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Effect of different watering regimes on growth of two wheat (*Triticum aestivum L*) cultivars at high terraces of North Sudan

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ABSTRACT
A Field experiment was conducted in the high terraces of Dongla area, Northern State, Sudan for two seasons (2008/09 and 2009/10). The objective of this study was to determine the effect of watering regimes on growth of two cultivars of wheat. The irrigation treatments were skipping one irrigation at certain stages of growth of wheat as following: W1 = 1-20 days (germination + seedling development), W2 = 21-39 days (tillering + stem elongation or jointing), W3 = 40-59 days (booting +heading), W4 = 60-79 days (flowering of anthesis + milk stage), W5 = 80-99 days (dough + ripening), and W_6 = control every 10 days. The two cultivars were WadiEliel and Npta. Parameters studied were plant height (cm), dry weight (gm) and number of tillers per squared meter every 24, 34, 44, 54, 64, 74, 84 and 94 days of growth. The results showed that Wadielneil cultivar had the highest weight compared with other cultivar (Npta) during all growth stages among the two seasons. And variation was significant (P=0.05) in 74, 84 and 94 days for growth in the first season; and 64, 74 and 94 days from growth of the second season. On the other hand, watering regimes obtained significant (P=0.05) effect in the second season at 54 and 74 days of growth at W_4 and W_6, respectively. The dry weight affected significantly (P=0.05) by watering regimes at 24, 34, 44 and 84 days of the first season and 24, 64 and 94 days of the second season. Wadielneil cultivar had the heaviest dry weight than Npta in all readings for both seasons, but showed significant difference (P=0.05) at 24 and 64 days at the second season. The watering regimes had significant difference (P=0.05) at tiller number/m at 84 of the first season and at 24, 44, 54 and 84 days at the second season. The cultivars had no significant effect on number of tillers except in 34, 74 and 94 days of the first season. The interaction of watering regimes X cultivars had no clear effect for all parameters of growth except the W_2V_1 in the number of tillers per meter in the second season only.

***Keywords*:** wheat, watering regimes, growth, Northern Sudan

INTRODUCTION
Water requirements of a crop are dependent on the botanical characters of the crop, its stage of growth and the prevailing weather conditions, Different criteria based on soil, plant and metrological factor were used for estimation of crop water needs. The grain yield was viewed by some research workers as a product of biological yield and harvest index (Donald and Hamblina, 1976). Passioura (1977) suggested that the yield could be a product of three factors viz.

usable water, water use efficiency and the harvesting index. The effect of water deficit on yield (total or economic) yield is the integral of its effects on the growth and other physiological process (Farah, 1996) Wheat (*Triticum aestivum* L.) is the main winter cereal crop in the Northern State (latitude 18 – 22 N) in terms of areas and production. Its area amounted to about 98000 Feddans in 1995 season, producing a total of 145500 tons with an average of 1.5 tons/faddan. The whole area is sown under surface-irrigation either on the old land nears the Nile or the newly upper terrace (Northern State-Ministry of Agriculture report, 1995). Elsir and Abdu Allah (2003), indicated that the main problems of irrigation in Northern Sudan were emanating from unavailability of water. Water stress during different plant growth stages usually decrease final grain yield of wheat. During vegetative growth, phyllochron decreases under water stress (McMaster and Smike,1988) and leaves become smaller, which results in low leaf area index, low tillers/plant, as well as low shoot dry weight (Abo El-Kheir, 2000 and McMaster,1997). Furthermore, low soil moisture conditions reduce the number of reproductive tillers which limit their contribution to grain yield (McMaster, 1997). Detection of crop water stress is critical for efficient irrigation water management, especially in the semi-arid regions. On the other hand, Irrigation water is becoming increasingly scarce; this highlights the importance of the effective and efficient use of this resource.

In the Northern state of Sudan, irrigation incurs the highest cost in crop production throughout the year. Saving one irrigation at any growth stage of wheat save more than 15% of the total irrigation cost. Therefore, the objective of this study was to assess the effect of watering regimes on growth, and yield of two wheat cultivars under Northern State.

