International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2013 IJFAS Journal-2013-2-15/505-509
ISSN 2322-4134 ©2013 IJFAS

Estimate the terminal drought tolerance indices in cultivars and promising lines of bread wheat in Ardabil

Farhad Alizadeh[1*], Reza Taghizadeh[1] and Gholamreza Aminzadeh[2]

[1]Department of Agronomy and Plant Breeding, Astara Branch, Islamic Azad University, Astara, Iran
[2]Ardebil Agricultural and Natural Resources Research Center, Ardabil, Iran

Corresponding author: Farhad Alizadeh

ABSTRACT: In order to evaluate end of season's drought resistance indices in promising lines of Wheat in Ardabil, twenty promising varieties and promising lines of Wheat were evaluated in randomized complete block design with three replications in two conditions at the Agricultural and natural resources research station Ardebil (alaruq) in 2011-2012. In the first experiment, the irrigation of wheat cultivars as usual continued to achieve physiological stage. But In the second experiment, from Panicle emergence stages in wheat cultivars and lines, irrigation was discontinued. Results showed that, in normal circumstances, between the lines and cultivars for most traits except the number of tillers, grain weight and total Seed weight per plant, straw and total plant weight was significant. In the Terminal drought conditions between the lines and cultivars, except for tiller number, harvest index and days to heading, there was a significant difference. In the normal conditions, Line No. 3 with 8.139 tons per hectare and cultivars, the highest and line number 12 with 5.945 ton/ha were produced lowest yield compared to the other lines. In the normal conditions, the correlation of seed yield with grain weight per panicle and panicle length 0.545 and 0.430, respectively, were positive and significant. In the terminal drought conditions, the Line No. 7 with 5.528 tons per hectare yield was one of the top lines. Estimation of drought tolerance indices for the varieties and lines tested showed that TOL index for lines of 12, 5, 11, and Mihan variety (No. 2), respectively, 1.51, 1.63, 1.91 and 1.87, were most tolerant lines under drought stress after pollination. In terms of index SSI, lines number 12, 5, 7, 11 and figure homeland with their respective index values equal to 0.81, 0.78, 0.83 0.91 and 0.86 were the most tolerant lines under drought stress after pollination of wheat in this investigation Recommend the addition of STI, K2STI and K1STI indicators in lines of wheat selection under normal and drought conditions should be used. Using this indicator, line of Number 7 and Number 10, they were the best treatments of the experiment.

Keywords**:** wheat cultivars, stress indices, yield, yield components, season finale drought

INTRODUCTION

Drought is considered the most important factor limit successful production of crop throughout the world. The factor is created when combination of physical and environmental factors increase the stress within plants and thus reduce production. Iran is located in the desert belt of the world. It is as arid and semiarid region and has limited rainfall. According to a statistics, about one-third of the total rainfall in the world is belonging to it (Faramarzi et al., 2010). According to some reports, the yield average of the wheat is 30 to 60 percent of the obtainable performance in the world that the main reason is the lack of water (Dang et al, 2003). Sidik et al. (1999) reported that drought affect almost all processes of plant growth as the most important factor control the products performance. The heritability of yield decreases under drought stress. In these conditions, high yielding and selected genotypes may not be able to show their yielding traits in all selective cycles because a significant portion of the variation in performance under drought stress conditions is due to the environment. Considering the low efficiency of these selective programs, some breeders use high genotypes and repeated experiments at several locations and years to relatively obtain accurate results. In recent years, the results of similar studies in the country has led to introduce the cultivars such as Chamran, Mahdavi, Alvand, Zarrin, Zagros, Nick Nejad , Kouhdasht and Azar 2. Every year, the results of similar studies in other countries and international research centers like ICARDA and CIMMYT has led to the introduction of high-yielding and stable genotypes around the world (Rustaei and Khanzadeh, 2004). Other stresses such as high temperatures, high radiation, low water and lack of nutrients in dry conditions occurs at the same time drought stress that make the process of plants breeding more complex for drought resistance. In addition, soil properties such as soil texture and structure have affected the balance of these tensions and makes studies to be more problems (Vitremur (Cutremur) and Vali, 2009).

