International Journal of Agriculture: Research and Review. Vol., 2 (6), 825-833, 2012
Available online at http://www.ecisi.com
ISSN 2228-7973

EFFECTS OF DEFICIT IRRIGATION ON YIELD, YIELD COMPONENTS AND SOME MORPHOLOGICAL TRAITS OF WHEAT CULTIVARS UNDER FIELD CONDITIONS

HOSSEIN AKBARI MOGHADDAM[*1,3], MOHAMMAD GALAVI[2], MAHMUOD SOLUKI[2], BARAT ALI SIAHSAR[2], SAYED MOHSEN MOUSAVI NIK[2] AND MOSTFA HEIDARI[2]

1- PhD student at the Field of Crop Physiology, University of Zabol, Iran.
2- Department of agronomy and plant breeding, faculty of Agriculture, University of Zabol, Iran.
3- Agricultural and Natural Resources Research Center of Sistan, Zabol, Iran.

***Corresponding Author Email**: h_akbari715@yahoo.com

ABSTRACT: Drought is a worldwide problem, constraining global crop production seriously and recent global climate change has made this situation more serious. This study was made to determine the influence of deficit irrigation on yield, yield components and some morphological traits of wheat cultivars under field conditions. The experiments were laid out in a randomized complete blocks design with four replications having split plot arrangement in two successive cropping seasons (2008-2009) at Agricultural and Natural Resources Research Center of Zabol, Iran. The main plots included deficit irrigation treatments at 5 levels: D_1-irrigation at the all growth stages (well-watered); D_2- no irrigation before stem elongation; D_3- no irrigation before stem elongation and after flowering stages; D_4- no irrigation after flowering stage; and D_5-Irrigation only before planting (severe stress). Subplots included wheat cultivars treatments at 4 levels; Hamoon, Hirmand, Chamran and Shiraz. Combined analysis variance indicated that there were significant differences among the deficit irrigation treatments in their grain yield, 1000 grain weight, peduncle length, plant height, grain spike^{-1}, spike m^{-2}, biomass and harvest index. Deficit irrigation significantly reduced grain yield and agronomic traits of all wheat cultivars. The highest reduction in all parameters was found in D5(severe stress) and stress at vegetative and reproductive stages(D3).The cultivars Chamran showed good performance in well watered as well as at deficit irrigation treatments than others cultivars.

Key words: Wheat, deficit irrigation, yield and yield components, morphological traits

INTRODUCTION

Drought is a worldwide problem, constraining global crop production seriously and recent global climate change has made this situation more serious (Pan et al., 2006).Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world. Wheat provides 21% of the food calories and 20% of the protein for more than 4.5 billion people in 94 countries. In North Africa, central and west Asia, which includes some of the currently most troubled countries, wheat provides from 35 to 60% of the daily calories (Braun et al, 2010). Drought is the most common environmental stress affecting about 32% of 99 million hectares under wheat cultivation in developing countries and at least 60 million hectares under wheat cultivation in developed countries (Rajaram, 2000). Water stress is major harmful factor in arid and semi-arid regions worldwide (Ranjana et al., 2006) that limits the area under cultivation and yield of crops. Drought stress may occur throughout the growing season, early or late season, but its effect on yield reduction is highest when it occurs after anthesis (Blum, 2005). Morphological characters such as root length, tiller, number of spike per m^2, grain per spike number, fertile tillers per plant, 1000 grain weight, peduncle length, spike weight, stem weight, awn length, grain weight per spike etc. Affect the wheat tolerance to the moisture shortage in the soil (passiora, 1977; plaut, 2004). Water stress not only affects the morphology but also severely affects the metabolism of the plant. The extent of modification depends upon the cultivar, growth stage, duration and intensity of stress (Mark and Antony. 2005; Araus et al., 2002). All stages of crop growth are not uniformly susceptible to water scarcity. On the other hand, some stages can cope-up with water shortage very well, while others are more susceptible and water shortages at such stages may result in distinct yield losses. Moisture stress is known to reduce biomass, tillering ability, grains per spike and grain size at any stage when it occurs. So, the overall effect of moisture stress depends on intensity and length of stress (Bukhat, 2005). Water stress at anthesis reduces pollination and thus less number of grains are formed per spike which results in the reduction of grain yield (Ashraf, 1998). Water stress imposed during later stages might additionally cause a reduction in number of kernels/ear and kernel weight (Gupta et al., 2001; Dencic et al., 2000). Selecting wheat genotypes that could tolerate drought stress and produce acceptable yield has been the major challenge for the wheat breeders in the past 50 years (Lopez, 2003). It has been found that under the drought stress conditions, those genotypes that show the highest harvest index and highest yield stability are drought tolerant (Rathore, 2005).it is the need of time to develop the varieties, which have drought tolerant potential to increase area under cultivation and yield of wheat crop. The present study was aimed to screen out drought tolerant varieties of wheat, which can spell drought. The information derived from the study will be helpful in breeding wheat for drought tolerance and early selection of genotypes with the desirable traits to be used in the breeding programs.

