American-Eurasian J. Agric. & Environ. Sci., 5 (3): 348-353, 2009
ISSN 1818-6769

Yield Potentional of Two Barely Genotypes Grown under Water Stress of Arid Ecosystem of Saudi Arabia

Ali Abdullah Alderfasi

Department of Plant Production, Faculty of Food and Agricultural Science,
King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia

Abstract: Under limited soil moisture conditions, water stress is a more yield limiting factor for most crop production under hot environments. The cost of water irrigation raises the quest in about the feasibility of applying water under limited soil moisture condition.For that field traits were carried out in Agriculture Research Station, Faculty of Food and Agriculture sciences, King Saud University, near Riyadh.The experiments included the combination comprising of 2 barely genotypes (Jesto and Sahrawe) and applied 50 mm. water irrigation in each of the five irrigation schedules (0, 50,100,150 and 200 mm)of cumulative pan evaporation, (CPE). The aim of the study was to assess the potentiality of barely genotypes under water stress condition. As expected the results indicated that, treatment which gave 10000 mm. over the growing season, weekly water applied (normal irrigation) at 0 cumulative pan evaporation, followed by the application of (8000 mm), recorded the highest value of grain yield, 1000 grain weight and water use efficiency of both cultivars in both seasons, as compared with the other levels of water irrigation. However the lowest values were found in most traits as the application of water irrigation at cumulative CPE 150 mm and 200 mm. Finally, we can conclude that 20 to 40 % of water irrigation could be conserved for growing barley under arid environment of Saudi Arabia.

Key words: Barley · Yield potential · Water stress · Water use efficiency

INTRODUCTION

Crop production in arid and semi-arid region is restricted by soil deficiencies in moisture and plant nutrients. Consequently adequate levels of irrigation and fertilizers are needed [1].

Barley (*Hordeum vulgere* L.), is not tolerate of prolonged or excessive drought. It will tolerate soil moisture depletion to 30- 35 per cent of available moisture during grain formation and 10 -20 per cent near maturity. For optimum yield and quality, it is important to monitor soil moisture condition regularly through out the growing season and irrigation accordingly [2].

Moisture stress at any stage of crop growth can cause an irreversible loss in yield potential. The severity of loss, depend upon many factors viz., timing, length and severity of the drought period. Moreover, yield reduction can be due to the reversible effect in number of tillers, reduced kernel weights or fewer kernels [3,4]. In addition to, results of Shone and Flood, [5], Teulat *et al*., [6] and Janieson *et al*., [7], indicated that, moisture stress at strew prior, or just after, the onset of flowering, reduces yields the most. The yield reducing effect of stress can be affect somewhat if the stress is relieved later in the season, but the yield recovery from stress near flowering stage is lower than recovery from stress in the vegetative stage of earlier growth. Moisture stress can also result in higher protein contents and a shortening of the grain filling period, leading to earlier maturity.

According to the experiment of Rahman and Islam [8], they found that the amount of water applied at each irrigation and how often a soil should be irrigated depend, however, on several factors such as the degree of soil water deficit before irrigation, soil types, crops and climatic conditions.

Ghahrome and Sepaskhah, [9], reported that,although the seasonal water requirement for barley, depended on variety, target yield and crop management, some water reduction is possible.. Barley requires 390-430 mm (15 -17 in.) for optimum yield. Malt barley may require

Corresponidng Author: Ali Abdullah Alderfasi, Department of Plant Production, Faculty of Food and Agricultural Science, ing Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia

more water over the growing season than feed barley. This addition water is required to maintain the protein content of the grain and meet the standards set by maltstero [5,7].

Therefore, the present investigation was focused on evaluation of the effect of irrigation schedules in grain yield and yield component characters of barley genotypes.

