

***Research Paper***

**EVALUATION OF WHEAT CULTIVARS UNDER VARIOUS IRRIGATION METHODS BASED ON SOME AGRONOMIC AND PHYSIOLOGICAL TRAITS**

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**Abstract**

Drought stress often causes serious problems in wheat production areas. A field study was conducted at Agriculture Research Station of Firoozabad, Fars, Iran during 2011-2012 growing season in order to evaluate genotypes for grain yield and its components of three wheat varieties (V1: Kouhdasht, V2: Dehdasht, V3: Behrang) as sub factors. An experiment was carried out in a split-plot experiment based on randomized complete blocks design with three replications. The main factors were 5 water stress treatments i.e. I1: four irrigation cycles after flowering, I2: three irrigation cycles after flowering, I3: two irrigation cycles after flowering, I4: one irrigation cycle after flowering and I5: dry-farming were applied. The effects of irrigation, genotype and irrigation×genotype interaction were significant on spike dry weight, number of spikes m<sup>-2</sup>, number of kernels spike<sup>-1</sup>, 1000 grain weight, biological yield, harvest index and grain yield. This finding suggested that Behrang genotype could be considered as more tolerance genotype against drought stress condition than Kohdasht and Dehdasht genotypes. The results of correlation analysis indicated that the effects of biological yield, harvest index followed by number of spikes m<sup>-2</sup> and number of kernels spike<sup>-1</sup> on grain yield were the highest and positive under various irrigation conditions, indicating that selection to improve yield with these traits would be effective.

Key words: Drought tolerance, Irrigation management, Wheat yield.

**INTRODUCTION**

With continuous major global climate changes and increasing dramatically lack of water resources and worsening eco-environment, wheat production is affected extremely [28, 29]. Statistics exhibited that 25% of the world's agricultural land is now influenced by high levels of water stress [4]. Water stress is connected with almost all aspects of biology and plant growth

[5]. It should pointed out that drought is one of the major causes of crop loss worldwide, which commonly reduces average yield for many crop plants by more than 50% [25].

Wheat (*Triticum aestivum* L.) is one of the world's most widely adapted crops supplying one-third of the world population with more than half of their calories and nearly half of their protein and Wheat is the leading crop of the temperate climates of the world and a unique world food grain and its grown on about 200 Million ha in a range of environments, with an annual production of more than 600 million metric tons [20]. On the other hand, global wheat production must continue to increase 2% annually until 2020 to meet future demands of imposed population and prosperity growth [14].

In Iran, wheat is a staple food and occupies a central position in setting farming and agriculture policies. Fars Province is the largest wheat producer in Iran [6]. Wheat production in Iran region is restricted mainly by the accessibility of water resources [3]. Statistics revealed that cultivation area of wheat (*Triticum aestivum* L.) in Iran is about 6 million hectares [8].

Although, wheat is mainly grown on rain fed land and about 35% of the area of developing countries such as Iran, consists of semiarid and arid environments in which available moisture constitutes a primary constraint on wheat production. Climatic variability in these marginal environments causes large annual fluctuations in yield. Selection of wheat genotypes with better adoption to drought stress should increase the productivity of rain fed wheat [27].

Improvement of wheat productivity for this biotic stress is therefore an important objective of research. Because of their better adoption under hot and arid regions, *Triticum durum* wheat is usually regarded as tolerance to stress condition [11, 27]. In addition among crop plants, durum wheat, which is often grown in water limited conditions, is an attractive study system due to of the natural genetic variation in traits related to drought tolerance [21].

However, the physiological basis of their stress tolerance is not well understood. An understanding of how plants respond to water deficits and in certain instances are able to tolerate them should lead us eventually to ways of optimizing plant productivity in marginal environments [11]. The sensitivity of crops such as wheat (*Triticum aestivum* L.) to soil drought is particularly important during the grain-filling period because the reproductive phase is extremely sensitive to plant water status [2].

