Mostafa Ahmadizadeh, Mostafa Valizadeh, Hossein Shahbazi, Mohammad Zaefizadeh and Mehdi Habibpor: Morphological Diversity and Interrelationships Traits in Durum Wheat Landraces under Normal Irrigation and Drought Stress Conditions

ABSTRACT

In order to evaluate and classify morphological traits in 37 durum wheat landraces originated from Iran and Azerbaijan, an experiment based on randomized complete block design with three replications was carried out in normal irrigation and drought stress conditions in agricultural research station of Islamic Azad University, Ardabil, Iran. Under the drought stress conditions there were positive significant correlations between the yield and the fertile tillers number per plant, spike length, Awn length and number of grains per spike. Principal components analysis showed that, three components explained 74% of the total variation among traits. The first PC assigned 42 and 42.2 percent and the second PC assigned 60.9 and 62.6 percent and of total variation between traits in normal and drought stress conditions, respectively. These PCs exhibited positive effects for yield and No. of Grain spike in both conditions and considering the importance of these traits. Therefore, selected based on these two components is helpful for a good hybridization breeding program.

Key words: Durum wheat, principal component, landrace, drought stress, yield.

Introduction

Durum wheat is a cultivated and important food crop in the world. The total area and production was about 20 million hectares and 30 million metric tons in the world, respectively. Durum wheat is mainly (>90%) cultivated in the Mediterranean basin, Europe and India [20,17]. In many part of the region durum wheat production is replaced by modern cultivars; landraces are only cultivated by farmers in very limited areas [23,1]. Nowadays, several breeding programs aim to develop new cultivars as well as release old durum landraces [9]. The development of high yielding wheat cultivars is a major objective in breeding programs [11,17]. Breeding for resistance to drought is complicated by the lack of fast, reproducible screening techniques and the inability to routinely create defined and repeatable water stress conditions where large populations can be evaluated efficiently.

Loss of yield is the main concern of plant breeders and they hence emphasize on yield performance under moisture- stress conditions. But variation in yield potential could arise from factors related to adaptation rather than to drought tolerance per se. [14].

The specific adaptation strategy may be explored on the basis of yield response of the germplasm pool that is representative of the available genetic base tested through a representative sample of sites within the target region [4].

Landraces and wild relatives of crop plants are very important sources to broaden genetic base and every trait of these should be characterized [1].

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The relative yield performance of genotypes in drought stressed and favorable environments seems to be a common starting point in the identification of desirable genotypes for unpredictable rain-fed conditions. There is some agreement that a high yield potential is advantageous under mild stress, while genotypes with low yielding potential and high drought tolerance may be useful when stress is severe [28,22]. 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 [19]. Knowledge of the genetic association between grain yield and its components can help the breeders to improve the efficiency of selection. Therefore, it is important to study the relationships among the characters [17]. Morphological characters such as number of tillers, grain per spike number, fertile tillers number per plant, 1000 grain weight, peduncle length, awn length, plant height, spike length, kernel number per spike, grain weight per spike and etc. affect the wheat tolerance to the moisture shortage in the soil [7,18,24,27,3].Pathak and Ncma [29]. In order to study the genetic diversity durum and bread wheat genotypes in India, With eight morphological characters measured on 25 samples of native wheat (20 Bread Wheat and 5 durum wheat) were the result between native wheat large variety of based on yield and its components exist. Bahari and Sabzi [5] Studying morphological traits with grain yield of durum and aestivum genotypes showed harvest index, no. grain in m2 and No. of grain spike traits Most have a role in increasing yield.

The purpose of this research was the investigation of genetic diversity in durum wheat landraces, determining effective traits on yield under drought and non stress conditions.

Materials and methods

In order to study the genetic diversity of durum wheat, 37 durum wheat (*Triticum durum* Desf.) landraces from Iran and Azerbaijan republic were evaluated under irrigated and non-irrigated conditions (Table 1).

Base on randomized complete block design with three replications. The experiment was carried out in agricultural research station of Islamic Azad University, Ardabil branch, Iran (Northwest of Iran), during the 2009 and 2010 cropping year. Plot size was 7m x 1.2 m. Standard cultural practices were followed for raising the crop.

