Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Effect of Deficit Irrigation and Weed Control Treatments on Grain Yield and Water Productivity for Three Bread Wheat Genotypes

Genedy, M. S.[1]; A. A. H. Sharshar[2]; A. M. Sharshar[1*]; M. A. Mahmoud[3] and Hoda E. A. Ibrahim[4]

Cross Mark

[1] Wheat Research Department, Field Crops Res. Inst., ARC. Giza. Egypt.
[2] Weed Research Central Laboratory. (WRCL), ARC. Giza. Egypt.
[3] Water Requirements and Field Irrigation Dept. Soils Water & Environment Res. Inst., ARC. Giza, Egypt
[4] Central Lab. for Design and Statistical Analysis Research, ARC. Giza. Egypt.

ABSTRACT

A field experiment was conducted during two winter seasons 2018/2019 and 2019/2020 at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt to study the effect of deficit irrigation and weed control treatments on grain yield and water productivity of three bread wheat genotypes. The experimental design was stripe split-plot, with three replicates. Irrigation treatments were in the vertical plots which include I_1 irrigation at all stages (full irrigation), while I_2, I_3 and I_4 were deficit irrigation through withholding one irrigation at elongation, booting, and anthesis stages, respectively. Four weed control treatments were allocated in horizontal plots that include, W_1 (Gerostar + Action), W_2 (Atlants), W_3 (hand weeding twice), and W_4 control (untreated), Sub-Subplots were three wheat genotypes G_1 (Giza 171), G_2 (Sakha 95) and G_3 (promising Line). The results revealed that the highest values of plant height, number of spikes m^{-2}, number of kernels spikes^{-1}, 1000-kernel weight, biological yield, grain yield and straw yield were recorded under I_1 compared to all the studied irrigation treatments, as well as under W_1 compared to other weed control treatments and G_2 compared to others genotypes in the two seasons. The highest values of water consumptive use (CU), and applied water (AW) were recorded under I_1 to be 37.67, and 48.26 cm respectively, the values of AW under I_2, I_3 and I_4 were reduced by 18.5%, 17.6%, and 22.3% respectively compared to I_1 as mean of the two seasons. The values of productivity of irrigation water (PIW), and water productivity (WP) were taken the descending order $W_1 > W_2 > W_3 > W_4$ and $G_2 > G_1 > G_3$ for weed, and genotypes respectively. It could be recommended the $I_2 \times W_1 \times G_2$ interaction which recorded the highest grain yield, PIW and WP, moreover saved a reasonable amount of irrigation water.

Keywords: Wheat, Deficit irrigation, water productivity, weed control

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in the world, provides about 21% of the food calories and 20% of the protein.

The proper wheat cultivar plays an important role in determining the grain yield of wheat. In Egypt increasing wheat production to reduce the gap between production and the rapid increase in the human population is a national target, but water scarcity is the main obstacle for horizontal expansion.

Drought is a worldwide problem; moreover, the expected impacts of global climate change will make the situation more serious, thus, there is a need to handle rational irrigation management practices to save irrigation water, enhance water productivity and increase the overall crop production using the same available water amount. Deficit irrigation (DI) is one of these irrigation management options, which increase water productivity by eliminating irrigation that has little impact on yield (Sarkar *et al.*, 2013). Many studies reported that deficit irrigation requires a clear understanding of the crop response to water stress during the growing season and water movement in the soil profile. (Tari, 2016; Saeed *et al*., 2017 and Fahad *et al*., 2019).

Water stress not only affects the morphology but also the metabolism of the plant. The extent of modification depends upon the genotype, growth stage, duration, and intensity of stress (Mark and Antony 2005). All stages of crop growth are not uniformly susceptible to water deficit. On the other hand, some stages can cope-up with water shortage very well. Moisture stress reduces biomass, tillering ability, grains per spike and grain size at any stage when it occurs, so the overall effect of moisture stress depends on the intensity and length of stress (Bukhat, 2005).

Selecting wheat genotypes that could tolerate drought stress and produce acceptable yield has been the major challenge for the wheat breeders. It has been found that under drought stress conditions, those genotypes that show the highest harvest index and highest yield stability are drought tolerant (Almeselmani *et al.,* 2015). It needs time to develop the varieties, which have drought tolerant potential to increase the area under cultivation and yield of the wheat crop.

The weeds cause extra competition of crop plants with biotic factors of the environment. The large population of weeds cause drought to the crop plants as more moisture is taken which ultimately caused damage to crop plants, (Ali *et al*.,2012 and Badawi, and Kenapar 2017) so, choose the high-yielding ability genotypes is very important to raise wheat productivity per unit of area and suppression weed growth. So, the main objective of the current study is to investigate the effect of deficit irrigation and weed control treatment on

*** Corresponding author.**
E-mail address:anassharshar@yahoo.com
DOI: 10.21608/jssae.2020.136088

growth, yield, yield components, and productivity of irrigation water on some wheat genotypes.

MATERIALS AND METHODS

Experimental site:

A field experiment was carried out during, 2018/2019 and 2019/2020 winter seasons at Sakha Agricultural Research Station, (31° 07' N latitude, 30° 57' E Longitude) Kafr El-Sheikh Governorate, Egypt. The agro-meteorological data for the two studied seasons were taken from Sakha Agro-meteorological Stationas (Table 1).

Soil properties for the experimental site were analyzed before cultivation, soil chemical properties were determined according to Page *et al.*, (1982). Particle-size distribution was carried out using the pipette method according to Klute, (1986), soil field capacity and permanent wilting point were determined by using pressure membrane method at 0.33 and 15 Atm according to James, (1988). Soil bulk density was determined according to Vomocil, (1957) and total porosity P% was computed using values of soil bulk density according to Black, (1965) as shown in Table 2.

Table 1. Monthly mean values of agro-meteorological data of Sakha Station in 2018 /2019 and 2019/2020 winter seasons.

Seasons	Months	Air temperature			Relative humidity			Wind Speed	Pan evaporation ($mm\ d^{-1}$)	Rain (mm)
		Max. (ºC)	Min. (ºC)	Mean (ºC)	Max. (%)	Min. (%)	Mean (%)	Mean ($km\ d^{-1}$)		
2018/2019	November	25.00	17.40	21.20	86.60	54.60	70.60	24.20	1.60	11.90
	December	19.50	13.90	16.70	88.70	62.40	75.55	24.50	0.84	21.70
	January	18.90	12.30	15.60	82.30	53.30	67.80	33.10	1.14	14.90
	February	19.70	14.30	17.00	86.90	58.20	72.55	28.60	1.78	15.30
	March	21.70	17.60	19.65	87.80	56.60	72.20	45.70	2.86	17.30
	April	25.10	21.30	23.20	80.80	48.60	64.70	44.80	3.70	3.90
	May	33.00	26.29	29.65	71.20	44.20	57.70	104.33	6.15	0.00
2019/2020	November	27.40	25.10	26.25	82.80	48.30	65.55	36.60	2.31	0.00
	December	21.40	13.40	17.40	86.90	58.90	72.90	38.50	2.66	60.68
	January	18.40	11.80	15.10	86.70	62.70	74.70	30.00	2.09	67.50
	February	20.40	12.70	16.55	84.60	56.50	70.55	51.00	1.83	14.30
	March	22.60	15.60	19.10	81.10	53.90	67.50	80.10	5.12	60.80
	April	26.00	18.90	22.45	80.00	45.10	62.55	98.80	6.08	0.00
	May	31.90	23.80	27.85	68.90	38.40	53.65	114.40	7.70	0.00

Table 2. The mean values of some chemical and physical soil properties of the experimental site for both growing seasons.

