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Effect of some Soil Amendments and Irrigation Treatments on Wheat Crop Productivity in Middle Egypt

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ABSTRACT

This study was carried out during the winter two seasons 2015 , 2016 on wheat (*Triticum aestivum* L.) at Malawi Agricultural Research Station in El-Minya Governorate, Egypt to study the effectiveness of three irrigation scheduling treatments (farmer practice (I1), irrigation with 100% ET_o (I2) and irrigation with 75% of ET_o(I3)) along with five treatments (100% N, potassium humate (KH), 75%N+KH, 50% N +KH and 25%N +KH). Results of soil chemical properties revealed that no great variables were observed in pH values between all treatments either when applied full dose of nitrogen fertilizer (100% N) , K^- humate (KH) alone or K^-humate (KH) in combination with nitrogen rates. This result was true for both studied season. Mean values of soil EC, in general, were increased when applied low nitrogen rate. Also, irrigation at I3 (75% $ET_{0)}$ recorded high value of EC as compared to other irrigation treatments. Moreover, organic matter values were increased as affected by K^-humate application as compared with control treatment (only nitrogen fertilizer) as well as OM content in I1 (Farmer practice) irrigation treatment decreased as compared to other application irrigation treatments. Concerning available N,P and K mean values showed an increase in N , P and K availability when applied K^-humate in combination with nitrogen fertilizer as compared to applied N fertilizer alone. Applied K^-humate with 75% N seems to be favorable treatment than other treatments. Applied Irrigation treatment 75% Et_0 was superior for NPK availability as compared to other irrigation treatment. Also, date reveled that highest crop water requirements (CWR) and seasonal water consumption use (WCU) under farmer irrigation practice in the two growing seasons and the lowest value was under irrigation treatment with (I3) of ET_o. The mean values of WCU were decreased when applied different nitrogen rates The value of WUE as a mean of two growing seasons were higher with irrigation treatment (I2) , also, with K humate in combination with 75% N rate.In addition, data showed that wheat yield and its components had significantly influenced by different applied treatments, compared to the control treatment. The plants receiving irrigation treatment at (100% of ET_o) in presence of KH +75% nitrogen gave the highest wheat yield components as compared to other tested treatments. Similar trend was recorded for total content of nitrogen, phosphors and potassium in wheat plant.

Keywords: soil amendment, nitrogen rate, potassium humate, irrigation scheduling, wheat yield

INTRODUCTION

Water availability is the most limiting factor for increasing agricultural production in Egypt. Agricultural sector is receiving the highest share of the available water, hence, over 80% of the water sources are allocated for agriculture. However, the demand on water resources in this field is growing up due to the expansion of irrigated areas to provide the increasing population with its need of food and fibbers.

Wheat is one of most important cereal crop in Egypt with total production of about 8 million tons, not enough to feed the increasing population being about of 100 million inhabitants. Kahlown *et al*. (2003) reported that wheat require about 400 to 650 mm water, where optimum yields observed with the application of 650 mm in depending upon weather, length of growing period, soil and irrigation supplies,. Increasing water stress level is detrimental to plant growth and may result in marked alteration in its morphological features including significantly reduction in shoot and root lengths, leaf area and total biomass production (Aldesuquy et al., 2012). Menshawey *et al*. (2006) found that number of kernels per spike is more drought sensitive than number of spikes per square meter. So, the reduced of biomass, tillering ability, grains per spike and grain size at any stage under moisture stress which depends on intensity and length of stress (Bukhat, 2005). Gupta *et al*., (2001) added that reduction in number of kernels er ear and kernel weight under influences of water stress imposed during later stages. Moreover, Zareian *et al*. (2014) found that the reduction of grain yield and its components of wheat plant along with emergence and grain filling under impact of water stress through withholding at the ear.

Nutrients availability is a major limiting factor for wheat production in the world (Curtis, 2002). Nitrogen is most recognized in plants for its presence in the structure of the protein molecule. Accordingly, nitrogen plays an important role in synthesis of the plant constituents through the action of different enzymes which playing management critical for economic production of wheat (Mullen *et al*., 2003). Pandey *et al*., (2001) found that the uptake of nitrogen by wheat plant changes significantly with soil moisture availability and time and amount of irrigation.

Studies on agronomic practices, such as application of potassium humate and irrigation intervals, as well as nitrogen fertilization on different crops yield are important to attain better use of agriculture resources and increase productivity (Said-Al Ahl *et al*., 2009). Concerning potassium humates (KH) as a soil conditioner, its derived from lignite brown coal are alkaline, rich in carboxylic and phenolic groups, aromatic in nature provide favorable conditions for biological activity, chemical reactions and physical improvement of soil. It promote chemical reaction for cation exchange, increase pH buffering capacity of soils, bind and sequester phytotoxic elements and accelerate transport of nutrients to plants (Shujrah *et al*., 2010). Under regulated deficit irrigation, potassium (K) fertilization increase crop tolerance to water stress by utilizing the soil moisture more efficiently than in K deficient plants. The increase in the stress tolerance by K fertilization may be due to promotion of root growth associated with more nutrient and water uptake (Umar and Din, 2002). Khaled and Fawy (2011) found that humic acids can significantly reduce water evaporation and increase its use by plants in non-day, arid, and sandy soils. Under the influence of humic acids, plants grow stronger, improve the soil structure and improve physical properties of soil by increasing the exchange capacity and buffering qualities, promoting the chelation of many elements and making these available to plants. Humic substances can ameliorate negative soil properties; improve the plant growth and nutrients uptake.