MATERIALS AND METHODS

An experiments were carried out between two seasons, 2008 and 2009 in the Agricultural and Natural Resources Research Center of Zabol, Iran (31°54′N, 61°41′E, and 483 m above sea level and average precipitation 35 mm year^{-1} and evaporation 4500-5000mmyear^{-1}). The experiment was randomized complete block design (RCBD) in a split-plot arrangement, with 4 replicates. The main plots were five levels of irrigation: D_1-irrigation at the all stages or well-watered (irrigation at tillering (29 Zadoks), stem elongation (39 Zadoks), booting (49 Zadoks) spike emergence (59 Zadoks), flowering (69 Zadoks) and milk grain development (77 Zadoks); D_2- no irrigation before stem elongation; D_3- no irrigation before stem elongation and after flowering stages stage; D_4- no irrigation after flowering stage; and D5- Irrigation only before planting. Sub plots were four wheat cultivars: C_1-Hamoon, C_2- Hirmand, C_3-Chamran and C_4-Shiraz. Each cultivar was sown in 6 rows with 6 meters long and 20 cm apart rows (sub plot size = 6 × 6 × 0.20 =7.2 m²). Sowing date at two seasons was in October, and the seeding rate calculated based upon 400 seeds per square meter taking into account 1000 kernel weight and sown using seed plotter(Winter Staieger). Based on soil analysis the required fertilizers (N.P.K) were used as follows: 100:50:50 kg ha^{-1}. Irrigation treatments: The first irrigation was carried out 1000 m^3 ha^{-1} before seed sowing. For each cycle of irrigation, water quantity was determined with counter 700 m^{3}ha^{-1} for each stage. Precipitation during growth of period was about 30 mm during growth stages. Each plot separated in two equal parts one part was used for sampling of physiological, biochemical traits and dry matter measurements. At the maturity stage, another part was harvested for yield and yield components, biomass and harvest index measurements. The data recorded were analyzed statistically by using statistical software package, MSTATC and graphs were developed using Excel. Least Significant Difference (LSD) test at the level of 5% probability was employed to compare the differences among the treatments means (Steel et al. 1997).

RSULTS AND DISCUTION

The result of combined ANOVA indicated that the deficit irrigation decreased the grain yield, 1000-grain weight, peduncle length, plant height, number of grains per spike, spike m^{-2}, biomass and harvest index. Also there were significant differences among wheat genotypes with respect to the number of grains per spike, 1000-grain weight; spike m^{-2}, peduncle length, plant height, harvest index and grain yield (Table 1).

Yield and harvest index

The highest grain yield was obtained in D1 (well-watered) treatment with 3934 kg ha^{-1} and lowest at the D4 treatment with 1037 kg ha^{-1}(Fig.1). Grain yield under deficit irrigation reduced at vegetative growth stage (D2) 14%, the reproductive growth stage (D4) 25% and at both vegetative and reproductive stages (D3) 39% than well-watered treatment (D1) (Fig.1).

The results showed that the maximum grain yield was recorded in Chamran with 2902 kg ha^{-1} and lowest in Hirmand cultivar with 2559 kg ha^{-1}. Hamoon and Shiraz cultivars were produced maximum grain yield by 2818 kg ha^{-1} and 2680 kg ha^{-1} respectively than other cultivars (Fig. 2).

Interaction effect of deficit irrigation and wheat cultivar on grain yield was highly significant. The highest grain yield belonged to Chamran cultivar at D1 treatment with 4241 kg ha^{-1} and lowest to Hirmand at D5 treatment with 892 kg ha^{-1}. Chamran cultivar had good stability in well-watered and water stress conditions, as well as Hamoon had good performance under water stress condition. Hirmand was susceptible cultivar to water stress conditions (Fig. 3).

These results are in concomitant with the findings of Mirbahar et al. (2009) and Farooq et al. (2009) that there was significant difference among the varieties with respect to irrigation regimes at any crop growth stage in terms of grain yield.

The analysis of variance showed significant differences between deficit irrigation on the biomass(Table 1). Well-watered treatment (D1) produced higher biomass with 10470 $kgha^{-1}$ significantly as compared to biomass of other treatments (Table 2). The maximum biomass was obtained in Shiraz and Hamoon cultivars with 8173 and 8114 kg ha^{-1} respectively, but no significant differences between cultivars (Table 2). Interaction effects of deficit irrigation treatment and wheat cultivars on biomass were highly significant. The highest biomass produced in Shiraz and Hamoon cultivars at D1 treatment with 10845kg ha^{-1} and 10575 kg ha^{-1} respectively and Lowest belonged to Hirmand at D5 treatment with 2882kg ha^{-1} (Table 3).

