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Article

Determination of Wheat Growth, Crop Coefficient (Kc) and Water Stress Coefficient (Ks) under Different Salinity

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Abstract: A field experiment was conducted for determination of crop coefficient (KC) and water stress coefficient (Ks) for wheat crop under different salinity levels, during 2015-16. Complete randomized block design of five treatments were considered, i.e., 0.51 dS/m (fresh water) as a control treatment and other four saline water treatments (4, 6, 8 and 10 dS/m), for S1, S2, S3 and S4 with three replications. The results revealed that the water consumed by plants during the different crop growth stages follows the order of FW>S1>S2>S3>S4 salinity levels. According to the obtained results, the calculated values of crop coefficients significantly differed from those suggested by FAO No.56 for the crops. The Ks values clearly differ from one stage to another because the salt stress causes both osmotic stress, due to a decrease in the soil water potential, and ionic stress which the average values of water stress coefficient (Ks) follows this order; FW(1.0)=S1(1.0)>S2(1.0)>S3(0.93)>S4(0.82). Overall, it was found the differences are attributed primarily to specific cultivar, the changes in local climatic conditions and seasonal differences in crop growth patterns. Thus, further studies are essential to determine the crop coefficient values under different variables, to make the best management practice (BMP) in agriculture.

Keywords: crop coefficient; evapotranspiration; salinity; wheat crop

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1. Introduction

The amount of water required to compensate the evapotranspiration loss from the cropped field is defined as crop water requirement. Although the values for crop evapotranspiration and crop water requirement are identical, crop water requirement refers to the amount of water that needs to be supplied, while crop evapotranspiration refers to the amount of water that is lost through evapotranspiration. The irrigation water requirement basically represents the difference between the crop water requirement and effective precipitation. The irrigation water requirement includes additional water for leaching of salts and to compensate for non-uniformity of water application [1]. Crop water requirement is an important practical consideration for improved crop water productivity. Crop water requirements vary during the growing stages, mainly due to variation in crop canopy and climatic conditions, and are governed by crop evapotranspiration [2].

The crop coefficient (KC) based estimation of crop evapotranspiration (ETC) is one of the most commonly used methods for irrigation water management at the field scale. Crop evapotranspiration (ETC) can be calculated using the Kc defined as the ratio of crop evapotranspiration to some reference evapotranspiration (ETo) defined by weather data [1]. In this framework, KC values are specific to each crop (and to the method used for ETo) and have traditionally been derived from data sets, where

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measured ETC for a well-watered crop is divided by a standard reference ETo (usually grass, but sometimes alfalfa and, most recently, not crop-specific, but only a tall or short crop. The crop coefficients representative of well watered conditions are tabulated for the practical purpose of crop water management among engineers, farmers and irrigation managers [1]. During the crop growing season, the value of KC for most agricultural crops increases from a minimum value at emergence, in relation to changes in canopy development, until a maximum KC is reached at about full canopy cover. A crop coefficient curve is the seasonal distribution of KC, often expressed as a smooth continuous function in time or some other time-related index. The KC tends to decline at a point after a full cover is reached in the crop season. The declination extent primarily depends on the particular crop growth characteristics and the irrigation management during the late season [1].

[3] Evaluated maize growth-stage-specific Coefficients using Weighing Lysimeter. The results revealed that, the measured KC values were different up to some extent from the FAO reported values.

Apart from this, availability of adequate good quality water is one of the most important inputs in successful crop production and sustainability. A complementary and more permanent approach to minimizing deleterious effects of soil and water salinity is to develop crops that can grow and produce economically sufficient yields under saline conditions [4, 5]. In this sense, extensive areas in Iran have arid and semi-arid conditions and severe problems of salinization due to poor drainage, mineral weathering or irrigation with low water quality. The knowledge of the crop coefficient in the regions of salt affected soils may help improve agriculture management practices. In this respect, a field experiment was conducted for determination of water stress coefficient (Ks) and KC for wheat under different salinity in the semi-arid environment. Thus, the objectives of study were:

1- Determination of the actual water consumptive use of wheat crop under tape irrigation system saline and non-saline water.
2- Determination of crop coefficient (KC) and water stress coefficient (Ks) for wheat plant through the plant growth stages under different salinity levels.