The previous research exhibited that yield and yield components of wheat depend on the proper irrigation management. Wheat irrigation prior to sowing, at the stem elongation, flowering and milking stages produced the highest yield. Whenever, irrigation only prior to sowing produced the lowest yield and 1000-grain weight [3, 10]. Some morphological characters such as root length, tillering, spike number per m<sup>2</sup>, grain number per spike, number of fertile tillers per plant, 1000 grain weight, peduncle length, spike weight, stem weight, awn length, grain weight per spike and affect wheat tolerance to the moisture shortage in the soil [4]. One or two times irrigation at the sensitive stages of wheat to water deficit increased grain yield (GY) as 2 to 5 times. In addition, limited irrigation at growing season especially at the critical stages of wheat reduced yield [3].

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 Fars province. Target of this study is investigate drought resistance of wheat's commonly grown in Iran (Fars) and the drought resistance of which was only determined by agronomic observation and which wheat should be of the ability of resisting drought on account of its genetic structure according to above mentioned characters.

## MATERIALS AND METHODS

A farm experiment was conducted at Agriculture Research Station of Firoozabad, Fars, Iran during 2011-2012 growing season (located at 52°, 28'N & 28°, 38'E and 1327 m above sea level) to evaluate the wheat cultivars under various irrigation methods based on some agronomic and physiological traits. The minimum and maximum cultivation temperatures were 21.1 and 38.1°C, respectively. The annual raining was 550 mm by average and it had a relative humidity of 36%.

The experiment design was laid out entirely in a split-plot arranged based on randomized completed block design (RCBD) with three replications.

Treatment consisted of water stress at different growth stages of wheat and it was confirmed at five levels. The main factors were I1: four irrigation cycles after flowering (The first irrigation cycle just after pollination and second irrigation cycle after emergence of spikes and onset of fertility, third irrigation cycle in milk development stage and forth irrigation cycle in grain dough stage), I2: three irrigation cycles after flowering (The first irrigation cycle just after pollination and second irrigation cycle in milk development stage and third irrigation cycle in grain dough stage), I3: two irrigation cycles after flowering (The first irrigation cycle in milk development stage and second irrigation cycle in grain dough stage), I4: one irrigation cycle after flowering (one irrigation cycle in milk development stage) and I5: dry-farming defining as drought stress. Sub plots were three wheat (*Triticum aestivum* L.) genotypes (V1: Kouhdasht, V2: Dehdasht, V3: Behrang).

Plots were established initially according to experimental design study. Each experimental plot area had a surface area of 7.5m<sup>2</sup>, with 3×2.5 dimensions. Each plot was consisted of 4 plant lines and six-meter length. In addition, the distance between main plots was estimated two meters, whereas the plant distance on each row was 20 cm and the rows were 25 cm far from each other.

Seeds were sown at 400 seeds m<sup>-2</sup> on 12<sup>th</sup> October. Based on soil analysis, the plots were fertilized with 60 kg N ha<sup>-1</sup> and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> at the planting and 60 kg N ha<sup>-1</sup> in spring at stem elongation for drought conditions. However, plots were fertilized with 80 kg N ha<sup>-1</sup> and 80 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> at planting and 60 kg N ha<sup>-1</sup> in spring at stem elongation for irrigation conditions. During the growth period, all plots were weeded manually. Plough, two vertical disks, leveling, furrow, mound were used regarding plot making. To fight the weeds which had side leaves and also thin leaves, a mixture of Granstar and Pumasuper was used. It was 20 grams and one liter in hectare in tillering stage until stem elongation, respectively. The soil texture was loamy silt clay as well. The first irrigation was immediately carried out after seeds were planted. At the end of growth period, plants from rows 4 and 5 of each plot, 3 meter long, were harvested from each plot center; and grain yield, was determined. In order to measuring of traits, 8 plants randomly selected and measurements were performed.

Skewness, kurtosis, homogeneity of variance and normality of data were tested by Minitab [18] statistical software. Analysis of variance of split-plot experiment based on RCBD and means comparison using Duncan's Multiple Range Test at P<0.05 were performed by SAS [24] and MSTATC [19] softwares. The phenotypic correlation between variable x and y ( $r_{xy}$ ) were performed in SAS [24] that it was estimated following Kwon and Torrie [17] using the formula:

$$r_{xy} = \frac{\text{Cov}_{xy}}{\sqrt{(\text{Var}_x \cdot \text{Var}_y)}} \quad (1)$$

Where,

$\text{Cov}_{xy}$  = covariance between variable x and y,  $\text{Var}_x$  = variance of x and  $\text{Var}_y$  = variance of y.