The studied characters were plant height, number of tillers, peduncle length, spike length, grain per spike numbers, fertile tillers per plant, 1000 grain weight, awn length, kernel per spike, harvest index and grain yield. The data were statistically analyzed by minitab15 and SPSS software's.

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

NO.	Landraces	Origin	Name	NO.	Landraces	Origin	Name
1	Korifla	Control	Korifla	20	Ardabil-samrein	Iran	Apolicum(1)
2	Chakmak	Control	Chakmak	21	Ardabil	Iran	Apolicum(2)
3	Zardak	Control	Zardak	22	Germi-moghoan	Iran	Hordeiforme(1)
4	Haurani-1	Control	Haurani-1	23	Germi-langin	Iran	Melasnopus(1)
5	Omrabi-5	Control	Omrabi-5	24	Naxcevan	Azerbaijan	Boeufii(2)
6	Germi-langin	Iran	Niloticum	25	Naxcevan	Azerbaijan	Africanum(3)
7	Ardabil-samrein	Iran	Albobscurum	26	Naxcevan	Azerbaijan	Leucumelan(1)
8	Germi-langin	Iran	No-name	27	lerik	Azerbaijan	Leucumelan(2)
9	Germi-langin	Iran	Riechenbachii(G1)	28	Naxcevan	Azerbaijan	Leucurum(3)
10	Germi-moghoan	Iran	Riechenbachii(G2)	29	Xanlar	Azerbaijan	Murciense(2)
11	Kordgheshlaghi	Iran	Albiprovinciale(1)	30	Guba	Azerbaijan	Hordeiforme(2)
12	Germi-langin	Iran	Albiprovinciale(2)	31	Xatmaz	Azerbaijan	Murciense(3)
13	Germi-langin	Iran	Melaleucum	32	Naxcevan	Azerbaijan	Boeufii(3)
14	Ahar	Iran	Leucurum(1)	33	Gux	Azerbaijan	Leucurum(4)
15	Ardabil-bagh oliya	Iran	Leucurum(2)	34	Ardabil	Iran	Hordeiforme(3)
16	Germi-boldash	Iran	Murciense(1)	35	Ardabil	Iran	Melasnopus(2)
17	Germi-langin	Iran	Boeufii(1)	36	Shamaxi	Azerbaijan	Hordeiforme(4)
18	Germi-langin	Iran	Africanum(1)	37	Naxcevan	Azerbaijan	Leucurum(5)
19	Sari boghda	Iran	Africanum(2)				

Results and discussion

Analysis of variance of data showed that there is considerable variability among genotypes in all of the traits, demonstrating the presence of genetic diversity among landraces under study. Environment mean squares were also significant for all the traits studied, showing that the water stress has significant effect on all traits.

G x E interaction was significant for all the traits except for spike length, awn length and biological yield, showing variation of genotypes over environments (Table 2). This could provide scope for breeding for traits studied, along with yield and its components, under drought stress condition. Naghavi *et al.,* [25] Studying genetic variation of durum wheat from to Italy, Mexico and Turkey reported, genotypes of the country's most traits except awn length and plant height are significant differences with each other. Many of researchers such as Yilmaz and Tahir [35] Jedynski [15] and Garcia Del Moral *et al.,* [13] Considerable genetic diversity in wheat genotypes achieved their study. Expresses high of the gene in wheat germplasm is.

Correlations:

Due to significant interaction between genotypes and environment the Pearson correlation has been evaluated separately for each condition (Table. 3, 4). For non-stress conditions, number of grains per spike showed positive and significantly correlation with biological yield, plant height, spike length and Awn length as well. That harvest index showed positive and significant correlation with yield, biological yield and1000 grain weight. Under stress, grain and biologic yield and number of Grains per Spike showed positive and significant correlation with fertile tillers number, spike length and Awn length. Calderini *et al.,* [8] concluded that increased number of grains per spike is the main yield component that influences the grain yield.