Rafat *et al*. (2012) reported that wheat grain yield under water deficit situation was higher than in control. At this irrigation level without application of potassium humate, 34% reduction was observed in grain yield, but with application of 2% potassium humate only 14% percent reduction was observed. Under water deficiency, potassium humate application led to decrease of water stress effects on grain yield.

Therefore, the goal of this work is to evaluate the efficiency of potassium humate in combinations with different nitrogen rates under irrigation scheduling to improve soil chemical properties and wheat crop productivity as well as water used efficiency.

MATERIALS AND METHODS

This study was carried out during the two seasons 2015 , 2016 on wheat (*Triticum aestivum* L.) at Malawi Agricultural Research Station in El Minya Governorate, Egypt (Latitude, 27° 34' 57.093" N and longitude, 30° 50' 32.819" E). Physical and chemical characteristics of the studied soil are presented in Table (1&2).

Table 1. Characteristics of experimental soil

Soil characteristic	Value	Soil characteristic	Value
Particle size distribution (%)		Soluble cations and anions (meq L^{-1})	
Sand	5.00	Ca^{+2}	1.53
Silt	50.0	Mg^{+2}	0.62
Clay	45.0	Na^{+}	1.21
Texture class	Silty clay	K^{+}	0.26
$CaCO_3$ %	0.97	$CO_3^{=}$	-
		HCO_3^{-}	1.00
		CL^{-}	2.00
		$SO_4^{=}$	0.60
Chemical properties		Available nutrients (mg L^{-1})	
pH	8.05	N	300
EC dSm^{-1}	0.36	P	8.65
Organic matter (%)	1.66	K	170

Table 2. Soil water constants and bulk density of the experimental site

Depth Cm	Field capacity %, w/w	Wilting point %, w/w	Available water %, w/w	Available water mm depth	Bulk density gcm^{-3}
0 0– 15	35.68	19.51	16.17	11.06	1.14
15 – 30	33.33	18.20	15.13	18.71	1.18
30 - 45	33.25	18.07	15.18	11.75	1.29
45 – 60	33.18	17.95	15.23	11.97	1.31
Mean	33.86	18.43	15.43	Total 53.49	1.23

Wheat crop (*Triticum aestivum* L, variety Bani Sweif 1) was used to study the effectiveness of three irrigation scheduling treatments (farmer practice (I1), irrigation with 100% ET_o (I2) and irrigation with 75% of ET_o (I3)) along with five treatments (100% N, potassium humate (KH), 75% N+KH, 50% N +KH and 25% N+KH) on improving soil chemical properties and wheat crop productivity. The chemical analysis of potassium humate applied in soil is present in Table 3.

Meteorological data for Malawy region in 2014/2015 and 2015/2016 growing seasons are shown in Table 4.

Table 3. Chemical analyses of potassium humate applied in this study.

Parameters	values	Parameters	values
pH	8.10	P mg L^{-1}	9.60
OC %	0.63	Ca mg L^{-1}	4.00
OM %	1.08	Mg mg L^{-1}	336
C/N	1.21	Fe mg L^{-1}	10.9
N %	0.52	Mn mg L^{-1}	1.70
K %	4.00	Zn mg L^{-1}	0.30
Na %	0.83	Cu mg L^{-1}	0.50

Table 4. Meteorological data for Malawy region in 2014/2015 and 2015/2016 growing seasons.

Month	Tmax(°C)	Tmin (°C)	WS (ms^{-1})	RH (%)	SR(M/J/^{m2}/day)
	2014/2015 growing season				
November	24.0	10.0	3.8	47.0	15.5
December	19.9	8.0	3.3	55.0	12.8
January	19.6	3.3	3.8	53.3	13.8
February	15.2	7.6	3.8	45.7	16.0
March	18.9	11.2	4.1	33.9	16.5
April	28.1	11.0	4.6	28.1	23.9
	2015/2016 growing season				
November	25.8	10.8	3.7	50.8	15.1
December	22.6	6.9	3.8	50.8	13.6
January	20.4	7.5	3.0	44.9	14.3
February	21.7	5.3	4.0	39.5	17.5
March	26.2	9.2	4.2	39.1	20.8
April	31.4	14.9	4.1	27.7	24.9

Tmax = Maximum temperature; Tmin = Minimum temperature; WS = Wind speed; RH =Relative humidity; SS = Actual sunshine duration; SR = Solar radiation.

