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The Effects of Global Environmental Changes and Reduction of Water Sources on the Growth and Yield of Barley Genotypes

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Abstract. In order to evaluate yield and yield components of five barley verities under non limited and limited irrigation (irrigation until earring) an experiment as two design based on Randomized Complete Block (RCB) with three replications were carried out.
A simple analysis of variance for both environment (water stress and water less ness) has shown that in the studied genotypes, there is a significant difference in grain yield and the 1000 seed weight.
The conclusion of combined analysis of variance of two environments has shows that there is a significant difference between the genotypes and environment for grain yield characteristics and the 1000 seed weight, that expresses the reduction of the characteristic under the effect of drought in the earring phases.
Reactive effect of environment and the genotype is significant only for grain yield character, that shows the genotype have different reactions in different environmental conditions.
A comparison of the average characteristics shows that in drought ness conditions genotypes: kavir, Gorgan and makouie being in one group, has shown higher grain yield compared to other genotype, and in drought conditions genotypes: Kavir, Sahand, Garaarpa there was the most grain yield.
A calculation of stress tolerance index (STI) for all genotypes has made it clear that genotypes: kavir, Sahand, Garaarpa, Gorgan have higher STI amount compared to others and have higher tolerance to the drought conditions.

Keywords: component; drought, barley, grain yield

1. Introduction

Drought is the most important factor of limiting the growth and yield of the plants, which effect on 40 to 60 percent of the agricultural fields all over the world [3] .Iran moderately with 260 millimeters of rainfall in year is one of the dry and semidry countries in the world and nearly half of the agriculture lands are in dry and semidry region [6].

After wheat, barley is the main crop in Iran and it is the forth agricultural product in the world. Barley is a drought resistance plant and is replaced by wheat in dry regions which their rainfall isn't enough for production of wheat, because of difference varieties in barley and its tolerance against drought stress is different, It is the genotypes with high yield, should be selected[9].

Samarah [8] reported on the base of done studies on cereals like barley and wheat on drought stress condition in CYMMIT and ICARDA international centers the grain yield depends on grain numbers, so studies are concentrated on earring period.

Samarah [8] concluded that in cereal the most stressful stage to the drought stress, is the time between earrings till blooming. Zhongjin[11] have reported in an experiment that drought stress would reduce the grain filling period, the grain yield and the 1000 seed weight, and the most important effect of it would be on the grain filling period between the first to the 14th day after and there is no enough water for seed during grain filling time in dry and semidry region as a result, the number and the weight of the seed decreased and yield did too.

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Benmoussa and Achouch [1] believe that the most important goal of the breeding program is the positive correlation between the grain yield and yield components from the functional point of view. As the grain yield has a low heritability and is controlled by different morphological and physiological mechanisms, so it is a complicated characteristics, and there would be a need for an indirect function in the breeding program me, for increasing it. That is, those characteristics are selected that contain a high heritability and have a positive and significant correlation with the grain yield.

Grain yield components are calculated through y= abc, in which 'y' is the grain yield , 'a' is the number of spikes in m2 , 'b' is the number of the seed in spike and 'c' is the average weight of each 1000 seed.

In dry and semidry region, drought stress, especially in the end of the growth season is one of the significant limiting factors of production. The spring barely genotypes in these regions face low hydration and draught stress in the end of their growth phases . The purpose of this research is to analyze the effects of drought stress on the grain yield and yield components and the selection of the genotypes with a high function and high stability capability to drought in the end of their growth period[11].

2. Methods and Materials

In their experiment 5 types of spring barley are used in two different experiments, which are shown by codes form 1-5 for easiness (Table1), and the use of Randomized Complete Blocks design with a three replication in equal conditions, and the only difference was the cut of irrigation for one of the experiments in the time of earring and providing drought stress from earring stage to the complete ripening phase.

Every variety in an experimental unit is composed of two rows, which are 60 cm in width, and every row includes two rows, which are 5 meter long and the distance between them is 30 cm, were planted, so that the area of every experimental unit at all blocks is 4×0.3×5=6.