Hossein Panahi et al (2011) by assessing yield and its components in tolerant and drought-sensitive wheat cultivars concluded that maintain the number of more spikes per unit area and produce more seeds per spike is part of the most important superiority factors the tolerant and sensitive varieties of wheat. Although, produce varieties with a short growing season is the best strategy for coping with stress (Araus et al, 2002) but it should be considered that it is possible shorten the growth period may reduces the yield or at best can maintain the current yield. While, it is necessary to increase the annual growth of wheat from the current 0.9 to 1.6 percent for the needs of a growing population in next 20 years (Reynolds et al, 2000). Salehi et al. (2003) has reported that parameters such as chlorophyll content and nitrogen levels are increased in response to drought stress in wheat and this reaction is remarkable, especially in flag leaves. Machado and Paulsen (2001) have been introduced fast physiological changes like tube-like leaves; leaf area reduction and stomata resistance increase as part of the mechanisms to avoid drought stress in wheat.

Sanjari and Yazdan sepas (2008) stated that find wheat genotypes that can have desirable performance in both normal and stress conditions is a complex task due to the significant interaction between them. Shiri et al. (2010) by studying different drought stress on 24 wheat genotypes concluded that indices GMP, MP, STI and KSTI is the best indicator to predict the wheat yield and drought tolerant genotypes can be easily selected by them. Zabet et al. (2003) investigate the effects of drought on the different characteristics and determine the best indicator of drought resistance in mung bean, stress tolerance indices, arithmetic and geometric means identified appropriate and stated that resistant genotypes can identify based them. In this study, significant positive correlation was obtained between the yields of environment and indices STI, GMP and MP. Tari nejad (1998), simple correlation between STI with Yp,Ys and SSI in wheat reported respectively 0.776, 0.889 and 0.318. He concluded that whatever value of calculated STI is high for each genotype, the genotype is drought tolerant and high performance. Study the effects of drought stress always is a research priorities and despite numerous published scientific resources in this area, there are still many gaps. Therefore, this study has been developed and implemented in this regard.

MATERIALS AND METHODS

This experiment was carried out in Agricultural Research and Natural Resources station of Ardabil (Alarug) in 2011-2012. In the experiment, 12 cultivars and promising lines of bread wheat in cold region (Table 1) were studied in two separate experiments in a randomized complete block design with three replications. Cultivation was performed after routine operations such as land preparation, distribution the fertilizer, disk, leveler with special seed drill (Winter Eshtiger). During growth, agronomic traits such as green percent, cluster heading date, yellow and brown rust damage, plant height, peduncle length, number of grains per spike, grain weight, grain weight per spike, grain yield and other traits such as biomass, harvest index were measured and then the moisture stress tolerance indices were calculated and analyzed. Finally, statistical analysis included analysis of variance, comparing the characteristics, the relationship between traits and plot graphs were performed using computer software MSTAT-C, SPSS and EXCEL. To estimate the sensitivity and drought tolerance indices, it was used the performance of lines and wheat cultivars in testing drought and irrigation after flowering (Ys) with their performance under without drought stress (Yp) as follows: Drought susceptibility index (SSI) and Fisher and Maurer (1978) was calculated by the following equation:

$$SSI = \{1 - (Y_s / Y_p)\} / SI$$

Yp = Potential yield of each cultivar or line under non-stress
Ys= Potential yield of each cultivar or line under drought stress
Y̆s= Yield average of all lines in terms drought stress
y̆p = Yield average of all lines in terms without drought stress

SI=((1-($\hat{Y}s$- $\hat{Y}p$)

Arithmetic mean of the product (MP) Rozil and Hamblin (1981):

Mp=(Yp+Ys)/2

Drought tolerance index (TOL) Rozil and Hamblin (1981):

TOL=Yp-Ys

Stress tolerance index (STI) Fernandez (1992):

$STI=(Y_p)(Y_s)/(\hat{Y}_p)^2$

Geometric mean of the product (GMP) Fernandez (1992):

GMP=SQRT(Yp*Ys)

Adjusted stress tolerance index for situation of without moisture stress (K1STI) Naderi et al. (2000):
$K1STI = (Yp)^2/(\hat{Y}p)2$ *STI