On the basis of a field experiment laid out in a split plot design with three replicates and the sub- plot area was 21 m^2. The treatments were arranged as followed:

1. Main plots (irrigation scheduling with three treatments).

A- Farmer practice (I1).

B-Irrigation with 100% of reference evapotranspiration, ET0 (I2)

C- Irrigation with 75% of reference evapotranspiration, ET0 (I3).

2- Sub-plots (nitrogen fertilizer in combination with KH)

1. Recommended nitrogen dose (100%N)
2. Potassium humate (KH).
3. 75% N + KH.
4. 50% N +KH
5. 25%N+KH.

Three irrigations treatments were applied during the two growing season of wheat. (15 % P_2O_5) of superphosphate at a rate of 200 Kg fed^{-1} was applied basically before sowing, (33 %N) of ammonium nitrate at rate of 360 Kg fed^{-1} and applied in two equal doses before first irrigation and the next dose applied before the second irrigation. Potassium humate (KH) was sprayed on soil surface at rate of (40 L fed^{-1}). Other cultural practices were applied according to the common methods being adopted for growing wheat crop at the region. Harvest took place at 2/5/2015 and 29/4/2016 in the first and second seasons, respectively. At harvest time, ten guarded plants were randomly taken from the central rows in each sub-plot to determine the following traits:

1. Plant number /m^2 were determined from 1 m^2 area in each sub-plot.
2. Plant height (cm).

3- Number of branches/ plant

4- Number of spikes/m^2 was determined from 1 m^2 area in each sub- plot.

5- Number of grains/spike.

6- 1000-kernel weight (g).

In addition, plants in the central area (4 m^2) of each sub-plot were harvested to determine:

7- Grain yield (ton fed^{-1}).

8- Straw yield (ton fed^{-1})

9- Biological yield (ton fed^{-1}).

After harvesting, surface soil samples were collected and subjected to analysis of some soil chemical properties according to Cottenie *et al*. (1982). Furthermore, straw and grains samples of wheat crop was weighed and oven dried at 70°C for 48 hour until to constant dry weight, grounded and prepared for digestion as described by Page *et al*. (1982). The digests were then subjected to the evaluation of macronutrients (N, P and K according to procedures described by Cottenie *et al*. (1982).

Water Relations

1. Water requirement

Reference evapotranspiration (ET_o) was calculated by CROPWAT model (version 4.3, Smith *et al*., 1992). The FAO Penman-Monteith method can be expressed as followed:

$$ETo = \frac{0.408\Delta(Rn - G) + \gamma \frac{900}{T+273} u2\,(es - ea)}{\Delta + \gamma(1 + 0.34u2)}$$

Where:

ETo: reference evapotranspiration (mm day^{-1})
Rn: net radiation at the crop surface (MJ m^{-2} day^{-1})
G: soil heat flux density (MJ m^{-2} day^{-1})
T: mean daily air temperature at 2m height (°C)
u2: wind speed at 2m height (m s^{-1})
es: saturation vapor pressure (kPa)
ea: actual vapor pressure (kPa)
es-ea: vapor pressure deficit (kPa)
Δ: slope vapor pressure-temperature curve (KPa $°C^{-1}$)
γ: psychrometric constant (kPa $°C^{-1}$)

2. Crop water requirements:

Crop water requirements (ETcrop) over the two growing seasons were determined from ET_o and estimates of crop evaporation rates, expressed as crop coefficient, (Kc) according to the following equation:

Crop water requirement= (ETcrop)=ET_o X Kc

Irrigation requirement =((ET_o X Kc) / system application efficiency + leaching requirement)).

Furthermore, the applied irrigation amounts on the field level were measured by using cut throat flume.

1. Water consumption use (WCU):

After each irrigation and at harvesting time, soil samples were taken using a regular auger just before and 48 hours in 15 cm increment system down word to 60 cm of soil profile. Water consumptive use was calculated according to Israelsen and Hansen (1962) as follows:

$$WCU = (\Theta_2 - \Theta_1)/100 \times (Bd) \times ERZ$$

Where:

WCU = water consumption use, (mm/depth)

Θ_2 = Percentage of soil moisture by weight 48 hours after irrigation

Θ_1 = Percentage of soil moisture by weight before the following irrigation

Bd = Bulk density, g cm^{-3} ERZ= Effective root zone, (0.6m).

Water consumptive use as ($m^3 fed^{-1}$) was obtained by multiplying the value WCU, m depth by 4200.

2. Water use efficiency (WUE):

Water use efficiency in kg m^{-3} was estimated for each treatment according to the equation described by Vites (1965*)* as follows:

WUE, kgm^{-3} = Grain yield (kg fed^{-1})⁄seasonal water consumption ($m^3 fed^{-1}$).

Data of grain yield and yield components in the two seasons were statistically analyzed according to Snedecor and Cochran (1980) and treatment means were compared by least significant difference test (LSD) at 0.05% level of significance. The differences between means followed the same alphabetical letter were not statistically significant according to Duncan's multiple range test (Cochran , 1953).