In the growth stage not only the agricultural cares, but also sampling and recording from the experiment plots were done. For the grain yield measurement, after the separation of the seed from the straw, the seeds weight is calculated according to gram in each experimental unit. After the appearance of the spikes, the number of mature spikes is counted and it is considered as the number of spikes in m2 and 4 samples of 1000 seeds of each type are counted and weighted separately. The average calculated number is considered as the weight of 1000 seeds. Also the complete number of seed in the spikes is counted. To provide a the drought stress susceptibility index, the analyzed genotypes are used from the suggested relations of Fischer and Maurer [5],Rosielle and Hamblin[7]:

$$MP = \frac{y_s + y_p}{2} \qquad TOL = y_p - y_s \qquad STI = \frac{(y_p)(y_s)}{(\bar{y}_p)^2}$$

$$SSI = \frac{1-(\frac{y_s}{y_p})}{SI} \qquad SI = 1-(\frac{\bar{y}_s}{\bar{y}_p})$$

$$GMP = \sqrt{(y_s)(y_p)} \qquad TOL = y_p - y_s$$

In the above relation:

Yp: Is the grain yield of each genotype in stress less environment.

Ys: Is the grain yield of each genotype in stressful environment.

Ys: Is the average grain yield of all genotypes in stress full environments.

Yp: Is the average grain yield of all genotypes in stress full environments.

SI: Is the stress intensity.

SSI: Is the stress susceptibility index.

TOL: Is the tolerance index.

MP: IS the mean productivity index.

MSTATC & SPSS software are wed for the analysis of the statistical calculations of the experiment data, and Qpro is used for graphs needed.

The tables of 2&3 show analysis of variance of non stress and drought stress, and according to these tables in both experiments, there is a significant difference between the varieties from grain yield characterizes the number of seeds in spikes and the 1000 seed weight, that is due to a genetically difference between the varieties. Table 4 is related to combined variance analysis of two environments. In this table there was no significant difference for the environment source of variance and genotypes

3. TABLES

Table 1- Number of each one of varieties

Number	Name
1	Maqouei
2	Gara arpa
3	Kavir
4	Gorgan
5	Sahand

Table 2- Analysis of variance (experiments without drought stress)

Source of variation	Degree of freedom	Mean of squares			
		Grain yield (gr/ha)	The number of spikes	The weight of 1000 seeds (gr/m2)	The grain numbers in spikes
Replication	2	455757.98	1.35	50.01	9.92
Genotype	4	4214251.1*	1.75	40.20**	88.42**
Error	8	420305.18	1.04	8.88	26.24
CV	-	13.1	14.81	7.3	15.16

* Significant at the 5% probability level.

** Significant at the 1% probability level.

Table 3- Analysis of variance (experiments of drought stress)

Source of variation	Degree of freedom	Mean of squares			
		Grain yield(gr/ha)	The number of spikes	The weight of 1000 seeds(gr/m2)	The grain numbers in spikes
Replication	2	747249.9	2.009	1.93	17.25
Genotype	4	1244222.1*	0.384	32.28**	79.56*
Error	8	480861.6	0.974	5.35	26.1
CV	-	20.15	15.21	5.65	18.01

Table 4- Combined analysis of varieties in both environments

Source of variation	Degree of freedom	Mean of squares			
		Grain yield(gr/ha)	The number of spikes	The weight of 1000 seeds(gr/m2)	The grain Numbers in spikes
Environment	1	14162000.6**	2.832	390.62*	257.95*
Error	4	396416.48	1.683	26.07	13.596
Genotype	4	4006847.7*	0.2835	65.11**	105.66*
Environment ×Genotype	4	1451625.3**	0.286	7.38	62.41**
Error	16	450583.16	0.861	7.11	26.21
CV	-	16.21	15.9	4.8	17.59

Table 5- Experiments without drought stress

Genotype	Grain yield (gr/ha)	The weight of 1000 seeds(gr/m2)	The grain Numbers in spikes
4	4295.8a	52.9b	39.68ab
1	3863.2a	49.5bc	42.2a
3	3703ab	51.7b	27.4bc
5	3140b	56.1a	23.9c
2	2028.9c	54.8ab	28.6bc
	3406.32	53	32.38
LSD 5%	597.6	2.9	4.91