Table 1. Analysis of variance (Mean squares) for the effects of deficit irrigation conditions on the grain yield and some agronomic traits in 2008 and 2009.

Source of variation	d.f	Mean squares (MS)							
		Grain yield (Kg ha^{-1})	Biiomass (kg ha^{-1})	Harvest index (%)	Grain $spike^{-1}$	Spike m^{-2}	1000-grain weight(g)	Peduncle Length (mm)	Plant Height(cm)
Replication	3	1256657.5	2985019.8	27.390	143.690	10491.67	7.133	1181.273	39.590
Year	1	21636939 *	176547030.6 **	28.056 ^{ns}	322.056	46785.60 *	25.600	272332.51 **	1351.406 **
Error a	3	1461502.8	4296568.8	18.773	53.156	2123.88	28.467	1757.356	39.323
deficit irrigation	4	3922267 **	264728607.4 **	192.616 **	434.588 **	171313.6 **	300.39 ^{7**}	30950.131 **	1892.131 **
Year× deficit irrigation	4	4337512.9 **	30176350.4 **	36.072 ^{ns}	217.838 **	56959.08 **	51.584 **	11179.319 **	131.375
Cultivar	3	904812.6 ^{ns}	925875.4 ^{ns}	203.99 **	264.040 **	13269.67	55.933 **	30731.540 **	283.106 **
Year× cultivar	3	215571.3 ^{ns}	2021542.6 ^{ns}	64.34 ^{ns}	23.940	6111.45	34.733 **	7956.29 **	17.673
deficit irrigation × cultivar	12	68256.2 ^{ns}	1247955.3 ^{ns}	22.974 ^{ns}	12.696	1700.17	4.001	1379.519 *	15.440
year× deficit irrigation	12	42879.2 ^{ns}	1873426.6 ^{ns}	10.105 ^{ns}	19.096	2226.04	6.489	1093.123	23.892
×cultivar	114	389678	3533764.1	40.235	23.809	7318.03	8.370	700455	62.640
Error b									

**,* and ^{ns} indicate significant at the 0.01, 0.05 probability levels and not significant, respectively.

Table 2. Mean comparison of some agronomic traits of wheat genotypes as affected by deficit Irrigation evaluated in 2008 and 2009.

Traits	Biiomass (kg ha^{-1})	Harvest index (%)	grain $spike^{-1}$	Spike m^{-2}	1000-grain weight(g)	Peduncle Length (mm)	Plant Height(cm)
deficit irrigation							
D_1	10470 a	37.574 a	40.97 a	510.2 a	35.50 a	275.8 a	83.81 a
D_2	9617 ab	35.198 ab	38.41 b	406.2 b	33.09 b	236.9 b	73.44 b
D_3	7558 c	31.701 bc	34.47 c	417.9 b	29.59 c	220.4 c	70.06 b
D_4	9212 b	31.936 c	38.91 ab	506.2 a	28.69 c	267.0 a	80.22 a
D_5	3236 d	32.045 bc	31.84 d	337.2 c	28.63 c	201.7d	64.96 c
Cultivar							
C1	8114 a	34.680 b	37.92 a	451.5a	30.45 bc	201.2 c	72.00 b
C2	7948 a	32.196 b	35.13 b	411.2b	31.60 ab	263.3 a	75.97 ab
C3	7814 a	37.138 a	34.55 b	447.3ab	32.50 a	256.0 a	72.40 b
C4	8173 a	32.970 b	40.08 a	432.2ab	29.85 c	241.1 b	77.40 a
Year							
2008	6968 b	34.027 a	38.34a	418.44b	30.70a	199.11b	71.54a
2009	9069 a	34.248 a	35.50b	452.64a	31.50a	281.63a	77.35a
Grand mean	8019	34.156	36.92	435.54	31.20	240.37	74.44

These results are in line with the findings of Wang et al. (2004) and Song et al. (1995) that skipping irrigation at different crop growth stages significantly influenced different wheat varieties for the parameter of biological yield. The results showed that Chamran cultivar had more harvest Index by 38% significantly larger as compared to other cultivars(Table 2).The maximum harvest index was obtained well-watered treatment when irrigation at the all growth stages by 38% and minimum harvest index belonged to D4 treatment with 32% when no irrigation after flowering stages (Table 2). The results of the interactive effect of irrigation regimes and wheat cultivars on harvest Index (%) was highly-significant. Chamran cultivar at well-watered had the highest harvest index with 42.5% and lowest belonged to Shiraz cultivar at D4 when no irrigation after flowering stages with 29.38%(Fig.3). These results are in line with the findings of Pettigrew (2004), Maniyannan et al. (2007) and Bayoumi et al. (2008) that skipping irrigation at different crop growth stages significantly influenced different wheat varieties for the parameter of harvest index.