Soil depth (cm)	Field capacity (%)	Wilting point (%)	Bulk density ($Mg\ m^{-3}$)	Total porosity (%)	Sand (%)	Silt (%)	Clay (%)	Texture class	EC_e ($dS\ m^{-1}$)	pH
0-15	46.71	23.66	1.19	55.09	19.22	26.93	53.85	Clayey	1.93	8.31
15-30	42.08	21.98	1.24	53.21	19.43	26.32	54.25	Clayey	2.25	8.39
30-45	40.24	21.52	1.38	47.92	20.15	25.44	54.41	Clayey	2.68	8.54
45-60	39.73	20.19	1.45	45.28	19.61	26.83	53.56	Clayey	3.05	8.68
Mean	42.19	21.84	1.32	50.38	19.60	26.38	54.02	Clay	2.48	

Experimental design and treatments:

The experimental design was a stripe split-plot, with three replicates. The irrigation treatments (I) were located in the vertical plots: I_1-irrigation at all stages, irrigation at planting plus four irrigations (full irrigation), I_2-irrigation as I_1, with withholding one irrigation at elongation stage, I_3 irrigation as I_1, with withholding one irrigation at booting stage and I_4 irrigation as I_1, with withholding one irrigation at anthesis stage.

Horizontal plots were four weed control (W), to control annual weeds of broad-leaves (*Chenopodium album*, *Sonchus oleraceus* and *Anagallis arvensis*) and grassy weeds (*Phalaris minor* and *Poa annua*) in the wheat crop, the treatments were as follows: W_1 (Gerostar at the rate of 20 g ha^{-1} spraying 21 days after planting (DAP) + Action at the rate of 336 g ha^{-1} spraying 40 DAP), W_2 (Atlants at the rate of 960 cm ha^{-1} spraying 40 DAP), W_3 (Hand weeding twice 30 and 45 DAP) and W_4 control (untreated).The weeds were identified into species and classified into annual broadleaf , grasses, and total annual weeds. The dry weights of each species were determined in g m^{-2}.

Sub-Subplots were three wheat genotypes (G): G_1 (Giza 171), G_2 (Sakha 95), and G_3 (promising Line) as shown in Table (3).

Table 3. Cross name, pedigree and selection history of the three bread wheat genotypes.

Genotypes	Pedigree	Selection history
Giza 171	SAKHA 93/GEMMEIZA 9	S.6-1GZ-4GZ-1GZ-2GZ-0S.
Sakha 95	PASTOR // SITE / MO /3/ CHEN / AEGILOPS SQUARROSA (TAUS) // BCN /4/ WBLL1.	CMA01Y00158S-040POY-040M 030ZTM-040SY-26M-0Y-0SY-0S.
Promising line	CHEN/AEGILOPS SQUARROSA (TAUS)//BCN/3/2*KAUZ/4/GEN*2//BUC/ FLK /3/ BUCHIN.	S.16280-020S-015S-4S-0S.

Wheat genotypes were planted on the 19th and 28th November in both seasons, respectively, the agricultural practices were carried out according to the local recommendations of the Agricultural Research Center. The irrigation treatments were isolated by ditches of 2.5 m in width to avoid lateral movement of water. The weed control treatments were sprayed with a knapsack sprayer by the flat nozzle and the water volume used was 500 liters ha^{-1}.

The recorded data were days to heading, days to maturity, plant height (cm), number of spikes m^{-2}, number of kernels $spikes^{-1}$, 1000-kernel weight (g), biological yield (ton ha^{-1}), grain yield (ton ha^{-1}) and straw yield (ton ha^{-1}).

Applied Water (AW)

The applied irrigation water to each experimental plot was measured using PVC spile tubes (5 cm inner diameter of 80 cm length). The spile tubes were utilized to let water flows from field ditches into each plot. The effective water head above the cross section center of the spile was kept constant at 10 cm using a fixed sliding gate type. Stage gauges were placed in each plot to measure the water depth which flows through the spiles. The amount of water in each application was recorded and the consumed time was also monitored using a stop watch. The amount of water delivered through the spile tube was calculated according to Majumdar (2002) by the following equation:

$$q = CA\sqrt{2gh}$$

Where: q is the discharge of irrigation water ($cm^3\ sec^{-1}$), C is discharge coefficient equal 0.62 (determined by experiment), A is the inner cross section area of the irrigation spile (cm^2), g is a gravity acceleration ($cm\ sec^{-2}$), and h is the average effective head (cm).

The volume of water delivered for each plot was calculated by substituting Q in the following equation:

$$Q = q \times T \times n$$

Where: Q is the volume of water $m^3\ plot^{-1}$, q is the discharge ($m^3\ min^{-1}$), T is total irrigation time (min) and n is number of spiles tube per each plot.

The amount of applied water (Aw) during the whole growing season including effective rainfall was calculated according to Early (1975), following the formula given below.

$$Aw\ (m^3\ ha^{-1}) = Iw + R$$

Where Aw is amount of seasonal applied water ($m^3\ ha^{-1}$); Iw is amount of water delivered to the field plot by irrigation($m^3\ ha^{-1}$); and R is effective rainfall ($m^3\ ha^{-1}$) where, Effective rainfall= incident rainfall × 0.70 (Novica, 1979)]. The amount of water in "cm" described as water depth/height was also estimated.

Water consumptive use (CU):

Water consumptive use was determined as the soil moisture depletion (SMD) using the following equation (Israelsen and Hansen, 1962).

$$CU\ (SMD) = \sum_{i=1}^{n=4} (\theta 2 - \theta 1)/100 \times Bd \times Di$$

Where CU is a water consumptive use in (cm) in the effective root zone of 60 cm; SMD is a soil moisture depletion; Θ_2 is a gravimetric soil moisture percentage 48 h after irrigation (% wet weight basis); Θ_1 is a gravimetric soil moisture percentage immediately before the next irrigation (% wet weight basis); Bd is a soil bulk density ($Mg\ m^{-3}$) for the concerned soil layer; Di is a soil layer depth (15 cm); n is a number of soil layers.

Productivity of Irrigation Water (PIW) and Water Productivity (WP).