MATERIAL AND METHODS

An experiment was conducted in the high terraces of Dongla area, Northern State for the two seasons (2008/09 and 2009/10). The Northern State occupies the Northern part of the republic of Sudan lies between latitudes 16 and 22 north and longitudes 25 and 23 east. The climate is desert and arid with cold winter (min 5 C) and hot summer (max 47 C). The soil is sandy clay, alkaline, with low organic matter

The experiment was laid out in the field in a split-plot design with three replications. Water stress during different developmental stages of growth of wheat was randomly assigned as a main plots and two cultivars (Wadi Elniele =V1 and Npta =V2) were randomized as subplots. At each experiment water stress was applied by skipping one irrigation (19 days) at each stage of wheat growth W1 = 1-20 days (seedling),W2 = 21-39 days (jointing),W3 = 40-59 days (heading),W 4 = 60-79 days (milk stage),W5 = 80-99 days (ripening). And the W6 = control irrigated every 10 days. The seeds material used in this study brought from Dongla Research Station.

The field was prepared according to Dongla station using different procedures of land preparation starting by land ploughing disc plough, and then the land was left for 1 month under sundry. Thereafter, the land was harrowed using disc harrow and it was leveled at the second day and divided into main plots and subplots. The seeds were sown in two years 2009, Dec 6 and 2010, Dec 8 manually on a seed rate of 100 grams for the experiment unit. The distance between lines was 20 cm and the line was 150 cm long. All these practices were taken place in both years. Fertilizer applied during both years in two doses (Urea 40kg/fed) and weeding was done every three weeks after crop emergence till grains filling, using hand hoe. During the two years, observation was taken on 5 plant randomly selected. Data

was recorded on vegetative and reproductive character. Plant height (cm) from the ground surface to the tip of the plant, number of tillers per meter square and dry weight was properly measured. Data were taken eight times at 24, 34,44,54,64,74,84,94 days after sowing. Yield kg/ha was also determined. Analysis of variance for split plot design according to (Gomez and Gomez, 1984) was done to find out the significant difference of the studied treatments. Means of the studied characters were compared by least significant difference (LSD0.05).

RESULTS AND DISCUSSION

Tables 1_a and 1_b showed the effect of different watering intervals on plant height on two cultivars of wheat at different growth stages of two seasons 2008/09 and 2009/10, respectively. Results revealed no significant difference at all stages between treatments and their interactions during the first season. However, cultivars showed significant difference (P=0.05) at 74, 84 and 94 days. V_1 (Wadi Elneil) represented the greater plant height compared with V_2 (Npta). In the second season (2009/10), there was no significant difference between cultivar and their interactions with watering regimes at all stage of growth (Table 1_b). From results cultivars had highly significant effect (P=0.01) at 64, 74 and significant difference (P=0.05) at 94 days. V_1 (Wadi Elneil) showed the tallest plant height than V_2 (Npta).. At 54 and 74 days watering regimes showed significant difference (P=0.05) and W_4 and W_6 gave the greatest value. In season 2008/09 (Table2_a), the watering regime showed no significant effect (P=0.05) on dry weight at 24, 34, 44 and 84 days. At 24 days, W_3 showed the highest dry weight (21.0 gm), while at 34 day, W_5 gave the highest dry weight (23.6) at 44 the day highest values was gave by W_4 (34.0) and at 84 days W_1 showed the highest record (310.7 gm). Cultivars and their interactions with watering regimes had no significant effect on dry weight.