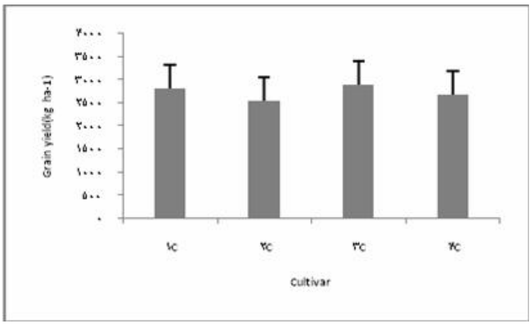

Fig.2: The effect of cultivar on grain yield in 2008 and 2009

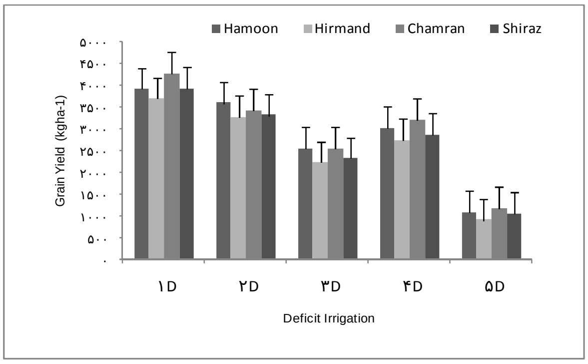

Fig.1: Interaction effect of different deficit Irrigation and cultivar on grain yield in 2008 and 2009.

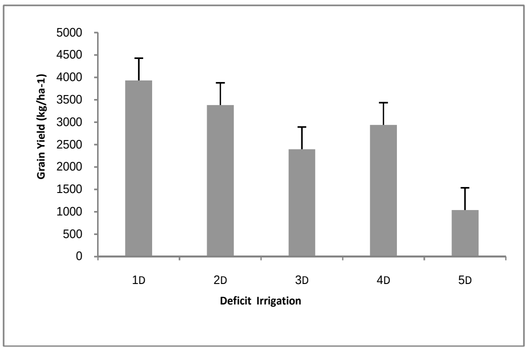

Fig.1: The effect of different deficit Irrigation on grain yield in 2008 and 2009.

Yield components

The analysis of variance predicted significant differences between deficit irrigation and cultivars as shown in Table1. Well watered treatment (D1) gave more 1000-grain weight with 35.50g that significantly more as compared other treatments. Among treatment means of cultivars, the 1000- grain weight was significantly varied between cultivars. The maximum grain weight were obtained Chamran(C3) and lowest in Shiraz(C4) cultivars(Table 2). Mean followed by similar letters in each column are not signitifinty different at 5% probability level using Least Significant Difference (LSD) Test; D_1-irrigation at the all stages or well-watered; D_2- no irrigation before stem elongation; D_3- no irrigation before stem elongation and after flowering stages stage; D_4- no irrigation after flowering stage; and D5-Irrigation only before planting. C_1-Hamoon, C_2- Hirmand, C_3-Chamran and C_4-Shiraz.

Table 3. Mean comparison of some agronomic traits of wheat genotypes as affected by deficit Irrigation evaluated in 2008 and 2009.