The productivity of irrigation water and water productivity were calculated according to (Ali *et al.*, 2007) as the following equations:

$$\textbf{Productivity of irrigation water (kg m}^{-3}\textbf{)} = \frac{\text{Grain yield kg ha}^{-1}}{\text{Amount of applied water m}^3\text{ha}^{-1}}$$

Where, amount of applied water = Irrigation water + effective rainfall

$$\textbf{Water productivity (kg m}^{-3}\textbf{)} = \frac{\text{Grain yield kg ha}^{-1}}{\text{Water consumptive use in m}^3\text{ha}^{-1}}$$

Statistical analysis

The results were statistically analyzed according to Gomez and Gomez (1984) for every single season. The comparisons of means were carried out using the least significant differences (L.S.D) at the 5% probability level to compare the differences among the treatments means (Steel *et al.*, 1997). The statistical analyses for the recorded data were conducted using Gen Stat software and the graphs by using Excel.

RESULTS AND DISCUSSION

Wheat water consumptive use (CU) and applied water (AW):

Data in Table 4 shows the values of seasonal water consumptive use, and seasonal applied water as affected by irrigation treatments, weed control treatments, and wheat genotypes. Differences were obtained for water consumptive use and applied water between all irrigation treatments in both studied seasons, the highest values of CU and AW were recorded for I_1 to be 37.67 and 48.26 cm respectively as mean of both seasons. The values of CU under I_2, I_3 and I_4 were reduced by 12.1%, 12.2% and 19.5% respectively compared to I_1; whereas the values of AW after the same irrigation treatments were decreased by 18.5%, 17.6% and 22.3% respectively compared to I_1 as mean of the two seasons.

These results may be due to deficit irrigation which significantly contributes decreasing the amount of CU and AW (Zaman *et al.*, 2017; Zhang *et al.*, 2018 and Sarkar *et al.*, 2013). These results agree with those obtained by Mohamed and Abo-Marzoka, (2017), they indicated that traditional irrigation received the highest values of water consumptive use and total applied water compared to deficit irrigation stress at the heading and ripening stages of wheat.

Table 4. Seasonal water consumptive use (CU) and seasonal applied water (AW) as affected by different irrigation treatments, weed control treatments and wheat genotypes during the two growing seasons.

Irrigation parameters	Seasons	Irrigations				Weed control				Genotypes		
		I_1	I_2	I_3	I_4	W_1	W_2	W_3	W_4	G_1	G_2	G_3
CU (cm)	2018/2019	36.89	32.60	32.96	29.75	33.25	32.40	31.96	34.60	33.93	33.04	32.18
	2019/2020	38.44	33.61	33.15	30.86	34.25	33.11	32.76	35.94	35.10	33.93	33.02
AW (cm)	2018/2019	49.72	40.72	41.91	38.82	43.26	42.34	41.86	43.71	43.30	42.77	42.31
	2019/2020	46.80	37.98	37.62	36.21	40.22	39.29	38.73	40.37	40.09	39.63	39.23

The values of CU were taken the descending order $G_1>G_2>G_3$ for wheat genotype and $W_4>W_1>W_2>W_3$ for weed control treatments. Water consumptive use for G_2 (Sakha 95), and G_3 (promising line) were decreased by 3%, and 5.6% respectively compared to G_1(Giza171), however, the values of CU for W_1, W_2, and W_3 were decreased by 4.3%, 7.1%, and 8.3% respectively compared to W_4 as mean of both seasons. In this concern, Fahad *et al.*, (2019) reported that no significant difference among evapotranspiration of different wheat genotypes. While there were no differences obtained of AW between all studied genotypes, as well as weed control treatments.

Concerning the effect of the interaction between irrigation treatments, weed control treatments, and wheat genotypes on the values of CU and AW, as shown in Table 5. There are noticeable differences in CU and AW values among all the interactions of irrigation treatments, weed control treatments and genotypes. The highest values of CU and AW were recorded with $I_1 \times W_4 \times G_1$ and $I_1 \times W_4 \times G_2$ interaction to be 41.03 and 40.35 cm for CU and 49.53 and 48.94 cm for

AW, respectively as mean of both seasons. But, the lowest values were observed for I_4 X W_3 X G_3 interaction to be 27.92 and 35.82 cm for CU and AW respectively as mean of the two seasons.

These results are in the same line with that reported by Imran *et al.,* (2015), they indicated that irrigation influenced the evaporation, transpiration, and canopy temperature of wheat crop. Evapotranspiration was significantly increased with the increasing amount of water applied, and the number of irrigations (Gao *et al.,* 2014 and Imran *et al.,* 2015). Irrigating the crop only at drought sensitive growth stages and withheld water at other stages can help to manage water resources to meet crop requirements (Du *et al.,* 2010).

Table 5. Seasonal water consumptive use (CU) and seasonal applied water (AW) as affected by the interaction between irrigation treatments, weed control treatments and wheat genotypes during 2018/2019 and 2019/2020 growing seasons.

Irrigation parameters	Genotypes	Seasons	I1				I2				I3				I4			
			W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
CU (cm)	G1	2018/ 2019	38.45	36.85	37.76	40.68	33.89	33.26	31.74	34.00	33.35	32.97	32.96	35.53	30.70	29.91	29.15	31.43
	G2		36.57	35.22	35.93	39.65	32.67	32.92	31.04	33.61	32.81	32.34	32.15	34.11	30.21	29.57	28.83	31.08
	G3		35.84	33.50	34.40	37.81	32.33	31.73	30.75	33.27	32.02	31.89	31.78	33.41	29.96	28.58	27.02	30.61
	G1	2019/ 2020	40.64	38.67	38.53	41.38	34.19	33.97	33.11	36.59	33.89	33.84	33.09	35.55	32.64	31.40	30.11	33.95
	G2		38.81	37.44	36.32	41.05	33.77	32.17	32.85	35.26	33.16	32.65	32.18	34.76	31.57	29.49	29.25	32.22
	G3		37.32	35.78	35.39	39.93	32.45	31.82	32.27	34.90	31.90	31.71	31.25	33.83	30.66	28.32	28.82	31.89
AW (cm)	G1	2018/ 2019	50.24	49.83	50.14	51.19	41.60	40.76	40.48	42.05	42.98	42.14	41.29	43.21	40.29	38.64	37.50	40.48
	G2		49.40	49.48	49.79	50.36	41.26	40.24	39.64	41.76	42.48	41.48	41.17	42.38	39.88	38.00	36.98	40.02
	G3		49.93	48.69	48.67	49.88	40.62	40.02	38.81	41.43	41.93	41.07	40.95	41.86	39.52	37.74	36.88	39.88
	G1	2019/ 2020	47.69	46.79	46.62	47.86	39.60	38.00	37.14	39.17	38.36	37.88	37.67	38.83	36.74	36.43	35.60	37.14
	G2		47.31	46.21	46.05	47.52	38.98	37.24	36.76	38.60	38.10	37.24	36.79	38.38	36.43	36.21	35.29	36.95
	G3		46.93	45.76	45.74	47.07	38.57	37.10	36.36	38.29	37.62	36.67	35.95	38.00	36.31	35.95	34.76	36.67

Productivity of irrigation water (PIW) and water productivity (WP):

Data in Table 6 present the effect of irrigation treatments, weed control treatments and different genotypes on (PIW) and (WP). There are significant differences between irrigation treatments, weed control treatments and genotypes. The highest values of PIW and WP were found under I_2 irrigation treatment to be 2.01 and 2.39 kg m^{-3} respectively, while the lowest values were found under I_3 irrigation treatment to be 1.49 and 1.79 kg m^{-3} respectively, as the mean of 1st and 2nd seasons.