2. Materials and Methods

2.1 Site description

A field experiment was conducted in the Farm of Soil and Water Research Department, Kashmar Higher Education Institute, located at Kashmar city, north-east of Iran. The latitude and longitude of the experiment site are 30° 24′ N, 31° 35′ E, respectively, while the altitude is 1180 m above the mean sea level. Complete randomized block design (CRBD) of five treatments with three replications were used for wheat crop. The experimental plot area was 2 m × 1.5 m under T-Tape irrigation system. The meteorological data recorded by the synoptic weather station which located approximately 300 m away from the experimental site. The measured weather parameters used in this study were the maximum and the minimum temperature, precipitation, wind speed, relative humidity, solar radiation and sun shine hours.

2.2 Soil propertice

Total soluble salts, soil reaction (pH), and soluble cations and anions were done in the saturation soil paste extract according to [6] as following:

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Calcium (Ca^{2+}) and magnesium (Mg^{2+}) were determined by titration with EDTA, with versenate method using ammonium perpurate as an indicator for calcium and Eriochrome Black T as an indicator for calcium and magnesium. Sodium (Na^{+}) and potassium (K^{+}) was determined photo-metrically using flame photometer. Also, Carbonate (CO_3^-) and bicarbonate (HCO_3^-) were determined volumetrically by titration with a standard solution of sulfuric acid (H_2SO_4), using phenolphthalein and methyl-orange as indicator for each element, respectively. Morover, Chloride (Cl) was determined by titration with standard $AgNO_3$. Some chemical characteristics of the soil under investigation are given in Tables (1).

Table (1). Some chemical characteristics of the experimental soil.

Depth (cm)	pH	ECe (dS/m)	Soluble anions (meq/l)			Soluble cations (meq/l)			
			Cl	HCO_3^-	SO_4	Ca	Mg	Na	K
0-20	8.46	0.58	2.2	2.88	0.12	1.51	0.87	2.62	0.25
20-40	8.41	0.55	2.25	2.83	0.25	1.47	0.94	2.47	0.55
40-60	8.57	0.52	2.01	2.89	0.15	1.54	1.14	1.91	0.47
60-80	8.62	0.52	2.0	2.87	0.28	1.40	1.38	1.84	0.33

2.3 Agronomy practices

Wheat crop (Triticum astivum L.) variety Pishtaz was cultivated on December 18, 2015 and harvested at May 26, 2016. The amount of seeds required was 160 kg seed per ha. The seeds planted with space of 5 cm within rows and 15 cm between rows. The field was fertilized at plowing with superphosphate (15%) and potassium sulfate (48%) at the equivalent rate of 80 and 100 kg per ha, respectively. The N fertilizer was applied with three split doses with one-third given as basal, one-third at 30days after sowing (DAS) and the remaining at 90 DAS of the crop.

Five different irrigation water salinities, i.e., 0.51 dS/m (fresh water) as a control treatment and other four saline water treatments (4, 6, 8 and 10 dS/m), for S1, S2, S3 and S4, respectively, were used for this research. The saline water was prepared by mixing fresh water with Sodium Chloride salt at a certain ratios. Some chemical characteristics of the used irrigation water through wheat season are shown in Table (2).

Table (2). Some chemical characteristics of the used irrigation water.