Deficit irrigation	Cultivars	Biiomass (kg ha^{-1})	Harvest index (%)	grain spike^{-1}	Spike m^{-2}	1000-grain weight(g)	Peduncle Length (mm)	Plant Height(cm)
	C1	10575.250 ab	38.000 ab	42.875 a	532.750 a	35.125 ab	230.000 ef	80.500 ab
D_1	C2	10460.625 ab	35.625 bc	37.875 bc	496.625 ab	35.750 ab	300.375 a	85.875 ab
	C3	10010.000 ab	42.500 a	40.125 ab	523.875 a	37.000 a	299.125 ab	82.500 ab
	C4	10845.000 a	36.250 ab	43.000 a	487.500 ab	34.125 bc	273.750 bc	86.375 a
	C1	9622.125 ab	36.750 ab	38.875 ab	428.375 bc	32.500 cd	207.000 gh	70.500 ef
D_2	C2	9894.250 ab	34.375 bc	37.000 cd	399.625 ef	34.000 bc	262.125 cd	76.875 cd
	C3	9401.125 ab	36.500 ab	34.625 de	411.625 de	34.500 ab	238.625 de	71.125 ef
	C4	9549.250 ab	35.625 bc	43.125 a	385.000 fg	31.375 ef	239.750 de	75.250 cd
	C1	8317.250 cd	31.125 cd	35.875 cd	429.625 bc	29.250 gh	189.875 hi	69.500 fg
D_3	C2	7605.875 de	30.875 cd	33.250 ef	390.375 fg	29.250 gh	253.500 cd	69.625 fg
	C3	7177.875 e	38.500 ab	32.875 fg	423.875 cd	32.125 de	237.875 de	67.875 gh
	C4	7129.625 e	32.625 bc	35.875 cd	427.875 cd	27.750 h	200.500 h	73.250 de
	C1	8821.625 bc	33.250 bc	39.625 ab	512.625 ab	27.875 h	208.625 gh	78.250 bc
D_4	C2	8897.625 bc	30.875 cd	37.375 bc	475.750 ab	29.250 gh	289.875 ab	82.375 ab
	C3	9402.875 ab	34.000 bc	36.750 cd	514.875 a	30.000 fg	294.250 ab	78.000 cd
	C4	9726.000 ab	29.375 d	41.875 ab	521.625 a	27.625 h	275.250 ab	82.250 ab
	C1	3232.500 f	34.000 bc	32.375 gh	354.000 fg	27.500 h	170.375 i	61.250 j
D_5	C2	2882.500 f	33.625 bc	30.125 hi	293.625 h	29.750 fg	210.500 gh	65.125 hi
	C3	3212.250 f	36.750 ab	28.375 i	362.125 fg	28.875 gh	210.000 gh	62.500 ij
	C4	3614.875 f	29.500 d	36.500 cd	339.000 gh	28.375 h	216.000 fg	69.875 fg
Grand mean		8019	34.156	36.92	435.54	31.20	240.37	74.44

Mean followed by similar letters in each column are not signitifinty different at 5% probability level using Least Significant Difference (LSD) Test; D_1-irrigation at the all stages or well-watered; D_2- no irrigation before stem elongation; D_3- no irrigation before stem elongation and after flowering stages stage; D_4- no irrigation after flowering stage; and D5-Irrigation only before planting. C_1-Hamoon, C_2- Hirmand, C_3-Chamran and C_4-Shiraz.

The results also showed that the interactive effect of deficit irrigations and wheat cultivars on1000- grain weight was highly-significant. Chamran cultivar produced maximum 1000-grain weight with 37g at D1 treatment and hamoon cultivar produced minimum 1000- grain weight to 27.5g at D5 treatment. These results are in line with the findings of Ismail et al. (2001), Yang et al. (2001), Rashid et al. (2003) and Jaleel et al. (2008) that skipping irrigation at different crop growth stages significantly reduced 1000-grain weight in different wheat varieties.

The spike m^{-2} was affected significantly by deficit irrigation as shown in Table1.Well watered treatment (D1) and D4 gave more spike m^{-2} with 510.2 and 506.2 that high significantly as compared to spike m^{-2}of other treatments. Among treatment means of cultivars, the Spike m^{-2} was significantly varied between cultivars. The maximum spike m^{-2} were obtained Hamoon and lowest in Hirmand cultivars (Table 2).

The results also showed that the interactive effect of deficit irrigations and wheat cultivars on spike m^{-2} was significant. Hamoon cultivar produced maximum spike m^{-2} with 532.750 at D1 treatment and Hirmand cultivar produced minimum spike m^{-2} to 293.625 at D5 treatment (Table 3). These results are in line with the findings of Song et al. (1995), Rashid et al. (2003) and Rafiq et al. (2005) that genetic potential of different varieties varies at different crop growth stages in respect of total number of tillers per pot.

The average number of grain spike^{-1} was affected significantly by deficit irrigation, cultivars and their interaction (Table 1). The highest number of grain spike^{-1} was obtained in D1 (well-watered) treatment with 40.97 and lowest at the D4 treatment with 31.84. Grain spike^{-1} under deficit irrigation reduced at vegetative growth stage (D2) 6%, the reproductive growth stage (D4) 5%, at the both vegetative and reproductive stages (D3) 16% and in severe stress treatment (D5)23% than

well-watered treatment (D1) (Table 2).
The mean number of grain spike^{-1} was 37.92, 35.13, 34.55 and 40.08 for hamoon, hirmand. Chamran and Shiraz cultivars, respectively. Shiraz produced maximum grain spike^{-1} by 40.07 than other cultivars (Table 2).
Interaction effect of deficit irrigation and wheat cultivar on grain spike^{-1} was highly significant. The highest kernels spike^{-1} belonged to Shiraz cultivar at D2 treatment with 43.125 and lowest to Chamran by 28.38 grain spike^{-1} at the D5 (severe stress) treatment (Table 3). Similar response of different wheat cultivars to different moisture levels was found by Motzo et al. (1996), Briggs et al. (1999) and Shahram et al. (2003).