In Table 2_b (season 2009/10) show no significant effect of watering interval on dry weight at 34,44,54 days, at 24 days cultivars and the watering regime x cultivars showed significant difference at (P=0.05). V_1 (Wadi Elniel) had the highest dry weight (33.1g) while W_4V_1 represented the highest dry weight (34.6g) among all treatments. At 64 days cultivar V_1 (Wadi Elniel) obtained the highest dry weight compared with V_2 (Npta), which was 251.1 gm and the difference significant at (P=0.05). Watering regimes also revealed highly significant difference (P=0.1) in dry weight. W_1 and W_2 had the highest value (262.6 and 262.2g), respectively. There was no effect due to cultivars and their interaction with watering regimes. Finally, at the last reading (94 days), there was clear significant difference (P=0.05) at W_4 due to the watering regimes (262.9g) the lowest values was obtained at W5 (165.3). Cultivars and watering regimes x cultivars had no significant effect on this parameters.

In season 2008/09 (Table 3_a), number of tillers/m^2 was not affected by treatment at 24 and 64 days. At 34 days, there was highly significant difference (P=0.1) between cultivars and watering regimes X cultivars while there was no effect due to watering regime. V_1W_4 and V_1 had the highest number of tiller/m^2(4.4 and 3.2), respectively. At 44, 54 and 84 days watering regimes revealed significant affect (P=0.05) and the highest values were observed at W_2, W_3 and W_2 (2.9, 3.5 and 4.0, respectively). The other treatments had no effect on number of tillers during this season. Cultivars had significant effect (P=0.05) at 64 and 84 days of growth at. both readings, V_1 (Wadi Eneil) had the highest tiller number/m^2 (1.99 and 2.6). The watering regimes and watering regimes X cultivars had no effect on number of tiller/m^2.

Results of the second season are shown in Table 3_b. Watering regimes showed significant difference
(P=0.05) at 24, 44 and 84 days. W_5 recorded the highest value at 24, 44 day, W_1 (4.3) and W_3 gave the highest at 84 day (3.7), respectively. The cultivars and interaction of watering regimes X cultivars had no effect on tillers number/m^2. At the fourth reading, 54 days watering intervals showed highly significant difference (P=0.01), and W_4 (4.0) represented the highest tillers number/m^2. They were no significant effect of treatments at other growth stages.

Table 4 shows the grain yield (kg/ha) of the two wheat cultivars under different watering regimes. The first season (2008/09) showed no significant effects for all treatments, while the second season (2009/10) revealed highly significant (P=0.01) for the two cultivars and significant (P=0.05) effect for the interaction of the cultivars and watering regimes. In the first season, V_2 (Npta) recorded higher grain yield compared with V_1 (WadiElneil) but without significant effect (4540.4 and 3818.6 kg/ha respectively).

In the second season, V_1 (WadiElneil) had the highest grain yield, which was (4377.5 kg/ha), while V_2 (Npta) gave the lowest (2609.6 kg/ha). The interaction between cultivars and watering regimes showed significant effect (P=0.05) and V_1W_2 had the highest yield (6281.6 kg/ha).

According to the above records the parameters of growth in this experiment had no clear trend. That may due to environmental factors between two seasons. We could put the result of final reading in consideration. But except in the final reading of dry weight of the second season there was no significant difference due to watering regimes, cultivars or their interaction on the parameters of growth which were taken. Were W4 (flowering of anthesis+ milk stage) showed the highest values and W5 (dought +ripening gave the lowest values). The above results were with agreed with Malik(2010) who reported that number of tiller/m^2 were not affected significantly due to watering regimes. Also Naseri *et. al*., (2010) found that grain yield and its components was significantly different among cultivars due to effect by different level of irrigation at different growth stages. Entz and Fowler (1988) found that environmental stress between 21 and 65days of growth most influenced grain yield, aerial dry matter, production, harvest index, grain protein yield, spikes per square meter, kernels per spike and kernels per square meter.