Irrigation treatments of I_2 increased PIW and WP by 21.8% and 12.5% respectively as the mean of both seasons compared to full irrigation treatment of I_1. These results agree with those obtained by Ali *et al.,* (2008); Sarkar *et al.,* (2013) and Zaman *et al.,* (2017); they indicated that water use efficiency and applied water productivity were higher in deficit irrigation treatments compared to full irrigation. This may be due to the reduction of the irrigation water input Zhang *et al.,* (2018).

Weed control treatment had a significant effect on PIW and WP, the values of PIW were taken the descending order $W_1 > W_2 > W_3 > W_4$, for the two studied seasons. Significant differences in PIW and WP values were recorded between the studied wheat genotypes, the highest values of PIW and WP were 1.86 and 2.28 kg m^{-3} respectively for G_2 (sakha95), while the lowest values of them were 1.56 and 1.95 kg m^{-3} respectively for G_3 (promising line) as an average of both seasons.

There are significant differences among different irrigation treatments, weed control treatments and different genotypes interaction on PIW and WP as shown in Table 7, the highest values of PIW and WP were found under $I_2 \times W_1 \times G_2$ and $I_2 \times W_2 \times G_2$ interactions to be 2.26 and 2.24 respectively for PIW and 2.73 and 2.66 kg m^{-3} respectively for WP, while the lowest values were obtained from $I_3 \times W_4 \times G_3$ interaction as mean of both seasons. Water productivity and productivity of irrigation water are present a good relation between irrigation grain yield, and water applied because they increase when grain yield increase and/or water applied decrease, (Ali *et al.,* 2007 and Mahmoud and Elsadany, 2017)

Table 6. Influence of irrigation treatments, weed control and wheat genotype on productivity of irrigation water and water productivity of wheat for both growing seasons.

Treatments	Irrigation parameters	PIW (kg m^{-3})		WP (kg m^{-3})	
	Seasons	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020
Irrigation treatments (I)	I1	1.64	1.66	2.21	2.04
	I2	1.98	2.03	2.48	2.3
	I3	1.39	1.59	1.77	1.81
	I4	1.68	1.83	2.19	2.15
	F test	**	**	**	**
	LSD at 0.05	0.019	0.02	0.032	0.029
Weed control treatments (W)	W1	1.79	1.87	2.33	2.19
	W2	1.73	1.82	2.25	2.16
	W3	1.66	1.78	2.17	2.09
	W4	1.5	1.65	1.89	1.85
	F test	**	**	**	**
	LSD at 0.05	0.039	0.012	0.043	0.019
Wheat Genotypes (G)	G1	1.73	1.8	2.2	2.05
	G2	1.83	1.89	2.36	2.2
	G3	1.47	1.65	1.93	1.97
	F test	**	**	**	**
	LSD at 0.05	0.017	0.019	0.027	0.021

Effect of irrigation treatments on studied wheat characters:

Data in Table 8 and 9 shows days to heading, days of maturity, Plant height (cm), number of spikes m^{-2}, number of kernels $spikes^{-1}$, 1000-kernel weight (g), biological yield (ton ha^{-1}), grain yield (ton ha^{-1}) and straw yield (ton ha^{-1}) as affected by irrigation treatments, weed management and some wheat genotypes. The irrigation treatment of I_1 recorded the highest values of all the studied characters compared to other irrigation treatments. They were taken the descending order $I_1 > I_2 > I_4 > I_3$ in the 1st and 2nd season. The best crop growth, thus the highest yield and its components may be due to better moisture availability, which maintained the internal water balance of the plant in the full irrigation compared to different deficit irrigation treatments (Rahim *et al.,* 2010).

Table 7. Influence of the interaction between irrigation treatments, weed control and wheat genotype on productivity of irrigation water and water productivity of wheat for both growing seasons

Irrigation treatments	Weed control	Genotypes	PIW ($kg\ m^{-3}$) 2018/2019	PIW ($kg\ m^{-3}$) 2019/2020	WP ($kg\ m^{-3}$) 2018/2019	WP ($kg\ m^{-3}$) 2019/2020
I_1	W 1	G_1	1.82	1.85	2.38	2.17
		G_2	1.89	1.92	2.55	2.33
		G_3	1.68	1.73	2.3	2.18
	W 2	G_1	1.61	1.67	2.18	2.01
		G_2	1.71	1.74	2.41	2.15
		G_3	1.65	1.63	2.4	2.08
	W 3	G_1	1.58	1.61	2.1	1.96
		G_2	1.62	1.72	2.25	2.19
		G_3	1.49	1.51	2.11	1.96
	W 4	G_1	1.53	1.56	1.92	1.8
		G_2	1.61	1.65	2.05	1.91
		G_3	1.42	1.43	1.87	1.69
I_2	W_1	G_1	2.05	2.06	2.52	2.38
		G_2	2.24	2.27	2.83	2.62
		G_3	1.95	1.89	2.45	2.24
	W_2	G_1	2.04	2.14	2.51	2.39
		G_2	2.21	2.26	2.7	2.62
		G_3	1.89	1.9	2.38	2.21
	W_3	G_1	1.97	2.09	2.51	2.35
		G_2	2.13	2.16	2.72	2.41
		G_3	1.85	1.94	2.33	2.18
	W_4	G_1	1.82	1.93	2.25	2.07
		G_2	1.97	1.99	2.45	2.18
		G_3	1.66	1.77	2.06	1.95
I_3	W_1	G_1	1.53	1.7	1.96	1.92
		G_2	1.68	1.73	2.17	1.99
		G_3	1.26	1.57	1.65	1.85
	W_2	G_1	1.51	1.65	1.93	1.84
		G_2	1.71	1.78	2.19	2.02
		G_3	1.13	1.47	1.46	1.7
	W_3	G_1	1.48	1.63	1.86	1.85
		G_2	1.58	1.69	2.02	1.92
		G_3	1.09	1.47	1.41	1.69
	W_4	G_1	1.33	1.51	1.62	1.65
		G_2	1.35	1.59	1.68	1.75
		G_3	1.03	1.35	1.29	1.51
I_4	W_1	G_1	1.9	1.96	2.5	2.2
		G_2	1.99	2.03	2.63	2.34
		G_3	1.53	1.76	2.02	2.08
	W_2	G_1	1.91	1.91	2.46	2.22
		G_2	2.01	1.95	2.59	2.4
		G_3	1.4	1.79	1.85	2.27
	W_3	G_1	1.87	1.84	2.4	2.18
		G_2	1.96	1.94	2.51	2.34
		G_3	1.32	1.73	1.81	2.08
	W_4	G_1	1.63	1.7	2.1	1.86
		G_2	1.53	1.78	1.97	2.05
		G_3	1.13	1.53	1.47	1.77
L.S.D			0.065	0.074	0.084	0.077

I_1-irrigation at the all stages (full irrigation), I_2-withholding irrigation at elongation stage, I_3- withholding irrigation at booting stage and I_4-withholding irrigation at anthesis stage. Weed control W_1-Gerostar + Action, W_2-Atlants, W_3-Hand weeding and W_4-control (without). Genotypes G_1-Giza 171, G_2-Sakha 95 and G_3-promising Line.

