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Investigation of Drought Stress on Morphological Traits in Some Bread Wheat Cultivars

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ABSTRACT

In order to study the drought stress effects on wheat morphological traits, 20 bread wheat cultivars evaluated in two separate experiments in field conditions. A completely randomized complete blocks design with three replications was used. The results showed that there is a considerable variation between the understudying genotypes for the most traits such as height of the plant, length of the spike, length of the awn, the weight of the 100 kernel, length of the seed, length of the peduncle and the diameter of the seed. Factor analysis indicated that 4 factor explains more than 70 percent of data variance. Among them, the first factor by 29.1 percent had the more important effect. In stress condition path analysis showed that biological yield had the most direct effect (0.97) on the kernel yield. The most indirect effect by this trait was caused by the length of peduncle (0.30). For classification the genotypes, we used the cluster analyzing with the method on the base of the squared Euclidean distance as a similarity matrix. The genotypes in the normal condition and the stress condition, was divided to three groups.

Key words: Bread Wheat, Cluster analysis, Regression.

Introduction

Increases in Human population, there is rising more demands for the agriculture products. In past, this demand have been comply by complex composed of the genetic breeding, increasing in cultivation area, increasing the fertility, using of the pesticides and advance in mechanization conditions. Water stress is the major limiting factor in crop production worldwide [7].

Drought stress has been shown to retard the formation of the yield component that is most actively developing at the time of stress [1]. Since the irrigation water and the petroleum resources have been decreased and also the problems relating agricultural pollution is going to increase anyway, it is obligation to produce the crop which has more yield in area unit, and this will necessitate to have done some more reforms so as to select the cultivars on which have more tolerance to abiotic stress. The reduction of genetic variation will put a limit on the breeding programs for some characteristics such as resistance to the pests and diseases and the tolerance against the biological tensions. In recent years, the breeders have focused on the gene banks, specially the native collections that diversity between them has been accumulated in thousands of years and have been insistent in the nature [11]. The assessment of the genetic diversity among the crops, from the eugenic and maintaining of the genetic resources is very important [10].

An experiment on 157 wheat double haploid lines, showed significant genetic diversity on last internode length, the number of fertile spikes in the area unit, the height of the plant, number of the seeds on spike, kernel yield on main spike [2].

For the first time, Paul and Pfifer used poli-ethylene-gelicole and manitole to create the dryness condition in germination seed stage. Using the sprouting stress index has also been reported for selection to stress condition [9].

In an experiment on 39 winter wheat cultivars, ten quantitative traits have been studied and investigated with factor analysis; the first factor was the height of bush, second was the number of seeds in the main spike [3]. Golabadi in an experiment had studied 300 durum wheat genotypes and stated that in factor analyzing, six hidden factors have been recognized that justified totally 76.7 percent of all data variation. These factors were correlated with the transfer potential, the various different pool of the

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plant, the relationships between source and pool, plant height and tillage potential [4].

With regard to this fact that the considerable areas of the farms under the wheat cultivation in Iran is located in dry and semi-arid regions, the objective of this study was evaluation of drought stress effect on yield and some morphological traits in some bread wheat cultivars.

Materials and Methods

In order to investigation of drought stress effect on yield and some agronomic traits in wheat were evaluated 20 bread wheat cultivars. Cultivars including C-81-10, Shiroodi, Mahdavi, Yavaros, Dez, C-81-14, M-V-17, Saisson, Golestan, Gascogene, Adl, Tous, Arvand, Azadi, Shoeleh, Navid, Shah-Pasand, Bayat, Karaj 2, C–83– 8. These cultivars evaluated in a Randomized Complete Block Design (RCBD) with three replications in researcher field of Islamic Azad University – Karaj branch in 2010-2011.

To simulation stress condition from flowering stage we did not use irrigation. This farm is located in the 1150 meters height above the sea level, and its longitude is 51 degrees and 8 minute east, by the latitude which is 35 degrees and 43 minutes in north .Each of the genotypes situated on to plot with 2 meters long, 30 centimeters distance from each other, based on the density by 350 seeds per meter. During the growth period, the cultivating maintenances such as weeding were done in the form of mechanical and chemical methods. In this experiment, the various morphological and quantitative parameters were measures, consisted of height of bush, length of the spike, length of peduncle, length of seed, length of the awn, diameter of the seed, diameter of the peduncle, weight of the spike, weight of the 100 seeds, biologic and seed yield in squared meter unit. The statistical analyses gathered, such as the variance analysis and factor analysis was done with Path, SPSS, SAS software's.

Results and Discussion

In the variance analysis (Table 1), height of the bush, length of the spike, length of awn, weight of 100 seeds, length of seed, length of peduncle was significant in the 0.01 probability level. Similar results reported in other researches, Khakwani *et al*. evaluated six wheat cultivars and indicate significant differences between genotype for yield and biological yield [5].

While disintegrating to the factors, 4 have been achieved (Table 2). In this investigation, the first factor was introduced as the functionality index with the biological functional attributes, height of the bush, and length of the peduncle and the function of the seed in squared meter. The second factor was the weight specification of the seed with the weight of 100 seeds and its diameter. The third factor also was attributes such as the weight of the spike and the length of seed in which describes the specs of the spike. At the end, the fourth factor is the diameter of the stem with respect to the amount and length of the seed. By consideration of to the results been taken, the first and second factors are the most important factors that justifies the function in squared meter.