MATERIALS AND METHODS

The present study was carried out at Agricultural and Research station, Faculty of Food and Agriculture sciences, Derab, near Riyadh, King Saud University, Saudi Arabia (24°42'N latitude and 46 ° 44' E Longitudes, Altitude 600 m), during 2004/2005 and 2005/2006 growing seasons. The main objective of this study was to evaluate the response of two barely genotypes (Jesto and Sahrawe) to water irrigation schedules. (0, 50, 100, 150 and 200 mm) of cumulative pan evaporation, (CPE). Sample from 0-30 of soil layer of the experimental soil site was taken for chemical and physical analysis according to the methods described by Cottenie *et al.*, [10] and But [11], results worthy clear that texture of soil site was sandy clay loam soil (50% sand, 26% silt and 24% clay), pH in 1:25 soil water (8.15), EC (2.1 dS/m) in extracted soil paste (2:1) and $CaCO_3$ (29.9 %). Soil macronutrients N, P and K were 120.6, 270.0 and 124.0 mg/Kg soil, respectively. While soil micronutrients in mg/Kg soil were 2.4, 15.1, 13.1 and 0.3 for Fe, Zn, Mn and Cu, respectively. Water used in irrigation was also analysis; results registered that, values of cation in irrigation water content in meq/Liter were 6.0, 3.2, 13.0 and 0.7 for Ca, Mg, Na, K and for anions Co_3^-, HCO_3^-, Cl,SO_4^- were 0.0,5.8,8.61 and 8.5, respectively. Irrigation water EC (2.3 dS/m), pH (7.2) and (6.06) sodium adsorption ratio (SAR). Seed bed was prepared before sowing as recommended according to the conventional production practices followed at the central region of Saudi Arabia. Phosphorus fertilizer was applied at the rate of 70 (kg P_2O_5/ha.) as the form of superphosphate (16 % P_2O_5) broadcasting during soil preparation, where as recommended dose of N (100 Kg N/ha.) were applied in three split equal doses in the form of ammonium nitrate (33.3 %N), at sowing, during tillering and at anthesis. Potassium fertilizer, as the form of potassium sulphate (42%K_2O), by the rate of (100 kg K_2O) were applied. Experimental soil sites were divided into plots, each plot consisted 8 lines 20 cm apart, 3 m in length. Plot area was 4.80 m^2. Split- split plot design with four replications was laid out. Irrigation was randomly assigned in main plots. Whereas, genotypes (Jeno and Sahrawe) were occupied the sub plots. All cultural practices were followed according to the conventional production practices followed at the central region of Saudi Arabia. Number of irrigation for each treatment and amount of water supplied over the growing season in both seasons were recorded and presented in Table 1. Seeds were sown, by the rate of 140 kg/ha. on 10 and 3 November, in the first and second seasons, respectively. Water irrigation applied when CPE reach to 50, 100, 150 and 200 mm. by using flowed irrigation system, through line pipe provide with meter gages for measuring water applied as a sum of daily- recorded evaporation from USWB class A open pan, compared with the control treatment (weekly irrigation).

During growth period and pre-harvest, number of days to heading and maturity as well as number of days to grain filling were recorded.

At harvest time, two central rows in each sub plot were harvested for determine grain yield ton/ha, biological yield ton/ha and harvest index.Water use efficiency was also calculated based on dry biomass production (WUE_b), Kg per hectare for each mm of water supplied during the growing season.

Table 1: Number of irrigation and amount of water used for each treatment over the growing season

Irrigation treatment (Irrigation schedules)	Mean water apply. (mm)	Number of Irrigations	
		First season	Second season
Weekly irrigation	1000	20.00	20.00
50mm of CPE	800	16.00	16.00
100mm of CPE	600	12.00	12.00
150mm of CPE	400	8.00	8.00
200mm of CPE	200	4.00	4.00

Data obtained for each season were subjected to statistical analysis according to the methods described by Gomez and Gomez [12].Means were compared using Fishers Protected Least Significant Differences methods (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

Effect on Plant Height, Number of Days Flowering, Grain Filling and Maturity Stages as Well as Number of Tillers/Plant: Data obtained clearly obvious that, the differences between the two barley varieties under investigation were significantly in all studied parameters viz., plant height, number of days to grain filling and maturity stage and number of tillers /plant.While, number of days to flowering stage was insignificant in both season. Such effect may be due to the genetic consistent more than the effect of experimental condition (Fig. 1).