Adjusted stress tolerance index for situation of moisture stress (K2STI) Naderi et al. (2000):
$K2STI = (Ys)^2/(\hat{Y}p)2$ *STI

The above equations $\hat{Y}s$ and $\hat{Y}p$ are respectively grain yield average of all lines and wheat cultivars in the test under normal irrigation and drought stress. Thus lines and critical tolerant cultivars to drought were evaluated using drought tolerance indices. After measure the traits and taking notes in the specific forms and then averaging, statistical calculations were performed as follows: Analysis of variance for all measured traits was performed in a randomized complete block design with three replications. Before performing statistical analysis, data were evaluated using the normal test index, then ensure normal distribution of the data, to analyze the data, statistical methods such as analysis of variance and mean comparison of lines with Duncan test and correlation coefficients was used at the 5% level.

RESULTS AND DISCUSSION

The effect of cultivars and lines on grain yield was non-significant in normal and drought conditions in this experiment. In normal conditions, lines 3 and 4, respectively with yield of 8.139 and 7.517 t ha had the highest grain yield and at least grain yield was related to the treatment 12 with 5.945 t ha. In the terminal drought test, lines 7 and 8 were among the top lines respectively with grain yield 5.528 and 5.344 t ha. Yield average of all lines and cultivars in the normal conditions has been 7.086 t ha and in drought stress has 4.869 t ha. In other words, stop watering after flowering or late season drought stress in cultivars has reduced yield average 31.3%. High average yield between cultivars and the lines in the normal conditions is related to the fill grains of wheat and more seed weight. In contrast, the yield average of the total cultivars was less due to the reduction in number of grains per spike and grain weight. The yield reduction in the situation is directly caused through wrinkled seeds and also reduces the grain weight and sterility spikelet's florets.

Indicators of drought tolerance in the test

Drought tolerance indices for cultivars and test lines yield under drought stress after pollination (Ys) were calculated with their performance in normal and without stress conditions (Yp) (Table 1). Based on TOL and lines 12, 5, 11, and Mihan cultivar (No. 2) respectively amount of TOL 1.51, 1.63, 1.91 and 1.87 were the most tolerant lines under drought stress after pollination. The lines and cultivars in drought stress and normal conditions have produced yield below the total average. Therefore, this index led selection of lines towards low-yielding cultivars in terms of performance but drought tolerant.

The SSI index and lines 12, 5, 7, 11 and Mihan cultivar respectively amount of 0.81, 0.78, 0.83, 0.91 and 0.86 were the most tolerant lines under drought stress after pollination (Table 1). These lines (except No. 7) had lower yield than total average of 12 varieties in drought after pollination. This indicates that SSI index, like the index TOL has selected drought tolerant and low-yielding cultivars in terms of performance. Given these two indexes, it seems that new Mihan cultivar along lines 5, 11 and 12 are among the most tolerant to drought and have less sensitive to water stress after pollination. This indicates that these two indexes have the same judgment and select tolerant lines with a low yield. It is better to use the indices to remove the susceptible cultivars and not selection of drought tolerant cultivars. Naderi et al. (2000) and Shiri et al. (2010) have been presented similar results.

According MP (Table 4-7) lines 3, 6, 7 and 8 were the most tolerant cultivars in drought after pollination respectively with values of 6.21, 6.19, 6.49 and 6.20 and had high yield in drought conditions. STI index with the performance of each of the lines and cultivars in normal and drought conditions, they can be divided into four groups according to Fernandez (1992). Lines 7, 8, 6, and 10 respectively with index values STI 0.82, 0.75, 0.74 and 0.73 are placed in group A. The lines with high values, offered the high mean of total average in both normal and stress environments, the performance of both performance. The line number 7, yield 5.528 t ha in drought conditions after pollination and yield 7.456 ton/ha were superior in normal circumstances than other lines in the group. Average yield of all lines and cultivars in drought stress after pollination and in normal conditions, was estimated respectively 4.869 and 7.086 t ha (Table 1).