In the regression analysis (Table 3) at the approximation of 1% with the mean squares of (163991.92) becomes meaningful. As shown in the Table 4, the biological trait and the diameter of seed, in the step-by-step regression model have been still effective. Kavarinejad and Karimov reported that harvest index and biomass traits were entered in regression equation in all environments but spikes per m^2 and spike weight were additional and important in some condition [6]. The amount of the biologic function 0.43 and the diameter of seed have been 19.09 and they had important effect on the seed yield. As we know, the coefficient of the explanation here reflects an indicator of the amount of effect of the efficient attributes on the seed function in terms of squared meter. The coefficients of the explanation for two attributes: biologic and diameter of seed functions is about 0.90. The regressive equations of these values are equals as: $Y = 30.98 + 0.43X_1 + 19.09\,X_2$

Correlation coefficient between traits:

As shown in the simple correlation of the traits (Table 4), correlation between the biological and seed yield in 1% probability level with amount (0.95) is significant. Also correlation between the height of the bush and the function of seed in one squared meter in the 1% probability level is meaningful. In this experiment, also the correlation between the lengths of peduncle with the function of the seed in one squared meter within 1% of the area unit got the meaning with 0.48. Khavarinejad and Karimov evaluated 20 wheat genotypes in greenhouse condition and indicate positive and significant correlation between yield with stem length, spike weight and spikes per square meter [6].

Paunescu and Boghici reported that yields in the normal condition were not correlated with yields in the stress condition [8].

In the path analysis (Table 5) biological yield had the most direct effect on kernel yield with the amount of 0.97. Also the height of the plant through indirect affection of biologic function has shown the amount of 0.379.

So as to determine the relationship between the genotypes and the classification of them in regard with the investigated traits, the cluster analysis had been applied. In this analysis, 11 attributes were assessed and by means of the related dendrogram, the genotypes observed in normal condition divided into 3 groups. The first one was made up of 25 percent of the genotypes, so that all the attributes within this cluster was weaker than two other ones. In the second group composed of 40 percent of the genotypes there we've seen attributes such as long-legged, and the high awn was dominant, in the third group 35 percent of the genotypes were engaged, in which among them, the biological functionality, seed yield in squared meter, weight of the spike and the weight of 100 seed was high and the items of this cluster was more small-legged than the other species or items (Fig. 1). But in the dry condition there emerged 5 groups, which in the first one there were 20 percent of all the genotypes and all the attributes were moderate. In second, we held 15 percent of genotypes and they have malfunctions in all the traits. In third one, there appeared 20 percent of the genotypes. In this cluster, the biological yield and seed yield was at an appropriate and very good position. In the fourth, we had 20 percent of the genotypes known. This cluster had demonstrated the worst function to be seen, and in the fifth group the 25 percent of genotypes lied there. This cluster had the best functionality among all the clusters and had the best performance between them and with regard to the situation and condition in this condition (Fig. 2).

Table 1: Analysis of variance for investigated traits in bread wheat

S.O.V.	Degree of freedom	Biological yield	Plant height	Spike length	Spike weight	Awn length	100 grain weight	Stem diameter	Kernel length	Seed diameter	Peduncle length	Plot kernel Yield
Replication	2	75376.82	59.12	0.37	0.18	2.73	0.59	0.13	0.007	0.14	10.87	7406.42
Genotype	19	42293.80^{ns}	184.41^{**}	4.51^{**}	0.16	3.76^{**}	0.64^{**}	0.13	0.99^{**}	0.07^{*}	53.71^{**}	5918.82^{ns}
Error	38	49603.75	69.77	1.27	0.14	1.07	0.08	0.07	0.13	0.04	12.81	7042.09

ns, * and ** : Not significant, significant at 5% and 1% probability levels, respectively.

Table 2: Factor analysis results in 20 wheat cultivars

	Biological yield	Plant height	Spike length	Spike weight	Awn length	100 grain weight	Stem diameter	Kernel length	Seed diameter	Peduncle length	Plot kernel Yield
First factor	-0.872	-0.748	-0.408	-0.358	-0.130	-0.518	-0.166	-0.122	-0.161	-0.688	-0.872
Second factor	-0.259	0.516	0.592	-0.264	0.414	-0.563	0.255	-0.150	-0.728	0.481	-0.369
Third factor	0.370	0.209	-0.147	-0.721	-0.292	0.239	-0.311	-0.641	-0.070	0.118	0.083
Fourth factor	0.100	0.162	0.170	-0.245	-0.237	-0.151	-0.627	0.659	-0.242	0.017	0.052

Table 3: Stepwise regression analysis of variance

S.O.V	Degrees of freedom	Mean of squares	Specify the coefficients
Regression	2	16391.92^{**}	
Error	57	58.127	90%
Total	59		

ns, * and ** : Not significant, significant at 5% and 1% probability levels, respectively.