Moustafa *et al*. (1996) reported that water stress caused large differences in yield and yield components. Stress applied at either tillering or heading gave similar results but effects were more pronounced when stress was applied at heading. This finding was in line with our result. Also Moustafa *et al*. (1996) reported that it was not possible to determine is osmotic adjustment contributed to the differences between cultivars in response to water stress. Also (Ali and Sirelkhatim, 2010) reported that wheat can tolerate intervals of up to 21 days during the vegetative growth stage and omission of the second or the final (at grain filling stage) irrigation and for attaining maximum yield, moisture stress should be avoided at the time of booting and anthesis. Ouda *et al*, (2005) revealed that any subsequent irrigation when skipped at any critical growth stage of wheat resulted in significant decrease in yield as compared to control treatment. Skipping one irrigation when the crop was 10-40 days old had no depressive effect on grain yield. On the other hand, reductions in grain yields occurred when the skipping commenced during heading and during the grain filling stages. Farah (1987) reported that skipping

Table (1a). Means plant height (cm) of two wheat cultivar affected by different watering regimes during season2008/09

	Days																							
	24			34			44			54			64			74			84			96		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
W_1	9.7	12.4	11.1	27.0	19.3	23.1	20.7	32.4	26.6	27.5	44.3	35.9	46.7	48.8	47.7	75	70.3	72.6	72.9	69.6	71.2	72.3	65.1	69.7
W_2	8.7	8.6	8.7	22.0	16.9	19.4	26.6	24.9	25.8	33.0	36.1	34.6	52.0	49.4	50.7	79.4	76.1	73.7	73.3	63.9	68.6	68.2	60.8	64.5
W_3	11.4	8.1	9.8	20.7	21.4	21.1	22.6	29.3	26.0	37.5	24.7	31.1	43.9	53.9	48.9	72.2	62.9	67.5	74.9	65.6	70.3	73.7	65.5	69.6
W_4	8.0	9.4	8.7	17.9	20.8	19.3	33.2	26.5	29.8	48.2	32.8	40.5	52.2	45.3	48.8	76.6	74.8	75.7	75.9	69.7	72.8	71.2	58.5	64.9
W_5	8.9	9.0	9.0	17.5	14.0	15.8	24.1	27.3	25.7	35.3	34.6	35.0	59.8	46.3	53.0	81.3	73.5	77.4	69.7	68.9	69.3	67.9	54.5	61.2
W_6	8.1	10.3	9.2	22.7	23.0	22.8	31.7	27.3	29.5	35.9	30.0	33.0	46.5	44.7	45.6	75.2	66.4	70.8	80.2	70.4	75.3	72.9	64.2	68.6
Mean	9.1	9.7	ns	21.3	19.2	ns	26.5	28.0	ns	36.2	33.7	Ns	51.2	48.1	ns	76.6^{*}	70.7	-	74.5^{**}	68.0	-	63.5^{**}	61.5	-
C.V%			21.58			18.86			18.07			27.95			15.43			13.61			6.73			11.50
LSD A			3.56			9.36			7.3			9.36			16.49			18.05			10.69			9.58
LSD B			3.49			6.75			8.72			17.43			13.51			17.87			8.50			13.51
LSD AB			4.58			8.72			15.25			25.49			17.43			6.75			8.06			6.34

W1 = 1-20 days (seedling),W2 = 21-39 days (jointing),W3 = 40-59 days (heading),W 4 = 60-79 days (milk stage),W5 = 80-99 days (ripening). And the W6 = control irrigated every 10 days. LSD A = main plot (treatment of watering), LSD B= sub plot (treatment of cultivar), LSDAB = (interactiozn of watering +cultivars),ns= non significant,*significant at p=0.05, **s= significant at p=0.1

Table (1b). Means plant height (cm) of two wheat cultivar affected by different watering regimes during season2009/10