Lines and cultivars 1 (Zare cultivars), 3 and 4 were placed in group B. They had good performance respectively 7.139, 8.139 and 7.517 t ha were in test normal were. Mihan (5.061 tons per acre) and line No. 5 (5.033 tons per hectare) were placed in group C. These two lines had just ideal performance under drought stress and their average was higher than total mean of the cultivars (4.869 t ha) of performance. In Group D three lanes 9, 11 and 12 were placed that had poor performance in both test environments and their STI index respectively with rate 0.62, 0.64 and 0.53 was less than others. In selecting lines of wheat in normal and drought conditions especially for groups a, it is better to be used K1STI and K2STI in addition STI index. After pollination in drought stress conditions the K1STI and K2STI values for line 7 was respectively 0.91 and 0.50 and for line 10 was 0.79 and 0.35. If in the area according to long-term weather statistics, likely to be more favorable terms, line 10 is recommended according to K1STI. If the likelihood of drought conditions is more, the cultivation of line 7 is expected according to K2STI and TOL. Naderi et al. (2000) and Shiri et al (2010) also recommended that for the best selection of wheat genotypes under stress, it is better to be used in addition to STI index the adjusted index KSTI.

Table 1. Estimation of stress tolerance index for grain yield in wheat cultivars

Row	Genotypes	Yp(t/ha)	Ys(t/ha)	MP	GMP	TOL	SSI	STI	K1STI	K2STI
1	Zareh	7.139	4.606	5.87	5.73	2.53	1.13	0.65	0.66	0.28
2	Mihan	6.928	5.061	5.99	5.92	1.87	0.86	0.7	0.67	0.36
3	MV17/3/Azd/Vee"s"//Seri82/Rsh/4/Fln/Acc//Ana/3/Pew"s"/5/Catbird	8.139	4.278	6.21	5.9	3.86	1.52	0.69	0.91	0.25
4	Zrn/Shiroodi/6/Zrn/5/Omid/4/Bb/Kal//Ald/3/Y50E/Kal*3//Emu	7.517	4.661	6.09	5.92	2.86	1.2	0.7	0.79	0.3
5	Passarinho//Vee/Nac	6.667	5.033	5.85	5.79	1.63	0.78	0.67	0.59	0.34
6	Cupra-1/3/Croc1/Ae.squarrosa(224)//2*Opata/4/Pantheo	7.3	5.089	6.19	6.10	2.21	0.97	0.74	0.79	0.38
7	Jagger 'sib'/3/Lagos-7//Guimatli 2/17	7.456	5.528	6.49	6.42	1.93	0.83	0.82	0.91	0.5
8	Ymh/Hys//Hys/Tur3055/3/Dga/4/Vpm/Mos/5/5/Tam200/Kauz (-0AP-0AP-7AP-0AP-5A-0AP)	7.061	5.344	6.20	6.14	1.72	0.78	0.75	0.75	0.43
9	Pantheon/Bluegil-2 (-030YE-030YE-2E-0E)	6.767	4.633	5.70	5.60	2.13	1.01	0.62	0.57	0.27
10	Zander//Attila/3*Bcn (-0SE-0YC-0YE-3YE-0YE-2YE-0YE	7.394	4.944	6.17	6.05	2.45	1.06	0.73	0.79	0.35
11	Solh	6.722	4.811	5.77	5.69	1.91	0.91	0.64	0.58	0.3
12	Soissons/M-73-4//Owl 852524-*3H-*0-*H0H	5.945	4.39	5.19	5.14	1.51	0.81	0.53	0.37	0.21
Mean		7.086	4.869	5.98	5.87	2.22	0.99	0.69	0.7	0.33

MP = the arithmetic average of the product, GMP = the geometric mean of the product, Tol = tolerance index, SSI = stress susceptibility index, STI = stress tolerance index, K1STI = stress tolerance index adjusted for normal conditions, K2STI = stress tolerance index adjusted for drought conditions

REFERENCES

Araus, J.L., Slafer, G.A., Reynolds, M.P. and Royo, C., 2002. Plant breeding and drought in C3 cereals: what should we breed for? Ann. Bot. 89, 925–940.

Deng, X.P., Shan, L., Kang, S.Z., Shinobu, I., 2003. Improvement of wheat water use efficiency in semiarid area of China. Agric. Sci. China. 2, 35-44.

Dencic. S. Kastori. R. Kobiljski. B. and Duggan. B. 2000. “Evaluation of grain yield and its components in wheat cultivars and landraces under near optimal and drought conditions”. Euphytica 113:43-52.