Table 6- Experiments of drought stress

Genotype	Grain yield(gr/ha)	The weight of 1000 seeds(gr/m2)	The grain Numbers in spikes
3	2894.8a	47.7ab	26.3ab
5	2826.2ab	48.1a	22.4b
1	2330.4abc	38.3d	23.8b
4	2221.5abc	47.1ab	38.7a
2	1821.8cd	43.5c	13.5c
	2418.94	44.94	24.94
LSD 5%	631.7	2.23	4.84

Table 7- Combined analysis of both environments

Genotype	Grain yield(gr/ha)	The weight of 1000 seeds(gr/m2)	The grain Numbers in spikes
3	3302.1a	50.96c	26.7bc
4	3256.7a	52.21ab	39.2a
1	3096.6a	44.45a	34.3ab
5	2977.3ab	53.15a	22.9c
2	1920.4c	50.75c	20.2c
	2910.6	50.30	28.66
LSD 5%	508	1.57	3.09

Table 8- Yield in drought stress and non stress

Genotype	Yp	Ys	MP	TOL	SSI	STI
1	3863.2	2230.4	3108.1	1609.7	2.222	1.785
2	2028.9	1821.8	1947.4	224.5	0.733	0.908
3	3803.6	2894.8	3306.3	857.1	1.337	2.232
4	4295.8	2221.5	3259.6	2150.8	2.99	1.967
5	3140.1	2826.2	3003.4	332.6	0.537	1.841
Average	3406.32	2418.9	2925.1	713.2	1.563	1.7466
CV	20.60	18.12	20.6	70.11	41.3	289

Table9- Correlation coefficients between resistances to drought index.

-	Yp	Ys	MP	TOL	SSI	SSI
Yp	1	0.596	0.98**	0.89*	0.767**	0.958*
Ys		1	0.83*	0.052	-0.21	0.878*
MP			1	0.651	0.498	0.997**
TOL				1	0.98*	0.605
SSI					1	0.431
SSI						1

4. Dissension

for the number of spikes characteristics, but there is a significant difference for the other characters.

Interact ional genotype and environment effect was also significant for the grain yield and the number of seeds in the spikes that shows a difference of reaction of genotypes from the mentioned characteristics point of view, in the both experiment.

According to the significance of the environment (Table 4) and the reduction of the yield of other varieties in the drought stress environment compared with the non stressed environment (Tabale5, 6, 7) we can

conclude that there is a significant difference between the two environments from the grain yield point of view. Fathi [4] believe that after the earring by the effect of the drought stress, photosynthesis reduces and the transition of the dry material to the seed faces problems, and it would affect the final yield of the seed.

5. Conclusion

In an experiment [8]concluded that in grains the most stressful stage to the drought stress, is the time between earring and blooming and the types that can product the dry matter before blossoming and save in the stem , is considered as the tolerance varieties to drought.

According to Blum[2] if there do isn't enough water in the semi-dry wears and the stored water in the soil is used up by other growth parts of the plant before earring, there would be no water for grain filling stage and concluding the number of seeds in the spike be a reduction the grain yield.

Zhongjin[11] have reported in an experiment that drought stress would reduce the grain filling period, the grain yield and the 1000seed weight, and the most important effect of it would be on the grain-filling period between the first to the 14th dry after pollination.

Tolerance indexes of drought stress for the 10 varieties under the experiment, are calculated trough the yp , ys under the drought stress hardness equal to SI=317 and are put in the table 8.

Simple correlation coefficient between STI, SSI, TOL, MP together and by yp, ys are also provided in table 9.

The correlation of STI with yp , ys is positive and significant and as it increase, it is an evidence of high tolerance of genotypes compared to stress and high yield[5].

The genotypes number 1, 3, 5 with a high STI had a more yield of total average in drought stress non stressed condition, as the STI genotypes select indexes with high tolerance and more yield, and according to positive and significant correlation of this index with ys, so among the analyzed indexes STI is the most important and MP index would go in the 2nd rate [10].

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