## RESULTS

The analyzed data indicated that the effect of irrigation on spike dry weight, number of spikes m<sup>-2</sup>, number of kernels spike<sup>-1</sup>, 1000 grain weight, biological yield, harvest index and grain yield was statistically significant, indicating that these traits were influenced by various irrigation conditions (Table 1). The results showed that the effect of genotype on all studied traits were significant, indicating the existence of genetic variability for these traits under various irrigation conditions (Table 1). The results indicated that irrigation×variety interaction effects were also significant at 0.01 probability level ( $P<0.01$ ) for the traits (Table 1).

Spike dry weight from the treatments of I1 (four irrigation cycles after flowering) and I4 (one irrigation cycle after flowering) statistically did not vary. I2 (three irrigation cycles after

flowering) had significant effect on spike dry weight. The highest and lowest spike dry weight was observed in Dehdasht and Behrang cultivars with mean values (3.61 and 3.07 g) respectively. These results were in accordance with the findings of Gholamin and Khayatnezhad, [11]. As shown in present study, Behrang cultivar with mean value (364.27) had the maximum and Dehdasht cultivar with mean value (201) had the minimum number of spikes  $m^{-2}$ , respectively. In addition, I3 had the highest significant effect on number of spikes  $m^{-2}$ .

Comparison means about induced irrigation cycles showed that imposition of water stress treatment (dry-farming level) had the highest effect on number of kernels spike<sup>-1</sup>. The maximum and minimum number of kernels spike<sup>-1</sup> was belonged to Behrang and Dehdasht with mean values (29.38 and 22.43), respectively. Flexas et al., [9] also reported that the number of kernels spike<sup>-1</sup> was decreased adversely under drought stress conditions. In present study, comparison means showed that the highest 1000 grain weight was related to irrigation treatment with two irrigation cycles after flowering (I3). On the other hand, the maximum and minimum 1000 grain weight were belonged to Dehdasht and Behrang with mean values (57.2 and 50.47 g), respectively.

The result indicated that three irrigation cycles after flowering (I2) had significant effect on biological yield. In addition, mean comparison indicated that biological yield was the highest in Behrang with mean value (840.27 g) and was the lowest in Dehdasht with mean value (658.6 g). Sun et al., [26] also obtained the same results. The highest and lowest harvest index (37.74 and 23.37) achieved from the varieties of Behrang and Dehdasht, respectively. In addition, two irrigation cycles after flowering (I3) had the highest effect on harvest index. The results of this study were in good agreement with the early findings of Jajarmi [13].

The highest grain yield was related to irrigation treatment with two irrigation cycles after flowering (I3). The highest and lowest grain yield was belonged to Behrang and Dehdasht with mean values (312.73 and 160.93 g), respectively. According to previous research was conducted by Gholamin and Khayatnezhad [11], various drought treatments significantly reduced number of spikes  $m^{-2}$ , biological yield, harvest index and grain yield traits.

According to the results of the correlation coefficients, spike dry weight had positive significant correlation with 1000 grain weight and biological yield ( $r=0.398$  and  $r=0.316$ , respectively) (Table 3). Number of spike  $m^{-2}$  showed positive significant correlation with all the studied traits except 1000 grain weight. 1000 grain weight was positively significantly correlated with biological yield at 1% probability level ( $r=0.404$ ). Biological yield and harvest index had the highest positive correlation with grain yield ( $r=0.795$ ). The findings of the current study were consistent with those of Reynolds et al., [22] who found wheat cultivars that have high biological yield and harvest index, most likely have high grain yield under various irrigation conditions.