Results concerning the effect of water irrigation treatments, on the above mention parameters (Fig. 2) illustrated that, application water irrigation either at 50 cumulative pan evaporation (CPE) or weekly irrigation (normal irrigation system) are nearly equal and exceeded significantly the other levels of water supplies, however, water application at 50 cumulative pan evaporation (CPE) surpassed the normal irrigation system and gave the higher value of most of the studied parameters in the first season viz., number of days to flowering, plant height and number of tillers /m^3, while in the second season, the picture was changed and all studied parameters were in the line with application water irrigation at 50 cumulative pan evaporation (CPE). These findings agree with the data reported by Jamieson *et al*., [13], they found that barley and wheat are similar in response to drought and critical potential soil moisture deficit was much smaller for barley than wheat. In addition, the experiments of Shone and Flood [5], indicated that, low water potential in the root zoon decreed ion up take and translocation to shoots, thus number of days to flowering, filling and maturity decreased.

Regarding the effect of interaction, data presented in Table 2 revealed that, values of water applied x genotypes were significant in most of the studied characters in both seasons. Sowing jeno variety and application water irrigation at 50 cumulative pan evaporation (CPE) or weekly irrigation (normal irrigation system) prolonged the growth season and gave the highest number of tillers/plant.

Effect on Grain Yield, Yield Component Characters and Water Use Efficiency (WUE_b): In both growing seasons, similar results were obtained regarding, the differences between two genotypes. Differences were insignificant in most yield component characters and grain yield per hectare.Whereas 1000 - seed weight showed significant response. However, the significant and non significant results, Jeno variety gave the highest grain yield in most studied parameters and surpassed Sahrawe variety. Concerning water use efficiency Jeno variety showed highly water use efficiency than Sahrawe variety. Spike, 1000 grain weight, biological yield/(ton/ hectare). This might be due to that, differences between grain yield

Table 2: Effect of water irrigation treatments, genotypic variation and their interactions on grain yield and yield component characters of barley grown under arid environment of Saudi Arabia, in 2004/2005 and 2005/2006 seasons

Treatments		First season					Second season				
		No. of days to					No. of days to				
Water irrigation levels	Varity	Filling grains	Flowering	Maturity	Plant Height, cm.	No. of tillers/m^2	Filling grains	Flowering	Maturity	Plant Height, cm.	No. of tillers/m^2
0	V1	86.50	42.25	128.75	73.99	577.5	83.00	50.50	132.00	85.38	540.0
	V2	85.50	46.00	131.50	95.00	552.5	85.75	46.38	132.50	117.00	580.0
50	V1	86.50	38.13	124.50	75.31	548.5	83.25	50.25	133.50	89.56	532.5
	V2	86.50	41.09	126.50	94.50	575.0	85.50	49.00	137.75	116.43	578.9
100	V1	85.25	32.25	116.75	60.25	512.3	81.25	47.75	127.75	73.67	455.0
	V2	84.25	35.50	119.75	81.21	507.5	84.75	45.75	129.50	102.56	570.0
150	V1	85.50	33.00	11725	57.88	552.5	82.50	43.75	126.00	68.06	550.0
	V2	84.50	35.00	119.50	79.56	570.0	84.00	44.75	127.50	105.44	480.0
200	V1	85.25	30.75	11500	59.75	597.5	79.50	42.75	123.75	63.38	540.0
	V2	84.25	34.50	118.75	77.71	537.5	83.50	42.25	127.00	110.65	465.0
LS.D 0.05 level at		1.22	1.84	1.75	2.28	12.67	2.15	2.31	1.55	30.18	7.35