Morphological Traits

Plant height significantly affected by deficit irrigations skipped level at different growth stages of wheat cultivars. The analysis of variance showed non- significant differences between different interactions (Table 1). Among treatment means, the highest plants were measured in well-watered and D4 with 83.81cm and 80.22 cm; whereas the lowest plants were recorded when irrigation was skipped at before stem elongation and after flowering (D3) and irrigation only before planting (D5) with 70.06 cm and 64.96cm tillering stage respectively (Table2).The interactive effect of deficit irrigation treatments and wheat cultivars on plant height (cm) was non-significant. The highest height plants belonged to Shiraz cultivar at D1 treatment with 86.375 and lowest belonged to Hamoon at D5 treatment with 61.25 cm. Hirmand and Shiraz cultivars had highest height plants at well-watered condition (D1) and severe drought condition (D5). Similar genotypic variability for plant height was observed among ten wheat genotypes (Alderfasi et al., 2001) These contrary are in accordance with the findings of Ahmad (2002), Kisana (2002) and Hagyo et al. (2007) found that there was no significant difference among the wheat varieties for plant height when irrigation was skipped at different crop growth stages of wheat. Peduncle is the section of stem between the flag leaf and the head. Peduncle length and flag leaf area in wheat was found correlated strongly and positively with grain yield when subjected to terminal drought and different irrigation levels, respectively (Ferrara, 1994). The analysis of variance showed significant differences between deficit irrigation, cultivars and their interaction as shown in Table1. Well-watered treatment (D1) produced higher Peduncle length with 275.8 mm ignificantly as compared to Peduncle length of other treatments (Table 2). The maximum Peduncle length was obtained in Hirmand to 263.3mm and lowest in Hamoon cultivar with 201.2 mm (Table 2). Interaction effects of deficit irrigation treatment and wheat cultivars on Peduncle length were highly significant. The highest Peduncle length produced in Hirmand and Chamran cultivars at D1 treatment with 300.375mm and 299.125mm respectively. Lowest Peduncle length belonged to Hamoon at D5 treatment with 170.375mm (table 3). The same results reported by kaya et al. (2002), alderfasi (2001), shamsi et al. (2010) and Bogale et al. (2011) that there was significant difference among the varieties with respect to deficit irrigation at any crop growth stage in terms of grain yield.

Table 3. Correlation coefficient of grain yield and some agronomic traits of wheat genotypes as affected by deficit Irrigation evaluated in 2008 and 2009.

Traits	Grain yield (Kg ha^{-1})	Biiomass (kg ha^{-1})	Harvest index (%)	Grain Spike^{-1}	Spike m^{-2}	1000-grain weight(g)	Peduncle Length (mm)	Plant Height (cm)
Grain yield (Kg ha^{-1})	1							
Biological yield (kg ha^{-1})	0.55**	1						
Harvest index (%)	0.30**	0.56**	1					
Grain spike^{-1}	0.43**	0.42**	0.096^{ns}	1				
Spike m^{-2}	0.40**	0.42**	0.032^{ns}	0.23**	1			
1000-grain weight (g)	0.55**	0.45**	0.27**	0.26**	0.18^{ns}	1		
Peduncle length(mm)	0.56**	0.55**	0.070^{ns}	0.16^{ns}	0.34**	0.34**	1	
Plant height (cm)	0.63**	0.62**	0.043^{ns}	0.43**	0.50**	0.37**	0.60**	1

**,* and ^{ns} indicate significant at the 0.01, 0.05 probability levels and not significant, respectively.

Correlation coefficient analysis indicated were significantly strong positive correlations (P≤0.01) between the grain yield and agronomic traits. biomass also was significantly and strong positive correlations (P≤0.01) with agronomic traits. Harvest index were significantly positive correlations with 1000-grain weight (r=0.27**). Grain Spike^{-1} also were significantly positive correlations with number spike m^{-2} (r=0.23**) and 1000-grain weight (r=0.26**) and plant high(r=0.43**). Spike m^{-2} were significantly positive correlations with peduncle height (r=0.34**) and plant height(r=0.50**). 1000-grain weight were significantly positive correlated with peduncle length (r=0.34**) and plant high(r=0.37**). Peduncle length was significantly positive correlated with plant high(r=0.60**). 1000-grain weight were significantly positive correlated with peduncle height (r=0.34**) and plant high(r=0.37**) (table 3). Many researchers such as kaya et al. 2002, Gupta et al, 2001, Richards et al, 2001, Nori ganbalani et al, 2009 , Shamsi et al, 2010 and Bogale et al. 2011, have reported significant correlation between the grain yield, yield components and morphological traits.