The highest grain yield was obtained from the full irrigation (I_1) with values of 8.13 and 7.81 ton ha^{-1} for the 1st and 2nd seasons respectively, while the lowest grain yield was found of I_3 (withholding irrigation at booting stage) with values of 5.83 and 5.99 ton ha^{-1} at 1st and 2nd seasons respectively as shown in Table 9. These results indicated that deficit irrigation negatively affected the grain yield of wheat in the two seasons of the experiments. Similar results were obtained by Badran and Moustafa (2014) and Mekki *et al.*, (2014). The reduction of grain yield under deficit irrigation of I_3 was 28% and 23%, whereas the reduction under I_4 was 20% and 15% in the first and second seasons respectively compared to I_1 treatment. This significant reduction may be due to deficit irrigation during moisture sensitive stages, tillering, booting and grain formation of wheat crop (Ali *et al.*, 2007).

The reduction of grain yield was ranged from 23% to 28% when irrigation was skipped at the booting and grain formation stage (Fahad *et al.*, 2019). A considerable wheat yield reduction happened due to water deficit during flowering and grain-filling stages, this may be due to accelerating leaf senescence, oxidative damage to photo-assimilatory machinery, assimilate translocation, and reduced grain set (Farooq *et al.*, 2014). The reduction of total dry matter in water stress treatments may be due to unstable plant-soil-water relations which led to decrease photosynthetic rate (Bashir *et al.*, 2017). Also, water shortage reduced nutrient availability and subsequently the photosynthesis process (Jazy *et al.*, 2007). Water stress at the late growth stage (grain formation) reduces the efficiency of transformation of accumulated dry matter into the economical yield of the plant (Ali *et al.*, 2007). Many studies showed that water deficit at the heading stage significantly decrease wheat yields and water deficit at the anthesis stage can negatively affect photosynthetic characteristics. (Tari, 2016)

Effect of weed control treatments on studied wheat characters:

Among weed control treatments as shown in Table 8 and 9. W_1 was recorded the highest values of yield and it`s components, as well as plant height and biological yield, this may be due to less crop-weed competition, which gave a better environment for the growth and development of wheat crop; in these treatments weed population and their growth was abstracted due to broad-spectrum activity. The lowest straw and grain yield were recorded in the W_4 treatment because of more weed growth and poor performance of yield attributing characters and straw yield of wheat. Weed control of W_2 treatment was statistically at par with W_3 treatment in the 1st and 2nd seasons with higher yield attributes. Similar results are in conformity with the findings of Pandey *et al.*, (2006).

Relative weed-free situation under weed control treatments reduced the crop weed competition and thus lead to higher vegetative growth and yield attributes and significantly affected the grain and straw yields of wheat (Verma *et al.*, 2008), while, W_4 treatment recorded the lowest values of grain and straw yields in the two seasons as shown in Table 9.

Effect of wheat genotypes on studied wheat characters:

The results in Table 8 and 9 showed the significant variations among the genotypes in yield and its components, biological yield, and straw yield, referring to the influence of the performance of the genotypes under the studied environments in order to identify the superior genotype for a suitable environment.

The highest grain yield was recorded in G_2 (sakha 95) with values 7.76 and 7.44 ton ha^{-1} while, the lowest one was in G_3 (promising line) with values of 6.23 and 6.47 ton ha^{-1} in the first and second season, respectively as shown in Table 9. These findings are agreeing with the findings of Abd El-Rahman, and Hammad (2014); Farhat, (2015) and El Hag-Dalia,(2017).

Interaction effect of different irrigation treatments, weed control and genotypes on grain yield over two seasons

Analysis of data revealed that the interaction between irrigation treatments, weed control and genotypes significantly affected grain yield as shown in Fig 1.

The highest grain yield was obtained with the interaction of $I_1 \times W_1 \times G_2$ and $I_2 \times W_1 \times G_2$, meanwhile the lowest grain yield was reported with the interaction of $I_3 \times W_4 \times G_3$. These results are in line with the findings of Bayoumi *et al.*, (2008) and Tesfay *et al.*, (2016), they found that skipping irrigation at different crop growth stages significantly affected wheat yield of different genotypes. The same results were reported by Shamsi (2010) and Bogale *et al* (2011) they reported that, there were significant differences among the varieties concerning deficit irrigation at any crop growth stage in terms of grain yield.

Higher yield attributes under these treatments may be due to less crop-weed competition, which gave a better environment for wheat crop growth and development of crop because in these treatments weed population and their growth was abstracted due to broad spectrum activity of mentioned weed control and reduced the associated weeds and thus reduced competition with the wheat crop on water, food, and light. The lowest grain yield was recorded in weed because of more weeds growth and poor performance of yield characters. Similar results were confirmed to the findings of Tesfay *et al.* (2016)

Relative weeds free situation under weed control treatments reduced the crop weeds competition, and thus lead to higher vegetative growth and yield components, significantly affected the grain and straw yield wheat Verma *et al.* (2008).

Interaction effect of different Irrigation treatments, weed control and genotypes on weeds dry weight

Data in Table 10 reveal that dry weight (gm^{-2}) of grassy, broad-leaved and total weeds were significantly affected by the interaction between irrigation, weed control and genotypes treatments.

The $I_2 \times W_1 \times G_3$ interaction recorded the lowest values of grassy and total weeds, while $I_3 \times W_1 \times G_3$ interaction recorded the lowest values of broad weeds. Similar results were in conformity with the findings of Tesfay *et al.* (2016).

Table 8. Mean of days to heading, days to maturity, plant height (cm), number of spikes m^{-2} and number of kernels $spikes^{-1}$ of wheat genotypes as affected by irrigation treatments and weed control in 2018/2019 and 2019/2020 seasons.