Treatment	pH	ECw	Soluble anions (meq/l)			Soluble cations (meq/l)			
			Cl	HCO_3	SO_4	Ca	Mg	Na	K
FW	7.52	0.5	1.43	1.25	0.03	1.12	1.23	0.27	0.09
S1	8.23	4	28.8	3.4	4.78	4.25	8.4	22.8	1.02
S2	8.38	6	40.1	3.2	8.9	3.68	17.6	30.7	1.28
S3	8.42	8	61.5	2.8	11.2	4.79	22.3	45.6	1.48
S4	8.27	10	88.3	3.1	10.8	6.27	27.5	66.3	1.74

Irrigation water was applied based on the 50 percent moisture depletion (MAD: 50%) of field capacity (FC) for all irrigation treatments. This amount was scheduled throughout the growth season and calculated according to the values of the recommended crop coefficient (KC) as well as the period of each stage.

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2.4 Estimation of reference evapotranspiration (ETo)

Reference crop evapotranspiration (ETo) was estimated by Penman-Monteith equation [1] as follows using Eq. (1):

$$ET_O = \frac{0.408\Delta\left(Rn - G\right) + \gamma\left(\frac{900}{T+273}\right)U_2\left(e_s - e_a\right)}{\Delta + \gamma\left(1 + 0.34\,U_2\right)} \quad (1)$$

Where:

ETo: Reference evapotranspiration (mm/day), Δ: Slope vapor pressure curve (kPa/°C), Rn: Net radiation at the crop surface (MJ/m^{2}day), G: Soil heat flux density (MJ/m^{2}day), T: Air temperature at 2 m height (°C), es: Saturation vapor pressure (kPa), ea: Actual vapor pressure (kPa), es-ea: Saturation vapor pressure deficit (kPa), U_2: Wind speed at 2 m height (m/s), γ: Psychometric constant (kPa/°C). Therefore, The CROPWAT v.8.0 software was used to compute the mean 10-day values for the reference evapotranspiration (ETo).

2.5 Calculation of crop evapotranspiration (ETC)

There are two methods to estimate ETC, one under standard conditions (Fresh water) and the other for nonstandard conditions (Saline water).

2.6 Crop evapotranspiration under standard conditions (ETC)

The crop evapotranspiration under standard conditions, denoted as ETC, is the evapotranspiration from disease-free, well-fertilized crops, grown in large fields, under optimum soil water conditions and achieving full production under the given climatic conditions, is given by Eq. (2):

$$ETC = KC \times ETo \quad (2)$$

Where:

ETC: Crop evapotranspiration under standard conditions (mm/day), KC: Single crop coefficient (dimensionless), and ETo: Reference crop evapotranspiration (mm/day).

2.7 Crop evapotranspiration under nonstandard conditions (ETC_{adj})

The crop evapotranspiration under nonstandard conditions (ETC_{adj}) is the evapotranspiration from crops grown under management and environmental conditions that differ from the standard conditions. The crop evapotranspiration under nonstandard conditions is calculated by using a water stress coefficient Ks and/or by adjusting KC for all kinds of other stresses and environmental constraints on crop evapotranspiration (ETC), where the effect of water stress (Ks) is incorporated into (KC) as:

$$ETC_{adj} = Ks \times KC \times ETo \quad (3)$$

Where:

ETC_{adj}: Crop evapotranspiration under nonstandard conditions (mm/day), Ks: Water stress coefficient (dimensionless), KC: Single crop coefficient (dimensionless), and ETo: Reference crop

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evapotranspiration (mm/day).

2.8 Water stress coefficient (Ks)

Water stress coefficient (Ks) describes the effect of water stress on crop transpiration. When salinity stress occurs without water stress, for these conditions ($EC_e > EC_t$ threshold), soil water depletion is less than the readily available soil water (Dr<RAW), the Ks Calculated by Eq. (4):

$$K_S = 1 - \frac{b}{100 K_y}\left(EC_e - EC_t\right) \tag{4}$$

Where:

ECe: Mean electrical conductivity of the saturation extract for the root zone (dS/m), EC_t: Electrical conductivity of the saturation extract at the threshold of ECe when crop yield first reduces below Ym (dS/m), b: Reduction in yield per increase in ECe (% /(dS/m)), Ky: A yield response factor, Dr: Root zone depletion (mm), RAW: The readily available soil water in the root zone (mm), and Ym: Maximum expected yield when $EC_e < EC_t$ threshold (kg/ha).