CONCLUSIONS

The highest reduction in all parameters was found in severe stress (D5) and deficit irrigation at vegetative and reproductive stages (D3). Cultivar Chamran showed good performance in well watered as well as at deficit irrigation treatments than others cultivars.

ACKNOWLEGMENTS

This research was supported by the Agricultural and Natural Resources Research Center of Zabol, division of seed and plant improvement.

REFRENCES

Ahmad J (2002) Effect of varying irrigation frequencies on phonology, growth and yield of three wheat varieties. M.Sc. Thesis, p 32-35, Dept. Agron. Univ. Agri., Faisalabad, Pakistan.

Alderfasi AA (2001) Evaluation of Certain Traits Associated with Drought Resistance in Wheat under Field Conditions. Annals Agric. Sci., Ain Shams Univ., Cairo 46 (1): 71-83.

Altman A (2003) From Plant tissue culture to biotechnology: Scientific Revolutions, abiotic stress tolerance and forestry. In vitro Cell. Dev. Biot. Plant 39:75-84.

Araus JL, Slafer G, Reynolds MP, Royo C (2002) Plant breeding and drought in C_3 cereals. What should we bread for? Ann. Bot. 89: 925-940.

Ashraf M Y (1998) Yield and yield components response of wheat (*Triticum aestivum* L.) genotypes tinder different soil water deficit conditions. Acta Agron. Hung. 46:45-51

Bayoumi TYM, Eid H, Metwali EM (2008) Application of physiological and biochemical indices as a screening technique for drought tolerance in wheat genotypes. African J. Biotech.7: 2341-2352

Blum A (2005) Mitigation of drought stress by crop management. available at: www.Plant Stress.com.

Bogale A, Tesfaye K, Geleto T (2011) Morphological and physiological attributes associated to drought tolerance of Ethiopian durum wheat genotypes under water deficit. J. Biodivers. Environ. Sci., 1(2): 22-36.

Braun HJ, Atlin G, Payne T (2010) Multi-location testing as a tool to identify plant response to global climate change. In: Reynolds MP, ed. Climate change and crop production. Wallingford, UK: CABI Publishers, 115–13

Briggs KG, Kiplagat OK, Johnson-Flanagan AM (1999) Effects of Pre-Anthesis Moisture Stress on Floret Sterility in Some Semi-dwarf and Conventional Height Spring Wheat Cultivars, Can. J. Plant Sci. 79: 515-520.

Bukhat NM (2005) Studies in yield and yield associated traits of wheat (*Triticum aestivum* L.) genotypes under drought conditions. M.Sc Thesis Department of Agronomy. Sindh Agriculture University, Tandojam, Pakistan.

Dencic S, Kastori R, Kobiljski B, Duggan B (2000) Evaporation of' grain yield and its components in wheat cultivars and land races under near optimal and drought conditions. Euphytica 1:43-52(Wheat. Barley and Triticale Absis. 3: 1197).

Farooq M, Wahid AN, Kobayashi D, FujitaBasra SMA (2009) Plant drought and molecular approaches. Haworth Press, New York. p. 23-25

Ferrara GO (1994) Experiences, Difficulties and Prospects for Stress Resistance Breeding in Wheat in WANA.