	Days																							
	24			34			44			54			64			74			84			96		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
W_1	14.5	14.4	14.4	19.1	23.1	21.1	32.0	30.5	31.2	42.3	34.2	38.3	69.1	49.0	59.1	64.0	60.2	62.3	74.3	63.6	68.9	68.7	61.2	64.9
W_2	17.2	17.6	17.4	26.7	24.1	25.4	34.5	39.1	36.8	41.2	34.8	38.0	68.7	58.4	63.6	69.4	60.0	64.7	72.6	69.8	71.2	67.9	68.2	68.1
W_3	17.2	20.3	18.8	26.1	22.5	24.3	30.1	30.7	30.4	35.0	36.7	35.9	62.5	53.9	58.2	68.7	53.3	61.0	72.1	70.6	71.3	68.4	64.9	66.7
W_4	14.7	17.8	16.2	22.4	28.6	25.5	28.7	32.1	30.4	38.3	40.9	39.6*	70.5	62.4	66.5	66.2	56.9	61.6	71.5	73.4	72.5	65.8	63.4	65.6
W_5	16.1	17.6	16.9	28.7	25.8	27.3	31.2	31.7	31.5	39.3	32.5	30.9	70.1	63.9	67.0	70.9	64.3	67.6	72.9	70.3	71.6	73.8	63.3	68.5
W_6	15.6	15.1	15.3	23.4	25.2	24.8	38.8	33.0	35.9	37.6	41.2	39.4	69.3	69.9	69.6	71.8	66.0	78.9*	79.4	78.8	79.1	72.9	62.5	67.7
Mean	15.9	17.2	Ns	24.5	26.4	ns	32.5	32.9	Ns	37.3	36.7	-	68.38**	59.5	-	68.5**	60.1	-	73.8	71.1	ns	69.6*	61.1	-
C.V%			26.39			16.67			18.71			11.71			12.76			10.25			11.84			10.24
LSD A			7.13			7.71			9.98			7.71			26.27			8.64			15.33			9.16
LSDB			7.63			7.32			10.87			7.69			14.51			11.72			15.25			12.14
LSDAB			3.44			8.78			8.04			11.31			14.60			8.85			9.3			9.7

W1 = 1-20 days (seedling),W2 = 21-39 days (jointing),W3 = 40-59 days (heading),W 4 = 60-79 days (milk stage),W5 = 80-99 days (ripening). And the W6 = control irrigated every 10 days. LSD A = main plot (treatment of watering), LSD B= sub plot (treatment of cultivar), LSDAB = (interaction of watering +cultivars),ns= non significant,*significant at p=0.05, **s= significant at p=0.1

Table (2a). Means dry weight (gm) of two wheat cultivars affected by different watering regimes during season 2008/09

	Days																							
	24			**34**			**44**			**54**			**64**			**74**			**84**			**96**		
	V_1	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**
W_1	18.6	21.9	20.3	27.9	18.5	23.2*	31.0	32.4	31.7	129.3	122.6	126.0	224.0	229.2	226.6	240.0	238.0	238.9	323.7	297.8	310.8*	265.5	301.1	283.3
W_2	20.5	17.2	18.9	22.2	17.1	19.6	29.2	38.2	33.7	116.9	119.1	118.0	223.3	237.8	230.5	244.4	240.0	242.4	231.8	324.5	278.2	400.7	350.8	375.8
W_3	20.1	22.0	21.1*	21.3	21.6	21.4	30.0	32.3	31.1	118.5	116.5	117.5	225.4	236.5	231.0	254.1	243.8	249.0	264.1	283.1	273.6	382.2	397.9	390.0
W_4	22.7	15.9	19.3	18.6	20.3	19.4	29.2	39.0	34.1**	121.7	116.4	119.0	231.4	228.5	230.0	225.5	241.4	233.5	276.9	261.2	269.0	412.7	376.6	394.7
W_5	21.0	14.5	17.7	20.8	26.4	23.6*	33.3	22.4	27.9	116.8	107.9	112.4	224.0	226.5	225.0	249.6	237.9	243.8	238.1	236.5	237.3	347.5	334.9	341.2
W_6	12.4	15.5	14.0	19.7	16.9	18.3	34.9	28.2	31.5	117.1	129.4	123.6	228.8	227.1	228.0	242.5	243.5	243.0	270.7	317.7	294.0	352.5	291.1	321.8
Mean	19.22	17.8	-	21.8*	20.1	-	31.3	32.1	-	120.2	118.6	Ns	226.2	230.9	ns	242.7	240.8	Ns	267.5	286.8	-	360.2	000	ns
C.V%		21.73			22.38			22.18			6.21			3.64			4.90			13.76			26.67	
LSD A		11.17			17.22			19.93			85.12			54.72			99.01			217.25			170.66	
LSDB		10.69			11.75			25.09			45.54			51.10			73.28			222.15			185.43	
LSDAB		10.30			11.52			17.99			16.23			15.01			11.13			96.36			83.02	