Slafer and Andrade [32] reported high significant and positive between yield and harvest index. Amini and Rezaei Danesh [2] Studying genetic variation and correlation between traits in wheat genotypes showed, number of grains per spike showed positive and significantly correlation with yield. These results are also agreement whit findings of other workers including Dugagan *et al.,* [10] Bhutta *et al.,* [6] Tavakolli *et al.,* [34] Slafer and Savin, [33] Nouri-Ganbalani *et al.,* [27] Nofouzi *et al.,* [26] and Kahrizi *et al.,* [16]. Plant height showed positive and significant correlation with spike length, peduncle length and Awn length.

Principal Component Analysis:

In principal component analysis, out of eleven, three principal components (PCs) exhibited more than one eigen value and showed about 73.6 and 74.3% of variability so these three were given due importance for further explanation in two condition respectively (Table. 5). The first PC was more related to plant height, number of grains per spike, biological yield, awn length, peduncle length and spike length as it was cleared from the values in normal condition and the first PC was more related to all of the traits except for the tiller numbers, 1000 grain weight and harvest index as it was cleared from the values in stress condition of Table 6 for PC1. In the second PC, fertile tillers, awn length, yield and harvest index were given due importance in normal condition. Under stress condition the second principal component exhibited positive effects for number of tillers, 1000 grain weight, harvest index and yield. The third principal component was more related to no. of tillers, fertile tillers, peduncle length and plant height in normal condition. Under stress condition the third principal component exhibited positive effects for no. of tillers and fertile tillers (Table. 6). From first three PCs it was cleared that among all the 11 variable, plant height and peduncle length had high value in normal condition and fertile tillers had high value in stress condition. Mostly, yield contributing traits were poor in these PCs except second PC in two conditions. From this study it is concluded that a good hybridization breeding program can be initiated by the selection of genotypes from the PC1 and PC2.

Scree Plot:

Scree Plot explains the percentage of variance associated with each principal component obtained by drawing a graph between eigenvalues and Principal component number. PC1 showed 42% variability with eigenvalue 4.6 in germplasm which then reduced gradually in two conditions (figure. 1). From graph it was concluded that maximum variation was present in first PC. So selection of genotypes from this PC will be useful.

Biplot:

A Principal component biplot showed that variables are super imposed on the plot as vectors. Distance of each variable with respect to PC1 and showed the contribution of this variable in the variation of germplasm (figure. 2 and 3).

Evaluation of germplasm on the basis of morphological characters was done by many researchers. Ranjbar *et al.,* [30] Escobar-hernandez *et al.,* [12] Sapra and Lal [31] and Maqbool *et al.,* [21] used Principal component method for grouping of germplasm. From these score given to genotypes on the basis of first and second PC, breeders can select genotypes with highest score having desirable characters for further breeding programmed.

Conclusions:

Principal component analysis and correlation coefficients analysis in durum wheat landraces facilitate Identify desirable traits and their relationship with yield and reliable classification of genotypes, According to the results in this study it is concluded that a good hybridization breeding program can be initiated by the selection of genotypes from the PC1 and PC2, identification of subset of core genotypes and correlated morphological characters with possible utility for specific breeding purposes.

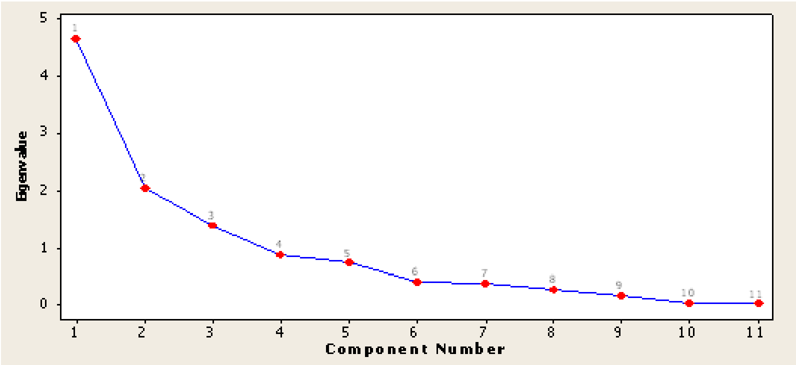

Fig. 1: Scree plot of principal component analysis between eigen value and number of PC in two conditions.