RESULTS AND DISCUSSION

1. Effect of potassium humate in combination with nitrogen rates on soil chemical properties and nutrients availability under irrigation scheduling.

1. Soil pH.

Data in Table (5) showed the effect of potassium humate in combination with nitrogen rate on soil pH under irrigation scheduling at two successive seasons cultivated with wheat crop.

Generally, obtained results revealed that no great variables were observed between all mean values of treatments either when applied full dose of nitrogen fertilizer (100% N) , K-humate (KH) alone or K-humate (KH) in combination with nitrogen rates. This result was true for both studied season in spite of relatively increased in pH values at first season.

Concerning the effect of irrigation scheduling, similar trend was observed on pH values. This properly due to the application of potassium humate which working as a buffering in soil solution and help stabilize in soil against strong pH changes from fertilizer application. This finding agrees with the results of Campitelli *et al*. (2008) who suggested that the most important properties of humic acid is its large buffer capacity in wide pH range, which arises essentially from the dissociation of acidic functional groups of which they are particularly rich. Also, Pertusatti and Prado (2007) found that the humic acid did not have a strong buffer capacity to base additions. They also found that humic acid resisted pH change in the range between pH 5.5 and 8.0.Humic acids contain chemical reactive functional groups, such as carboxyl as well as phenolic and alcoholic hydroxyls that have pH dependent change properties.

2. Soil electric conductivity (EC).

Data in Table (5) observed the effect of potassium humate in combination with nitrogen rates on soil EC under irrigation scheduling at two successive seasons of wheat crop. Obtained results revealed that mean values of soil EC, in general, were increased when applied Low nitrogen fertilizer rate.

Table 5. Soil parameters as affected by potassium humate in combination with nitrogen rates under irrigation treatments at first and second seasons after wheat crop harvested

Irrigation	Treatments	pH (1:2 suspension)		EC dSm^{-1}		OM%	
		1^{th} season	2^{nd}season	1^{th}season	2^{nd} season	1^{th} season	2^{nd} season
	100%N	8.09	7.90	0.10	0.20	1.15	1.20
	KH	8.10	8.13	0.17	0.12	1.81	1.20
I1	75%N+KH	8.10	8.05	0.15	0.12	2.13	1.54
	50%N+ KH	8.12	8.14	0.21	0.19	2.31	1.44
	25%N+KH	8.07	8.01	0.18	0.16	2.13	1.44
Mean I1		8.10	8.03	0.16	0.16	1.91	1.36
	100%N	8.03	8.01	0.12	0.15	1.64	1.06
	KH	8.02	7.92	0.17	0.20	2.13	1.44
I2	75%N+KH	8.03	7.90	0.17	0.20	2.13	1.44
	50%N+ KH	8.18	8.10	0.17	0.20	3.45	1.44
	25%N+KH	8.07	7.92	0.24	0.23	2.16	1.20
Mean I2		8.07	7.93	0.17	0.20	2.36	1.32
	100%N	8.07	7.92	0.29	0.21	1.64	1.34
	KH	8.10	8.15	0.25	0.16	2.30	1.44
I3	75%N+KH	8.08	7.98	0.15	0.23	2.30	1.44
	50%N+ KH	8.10	7.93	0.27	0.22	2.13	1.44
	25%N+KH	8.16	8.08	0.24	0.25	2.30	1.52
Mean I3		8.10	8.01	0.24	0.23	2.13	1.52
Mean of treatments							
100%N		8.06	7.94	0.17	0.19	1.48	1.20
KH		8.06	8.07	0.20	0.16	2.08	1.33
75%N+ KH		8.07	7.98	0.16	0.18	2.18	1.47
50%N+ KH		8.12	8.06	0.22	0.22	2.63	1.44
25%N+ KH		8.10	8.00	0.22	0.21	2.20	1.39

Regarding the effect of irrigation treatments on EC values, obtained data show that mean value of I3 (75% $ET_{0)}$ was recorded higher value of EC than other irrigation treatments. Probably due to the excess of water from (I1 and I2) which dilution effect on salt compared to (I3) therefor; the salt in soil solution was increased. With raged to the effect of K-humate with a combination of N rates on soil EC, it seemed to be no low variability between treatments. The same trend was observed in both seasons. It worth mentioning that there is no accumulation of salt was found, especially in clay soil under treatments of potassium humat which consists of a greater compound of humic acid, which improved physical promotes soil agglomeration and cause better soil structure, helps soil wetting which reduces surface soil crusting and retention in the soil for that doesn't appear salinity in the soil (Mikkelsen., 2005).