Treatments	Characters	Days to heading		Days to maturity		Plant height (cm)		Number of spikes m^{-2}		Number of kernels $spikes^{-1}$	
	seasons	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Irrigation treatments	I_1	92.00	101.64	140.06	149.33	107.44	123.61	406.60	482.50	65.65	50.82
	I_2	91.47	101.11	138.97	148.36	105.56	122.36	394.90	468.80	64.21	50.08
	I_3	90.44	99.58	136.06	145.88	101.86	119.06	341.90	393.10	58.52	46.62
	I_4	90.66	100.28	137.50	146.58	104.75	120.86	364.00	437.80	62.11	48.07
	F test	**	**	**	**	**	*	**	**	**	**
	LSD at 0.05	0.59	0.86	0.39	0.59	1.32	2.66	14.18	16.34	2.15	0.89
Weed control treatments (W)	W_1	91.83	101.78	138.78	148.31	107.50	123.75	401.00	481.30	64.09	50.51
	W_2	91.33	101.36	138.42	147.86	106.67	122.28	393.90	452.20	63.24	48.75
	W_3	90.94	99.92	137.92	147.22	103.78	120.64	363.90	432.40	62.15	48.39
	W_4	90.47	99.56	137.47	146.78	101.67	119.22	348.60	416.30	61.01	47.93
	F test	**	**	**	**	**	**	**	**	**	**
	LSD at 0.05	0.44	0.31	0.46	0.36	1.35	1.64	8.39	14.37	1.314	1.17
Wheat Genotypes (G)	G_1	91.96	100.21	139.81	145.21	105.46	121.96	378.60	449.70	63.66	49.16
	G_2	90.69	101.67	136.75	150.92	108.62	123.90	406.10	466.10	65.09	52.83
	G_3	90.79	100.08	137.80	146.50	100.62	118.56	345.90	420.80	59.12	44.70
	F test	**	**	**	**	**	**	**	**	**	**
	LSD at 0.05	0.28	0.28	0.29	0.29	1.43	1.22	9.40	8.45	1.00	0.83
Interactions	I×W	NS	NS	NS	NS	NS	NS	**	*	NS	NS
	I×G	NS	NS	**	**	NS	NS	NS	NS	NS	NS
	W×G	NS	**	NS	NS	NS	NS	NS	NS	NS	NS
	I×W×G	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 9. Mean of 1000-kernel weight (g), Biological yield (ton ha^{-1}), Grain yield (ton ha^{-1}) and Straw yield (ton ha^{-1}) of wheat genotypes as affected by irrigation treatments and weed control in 2018/2019 and 2019/2020 seasons.

Treatments	Characters	1000-kernel weight (g)		Biological yield (ton ha^{-1})		Grain yield (ton ha^{-1})		Straw yield (ton ha^{-1})	
	Seasons	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Irrigation treatments (I)	I_1	50.61	49.91	18.52	18.27	8.13	7.81	10.39	10.46
	I_2	49.72	49.10	17.91	17.84	8.07	7.72	9.84	10.12
	I_3	45.81	45.77	14.68	16.13	5.83	5.99	8.85	10.14
	I_4	47.29	47.24	16.07	16.97	6.53	6.62	9.54	10.35
	F test	**	**	**	**	**	**	**	**
	LSD at 0.05	1.23	0.95	0.175	0.161	0.109	0.094	0.129	0.191
Weed control treatments (W)	W_1	49.38	49.27	17.61	17.94	7.76	7.52	9.85	10.42
	W_2	49.18	48.15	17.08	17.52	7.31	7.13	9.77	10.39
	W_3	47.98	47.88	16.55	17.10	6.93	6.84	9.62	10.25
	W_4	46.90	46.71	15.94	16.64	6.56	6.64	9.38	10.00
	F test	**	**	**	**	**	**	**	**
	LSD at 0.05	0.90	0.76	0.21	0.11	0.10	0.08	0.255	0.149
Wheat Genotypes (G)	G_1	49.15	48.75	17.06	17.80	7.43	7.19	9.62	10.61
	G_2	50.49	50.78	18.32	18.35	7.76	7.44	10.56	10.90
	G_3	45.45	44.48	15.00	15.75	6.23	6.47	8.78	9.28
	F test	**	**	**	**	**	**	**	**
	LSD at 0.05	0.79	0.64	0.16	0.09	0.07	0.06	0.18	0.10
Interactions	I×W	NS	NS	**	**	*	**	*	**
	I×G	NS	NS	*	**	**	**	*	**
	W×G	NS	NS	**	**	**	*	**	**
	I×W×G	NS	NS	**	**	**	*	**	**

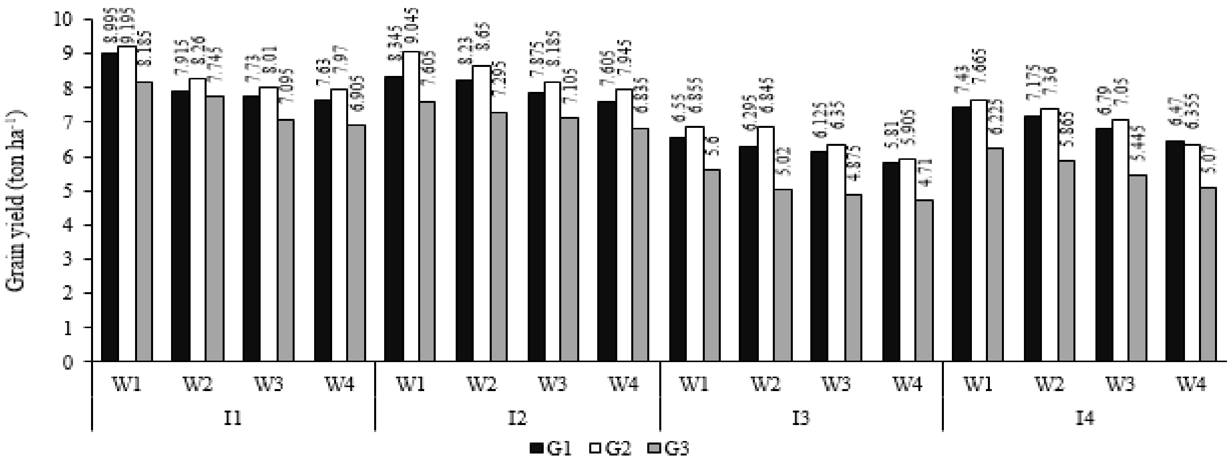

Fig. 1. Interaction effect of different irrigation treatments, weed control, and genotypes on grain yield as the mean of the two studied seasons.

Table 10. Interaction effect of irrigation treatments (I), weed control (W) and genotypes (G) on dry weight of the grassy, broad–leaved weeds and total weeds average two seasons.