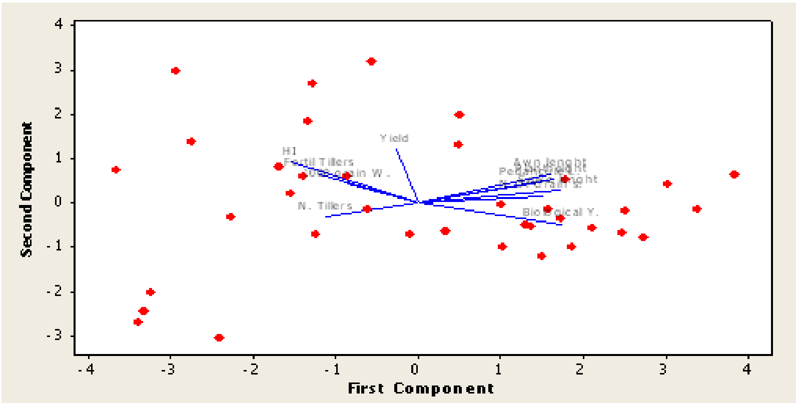

Fig. 2: Principal component biplot of 37 genotypes of durum wheat in normal irrigation condition.

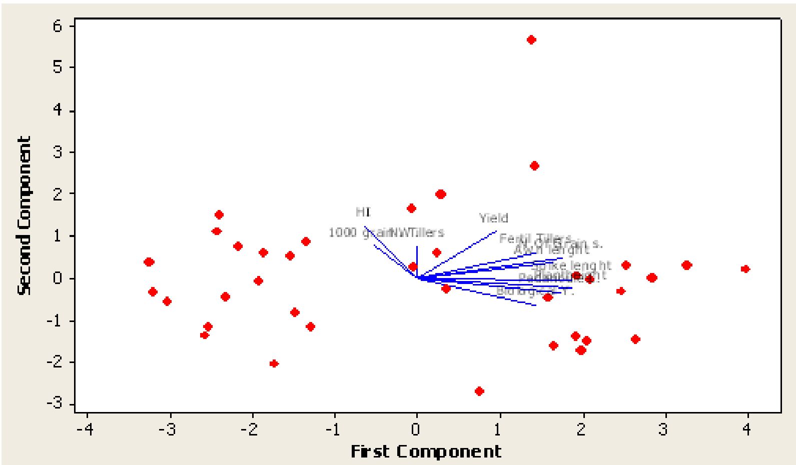

Fig. 3: principal component biplot of 37 genotypes of durum wheat in drought stress condition.

Table 2: Mean squares of components 37 durum wheat genotypes under normal irrigation and drought stress condition.

		Means Square										
S. O. V	df	No. of Tillers	Fertile Tillers per Plant	Plant Height	Spike Length	Peduncle Length	Awn Length Length	No. of Grain Spike	1000 Grain Weight	Grain Yield	Biological Yield	Harvest Index
Replication	2	0.883Ns	0.499Ns	11.56Ns	0.119Ns	6.887Ns	0.80Ns	6.66Ns	75.1Ns	0.544Ns	145.4**	459.6**
Condition	1	48.7**	90.7**	13092**	12.67**	7302.4**	40.19**	1547**	3534**	30.05**	2893**	1754.6**
Genotype	36	3.24**	2.92**	2496.7**	14.45**	489.1**	38.14**	1234.3**	489.7**	1.63**	254.1**	577.1**
C × G	36	0.85*	2.05**	207.5**	0.172Ns	101.1**	0.672Ns	55.57**	101.7**	0.534**	22.6Ns	107.3**
Error	146	0.513	0.345	22.315	0.19	14.456	0.706	26.918	34.832	0.255	15.547	45.78

**,* and Ns, significant at 1%, 5% level of probability and non-significant, respectively.

Table 3: Correlation coefficient yield components in durum wheat genotypes in normal irrigation condition.