## DISCUSSION

Water deficit is a common abiotic stress adversely affecting crop production. The responses of three winter wheat's productions to limited water condition under a semi-arid environment were investigated. Stress at stem elongation stage had high sensitivity, because this stage is the most determined factor for yield components. Fallahi et al., [7] suggested that water stress in beginning of stem elongation induced decreasing number of spikes and 1000 grain weight. Results of this study showed that the effect of moisture during forming and late growth stage which is coincident with stem elongation stage had important role in enhancing wheat grain yield. Number of fertile tillers that resulted in number of spikes is determined at stem elongation stage. Irrigation at primary stages of growth of wheat cultivars could effect on productivity of tillers and more produced spike. A significant difference was observed in number of spikes among tested cultivars.

The 1000 grain weight is an important component contributing towards the final yield of wheat. Decreased 1000 grain weight was reported by Plaut et al., [20] under drought at flowering stage due to less efficient and disturbed nutrient uptake and limited photosynthetic translation within the plant which hastened maturity producing shriveled kernels. Drought stress either at

vegetative or flowering stage considerably decreased grain yield and yield components in wheat [15].

Normal required number of irrigations is compulsory for ideal crop growth and production but when there is limited water available, it is necessary to identify growth stage of the crop where irrigation could be skipped with minimum loss in grain yield. Final grain yield of wheat depends on its efficient use of water [3]. Normal water at flowering increased photosynthetic rate and also enhanced duration of grain filling [12].

In any crop, the leaves and other green tissues are the original sources of assimilates. The leaves, being the site of photosynthetic activity, appear to have an obvious relation to the plant's grain yield ability [1]. In addition, Ahmadi et al., [3] exhibited that drought stress during stem elongation stage reduced number of spike per unit area and grain yield therefore, a significant correlation is observed between number of grain per spike and grain yield.

Richards et al., [23] demonstrated that harvest index is indicators of the genetic potential of plant to produce economic yield. In post anthesis water deficiency, a positive correlation was found between grain yield and harvest index. It means that increasing of grain yield is accompanied with increasing harvest index [16].

This finding suggested that Behrang genotype could be considered as more tolerance genotype against drought stress condition than Kohdasht and Dehdasht genotypes. It is concluded from the results of this study that water stress reduced wheat yield and some yield components in all varieties. The differential response of varieties to imposed water stress condition indicates the drought tolerance ability of wheat varieties. The results showed that a strategy of selecting should take into consideration early flowering, long grain filling period and high number of spike  $m^{-2}$  for increasing grain yield under drought stress conditions.

The knowledge generated through these studies should be utilized in making transgenic plants that would be able to tolerate stress condition without showing any growth and yield penalty. In recent study, the effects of drought stress and irrigation regimens on Wheat (*Triticum aestivum* L.) were significant. Concurrently management of wheat plant in Firoozabad, Fars, Iran region with high potential of wheat yield is inevitable.

Results of this study indicated that drought stress had the significant effect on all studied traits specially grain yield. Therefore, in regions which are subjected to drought stress, using genotypes that are drought tolerant and compatible to circumstances of region can be valuable.

**Table 1. Analysis of variance for studied traits in wheat**

SOV	df	Mean squares (MS)						
		Spike dry weight	Number of spikes $m^{-2}$	Number of kernels spike $^{-1}$	1000 grain weight	Biological yield	Harvest index	Grain yield
Block	2	6.02 <sup>ns</sup>	2.75 <sup>ns</sup>	5.49 <sup>ns</sup>	29.40 <sup>ns</sup>	114.02 <sup>**</sup>	56.24 <sup>**</sup>	1288.86 <sup>ns</sup>
Irrigation	4	96.38 <sup>*</sup>	28870.96 <sup>**</sup>	47.93 <sup>**</sup>	254.19 <sup>**</sup>	222940.14 <sup>**</sup>	280.29 <sup>**</sup>	30415.41 <sup>**</sup>
E (a)	8	16.19	10.87	1.87	21.12	13.74	4.24	315.98
Genotype	2	119.62 <sup>**</sup>	107552 <sup>**</sup>	227.54 <sup>**</sup>	170.07 <sup>**</sup>	126680.56 <sup>**</sup>	790.78 <sup>**</sup>	90646.20 <sup>**</sup>
Irrigation×Genotype	8	157.12 <sup>**</sup>	13735.88 <sup>**</sup>	112.59 <sup>**</sup>	165.37 <sup>**</sup>	4823.92 <sup>**</sup>	112.33 <sup>**</sup>	15545.8 <sup>**</sup>
Error	44	9.36	3.84	0.701	9.68	12.67	3.40	196.42
CV (%)		9.30	0.72		5.78	0.48	6.16	6.17