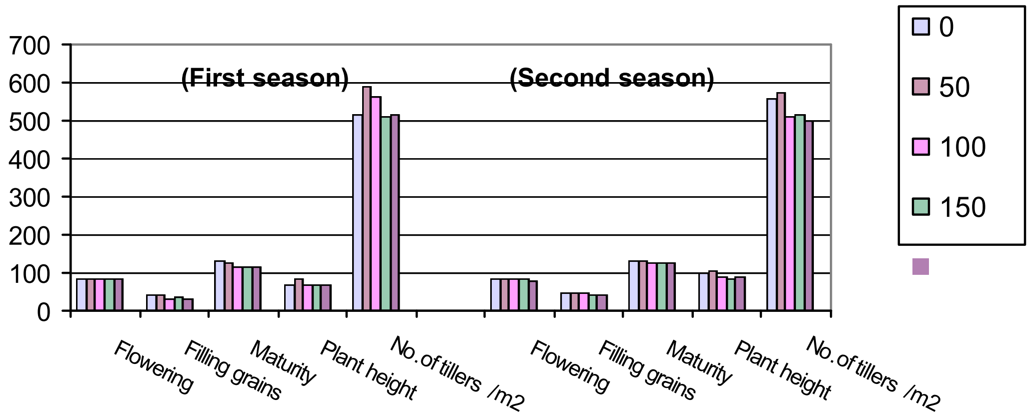

Fig. 1: Effect of water irrigation applied to barley grown under different water stress on some of the preharvest parameter

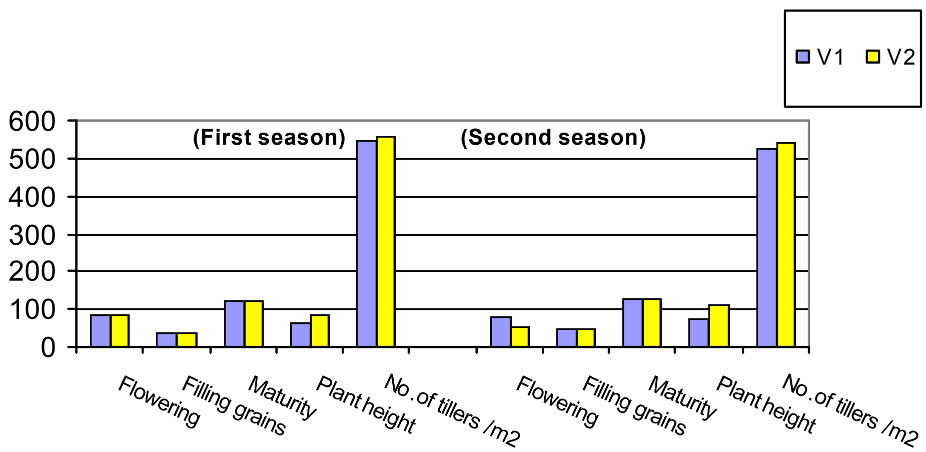

Fig. 2: Effect of genetic variation on some pre-harvest parameter of barley grown under water stress

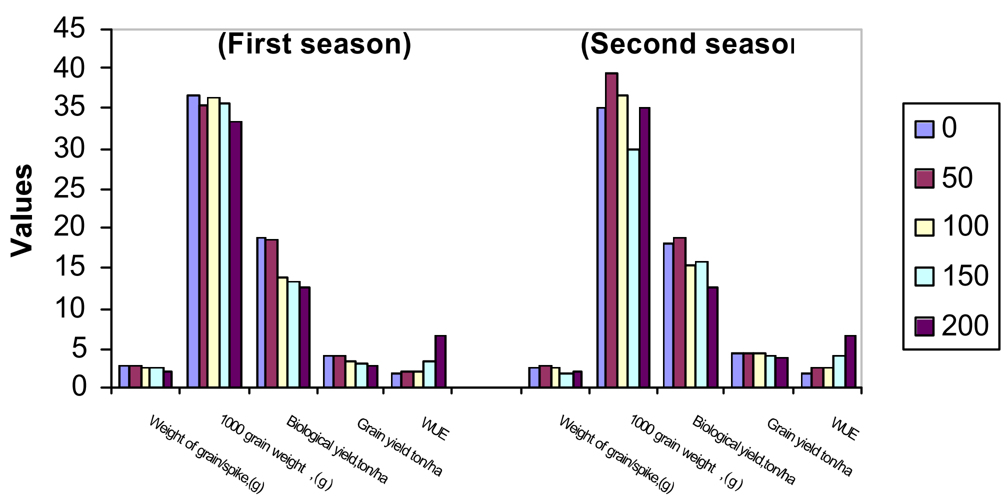

Fig. 3: Effect of water irrigation on grain yield and yield components characters of barley