Traits	No. of Tillers	Fertile Tillers	Plant Height	Spike Length	Peduncle Length	Awn Length	No. of Grain Spike	Biological Yield	1000 Grain Weight	Yield	Harvest Index
No. of Tillers	1										
Fertile Tillers	0.460**	1									
Plant Height	-0.355*	-0.102	1								
Spike Length	-0.412*	-0.348*	0.595**	1							
Peduncle Length	-0.260	-0.023	0.943**	0.511**	1						
Awn Length	-0.413*	-0.200	0.644**	0.606**	0.545**	1					
No. of Grain Spike	-0.385*	0.513**	0.341*	0.565**	0.205	0.657**	1				
Biological Yield	-0.189	-0.451**	0.473**	0.577**	0.479**	0.487**	0.453**	1			
1000 Grain Weight	0.069	0.174	-0.196	-0.197	-0.207	-0.144	-0.272	-0.316	1		
Yield	-0.139	0.323	0.030	0.078	0.003	0.296	0.137	-0.283	0.186	1	
Harvest Index	0.168	0.566**	-0.309	-0.417*	-0.321	-0.262	-0.364*	-0.889**	0.396*	0.605**	1

** and *, significant at 1% and 5% level of probability respectively.

Table 4: Correlation coefficient yield components in durum wheat genotypes in drought stress condition.

Traits	No. of Tillers	Fertile Tillers	Plant Height	Spike Length	Peduncle Length	Awn Length	No. of Grain Spike	Biological Yield	1000 Grain Weight	Yield	Harvest Index
No. of Tillers	1	0.570**	-0.147	-0.089	-0.078	-0.059	-0.010	-0.057	0.113	0.156	0.220
Fertile Tillers		1	0.466**	0.488**	0.480**	0.448**	0.558**	0.330*	-0.110	0.410*	0.047
Plant Height			1	0.727**	0.894**	0.697**	0.557**	0.459**	-0.260	0.115	-0.261
Spike Length				1	0.640**	0.657**	0.629**	0.543**	-0.216	0.398*	-0.250
Peduncle Length					1	0.439**	0.529**	0.428**	-0.348*	0.093	-0.288
Awn Length						1	0.622**	0.361*	0.059	0.424**	0.024
No. of Grain Spike							1	0.467**	-0.068	0.718**	-0.015
Biological Yield								1	-0.185	0.091	-0.806**
1000 Grain Weight									1	0.230	0.308
Yield										1	0.405*
Harvest Index											1

** and *, significant at 1% and 5% level of probability respectively.

Table 5: Eigenvalues and Cumulative% for first 3 PCs.

	Eigenvalue		Propertion		Cumulative%	
	Normal	Stress	Normal	Stress	Normal	Stress
PC1	4.64	4.61	0.42	0.42	42.2	42
PC2	2.05	2.26	0.18	0.206	60.9	62.6
PC3	1.39	1.28	0.12	0.117	73.6	74.3

Table. 6: Principal components (PCs) for eleven characters in 37 genotypes of durum wheat.

Variables	Eigen vectors					
	PC1		PC2		PC3	
	Normal	Stress	Normal	Stress	Normal	Stress
No. of Tillers	-0.241	0	-0.158	0.328	0.397	0.762
Fertile Tillers	-0.254	0.311	0.313	0.26	0.461	0.479
Plant height	0.352	0.404	0.259	-0.12	0.367	-0.092
Spike length	0.369	0.404	0.134	-0.017	-0.06	-0.103
peduncle length	0.321	0.374	0.225	-0.149	0.481	0.044
Awn length	0.348	0.352	0.315	0.157	-0.075	-0.255
No. of Grain spike	0.324	0.379	0.071	0.208	-0.409	-0.14
Biological yield	0.378	0.31	-0.231	-0.286	0.12	0.144
1000 Grain weight	-0.183	-0.115	0.202	0.332	-0.118	-0.232
yield	-0.055	0.204	0.585	0.481	-0.225	-0.188
Harvest index	-0.33	-0.138	0.448	0.544	-0.092	-0.168

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