3. Organic matter

Data in Table (5) show the effect of potassium humate in combination with rates of nitrogen fertilizer under influences of irrigation scheduling on organic matter content in soil after cultivated with wheat crop at two successive seasons. Results revealed that there is an increase in organic matter values as effect by K-humate application as compared with control treatment (only nitrogen fertilizer). This is expected because the K-humate is a considered as an organic fertilizer. Also, the K-humate is a highly concentration of humic acid, which greatly improve the ability of soils fertility. This result is similar with the results of Melero *et al*. (2007) who found that the application of organic amendments increased the organic carbon. Also, Mikkelsen (2005) reported that humic acid improve soil structure, catian exchange, nutrient retention and soil microbial activity. On the other hand, humic acid can be inexpensively incorporated into soils through bio-wastes, such as manure and the resulting organic matter has the added benefit of improving soil physical properties (Mackowiak *et al*., 2001). Moreover, mean values of irrigation treatments reveal that generally decreased in OM content in I1 (Farmer practice) irrigation treatment as compared to other application irrigation treatments. Also, organic matter content was superior in the first season as compared to second season.

4. Available macronutrients in soil.

Results in Table (6) observed that the effect of potassium humate in combination with different rates of nitrogen fertilizer under influences of irrigation treatments on available N, P and K in soil at two successive seasons cultivated with wheat.

Concerning available nitrogen, mean values showed an increase in N availability when applied K^- humate in combination with nitrogen fertilizer as compared to applied N fertilizer alone. Applied K^- humate with 75% N seems to be favorable treatment than other treatments. This result could be due to the K^- humate working as good chelating properties, which reduce loss of nutrients due to leaching and run off. Also, Melero *et al*. (2007) found that application of organic amendment increase the N content in soil.

Moreover, mean value of available N was affected by irrigation treatments; high value of available N was recorded under I3 (75% of ET_o) irrigation treatment for two studied season. Also, first season was superior in available N as compared to second season.

Regarding to available phosphorus and potassium, the same trend was observed as in available nitrogen. This again, may be attributed to application of K^-humate, which increase the activity microorganism to mobile the unavailable forms of nutrient elements and increase soil fertility and cation exchange capacity (Natsheh and Mousa, 2014) along with potassium humate consists of N, P and K. Also, Filip and Bielek (2002) found the most striking characteristics of humic acids in soil and other environments is its ability to interact with metal ions and soil minerals which forming complexes of varying properties, especially phosphorus, and increasing chemical stability.

Table 6. Available macronutrients (N, P and K) in soil as affected by potassium humate in combination with nitrogen rates and irrigation scheduling treatments after wheat crop harvested

Irrigation	Treatments	1th season			2nd season		
		N	P	K	N	P	K
	100 %N	364	12.7	204	182	4.70	316
	KH	420	10.9	211	175	5.30	338
I1	75%N+KH	476	14.3	244	189	22.5	395
	50%N+.KH	420	15.8	297	189	11.7	402
	25%N+KH	420	12.1	310	180	8.70	359
Mean I1		420	13.2	253	183	10.6	362
	100 %N	420	12.1	250	200	5.30	215
	KH	364	13.4	257	175	10.1	244
I2	75%N+KH	448	17.0	336	210	14.3	323
	50%N+.KH	476	15.5	310	202	14.3	316
	25%N+KH	420	17.8	257	203	9.10	323
Mean I2		425	15.2	282	200	10.6	284
	100 %N	420	12.7	264	205	8.50	294
	KH	420	15.6	330	196	9.50	258
I3	75%N+KH	476	18.0	366	210	16.9	452
	50%N+.KH	420	17.0	362	210	14.3	352
	25%N+KH	420	17.3	303	203	12.1	323
Mean I3		431	16.3	325	206	12.23	336
Mean of treatments							
100%N		401	12.5	239	196	6.16	275
KH		401	13.3	266	182	8.50	280
75%N+ KH		466	16.4	325	203	17.9	390
50%N+ KH		457	16.1	323	200	13.4	357
25%N+ KH		420	15.7	290	195	6.66	335

2. Effect of potassium humate in combination with nitrogen rates and irrigation scheduling on seasonal water relations.

1. Crop Water Requirements (CWR).

Results in Tables (7) indicated the effect of potassium humate in combination with different rates of nitrogen fertilizer under influences irrigation scheduling on Seasonal crop water requirements. With respect to irrigation regimes, values of crop water requirements in the second season were higher as compared to the first season. The average amount for each irrigation treatment was 2619, 2284 and 1911m^3/fed for irrigation treatment I_1, I_2, and I_3, respectively. On the other hand, the values in the second season were 2630, 2299, 1932 m^3/fed, respectively.

These results show that water requirements increased as available soil moisture increased in the root zone of plants. While, subjecting wheat plants to soil water deficit caused decrease in crop water requirements. The results indicated that the average of water applied was high in the second season compared with the first season, due to high temperature. This higher temperature would automatically result in higher consumptive use and consequently increased crop water requirements.

2. Seasonal water consumption use (WCU).

Seasonal water consumptive use by wheat plants under the adopted treatments are presented in Table 7. The results indicated that the values of WCU for wheat plant ranged between 1561 to 1147 m^3fed^{-1} averaged on both growing seasons. The results revealed that WCU increased with increasing soil moisture. The highest value of WCU were 1557 and 1565 $m^3 fed^{-1}$ in the first and second seasons, respectively was obtained under Farmer practice (I_1). Nevertheless, the lowest value were 1142 and 1151 $m^3 fed^{-1}$ for the same respective was obtained when irrigating at 75% ET_o (I_3), consequently irrigating at 100% ET_o (I_2) had an intermediate value. This can be explained that the increase in irrigation water provides an opportunity to irrigation water to be use in the soil. In this connection results showed that total water use by wheat crop was increased with increasing the amount of applied water.