W1 = 1-20 days (seedling),W2 = 21-39 days (jointing),W3 = 40-59 days (heading),W 4 = 60-79 days (milk stage),W5 = 80-99 days (ripening). And the W6 = control irrigated every 10 days. LSD A = main plot (treatment of watering), LSD B= sub plot (treatment of cultivar), LSDAB = (interaction of watering +cultivars),ns= non significant,*significant at p=0.05, **s= significant at p=0.1.

Table (2b). Means dry weight (gm) of two wheat cultivars affected by different watering regimes during season 2009/10

	Days																							
	24			34			44			54			64			74			84			96		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
W_1	30.8	26.7	28.8	84.6	82.2	83.4	107.5	131.9	119.7	201.5	208.0	204.7	265.1	260.1	262.6**	368.7	332.4	350.6	447.7	459.8	453.8	201.4	173.8	187.6
W_2	33.5	31.5	32.5	73.9	84.8	79.3	100.9	105.5	103.2	205.5	205.8	205.6	262.6	261.9	262.2**	335.7	335.6	335.6	470.2	441.6	455.9	186.7	171.9	179.3
W_3	34.1	33.3	33.7	88.7	87.4	88.0	106.0	109.8	107.9	194.0	193.5	193.8	258.7	256.6	257.7	343.7	331.6	337.4	455.6	443.4	444.5	256.5	229.8	243.2
W_4	34.6*	28.0	31.3	76.3	77.3	76.8	109.2	106.3	107.7	204.4	168.0	186.4	256.2	216.6	236.4	337.3	338.9	338.1	461.9	456.1	459.0	238.4	287.5	263.0*
W_5	33.7	30.3	32.0	89.7	79.2	84.5	108.5	109.4	108.9	201.5	213.1	207.3	222.9	230.8	226.8	336.1	338.4	337.3	439.0	455.6	447.3	142.7	188.0	165.4
W_6	31.7	34.1	32.9	93.3	82.2	87.8	114.6	101.7	108.2	195.7	204.2	200.0	241.1	218.7	230.0	333.9	369.5	351.7	423.4	455.1	439.3	182.1	242.9	212.5
Mean	33.1*	30.7	-	84.4	82.2	ns	107.8	110.8	Ns	200.4	198.8	Ns	251.11**	240.8	-	342.5	341.1	Ns	449.6	452.0	ns	201.3	215.6	-
C.V%		11.49			14.68			14.02			10.54			6.45			7.60			5.07			29.32	
LSD A		24.34			66.19			94.97			103.07			77.17			162.76			174.47			128.07	
LSDB		22.47			75.04			94.02			129.2			97.44			159.36			140.25			108.75	
LSDAB		6.68			17.64			26.63			38.00			37.87			50.57			47.38			90.36	

W1 = 1-20 days (seedling),W2 = 21-39 days (jointing),W3 = 40-59 days (heading),W 4 = 60-79 days (milk stage),W5 = 80-99 days (ripening). And the W6 = control irrigated every 10 days.

LSD A = main plot (treatment of watering), LSD B= sub plot (treatment of cultivar), LSDAB = (interaction of watering +cultivars),ns= non at p=0.05, **s= significant at p=0.1.