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



**Table 2. Effect of irrigation, genotype and irrigation\*genotype interaction effects on studied traits in wheat**

Treatment		Mean						
		Spike dry weight (g)	Number of spikes m <sup>-2</sup>	Number of kernels spike <sup>-1</sup>	1000 grain weight (g)	Biological yield (g m <sup>-2</sup> )	Harvest index	Grain yield (g m <sup>-2</sup> )
Irrigation level	I1	3.41 ab	260 b	23.36 b	55 ab	771.89 c	23.27 d	182.56 d
	I2	3.63 a	262.33 b	26.87 a	53.33 b	865.33 a	26.91 c	256.67 b
	I3	3.13 bc	364 a	22.83 b	59.22 a	850.67 b	36.86 a	312.78 a
	I4	3.47 ab	250.78 c	23.53 b	56.33ab	743.78 d	28.26 c	212.22 c
	I5	2.80 c	211.11 d	27.88 a	45.11 c	475.22 e	34.43 b	171.44 d
Genotype	V1	3.19 b	243.67 b	22.88 b	53.73 b	725.27 b	28.74 b	207.73 b
	V2	3.61 a	201 c	22.43 b	57.2 a	658.6 c	23.37 c	160.93 c
	V3	3.07 b	364.27 a	29.39 a	50.47 c	840.27 a	37.74 a	312.73 a
Interaction	I <sub>1</sub> ×V <sub>1</sub>	34 bcd	281.7 f	16.78 h	60.33 ab	680 i	16.52 h	112.3 i
	I <sub>1</sub> ×V <sub>2</sub>	35 bc	238.7 i	23.09 ef	59 b	836 f	25.36 fg	212 fg
	I <sub>1</sub> ×V <sub>3</sub>	33.33 bcd	259.7 g	30.22 c	45.67 d-g	799.7 g	27.93 ef	223.3 ef
	I <sub>2</sub> ×V <sub>1</sub>	36 b	290.3 e	28.84 c	44.33 efg	883.7 b	30.64 de	270.7 c
	I <sub>2</sub> ×V <sub>2</sub>	30 cd	164.3 l	17.40 h	51.67 c	553.3 j	13.38 i	74 j
	I <sub>2</sub> ×V <sub>3</sub>	43 a	332.3 c	34.39 a	64 ab	1159 a	36.70 c	425.3 a
	I <sub>3</sub> ×V <sub>1</sub>	24 e	250.3 h	14.89 i	50.67 cd	844.3 e	30.64 de	258.7 cd
	I <sub>3</sub> ×V <sub>2</sub>	37.67 ab	301 d	26.76 d	65.67 a	872.7 c	32.20 d	281 c
	I <sub>3</sub> ×V <sub>3</sub>	32.33 bcd	540.7 a	26.84 d	51.33 cd	835 f	47.74 a	398 b
	I <sub>4</sub> ×V <sub>1</sub>	33.33 bcd	205.3 j	21.68 f	60.33 ab	675.7 i	29.76 de	201 fg
	I <sub>4</sub> ×V <sub>2</sub>	41.67 a	202.7 j	25.54 d	60 ab	689.3 h	23.25 g	160.3 h
	I <sub>4</sub> ×V <sub>3</sub>	29 de	344.3 b	23.37 e	48.67 c-f	866.3 d	31.78 d	275.3 c
	I <sub>5</sub> ×V <sub>1</sub>	32.33 bcd	190.7 k	32.19 b	43 fg	542.7 k	36.13 c	196 g
	I <sub>5</sub> ×V <sub>2</sub>	36 b	8.33 m	19.35 g	49.67 cde	341.7 l	22.64 g	77.33 j
	I <sub>5</sub> ×V <sub>3</sub>	15.67 f	344.3 b	32.11 b	42.67 g	541.3 k	44.52 b	241 de

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

Means in each column, followed by similar letter(s) are not significantly different at 5% probability level, using Duncan's Multiple Range Test.