Table 4- Affective and remaining traits in regression model		
Topics in Regression Model	Symbol	Values
Intercept	a	-30.98
Biological function	X_1	0.43
Seed diameter	X_2	19.09

$Y=-30.98+0.43X_1+19.09X_2$

Table 4: Simple correlation coefficient between investigated traits in wheat cultivars

	Plant height	Spike length	Spike weight	Awn length	100 grain weight	Stem diameter	During seed	Seed diameter	Peduncle length	Plot Yield
Biological function	0.51^{**}	0.4^{ns}	-0.02^{ns}	0.089^{ns}	0.12^{ns}	0.12^{ns}	-0.03^{ns}	-0.1^{ns}	0.35^{**}	0.95^{**}
Plant height		0.37^{**}	0.03^{ns}	0.23^{ns}	0.1^{ns}	0.41^{**}	-0.06^{ns}	-0.02^{ns}	0.75^{**}	0.48^{**}
Spike length			0.087^{ns}	0.1^{ns}	-0.07^{ns}	0.32^{*}	-0.12^{ns}	0.013^{ns}	0.24^{ns}	0.009^{ns}
Spike weight				0.15^{ns}	0.18^{ns}	0.36^{**}	0.07^{ns}	0.22^{ns}	0.08^{ns}	0.04^{ns}
Awn length					-0.15	0.31^{*}	0.39^{**}	-0.04^{ns}	0.42^{**}	-0.11^{ns}
100 grain weight						-0.06^{ns}	0.38^{**}	0.4^{**}	0.02^{ns}	0.2^{ns}
Stem diameter							-0.16^{ns}	0.14^{ns}	0.32^{ns}	0.14^{ns}
Kernel								0.22^{ns}	-0.19^{ns}	0.01^{ns}

length										
Seed diameter									0.1^{ns}	0.019^{ns}
Peduncle length										0.38**

ns, * and ** : Not significant, significant at 5% and 1% probability levels, respectively.

Table 5: Direct and indirect effects of various traits on grain yield in wheat under drought stress

Indirect effect through				Direct effect	Treats
Peduncle length	Seed diameter	Plant height	Biological function		
0.03	-0.01	-0.04	-	0.97	Biological function
0.067	-0.003	-	0.49	-0.08	Plant height
0.009	-	0.001	-0.097	0.1	Seed diameter
-	0.01	-0.06	0.339	0.09	Peduncle length

For clarification and also justification of the results taking into account, we might declare that for increase of the seed yield in the tensional circumstances between the components of the seed function in terms of the priority, we should increase the biologic performance, the height of the bush and the length of the peduncle so as to compensate the increase of the seed function because of the dry conditions in the environment. On the other hand, with notifying to the step- by – step variance regressive analysis, we have to increase the biological function and the diameter of the seed to be able compensating the seed function in dry conditions. Also the performance of the seed has a direct relationship with biological functionality, and we might increase this function with increasing the height of the bush and the length of the peduncle in the dry and tensional circumstances.

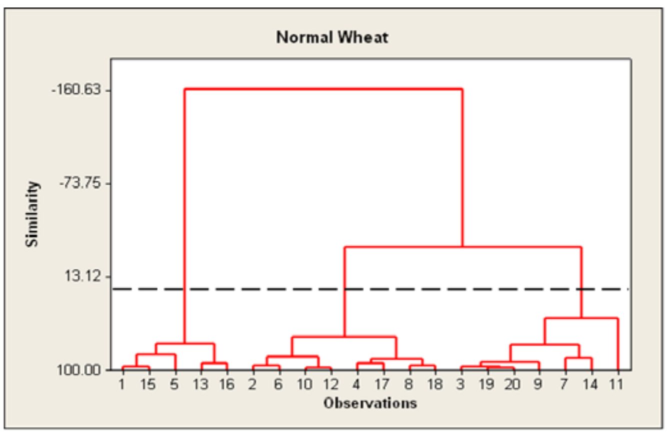

Fig. 1: Dendrogram resulting from a cluster analysis in normal condition

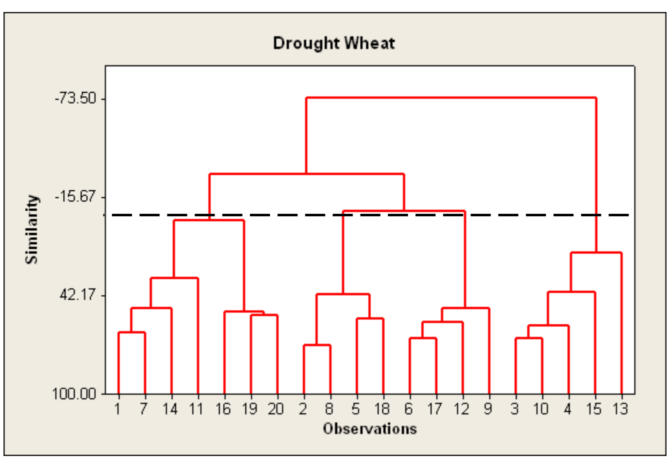

Fig. 2: Dendrogram from cluster analysis for 20 wheat cultivars under drought stress condition

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