Irrigation	Weed control	Genotypes	Grass weeds	Broad weeds	Total weeds
I 1	W 1	G_1	10.23	9.36	19.59
		G_2	10.30	9.29	19.59
		G_3	10.10	9.38	19.48
	W 2	G_1	12.07	10.93	22.99
		G_2	12.03	10.86	22.90
		G_3	12.00	11.04	23.04
	W 3	G_1	15.80	14.22	30.02
		G_2	15.80	14.18	29.98
		G_3	15.83	14.25	30.08
	W 4	G_1	52.67	46.98	99.65
		G_2	53.33	47.21	100.54
		G_3	53.13	47.54	100.67
I_2	W_1	G_1	10.13	9.20	19.33
		G_2	10.23	9.31	19.55
		G_3	5.57	9.43	14.99
	W_2	G_1	11.97	10.79	22.76
		G_2	12.09	10.95	23.04
		G_3	6.83	11.08	17.91
	W_3	G_1	15.70	14.13	29.83
		G_2	15.86	14.11	29.97
		G_3	8.77	14.28	23.05
	W_4	G_1	52.57	47.43	99.99
		G_2	53.09	46.92	100.01
		G_3	29.50	47.48	76.98
I_3	W_1	G_1	9.50	9.54	19.04
		G_2	9.50	9.33	18.83
		G_3	9.47	9.28	18.74
	W_2	G_1	11.50	11.21	22.71
		G_2	11.50	11.02	22.52
		G_3	11.67	10.94	22.61
	W_3	G_1	15.00	14.45	29.45
		G_2	13.80	14.27	28.07
		G_3	15.17	14.16	29.32
	W_4	G_1	50.67	48.05	98.72
		G_2	51.33	48.00	99.33
		G_3	51.13	47.49	98.62
I_4	W_1	G_1	7.07	9.39	16.46
		G_2	8.80	9.51	18.31
		G_3	7.23	9.30	16.54
	W_2	G_1	8.43	11.08	19.51
		G_2	10.70	11.21	21.91
		G_3	8.50	11.02	19.52
	W_3	G_1	11.00	14.33	25.33
		G_2	14.00	14.50	28.50
		G_3	11.17	14.32	25.49
	W_4	G_1	36.67	48.06	84.73
		G_2	47.33	48.64	95.97
		G_3	37.13	48.60	85.73
L.S,D			1.99	0.89	1.66

CONCLUSION

The highest grain yield was obtained from $I_1 \times W_1 \times G_2$ and $I_2 \times W_1 \times G_2$ without any significant differences among them, but it could be concluded that the application of $I_2 \times W_1 \times G_2$ interaction, achieved the highest values of WP and PIW to be 2.72 and 2.26 kg m^{-3}, respectively compared to all the studied treatments. Whereas this interaction saved about 12% and 17 % of CU and AW respectively compared to $I_1 \times W_1 \times G_2$ interaction as the mean of both seasons.

REFERENCES

Abd El-Rahman, M. E. and S.M. Hammad (2014). Evaluation of some bread wheat (*Triticum aestivum* L) genotypes under normal and reduced irrigation regimes. Minufiya J. Agric. Res. 39 (2): 711-721.

Ali, M.H.; Hoque M.R., Hassan A.A., and A. Khair (2007). Effects of deficit irrigation on yield, water productivity, and economic returns of wheat. Agric. water Manag 92:151-161.

Ali, M. H., M. R. Haque and M. A. Khair (2008). Effective management of water in wheat cultivation under water limiting condition. Proceedings of Paper Meet, Agril. Engg. Division, The Institute of Engineers, Bangladesh. Pp. 15-26.

Ali, M., Ali, L., Waqar M.Q. and M.A. Ali (2012). Bedplanting; A new crop establishment method for (*Triticum aestivum* L.). Int. J. Agric. Appl.Sci., 4(1): 834-841.

Almeselmani, M.; S.A. AL-Rzak; K. Al-Zubi, S. AL-Ghazali, F. Hareri, M. AL-Nassan, M.A. Ammar, O.Z. Kanbar, H. AL-Naseef, A. AL-Nator, A. AL-Gazawy and J.A.T. Da Silva (2015). Evaluation of physiological traits, yield and yield components at two growth stages in 10 durum wheat lines grown under rainfed conditions in Southern Syria. Cercetări Agronomice in Moldova. 2(162): 29-49.

Badawi, M.I. and M.E.Z. Kenapar (2017). Roles of planting methods, irrigation techniques and weed control treatments in wheat crop performance, associated weeds and water productivity. J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (8): 371-381.

Badran, A.E. and E.S.A. Mustafa (2014). Drought Resistance Indices and Path Analysis in Some Wheat Genotypes. World Applied Sci. J., 30: 1870-1876.

Bashir, M.U., S. A. Wajid, A.Ahmad, M. Awais, M. A.S. Raza, G. M. Tahir, U. Saeed, M.H. Ur Rehman, M. Waqas and S. Abbas (2017). Rrigation scheduling of wheat at different Nitrogen levels in semi-arid region Turk J Field Crops, 22(1), 63-70.

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

Black C.A. (1965) Methods of Soil Analysis: 2 Parts. American Society of Agronomy.

Bogale, A., Tesfaye K. and T. Geleto (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.

Bukhat, N.M. (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.

Du, T.; S. Kang, J. Sun, X. Zhang and J. Zhang. (2010). An improved water use efficiency of cereals under temporal and spatial deficit irrigation in north China. Agric. Water Management. 97: 66-74.

Early, A.C., 1975. Irrigation Scheduling for Wheat in the Punjab. CENTO Scientific Programme on the Optimum Use of Water in Agriculture: Report No. 17. CENTO, Lyllpur, Pakistan, pp. 115–127.

El Hag-Dalia, A. A. (2017). Effect of irrigation number on yield and yield components of some bread wheat cultivars in North Nile Delta of Egypt. Egypt. J. Agron. Vol. 39, (2):137-146.

Fahad, M., S.A. Wajid, A. Ahmad and M.J.M. Cheema (2019). Response of wheat cultivars to deficit irrigation under semiarid conditions of Faisalabad. Intl. J. Agric. Biol., 21: 1004-1012.

Farhat, W. Z. E. (2015). Response of 21 spring bread wheat genotypes to normal and reduced irrigation in North Delta. J. of Plant Production, Mansoura Univ., Vol. 6 (6): 943-963.

Farooq, M., Mubshar, H., and Kadambot, H. M. S. (2014). Drought stress in wheat during flowering and grain-filling periods. Crit. Rev. Plant Sci. 33, 331-349.

Gao, Y., Y. Linlin, X. Shen, X. Li, J. Sun, A. Duan and L. Wu. (2014). Winter wheat with subsurface drip irrigation (SDI): Crop coefficients, water-use estimates, and effects of SDI on grain yield and water use efficiency. Agricultural Water Management, (146): 1-10.

Gomez, K.A. and Gomez A.A. (1984). Statistical Procedures for Agricultural Research. John Wiely and Sons. Inc, New York.

Imran, M., A. Ul-Hassan, M. Iqbal, E. Ullah and J. Šimunek (2015). Assessment of actual evapotranspiration and yield of wheat under different irrigation regimes with potassium application. Soil Environ. 34(2): 156-165.

Israelsen, O.W. and V.E. Hansen (1962). Irrigation Principles and Practices 3rd Edit. John Willey and Sons. Inc., New York.

James, L.G. (1988). Principles of farm irrigation system design. John Wil-ley&Sons (ed.), New Yourk, pp.543.

Jat, M.L.; Pal S.S.; Singh R.; Singh D. and M.S. Gill (2008). Effect of moisture regimes and nitrogen management options on crop and water productivity and nitrogen-use efficiency in maize and wheat cropping system. Ind. J. Agric. Sci.78 (10):881-883.

Jazy, H.D., M.R. Poor, H.H. Abad and A. Soleimani. (2007). Growth indices of winter wheat as affected by irrigation regimes under Iran conditions. Pak. J. Bio. Sci. 10 (24): 4495-9.

Klute, A. (1986). Methods of soil analy-sis, part 1: physical and Miner-alogical methods (2nd) Ed Ameri-can Soci. of Agronomy, Madison, Wisconsin, USA.