2.9 Actual evapotranspiration (ETa)

Soil moisture content through the soil profile was determined using TDR (Time Domain Reflector meter). Measures were determined immediately before irrigation and one hour after irrigation. The soil moisture reading using TDR was recorded every 20 cm from soil surface up to 80 cm depth. The daily and seasonal evapotranspiration of wheat plant were calculated under all irrigation water treatments.

3. Results and Discussion

3.1 Reference evapotranspiration (ETo)

Table (3) shows values of reference crop evapotranspiration through the growth stages of wheat season. The values of ETo through growth season indicate that it is lowest with the beginning of season and increased till harvesting time. This may be due to the changes in the climatologically norms of the area, as the cultivation starts with both relatively low temperature and solar radiation and ended by high of it was. The total reference evapotranspiration value during the growth season of wheat was 514 mm.

Table (3) Values of reference crop evapotranspiration for all growth stages of wheat season (2015/2016).

Growth stages	Initial	Development	Mid-season	Late	Total
Duration (day)	20	57	58	25	160
mm/stage	42	137	230	105	514
m^3/ ha	420	1370	2300	1050	5140

3.2 Actual evapotranspiration (ETa)

Data in Table (4) show the actual evapotranspiration values for wheat crop. The obtained results indicate that the irrigation water salinity affects mainly the plant consumptive use i.e. the actual

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evapotranspiration (ETa). It is obvious that the total amount of the actual evapotranspiration (ETa) of plants irrigated with fresh water (FW) is higher (491 mm/season) compared with that of saline water irrigated once, where it was 483, 470.5, 460 and 451 (mm/season) for S1, S2, S3 and S4 salinity levels, respectively. This finding is in agreement with that obtained by Bhantana and Lazarovitch (2010); they found that the daily ET of pomegranate plants was significantly lower under saline water irrigation than under fresh water irrigation. Irrigation with saline water was significantly lower than that of fresh water (FW) irrigated once.

Table (4). The average seasonal ETa values of wheat plants grown under different irrigation water salinity.

Treat ment	Growth stages								
	Initial		Development		Mid-season		Late		Total
	mm/day	mm	mm/day	mm	mm/day	mm	mm/day	mm	mm
FW	1.25	25.0	2.32	132.3	4.20	243.6	3.60	90	490.9
S1	1.23	24.6	2.24	127.7	4.21	244.2	3.45	86.3	482.8
S2	1.20	24.0	2.10	119.8	4.18	242.4	3.37	84.3	470.5
S3	1.18	23.6	2.03	115.7	4.10	237.8	3.32	83.0	460.1
S4	1.14	22.8	1.95	111.2	4.08	236.6	3.21	80.3	450.9

Referring to the effect of irrigation water salinity on the water consumptive use, the data in Table (6) reveal that the water consumed by plants during the different periods of plant growth follows the order of FW>S1>S2>S3>S4 salinity levels. Irrigation water salinity affects the actual evapotranspiration, depends on the amount of water in the soil profile, soil physical properties and land cover characteristics [7, 8].
From the data presented in Table (4), it could be found that the mean values of seasonal actual crop evapotranspiration (ETa) of wheat crop varied with the variation of irrigation water salinity, plant growth stage and the changing in climatic conditions. At the initial stage, the average daily ETa was lower than other growth stages; it was 1.25, 1.23, 1.20, 1.18 and 1.14 mm/day for S1, S2, S3 and S4, respectively. Subsequently, ETa was increased to reach maximum value at mid-season stage, where it was 4.20, 4.21, 4.18, 4.1 and 4.08 mm/day for S1, S2, S3 and S4, respectively. Then, at the end of season it was decreased. This is in agreement with the finding of Doorenbos and Pruitt [9], reported the water consumptive use increases with the progress in plant growth and reaches a peak during some part of the plant growth period, depending on the plant type, growth characteristics and the environmental conditions, and then tapers off till harvest time.