Table 3: Effect of water irrigation treatment, genotypic variation and their interactions on grain yield and yield component characters of barley grown under arid environment, in 2004/2005 and 2005/2006 seasons

Treatments		First season						Second season					
Water irrigation levels	Variety	Weight of grain/ Spike,(g)	1000 grain weight, (g)	Biological yield Ton/ha	Grain yield ton/ha	WUE_b Kg/mm	Harvest Index %	Weight of grain/ spike,(g)	1000 grain weight, (g)	Biological yield ton/ha	Grain yield ton/ha	WUE_b Kg/mm	Harvest index%
0	V1	2.61	30.22	17.51	4.45	1.75	27.60	2.43	31.50	18.21	5.51	1.82	30.85
	V2	2.78	42.88	20.29	3.68	2.03	18.65	2.21	38.86	18.15	3.30	1.82	22.34
50	V1	2.69	30.33	18.10	4.29	2.26	28.46	2.32	36.48	18.36	5.52	2.30	31.55
	V2	2.65	40.71	18.61	3.44	2.32	22.08	3.18	42.34	18.98	3.32	2.37	18.32
100	V1	2.31	33.37	13.37	4.04	2.23	31.28	2.49	35.12	16.62	5.03	2.77	34.87
	V2	2.49	39.31	14.23	2.84	2.37	20.10	2.47	38.40	14.31	3.43	2.39	22.56
150	V1	2.27	30.02	13.07	3.38	3.27	25.91	2.03	24.16	16.13	5.14	4.03	32.07
	V2	2.45	41.29	13.71	3.08	3.43	20.95	1.84	35.77	15.01	2.61	3.75	20.20
200	V1	2.27	27.35	12.69	2.81	6.35	23.35	2.33	31.26	12.45	4.08	6.23	33.82
	V2	2.28	39.23	12.75	2.32	6.38	18.98	2.11	38.84	13.06	3.11	6.53	24.58
LSD at (0.05 %)		NS	6.87	2.47	1.16	3.14	1.82	NS	1.36	1.55	1.52	2.21	1.37

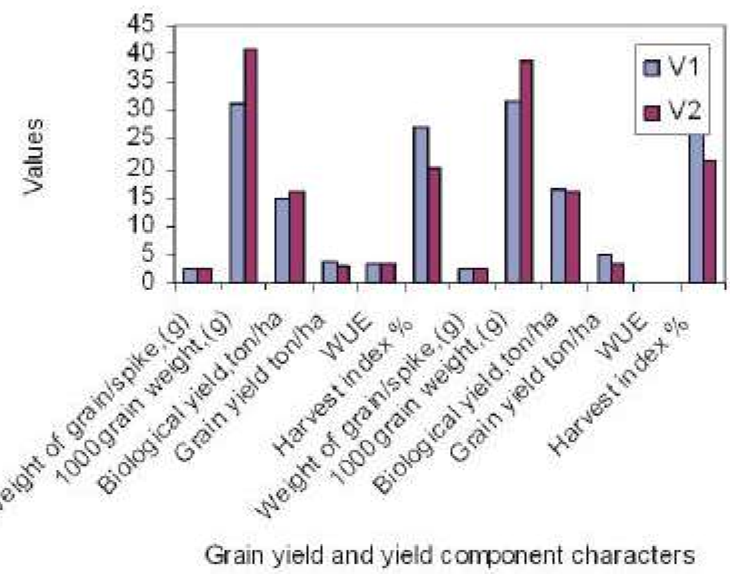

Fig. 4: Genitic variation between two barley genotypes

traits is less sensitive between the two selected genotypes under investigation. The present results are in general agreed with those reported by Alderfasi, [14] in the previous work.