Table (3a). Means of number of tillers/m^2 of two wheat cultivars affected by different watering regimes during season 2008/09

	Days																							
	24			34			44			54			64			74			84			96		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
W_1	1.8	2.1	2.0	3.2	2.2	2.7	1.7	2.6	2.2	2.1	1.6	1.9	3.4	2.7	3.1	2.0	2.0	2.0	2.4	3.9	3.2	2.5	1.9	2.2
W_2	1.8	1.7	1.8	2.3	3.2	2.7	3.4	2.4	2.9*	1.7	3.8	2.8	2.6	3.0	2.8	2.0	2.0	2.0	4.5	3.5	4.0*	2.7	2.2	2.5
W_3	1.9	1.6	1.8	4.1	2.3	3.2	2.9	2.3	2.6	3.7	3.3	3.5*	2.9	3.3	3.1	1.9	2.0	1.9	2.7	2.8	2.7	3.3	2.0	2.6
W_4	1.9	2.0	1.9	4.4**	1.7	3.1	2.1	1.9	2.0	3.0	2.2	2.6	2.5	3.2	2.5	2.1	1.9	2.0	2.7	3.3	3.0	2.6	1.7	2.1
W_5	1.9	1.7	1.8	3.0	2.2	2.6	3.3	2.1	2.7	3.0	3.3	3.2	2.5	3.5	3.0	2.0	2.2	2.1	2.5	2.2	2.4	2.0	2.2	2.1
W_6	2.0	1.8	1.9	2.3	3.5	2.9	2.2	2.0	2.1	3.7	2.2	2.9	3.0	3.3	3.1	2.1	1.8	1.9	3.5	3.5	3.5	2.5	2.0	2.3
Mean	1.9	1.9	ns	3.2**	2.5	-	2.6	2.2	-	2.3	2.7	-	2.8	3.7	Ns	2.0*	2.0	-	3.1	3.2	-	2.6**	2.0	-
C.V%	30.10			27.05			33.40			35.68			34.46			14.72			30.61			19.99		
LSD A	0.67			4.0			3.88			1.2			1.3			1.2			1.7			1.5		
LSDB	0.87			1.31			1.2			1.1			1.3			1.7			1.8			1. 3		
LSDAB	0.44			3.24			1.5			1. 4			1. 4			0.38			1.1			1.2		

W1 = 1-20 days (seedling),W2 = 21-39 days (jointing),W3 = 40-59 days (heading),W 4 = 60-79 days (milk stage),W5 = 80-99 days (ripening). And the W6 = control irrigated every 10 days. LSD A = main plot (treatment of watering), LSD B= sub plot (treatment of cultivar), LSDAB = (interaction of watering +cultivars),ns= non significant,*significant at p=0.05, **s= significant at p=0.1

Table (3b). Means of number of tillers/m^2 of two wheat cultivars affected by different watering regimes during season 2009/10

	Days																							
	24			34			44			54			64			74			84			96		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
W_1	4.3	4.3	4.3	4.5	3.9	4.2	3.7	4.8	4.3*	2.5	3.7	3.1	4.8	3.3	4.1	3.3	3.0	3.1	3.9	2.9	3.4	3.3	2.9	3.1
W_2	4.5	3.8	4.1	4.6	4.8	4.7	3.0	4.1	3.6	4.6	4.0	4.3	4.2	3.6	3.9	3.6	3.5	3.6	4.2	3.2	3.7*	3.1	2.8	3.0
W_3	3.7	4.1	3.9	5.2	3.4	4.2	4.5	3.1	3.8	4.2	4.1**	4.2	3.0	4.0	3.5	4.0	3.4	3.7	3.4	4.1	3.8*	2.3	3.1	2.7
W_4	3.9	4.0	3.9	4.5	4.1	4.3	3.3	2.9	3.1	3.6	3.1	3.3	2.7	3.9	3.3	3.3	4.2	3.7	3.7	3.2	3.4	3.4	3.1	3.3
W_5	4.9	3.4	4.1*	3.6	4.5	4.1	3.4	4.9	4.1*	2.2	3.3	2.7	3.7	3.3	3.5	3.2	4.4	3.8	3.4	3.4	3.4	3.0	3.2	3.1
W_6	3.0	4.2	3.6	3.4	4.4	3.9	2.9	3.2	3.0	3.6	3.2	3.4	3.8	3.3	3.6	3.9	3.8	3.9	4.0	3.3	3.7	2.2	2.2	2.6
Mean	4.0	3.9	-	4.3	4.2	Ns	3.5	3.9	-	3.5	-	-	3.7	3.6	Ns	3.6	3.7	ns	3.8	3.4		2.91	2.9	ns
C.V%		22.30			26.83			19.81			24.15			22.52			28.81			23.11			25.2	
LSDA		1.56			2.27			2.2			2.1			2.4			3.2			3.44			1.29	
LSDB		1.46			2.98			2. 3			2.00			2.02			6.4			2.06			1.31	
LSDAB		1.46			2.33			2.3			1.78			2.17			1.52			1.42			0.98	