3.3 Crop coefficient (KC)

The calculated crop coefficients (KC), derived from ETo and ETC or ETa. At the initial stage of the plant (at the beginning to 22 days after sowing), KC values were 0.59, 0.58, 0.0.57, 0.56 and 0.54 for FW, S1, S2, S3 and S4, respectively. According to [10], this value is a function of the frequency of irrigation and the evaporative power of atmosphere (ETo). Also KC values at the vegetative growth stage (development: 57 days after end of initial stage) which is a dynamic growth period the KC value increased to 0.96, 0.93, 0.87, 0.84 and 0.81 for FW, S1, S2, S3 and S4, respectively. Subsequently, at the beginning of the mid-season stage (flowering and seed filling period: 58 days after end of development stage) the KC values increased to a maximum of about 1.06, 1.06, 1.05, 1.03 and 1.03 for

FW, S1, S2, S3 and S4, respectively. KC values for mid season in cereals are generally higher than those observed in development stage [1, 11]. Low KC values mean reduced water requirements than that occurred from evapotranspiration of wheat, generally, less than that of cereals. Finally, during the late season (from end of mild-stage till harvest: 60 days), the KC decreased and reached a value of 0.86, 0.82, 0.80, 0.79 and 0.76 for FW, S1, S2, S3 and S4, respectively. Figure (1) and Table (5) shows that the average crop coefficient of wheat plants for four stages of growth season as affected by irrigation water salinity. The average calculated KC values clearly differ from the average KC values of FAO No.56 during all stages, in the initial and development stage the average calculated KC values for FW, S1, S2, S3 and S4, were more than the average KC values suggested by FAO No.56; the opposite observations were found in mid-season and late stages, the average calculated KC values for FW, S1, S2, S3 and S4 lower and more than the average KC values suggested by FAO No.56, respectively.

Table (5) Crop coefficient (KC) of the four growth stages of wheat plants as affected by irrigation water salinity compared with KC values suggested by the FAO No.56.

Growth stages	Initial	Development	Mid-season	Late
Period (day)	22	57	58	25
KC (FAO, No.56)	0.4	0.8	1.2	0.7
FW	0.59	0.96	1.06	0.86
S1	0.58	0.93	1.06	0.82
S2	0.57	0.87	1.05	0.80
S3	0.56	0.84	1.03	0.79
S4	0.54	0.81	1.03	0.76

According to the obtained results in this study, the calculated values of crop coefficients differed from values suggested by FAO No.56 for the crops estimated. Where it was found to be lower the differences are attributed primarily to specific cultivar, the changes in local climatic conditions, and seasonal differences in crop growth patterns. A researcher reported that the KC values can be different from one region to other [12]. It is assumed that the different environmental conditions between regions allow variation in variety selection and crop developmental stage which affect KC [1].

Such differences obviously reflect the difficulty not only in extrapolating crop coefficients to other environments, but also in applying crop coefficients in individual year with differing crop development patterns. [13] Reported that the values of KC for most agricultural crops increase from a minimum value at planting until a maximum KC is reached at about full canopy cover. The KC tends to decline at a point after a full cover is reached in the crop season.