Melhoramento 33 (1): 105-118.
Gupta NK, Gupta S, Kumar A (2001) Effect of water stress on physiological attributes and their relationship with growth and yield in wheat cultivars at different growth stages. J. Agron. 86:1437-1439.
Hagyo A, Farkas C, Lukacs A, Csorba S, Nemeth T (2007) Water cycle of different wheat genotypes under different water stresses. Cereal Res. Comm. 35:437- 440.
Ismail RM (2001) Correlation and path coefficient analysis of some quantitative traits with grain yield in bread wheat (*Triticum aestivum* L.) Bull. Nat. Res. Center Cairo.
Jaleel, CA Manivannan P, Lakshmanan GMA, Gomathinayagam M, Panneerselvam R(2008) Alterations in morphological parameters and photosynthetic pigment responses of Catharanthusroseus under soil water deficits. Colloids Surf. B: Bionterfaces 61: 298-303.
Kaya Y, Topal R, Gonulal AE, Arisoy RZ (2002) Factor analyses of yield traits in genotypes of durum wheat. Indian J. Agric. Sci. 72: 301-303.
Kisana NS, Mustafa SZI, Hussain L (2002) Wheat importance and production factors Jaded Zaraat 21: 10-12.
Larson KL (1992) Drought Injury and Resistance of Crop Plants. In: Gupta, S.U. (Ed) Physiological Aspects of Dry land Farming. Oxford and IBH Publishing Co. Pvt. Ltd.: New Delhi pp.147-162.
Lopez C, Banowetz GM, Peterson CJ, Kronstad WE(2003) Dehydrin expression and drought tolerance in seven wheat cultivars. Crop Sci. 43:577-582.
Manivannan P, Jaleel CA, Sanker B, Kishorekumar A , Somassundaramand R, AlaguLakshmanan GM, Panneerselvam R (2007) Growth, biochemical modifications and praline metabolism in Helianthus annuus L. as induced by drought stress. Colloids Surf. Bionierfaces 59: 141-149.
Mark T, Antony B (2005) Abiotic stress tolerance in grasses from model plants to crop plants. Plant Physiol. 137: 79 1-793.
Mirbahar AA, Markhand GS, Mahar AR (2009) Effect of water stress on yield and yield component of wheat (Triticum aestivum) varieties. Pak. J. Bot. 41:1303-1310
Motzo R, Giunta F, Deidda M (1996) Relationships Between Grain Filling Parameters, Fertility, Earlines and Grain Protein of Durum Wheat in a Mediterranean Environment, Field Crops Res. 47:129-142.
Nouri-Ganbalani A, Nouri-Ganbalani G, Hassanpanah D (2009) Effects of drought stress condition on the yield and yield components of advanced wheat genotypes in Ardabil, Iran. J. Food Agric. Environ. 7(3&4): 228-234.
Pan Y, Wu LJ, Yu ZL (2006) Effect of salt and drought stress on antioxidant enzymes activities and SOD isoenzymes of liquorice (Glycorhiza uralensis Fisch).Journal of Plant Growth Regulation 49: 157–165.
Passioura JB (1977) Grain yield, harvest index and water use of wheat J. Aust. Inst. Agric. Sci. 43:117-120.
Pettigrew, TW (2004) Physiological consequences of moisture deficit stress in cotton. Crop Sci. 44: 1265-1272.
Plaut Z, Butow BJ, Blumenthal CS, Wrigley CW(2004)Transport of dry matter into developing wheat kernels. Field Crops Res. 96:185-198.
Rafiq M, Hussain A, Ahmad A, Basra SMA, Wajid A, Anwar J, Ibrahim M, Goheer MA (2005) Effect of irrigation on agronomic traits of wheat (Triticum aestivum L.). Int. J. Bio. Biotech. 2 :751-759.
Rajaram S (2000) International wheat breeding: Past and present achievements and future directions. Warren E. Kronstad Honorary Symposium. Oregon State University Extension Service. Special Report 1017. June 2000.
Ranjana Roy, Ram Singh P, Agarwal V, Gupta C (2006)Transformation tomato cultivars 'Pusa Ruby' with bsp A gene from Populus tremula for drought tolerance. Plant Cell, Tissue and Organ Culture 84: 55-67.
Rashid HK, Qayyum MK, Abbasi A(2003) Effect of water stress on the performance of wheat grown under controlled conditions at Rawalakot, Azad Jammu and Kashmir Sarhad J. Agric. 19: 60-75.
Rathore PS (2005) Techniques and Management of Field Crop Production. Agribios, India, 525 pp.
Richards RA, Condon AG, Rebetzke GJ (2001) Traits to improve yield in dry environments p.88-100. Mexico, DF, CIMMYT.
Shahram MD, Moore K, Ollerenshaw J (2003)

Qualitative Inheritance of Water-stress Induced Apical Sterility in Wheat (*Triticum aestivum* L.) Hereditas 138: 237-240.
Shamsi K (2010) The effects of drought stress on yield, relative water content, proline, soluble carbohydrates and chlorophyll of bread wheat cultivars. J. Anim. Plant Sci. 8(3): 1051-1060.
Song FB, Dai JY, Gu WB, LI HY (1995) The effect of water stress on leaf water status in maize. J. Jillin. Agric. Univ. 17(1):5-9.
Steel, RGD, Torrie JH, Dicky DA (1997) Principle and procedure of statistics-A Biometrical Approach 3rd Ed. McGraw Hill Book International Co., Singapore 204-227.
Tunio SD, Korejo MN, Jarwar AD, M.R. Waggan MR (2006) Studies on indegenious and exotic weed competition in wheat. Pak. J. Agri. Biol. 5(4): 1-8.
Wang CR, Tian XH, Li SX (2004) Effects of ridge- mulching with plastic sheets for rainfall-harvesting cultivation on water use efficiency and yield of winter wheat. J. Agric. Sci. 3(1):14-23.
Yang J, Zhang J, Wang Z, Zhu Q, Wang W (2001) Hormonal changes in the grains of rice subjected to water stress during grain filling. Plant Physiol. 127: 315-323.
Zahid P, Khadim H, Gill SSH, Sheikh AA (2003) Iron requirement of Barani wheat. Int. J. Agri Biol. 5(4): 608-610.