Regarding with water application, although there is insignificant effect in most yield and yield component characters, irrigation water at 50mm cumulative pan evaporation (CPE) and weekly water applied are nearly equal in their effect and gave the highest value of grain weight / spike,1000 grain weight, biological yield ton/ha and grain yield ton/ha. Such results indicated that, sufficient moisture soil content in root zone enhanced nutrient up take and transport to shoot.Thus, good relationship between plant growth and environment put in together in grain yield. Shone and Flood [5] in field traits,they reported that the restoration of the capacity for wheat roots to take up nutrients following periods of water stress viz., when rainfall follow drought, is less well understood.

Concerning water use efficiency, data obtained reveal that the highest value of water use efficiency recorded when water applied at cumulative pan evaporation (CPE) or150 and 200 without significant differences between them. Such effect is due to higher reduction in water applied during the growing seasons more than the change in biomass.This findings, are agree with those obtained by Shone and Flood, [5] and Janieson *et al*., [7].

With respect to the effect of interactions, data obtained reveal that, the highest grain yield can obtained by growing barley and applied water irrigation at 50mm cumulative pan evaporation (CPE).By this way 20 to 40 % of water irrigation could be conserved for growing barley under arid environment of Saudi Arabia.

Recommendation: Can be recommended that water supply at 50 mm cumulative pan evaporation (CPE) for barley production under middle region of Saudi Arabia can meet directly the economic beneficial evaluation.

REFERENCES

1. EL-Siddig, K.L., P. Udders, G. Ebert and S.G.K. Adiku, 1998. Response of rose apple (*Eugenia jambos* L.) to water and nitrogen supply. J. Applied Botany, 72: 203-206.
2. Stuart Chepian, F., C.H.S. Walter and T. David Chorkson, 2007. Growth response of barley and Tomato to nitrogen stress and water relation and photosynthesis. Plant Physiology, 145(2): 441-454.
3. Reginato, R.J., 1993. Field quantification of crop water stress. ASAE, 26: 772-775.
4. Reginato, R.J. and D.J. Carrot 1997. Irrigation scheduling with the crop water stress index. (C.F.springerLink- www.springlink.com)
5. Shone, M.G.T. and A.N.N.V. Flood, 1988. Effect of period of localized water stress on subsequent nutrient uptake by barley root and their adaption by osmotic adjustment. New Phytologist, 94(4): 561-577.
6. Teulat, A.S., J.W. Sammis and D.G. Lugg, 1997. Utilization of thermal in feared thermometry for detection of water stress in spring barley. Agric. Water Manage, 12: 75-85.
7. Janieson, P.D., R.J. Martin and G.S. Francies, 2005. Drought influences on grain yield of barley, wheat and maize. New Zealand Journal of crop and Horticultural Science, Doos, 23: 55-66.
8. Rahman, S.M. and A. Islam, 2004. Yield and water relation as influenced by irrigation and depth of tillage. (C.F.springerLink- www.springlink.com).
9. Ghahrome, B. and A.R. Sepaskhah, 1998. Use of a water deficit sensitivity index for partial irrigation scheduling of wheat and barley. (C.F. SpringerLink- www.springlink.com).
10. Cottenie, A., M. Verlo, L. Kjekens and R. Camerlynch, 1982. Chemical Analysis of Plant and Soil. Laboratory of Analytical Agro chemistry. State Univ. Gent, Belgium., 42: 280-284.
11. But, R., 2004. Soil Survey laboratory Manual Report No.42 USDA, National Resources Conservation Service. Washington.
12. Gomez, K.A. and A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd ed. John Wiley and Sons, New York.
13. Janieson, P.D., R.J. Martin and G.S. Francies, 2005. Drought influences on growth of barley, wheat and maize. New Zealand Journal of crop and Horticultural Science, Doos, l23: 78-89.
14. Aderfasi, A.A., 2000. Response of four genotypes of wheat to irrigation schedules. Saudi. J. Biol. Sci., 7(2): 171-178.