I1: four irrigation cycles after flowering, I2: three irrigation cycles after flowering, I3: two irrigation cycles after flowering, I4: one irrigation cycle after flowering, I5: dry-farming.

V1: Kouhdasht, V2: Dehdasht, V3: Behrang

**Table 3. Correlation coefficients among studied traits in wheat**

Trait	Spike dry weight	Number of spikes m <sup>-2</sup>	Number of kernels spike <sup>-1</sup>	1000 grain weight	Biological yield	Harvest index	Grain yield
Spike dry weight	-						
Number of spikes m <sup>-2</sup>	-0.148 <sup>ns</sup>	-					
Number of kernels spike <sup>-1</sup>	0.141 <sup>ns</sup>	0.354 <sup>*</sup>	-				
1000 seed weight	0.398 <sup>**</sup>	-0.021 <sup>ns</sup>	-0.307 <sup>*</sup>	-			
Biological yield	0.316 <sup>*</sup>	0.56 <sup>**</sup>	0.310 <sup>*</sup>	0.404 <sup>**</sup>	-		
Harvest index	-0.259 <sup>ns</sup>	0.701 <sup>**</sup>	0.632 <sup>**</sup>	-0.218 <sup>ns</sup>	0.294 <sup>ns</sup>	-	
Grain yield	0.084 <sup>ns</sup>	0.787 <sup>**</sup>	0.562 <sup>**</sup>	0.137 <sup>ns</sup>	0.795 <sup>**</sup>	0.795 <sup>**</sup>	-

ns, \* and \*\*: Not significant, significant at P < 0.05 and P < 0.01, respectively.

## REFERENCES

- [1] Abdoli, M., and Saeidi, M., 2012, Using different indices for selection of resistant wheat cultivars to post anthesis water deficit in the west of Iran. Ann. Biol. Res., 3, 1322-1333.
- [2] Abhari, A., and Galeshi, S., 2007, Effect of terminal drought stress on seed vigour of wheat genotype (*Triticum aestivum* L.), J. Agric. Sci. Natural Res., 14, 11-17.
- [3] Ahmadi, A., Joudi, M., Tavakoli, A., and Ranjbar, M., 2009. investigation of yield and its related morphological traits responses in wheat genotypes under drought stress and irrigation conditions, J. Sci. Technol. Agric. Natur. Resour., 12, 155-166.