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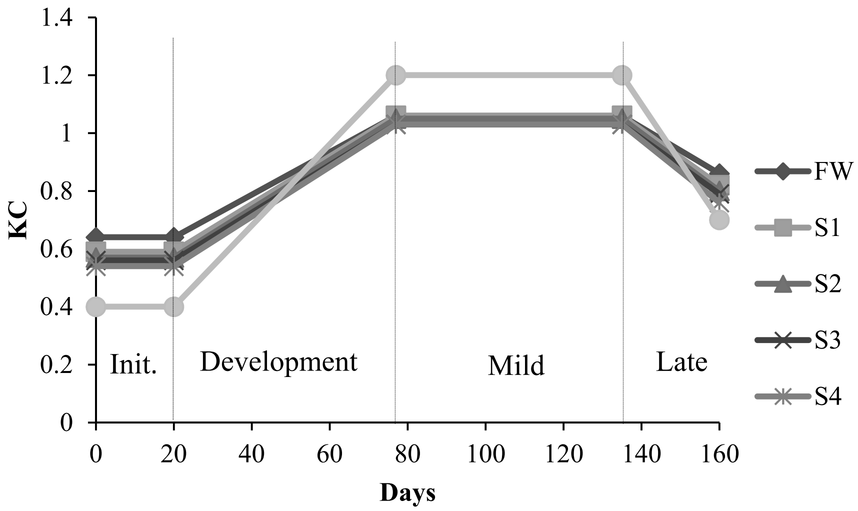

Figure 1. Crop coefficient of wheat growth periods as affected by saline water

3.4 Water stress coefficient (Ks)

Table (6) indicates the mean values of soil electrical conductivity in the root zone from 0 – 30 cm; it was used to calculate the water stress coefficient (Ks). Table (6) illustrates water stress coefficient (Ks) of wheat for the four growth stages under irrigation treatments. The Ks values clearly differ from one stage to another because the salt stress causes both osmotic stress, due to a decrease in the soil water potential, and ionic stress, due to toxicity caused by high concentrations of certain ions within the plant [14]. During the initial stage, the Ks values close to 1.00 for FW, S1, S2 and S3 that is mean that the root zone salinity (ECe) did not reach to ECe threshold value for wheat (6 dS/m) [10], but a moderate effect appears for S4 with Ks (0.83). It can be stated that, soil texture may play an important role in this respect beside the effect of salt accumulation in the root zone in this stage. The accumulation of solutes may allow plants to maintain a positive pressure potential, which is required to keep stomata open and to sustain gas exchange and growth [15]. Meanwhile, development stage, the data in Table (7) demonstrates the same values; the Ks values were identical (1.00) for FW, S1, S2 and S3 but the Ks value was amounting of 0.88 for S4. However, during the mid-season stage the influence of soil salinity (ECe) in the root zone were obtained especially for S2, S3 and S4, with Ks, 1.00, 0.93 and 0.81, respectively. At the end stage, the Ks values were 1.00, 1.00, 1.00, 0.81 and 0.78 for FW, S1, S2, S3 and S4, respectively; the direct increase in salt accumulation as well as the irrigation with saline water had reduced the Ks values. Generally, the average values of water stress coefficient (Ks) follows this order; FW (1.00) = S1 (1.0) =S2 (1.0)>S3 (0.93)>S4 (0.82).

Table (6): Electrical conductivity ECe (dS/m) in the root zone of wheat plants.

Growth stages	Initial	Development	Mid-season	Late
Days after sowing	20	77	135	160
FW	0.56	0.48	0.62	0.88
S1	1.4	1.38	2.1	3.18
S2	3.05	3.55	4.14	4.57
S3	4.53	5.65	6.48	6.71
S4	6.47	6.91	7.31	7.56

Table (7). Water stress coefficient (Ks) for the four growth stages of wheat under irrigation with saline water.

Growth stages	Initial	Development	Mid-season	Late
Period (d)	20	57	58	25
FW	1.00	1.00	1.00	1.00
S1	1.00	1.00	1.00	1.00
S2	1.00	1.00	1.00	1.00
S3	1.00	1.00	0.93	0.81
S4	0.83	0.88	0.81	0.78

[16] mentioned that the soil water stress coefficient (Ks) values of wheat, at the early of the growing season (4 weeks after sowing), the values of Ks = 1, i.e. the soil water deficit is less than the readily available water of the root zone and it decrease gradually until rainfall or irrigation are applied to the root zone. The diminution of Ks values may be attributed to the increase in water depletion at the root zone through the removal of water by ET and percolation losses that induced stress condition. Again, by the addition of water to the root zone through irrigation and rainfall, the root zone depletion decrease and Ks becomes increased as evidenced by the increase of Ks values on 7 and 13 weeks after sowing and on 9 weeks after sowing, it is also noticed that Ks values increase slightly at the end of growth period due to capillary contribution from ground water.