The results also indicated that the maximum value of WCU was obtained when wheat plants treated with 100%N. Such results may be due to that applying higher nitrogen rate enhanced wheat growth, which in turn increased plant canopy, thereby increasing transpiring surface and reflected on higher seasonal water Consumptive use. As for the interaction effect between irrigation regimes and nitrogen fertilization rates shown in Table 7. It is clear that the highest value of WCU was recorded from Farmer practice (I_1) and 100%N fed^{-1}.

3. Water use efficiency (WUE)

Results in Tables (7) indicate the effect of potassium humate in combination with different rates of nitrogen fertilizer under influences irrigation scheduling on water use efficiency (WUE).

Water use efficiency for wheat expressed as kg of grains produced per m^3 of water consumed in the herein study is presented in Table 7. According to the mean of the two growing seasons results indicated that water use efficiency value was higher under irrigation at 100% ET_o (I_2) where the value reached 2.29 kg/ m^{-3}, while lower values were recorded by farmer practice (I_1) and followed by 75%ET_o (I_3). These results may be due to the higher wheat grain yield and the less water under irrigation at 100% ET_o (I_2).

Table 7. Seasonal crop water requirements (CWR m^3 fed^{-1}), water consumption use (WCU, m^3 fed^{-1}), and water use efficiency (WUE, kg/ m^{-3}) under K humate, N –rate and irrigation treatments in first and second seasons of wheat crop

Irrigation Regime	Nitrogen rate	CWR		WCU			WUE		
		1th season	2nd season	1th season	2nd season	Mean	1th season	2nd season	Mean
Farmer practice (I_1)	100%N			1591	1602	1597	2.03	2.04	2.04
	KH			1580	1589	1585	1.35	1.43	1.39
	75%N +KH		2630	1573	1577	1575	2.45	2.56	2.51
	50% N +KH			1549	1555	1552	2.07	2.07	2.07
	25%N+KH			1490	1500	1495	1.71	1.85	1.78
Mean I1		2619	2630	1557	1565	1561	1.92	1.99	1.96
100% ET_o (I_2)	100%N			1389	1410	1400	2.37	2.45	2.41
	KH			1384	1396	1390	1.65	1.68	1.67
	75%N +KH			1379	1385	1382	2.94	3.01	2.98
	50%N +KH			1355	1367	1361	2.17	2.43	2.30
	25%N+KH			1305	1325	1315	2.03	2.13	2.08
Mean I2		2284	2299	1362	1377	1370	2.23	2.34	2.29
75% ET_o (I_3)	100%N			1160	1169	1165	2.16	1.89	2.03
	KH			1158	1164	1161	1.55	1.26	1.41
	75%N +KH			1150	1160	1155	2.83	2.40	2.62
	50%N+KH			1141	1153	1147	2.46	1.99	2.23
	25%N+KH			1100	1109	1105	1.89	1.71	1.80
Mean I3		1911	1932	1142	1151	1147	2.18	1.85	2.02
Mean of treatments									
100%N				1380	1394	1387	2.19	2.13	2.16
KH				1374	1383	1379	1.52	1.46	1.49
75%N +KH				1367	1374	1371	2.74	2.66	2.70
50%N +KH				1348	1358	1353	2.23	2.16	2.20
25%N+KH				1298	1311	1305	1.88	1.9	1.89

On the contrary, the other regimes caused a reduction in wheat yield more than the reduction in water consumption thereby resulted in lower values of water use efficiency. Under farmer practice (I_1), wheat yield was slightly lower than 100%ET_o (I_2) irrigation regime and consumed more water compared with 100% ET_o (I_2) irrigation regime which in turn resulted in lower water use efficiency values. It could be concluded that wheat crop consumed the soil water efficiently under100%ET_o (I_2) irrigation regime, compared with either farmer practice or 100% ET_o (I_2) irrigation regimes. In other words, maintaining soil moisture using irrigation at 100%ET_o (I_2) not only increased crop productivity but also allows the plants to use the soil water efficiently.

Concerning nitrogen rates, results in Table 7 showed that using 75%N + KH seemed to improve WUE, The increase in WUE values could be attributed to the role of soil conditioners as sources of nutrients and increasing the soil fertility, which consequently increased the growth of wheat plants. The increase in grain yield was higher than that in water consumed by wheat plants, hence, WUE values tended to improve. These results are in agreement with those obtained by Oktem *et al*. (2003) who reported that an increase in WUE as water utilization rate increased. The interaction effect between irrigation regimes and nitrogen fertilization rates showed that the maximum values of water use efficiency for wheat crop was obtained under irrigating at 100% ET_o(I_2) in combination with 75% N + KH. These results were agreement of resultant those obtained by Munoz- Perea *et al*. (2007), Teran *et al*. (2005) and Frahm *et al*. (2004).