- [4] Alaei, M., Zaefizadeh, M., Khayatnezhad, M., Alaei, Z., and Alaei, Y., 2010, Evaluation of germination properties of different durum Wheat genotypes under osmotic stress, Middle-East J. Sci. Res., 6, 642-646.
- [5] Azarpanah, A., Alizadeh, O., Dehghanzadeh, H., and Zare, M., 2012, Investigation on yield and yield components of zea mays L. under drought stress condition, International journal of Agronomy and plant production, 3(12), 566-571.
- [6] Emam, Y., 2007, Cereal Production, 3rd Edn., Shiraz University Press, Iran, 190.
- [7] Fallahi, H.A., Nasserli A., and Siadat, A., 2008, Wheat yield components are positively influenced by nitrogen application under moisture deficit environments, Int. J. Agri. Biol., 10, 673-676.
- [8] FAO. FAOSTAT. Agriculture. Rome, 2010, Available in <http://faostat.fao.org/faostat/collections?subset=agriculture>.
- [9] Flexas, J., Bota, J., and Cifre, J., 2004, Understanding down regulation of photosynthesis under water stress, future prospects and searching for physiological tools for irrigation management, Ann. Appl. Biol., 144, 273-283.
- [10] Galeshi, S.A., and Bayat Tork, Z., 2005, Effects of post anthesis drought stress on seed vigour in two wheat cultivars. J. Agri. Sci. Natural Res., 12, 113-119.
- [11] Gholamin, R., And Khayatnezhad, M., 2010, Study of some physiological responses of drought stress in hexaploid and tetraploid wheat genotypes in Iran, J. Sci. Res., 6, 246-250.
- [12] Gravandi, M., Farshadfar, A., and Kahrizi, D., 2011, Evaluation of Drought Tolerance in Bread Wheat Advanced Genotypes in Field and Laboratory Conditions, Seed and Plant Journal, 26, 252-233.
- [13] Jajarmi, V., 2009, Effect of water stress on germination indices in seven wheat cultivar. Acad. Sci. Eng. Technol., 49, 105-106.
- [14] Karam, F., Kabalan, R., Breidi, J., Rouphael, Y., and Oweis, T., 2009, Yield and water-production functions of two durum wheat cultivars grown under different irrigation and nitrogen regimes, Agricultural Water Management, 96(4): 603-615.
- [15] Khan, A. J., Azam, F., Ali, A., Tariq, M., and Amin, M., 2005, Inter-relationship and path co-efficient analysis for biometric traits in drought tolerant wheat (*Triticum aestivum* L.). Asian Journal of Plant Sciences, 4(5), 540-543.
- [16] Koocheki, A.R., Yazdansepar, A., and Nikkhah, H.R., 2006, Effects of terminal drought on grain yield and some morphological traits in wheat (*Triticum aestivum* L.) genotypes, Iran J. Agric. Sci., 8, 14-29.
- [17] Kwon, S.H., and Torrie, J.H., 1964, Heritability and interrelationship among traits of two soybean populations, Crop Sci., 4, 196-198.
- [18] Minitab, MINITAB 12, Minitab, State College, PA, 1998.
- [19] MSTATC, MSTATC a Microcomputer program for the design, management, and analysis of agronomic research experiments. Michigan State University, East Lansing, MI, 1990.
- [20] Plaut, Z., Butow, B.J., Blumenthal, C.S., and Wrigley, C.W., 2004, Transport of dry matter into developing wheat kernels and its contribution to grain yield under post-anthesis water deficit and evaluated temperature, Field Crops Res., 86, 185-198.
- [21] Rauf, M., Munir, M., Ul-Hassan, M., Ahmad, M., and Afzal, M., 2007, Performance of wheat genotypes under osmotic stress at germination and early seedling growth stage, Afr. J. Biotechnol., 6, 971-975.
- [22] Reynolds, M., Foulkes, M.J., Slafer, G.A., Berry, P., Parry, M.A.J., Snape, J.W., and Angus, W.J., 2009, Raising yield potential in wheat, J. Exp. Bot., 60, 1899-1918.
- [23] Richards, R.A., Rebetzke, G.J., Condon, A.G., and Herwaarden, A.F., 2002, Breeding opportunities for increasing the efficiency of water use and crop yield in temperate cereals, Crop Sci., 42, 111-131.
- [24] SAS I, SAS user's guide, Version 8, SAS Institute Inc Cary, NC, 2001.
- [25] Shao, H.B., Liang, Z.S., and Shao, M.A., 2005, Changes of anti-oxidative enzymes and MDA content under soil water deficits among 10 wheat (*Triticum aestivum* L.) genotypes at maturation stage, Colloids Surf. B: Biointerfaces, 45, 7-13.

- [26] Sun, Y.H., Liu, C.M., Zhang, X.Y, Shen, Y.J. and Zhang, Y.Q., 2006, Effects of irrigation on water balance, yield and water use efficiency (WUE) of winter wheat in North China plain, *Agricultural Water Management*, 85, 211-218.
- [27] Zaeifyzadeh, M., And Goliov, R., 2009, The Effect of the Interaction between Genotypes and Drought Stress on the Superoxide Dismutase and Chlorophyll Content in Durum Wheat Landraces, *Turk. J. Boil.*, 33, 1-7.
- [28] Zare, M., Siasinejad M., Ghasemi S., and Azarpanah, A., 2013, Various irrigation cycles effect on grain yield, proline and adaptive metabolites in some wheat genotypes, 12(4), 653-657.
- [29] Zumber, M.A., Chowdhury, A.K., Islam, M.Z., Ahmad, T., and Hasa, M.A., 2007, Effects of water stress on growth and yield attribute aman rice genotype, *Int. J. Sustain Crop Prood.*, 2(6), 25-30.