Mark, T. and B. Antony (2005). Abiotic stress tolerance in grasses from model plants to crop plants. Plant Physiol. 137: 79 1-793.

Mekki, M.E.R., E. Haggan and E.A.M. El Haggag (2014). Effect of different irrigation regimes on grain yield and quality of some Egyptian bread wheat cultivars. J. Agri. Food and Appl. Sci., 2: 275-282.

Mohamed, A.A.A. and E.A. Abo-Marzoka (2017). Effects of some antioxidant materials as a foliar and water deficit stress at identify growth stages on productivity of wheat crop. J. Plant Production, Mansoura Univ., 8(3) :353-360.

Novica, V., 1979. Irrigation of Agriculture Crops. Faculty of Agriculture Press, Novi Sad, Yugoslavia.

Page A.L., Miller R.H. and D.R. Keeney (1982). Methods of Soil Analysis -Chemical and Microbiological Properties. Madison, Wisconsin.

Pandey, A.K.; Gopinath A.K. and H.S. Gupta (2006). Evaluation of sulfosulfuron and metribuzin for weed control in irrigated wheat. Ind. J. Agron. 51 (2): 135-138.

Rahim, R.; Rahamtullah M.A. and A.E. Waraich (2010). Effect of phosphorus application and irrigation scheduling on wheat yield and phosphorus use efficiency. Soil and Env. 29(1):15-22.

Saeed, U., S.A. Wajid, T. Khaliq and Z.A. Zahir (2017). Optimizing irrigation and nitrogen for wheat through empirical modeling under semi-arid environment. Environ. Sci. Pollut. Res., 24: 11663-11676.

Sarkar, P.K., M.S.U. Talukder, S.K. Biswas and A. Khatun (2013). Growth and yield of wheat (Triticum aestivum) under deficit irrigation. Bangladesh J. Agril. Res. 38(4): 719-732.

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.

Steel, R.G.D., Torrie J.H. and D.A. Dicky (1997). Principle and procedure of statistics-A Biometrical Approach 3 rd Ed. McGraw Hill Book International Co., Singapore 204-227.

Tari, A.F. (2016). The effects of different deficit irrigation strategies on yield, quality, and water-use efficiencies of wheat under semi-arid conditions. Agricultural Water Management 167:1-10.

Tesfay, A.; Cherukuri V.R. and T. Zeki (2016). Productivity, Yield Attributes and Weed Control in Wheat (*Triticum aestivum L.*) as Influenced by Integrated Weed Management in High Lands of Ethiopia, Adv. Crop Sci. Tech, 4:1 DOI: 10.4172/2329 8863.1000206.

Verma, S.K., Singh S.B., Rai O.P., Sharma R. and G. Singh (2008). Effect of cultivars and herbicides on yield and nutrient uptake by weed and wheat under zero-tillage system. Ind. J. Agric. Sci. 78(11): 985-989.

Vomocil JA (1957) Measurement of soil bulk density and penetrability: a review of methods. Adv Agron 9:159-175.

Zaman, R., A.R. Akanda, S.K. Biswas and M.R. Islam (2017). Effect of deficit irrigation on raised bed wheat cultivation. Cercetări Agronomice in Moldova. 4 (172): 17-28.

Zhang, M.M., Dong, B.D., Qiao, Y.Z., Shi, C.H., Yang, H. and Y.K. Wang (2018). Yield and water use responses of winter wheat to irrigation and nitrogen application in the North China Plain. Journal of Integrative Agriculture 17: 1194-1206.

تأثير نقص الري ومعاملات مكافحة الحشائش علي محصول الحبوب وانتاجية المياه لثلاثة تراكيب وراثية من قمح الخبز

محمد سعيد جنيدي[1]، علي علي شرشر[2]، أنس محمد صفاء الدين شرشر[1]*، محمود محمد عبدالله[3] وهدي السيد العربى إبراهيم[4]

[1]قسم بحوث القمح - معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة - مصر

[2]المعمل المركزي لبحوث الحشائش مركز البحوث الزراعية – الجيزة – مصر

[3]قسم بحوث المقننات المائية والرى الحقلى - معهد بحوث الأراضى والمياه والبيئة - مركز البحوث الزراعية - الجيزة

[4]المعمل المركزي للتصميم والتحليل الاحصائي مركز البحوث الزراعية – الجيزة – مصر

أجريت تجربة حقلية خلال موسمي الزراعه 2019/2018 و2020/2019 في محطة البحوث الزراعية بسخا بمحافظة كفر الشيخ وذلك بهدف دراسة تأثير نقص الري ومكافحة الحشائش على المحصول وانتاجية المياة لثلاث تراكيب وراثية من قمح الخبز. كان التصميم المستخدم هو الشرائح المنشقة في ثلاثة مكررات، حيث وزعت معاملات الري فى الشرائح الراسية و كانت: I_1 (الرى الكامل) ،بينما I_2 و I_3 و I_4 معاملات نقص الرى من خلال حرمان رية واحدة فقط فى مرحلة الإستطالة و إمتلاء السنابل و التزهير على الترتيب ،فى حين وزعت فى الشرائح الافقية أربعة معاملات لمكافحة الحشائش وهى W_1 (Gerostar + Action)، W_2 (Atlants)، W_3 (مكافحة الحشائش يدويًا مرتين)، W_4 (بدون مكافحه) ، أما القطع المنشقة الفرعية فكانت لثلاثة تراكيب وراثية من قمح الخبز وهى G_1 (صنف جيزة 171) ، G_2 (صنف سخا 95) و G_3 (سلاله مبشره). أظهرت النتائج ان أعلى قيم لطول النبات، عدد السنابل /م2، عدد الحبوب/السنابله، وزن 1000 حبة، المحصول البيولوجي ومحصول القش ومحصول الحبوب وجدت للمعاملة I_1 مقارنة بباقى معاملات الرى وكذلك للمعاملة W_1 مقارنة بباقى معاملات مكافحة الحشائش وايضا عند G_2 مقارنة بباقى التراكيب الوراثية خلال موسمى الزراعة. لقد سجلت أعلى قيم للاستهلاك المائى وكمية المياه المضافة بعد معاملة الرى I_1 حيث كانت 37.67 و 48.26 سم على الترتيب وانخفضت كمية مياه المضافة بعد المعاملات I_2 و I_3, و I_4 ب 18.5 % و 17.6 % و 22.3% مقارنة بمعاملة الري I_1 كمتوسط لموسمى الزراعة . أخذت قيم انتاجية مياه الرى و انتاجية المياه الترتيب التنازلى التالى $W_1 > W_2 > W_3 > W_4$ و $G_2 > G_1 > G_3$ لمعاملات مكافحة الحشائش والتراكيب الوراثية على الترتيب. وبالتالي يمكن التوصية بتطبيق التفاعل $I_2 \times W_1 \times G_2$ حيث انه سجل أعلى قيم لانتاجية الحبوب وانتاجية مياه الرى وانتاجية المياة بالاضافة الى توفير مياه الرى.