3. Yield and yield components.

Statistical interaction analysis of data in Table (8 & 9) showed that the biological yield, straw and grains of wheat yield were positive significant increases by variety of applied treatments, compared to the control treatment. The plants receivingI$_2$ (100% ET$_o$) in presence of 75% recommended nitrogen dose and KH were significantly compared to other tested treatments. On the other hand, the decrease of yield components was recorded for the application of potassium humate only under irrigation treatment I3 (irrigation with 75% ET$_o$).

Table 8. Yield and yield components of wheat crop at first season as affected by potassium humate in combination with nitrogen rates and irrigation scheduling treatments

Treatments Irrigation	N rates	Plant No/m^2	Plant height cm.	No of branches/ pant	No of spikes/m^2	Number of grains/spike	Grain yield kg fed^{-1}	Straw yield kg fed^{-1}	Biological yield kg fed^{-1}	1000-grain yield kg fed^{-1}
	100%N	492_{CDEF}	93.3_{AB}	6.7_{A}	491_{CDE}	52.3_{B}	3233_{BC}	5298_{BC}	8531_{B}	56.8_{BCD}
	KH	343_{H}	74.0_{E}	3.3_{D}	329_{H}	45.0_{EF}	2129_{GHI}	3292_{FG}	5421_{F}	50.8_{DEF}
	75%N+ KH	533_{AB}	93.0_{AB}	7.0_{A}	532_{AB}	50.7_{BCD}	3858_{A}	6093_{A}	9933_{A}	61.9_{AB}
I1	50%N+ KH	498_{BCDE}	88.3_{CD}	6.3_{AB}	497_{BCDE}	48.0_{BCDE}	3199_{BC}	5194_{BC}	8393_{BC}	56.9_{BCD}
	25%N+ KH	428_{G}	88.0_{D}	5.7_{BC}	428_{FG}	51.0_{BCD}	2551_{DEFG}	3979_{EF}	7762_{A}	54.9_{BCDEF}
Mean of I1		459_{AB}	87.3_{A}	5.8_{AB}	456_{B}	49.4_{A}	2994_{A}	4771_{A}	7762_{A}	56.2_{A}
	100%N	530_{AB}	92.7_{ABC}	7.0_{A}	528_{ABC}	51.7_{BCD}	3294_{B}	5669_{AB}	8963_{B}	54.523_{BCDEF}
	KH	345_{H}	74.3_{E}	3.7_{D}	345_{H}	41.3_{F}	2281_{FGH}	4105_{E}	6386_{E}	48.9_{EF}
	75%N+ KH	553_{A}	95.0_{A}	7.0_{A}	542_{A}	58.7_{A}	4049_{A}	6161_{A}	10210_{A}	68.2_{A}
I2	50%N+ KH	510_{BCD}	93.0_{AB}	6.3_{AB}	508_{ABCD}	52.0_{BC}	2942_{BCD}	5217_{BC}	8459_{BC}	54.2_{CDEF}
	25%N+ KH	474_{DEF}	89.3_{BCD}	5.3_{C}	471_{DE}	47.0_{DE}	2644_{DEF}	4425_{DE}	7069_{DE}	52.6_{CDEF}
Mean of I2		482_{A}	88.9_{A}	5.9_{A}	479_{A}	50.1_{A}	3042_{A}	5115_{A}	8218_{A}	55.7_{A}
	100%N	460_{FG}	89.3_{BCD}	6.3_{AB}	468_{E}	48.0_{BCDE}	2509_{EFGH}	3956_{EF}	6465_{E}	52.7_{CDEF}
	KH	329_{H}	69.0_{F}	3.3_{D}	343_{H}	43.7_{EF}	1791_{I}	2849_{G}	4639_{F}	47.6_{F}
	75%N+ KH	519_{ABC}	92.7_{ABC}	6.7_{A}	516_{ABC}	59.0_{A}	3251_{B}	4865_{CD}	8116_{BC}	59.5_{BC}
I3	50%N+ KH	471_{EF}	89.3_{BCD}	5.7_{BC}	460_{EF}	51.3_{BCD}	2808_{CDE}	4835_{CD}	7643_{CD}	56.0_{BCDE}
	25%N+ KH	428_{G}	89.3_{D}	5.3_{C}	410_{G}	47.3_{CDE}	2078_{HI}	3101_{G}	5244_{F}	52.9_{CDEF}
Mean of I3		441.5_{B}	85.3_{A}	5.5_{B}	440_{B}	49.9_{A}	2487_{B}	3921_{B}	6421_{B}	53.7_{A}
					Mean of treatments					
100%N		494_{B}	91.8_{AB}	6.7_{AB}	496_{B}	50.7_{B}	3012_{B}	4974_{B}	7986_{B}	496_{B}
KH		339_{D}	72.4_{D}	3.4_{D}	339_{D}	43.3_{C}	2067_{D}	3415_{D}	5482_{D}	339_{D}
75%N+ KH		535_{A}	93.6_{A}	6.9_{A}	530_{A}	56.1_{A}	3719_{A}	5706_{A}	9420_{A}	530_{A}
50%N+ KH		493_{B}	90.2_{BC}	6.1_{B}	489_{B}	50.4_{B}	2983_{B}	5082_{B}	8165_{B}	489_{B}
25%N+ KH		443_{C}	87.889C	5.4_{C}	437_{C}	48.4_{B}	2424_{C}	3835_{C}	6281_{C}	437_{C}