W1 = 1-20 days (seedling),W2 = 21-39 days (jointing),W3 = 40-59 days (heading),W 4 = 60-79 days (milk stage),W5 = 80-99 days (ripening). And the W6 = control irrigated every 10 days. LSD A = main plot (treatment of watering), LSD B= sub plot (treatment of cultivar), LSDAB = (interaction of watering +cultivars),ns= non significant,*significant at p=0.05, **s= significant at p=0.1.

irrigation during early growth did not affect growth of the crop because, the crop was small and water requirement were still very small. Similarly, crop water requirements (CWR) during grain filling decrease because the crop was become mature and crop cover was decrease as a result of the senescence of the leaves. Little responsiveness of wheat to excessive irrigation during the final growth stage was also noticed by Farah (1987).

Table (5) shows the grain yield (kg/ha) of the two wheat cultivars under different watering regimes. The first season (2008/09) showed no significant effects for all treatments, while the second season (2009/10) revealed highly significant (P=0.01) for the two cultivars and significant (P=0.05) effect for the interaction of the cultivars and watering regimes. In the first season, V_2 (Npta) recorded higher grain yield compared with V_1 (Wadi Elneil) but without significant effect (4540.4 and 3818.6 kg/ha respectively). In the second season, V_1 (Wadi Elneil) had the highest grain yield, which was (4377.5 kg/ha), while V_2 (Npta) gave the lowest (2609.6 kg/ha). The interaction between cultivars and watering regimes showed significant effect (P=0.05) and V_1W_2 had the highest yield (6281.6 kg/ha). Moustafa *et al*. (1996) reported that water stress caused large differences in yield and yield components. Stress applied at either tillering or heading gave similar results but effects were more pronounced when stress was applied at heading. This finding was in line with our result.

Table 5. Grain yield (kg/ha) of two wheat cultivars as affected by different water regimes, during 2008/09-2009/10 seasons

Water regimes	Season					
	2008/09			2009/10		
	Cultivars					
	V1	V2	Means	V1	V2	Means
Germination+seedling(W1)	3486.7	8129.7	5808.2	3304. 7	2742. 7	3023.7
Tillering+jointing(W2)	3485.7	4047.7	3766.7	6281. 7	2720. 7	4501.2
Booting+heading(W3)	3898.3	3866.7	3882.5	4024. 7	2567.0	3300.3
Flowering +milking(W4)	3917.3	5547.7	4732.5	5041. 7	3052.0	4046.8
Dough+ ripening(W5)	4635.3	2636.3	3635.8	4129.0	3317. 7	3723.3
Irrigated every 1days(W6)	3488.7	3014.7	3251.7	3483.3	4270.3	3876.8
Mean	3818.7	4540.4	-	4337.5	2609.6	-
C.V%			40.60			29.20
LSD(V)			2342.72			2210.29
LSD (W)			2639.55			1945.72
LSD(VXW)			3037.72			3193.72

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