3.5 Wheat crop production

As for the effect of irrigation water salinity on wheat yield, data indicate that with less stressed condition (FW) treatment, wheat yield increased compared with the other salinity treatments. Table 10 illustrates the yield of wheat plants cultivated under T-Tape irrigation system as affected by different irrigation water salinity. The total yield varied between 3.54 to5.06 ton/ha. The highest yield was obtained, when using fresh water (FW) which represents nearly non-stressed conditions and the lowest one was obtained with using saline water S4 treatment. The obtained yield follows the descending order of: FW>S1>S2>S3>S4. There are significant differences were obtained between FW yield (control) and other salinity treatments. On the other hand, S1, S2 and S3 treatments gave the same yield approximately; where no significant differences between them. Where, wheat (Triticum aestivum) is a moderately salt-tolerant crop [17]. But, there is significant different between all treatments and S4, whenever significant differences between S1 and S4 treatments. A low level of salinity may not reduce grain yield even though the leaf area and shoot biomass is reduced, which is reflected in a harvest index that increases with salinity, and the fact that grain yield may not decrease until a given (threshold) salinity is reached [18]. In that survey, the yield of wheat starts to decline at 6

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– 8 dS/m (NaCl), and the subsequent linear yield decline of wheat with increasing salinity.

Table (8). Effects of different water salinity on wheat yield, biomass water use efficiency, irrigation water use efficiency and harvest index.

Treatment	Yield kg/ha	Biomass kg/ha	WUE kg/m3	IWUE kg/m3	HI	100 grain g
FW	5060[a]	12767.4[a]	1.03[a]	0.75	0.40	4.08 [a]
S1	4380[ab]	10428.6[ab]	0.91[ab]	0.66	0.42	3.65[ab]
S2	4350[ab]	10408.9[ab]	0.92[ab]	0.67	0.42	3.57[ab]
S3	4020[b]	9348.7[b]	0.87[b]	0.63	0.43	3.36 [b]
S4	3540[c]	8620.5[c]	0.78[c]	0.54	0.41	3.08 [c]

The data Table 8 show water use efficiency (WUE) of wheat crop as a function of irrigation water salinity. The obtained data indicate that a slightly decrease in the WUE with increasing irrigation water salinity from S1 up to S3 but sharply decreased occurred with S4. The highest WUE value was obtained by (FW) and the lowest one was obtained by S4. Values of WUE were 1.03, 0.93, 0.92, 0.87, and 0.78 kg/m3 for FW, S1, S2, S3 and S4, respectively. Increasing salinity level of irrigation water progressively decreased water use efficiency. This may be due to the decrease of dry matter yield with increasing salinity level of irrigation water which increases the energy that plant must expend to acquire water from the soil and make the biochemical adjustments necessary to survive as reported by (Mostafa et al. 2004). Also, reduction in photosynthesis and plant dry mass with increased salinity could be attributed to the difference in the efficiency of root system in limiting the transport of ions to shoots [18]. Zhang et al. 2004, studied on WUE for winter wheat; they found that the values of WUE ranged between 1.11 and 1.61 kg/m^3 under different irrigation depths.

4. Conclusion

The daily ET of wheat under saline irrigation water is lower than under non-saline irrigation. The total yield varied between 3.54 to 5.06 ton/ha. The highest yield was obtained, when using fresh water (FW) which represents nearly non-stressed conditions and the lowest one was obtained with using saline water S4 treatment. Also, increasing salinity level of irrigation water progressively decreased water use efficiency. Thus, future study of the antioxidants ingredients of these varieties under salt stress should be examined using well-controlled water and solutes flux experimental system.

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