Faramarzi, M., Yang, H., Schulin, R., Abbaspoura, K.C., 2010. Modeling wheat yield and crop water productivity in Iran: Implications of agricultural water management for wheat production. Agric. Water Manage. 97, 1861–1875.

Fernandez, G.C.J. 1992. Effective selection criteria for assessing plant stress tolerance. In: Adaptation of Food Crops to Temperature and Water Stress, Kuo, C.G. (Ed.). AVRDC Publication, Shanhua, Taiwan, pp: 257-270.

Fischer, A.T. and Maurer, R. 1978. Drought resistance in spring wheat cultivars. I: Grain yield responses. Aus. J. Agric. Res. 29:897-912.

Fisher, R.A., and J. T. Wood.1979. Drought resistance in spring wheat cultivation. III. Yield association with morphological traits. Aust.J. Agric.Res.30:1001-1020.

Hossein Panahi, F., M. Kafi, M. Parsa, M. Nasiri Mahallati and M. Banayan.In 2011. Evaluation of yield and yield components of resistant to drought cultivars of wheat under moisture stress, using Penman - FAO Muntis model, Journal of Environmental Stress in crop science, Vol IV, No.1.

Gutrie, M. J. Stark. J. C. O' Brien. K. and Souza. E. 2001. "Retative sensitivity of soring wheat grin yield and quality parameters to moisture deficit".Grop Sci 41:327-335.

Machado ,S. and G. M. Paulsen. 2001. Combined effects of drought and high temperature on water relations of wheat and sorghum. Plant and Soil , 223:179-187.

Naderi, A., Majidi-Hervan, E., Hashemi-Dezfoli, A., Rezaei, A., and Nourmohammadi, G. 2000. Efficiency analysis of indices for tolerance to environmental stresses in field crops and introduction of a new index. Plant Seed J. 15: 390-402.

Reynolds, M.P., van Ginkel, M., Ribaut, J.M., 2000. Avenues for genetic modification of radiation use efficiency in wheat. J. Exp. Bot. 51, 459–473.

Rosielle, A.A. and Hamblin, J. 1981. Theoretical aspects of selection for yield in stress and non-stress environments. Crop Sci. 21:943.946.

Rustaei, M. and Khanzadeh, H. In 2004. Adaptability and yield stability of bread wheat in warm dry land areas in uniform national experiments. Final Report, Dry land Agricultural Research Institute's publications.

Salehi, M., A. M. Kouchaki, and M. Nasiri Mahallati. 2003. Nitrogen and chlorophyll as an indicator of water stress in wheat. Journal of Agricultural Research. Vol. 1, No. 2, p. 199-205.

Sanjari-Pirevatlou, A. and Yazdansepas, A. 2008.Evaluation of wheat (*Triticum aestivum* L.) Genotypes under pre- and post-anthesis drought stress conditions. J. Agric.Sci. Technol. 10: 109-121.

Shiri, M. R., Valizadeh, M. Majidi Harvan, A., Sanjari, A. G. and Garib Eshgi, A. In 2010. Evaluate the indices of moisture tolerance in wheat. Electronic Journal of Crop Production. Volume III. No. 3. 143-161.

Siddique , M. R. B. , A. Hamid , and M. S. Islam .1999. Drought stress effects on photosynthetic rate and leaf gas exchange of wheat. Bot. Bull. Acad. Sin., 40:141-145.

Schillinger,W.F., 2005. Tillage method and sowing rate relations for dry land spring wheat, barley and oat. Crop Sci. 45: 2636-2643.

Whitmore, A.P., Whalley, W.R.. 2009. Physical effects of soil drying on roots and crop growth. J. Exp. Bot. 60, 2845–2857.

Tari Nejad, A. In 1998. Assessment of lines from local populations of winter wheat genotypes under irrigated and drought stress. MSc thesis breeding. Agricultural Faculty. Tabriz university.

Zabet, M., Hosseinzadeh, A. H., Ahmadi, A. And Khial parast, F. In 2003. Effects of drought stress on different characteristics and determine the best indicator of drought resistance in mungbean. The Journal of Agricultural Science, 4: 889-897.