These results were agreement of resultant those obtained by (Said-Al Ahl *et al*., 2009) who reported that application of potassium humate and irrigation intervals, as well as nitrogen fertilization are important in better use of the agriculture resources and increased productivity. Mazhar *et al*. (2012) added that the positive effects of potassium humate on plant growth and productivity, which seem to be concentration related, could mainly be due to hormone-like activities of the potassium humate through its involvement in cell respiration, photosynthesis, oxidative phosphorylation, protein synthesis, antioxidant and various enzymatic reactions. Furthermore, they added that the role of potassium humate may primarily increase root growth by increasing cell elongation, therefore increased water uptake through increasing the length of plant roots.

With concern to the effect of irrigation scheduling, I2 recorded higher value for all parameters of wheat yield and its components, as compared to other irrigation treatments (I1 and I3).The obtained results agreement with the results obtained by Aldesuquy *et al*. (2012) who reported that water stress conditions is detrimental to plant growth and may result in marked alteration in its morphological features including significantly reduction in shoot and root lengths, leaf area and total biomass production .

Results also revealed that the yield components of wheat crop in two studied seasons increased gradually by increasing nitrogen rate in combination with potassium humate. Mean values of wheat yield component recorded high values when 75%N+ KH was applied, as compared to either applied 100%N or KH treatments. The obtained data are in agreement with Khan *et al*. (2010) who found that humic acid (HA) applied alone at 3 kg/ha or in combination with nitrogen fertilizer recorded the maximum yield of wheat. HA has great potential as a low cost natural fertilizer to improve soil fertility on sustainable basis. In the same trend, El-Bakry *et al*. (2013) concluded that foliar spraying wheat plants with humic acid at 13 mg/L significantly increased growth, yield components and grain yield.

Table 9. Yield and yield component of wheat crop at second season as affected by potassium humate in combination with nitrogen rates and irrigation scheduling treatments

Treatments Irrigation	N rates	Plant No /m^2	Plant height cm.	No of branches/ pant	No of spikes /m^2	Number of grains /spike	Grain yield kg fed^{-1}	Straw yield kg fed^{-1}	Biological yield kg fed^{-1}	Weight of 1000 grain
I1	100%N	515_{BCD}	92_{BC}	7_{BCD}	514_{CDE}	54.0_{BCD}	3261_{B}	4698_{BC}	7949_{CD}	55.0_{ABC}
	KH	358_{FG}	68_{GH}	3_{G}	346_{J}	44.7_{HI}	2247_{D}	2853_{F}	5100_{H}	46.3_{EF}
	75%N+ KH	565_{AB}	93_{AB}	7_{ABC}	562_{AB}	57.3_{AB}	4040_{A}	5014_{ABC}	9054_{AB}	56.3_{AB}
	50%N+ KH	605_{A}	88.7_{CDE}	6_{CDE}	504_{DEFG}	51.7_{CDE}	3223_{B}	4558_{C}	7781_{CD}	50.8_{CDE}
	25%N+ KH	431_{EF}	86_{E}	6_{CDE}	431_{I}	50.3_{DEFG}	2774_{C}	3820_{DE}	6594_{EF}	$53.0B_{CD}$
Mean of I1		495_{A}	85.5_{B}	6_{B}	472_{B}	51.6_{A}	3107_{A}	4189_{A}	7296_{A}	52.3_{A}
I2	100%N	557_{ABC}	93_{AB}	7_{ABC}	546_{ABC}	52.0_{CD}	3458_{B}	4851_{ABC}	8309_{BC}	56.1_{AB}
	KH	376_{FG}	71_{G}	5_{F}	376_{J}	47.3_{FGH}	2349_{D}	3678_{E}	6027_{FG}	47.1_{EF}
	75%N+ KH	584_{AB}	96_{A}	8_{A}	582_{A}	59.3_{A}	4166_{A}	5280_{AB}	9446_{A}	85.9_{A}
	50%N+ KH	535_{ABCD}	90_{BCD}	7_{AB}	530_{BCD}	50.7_{DEF}	3318_{B}	4504_{C}	7822_{CD}	55.1_{ABC}
	25%N+ KH	468_{DE}	88_{DE}	6_{BCDE}	468_{GHI}	51.3_{CDE}	2825_{C}	4463_{C}	7288_{DE}	53.1_{BCD}
Mean of I2		504_{A}	87.7_{A}	7_{A}	501_{A}	52.1_{A}	3223_{A}	4555_{A}	7778_{B}	54.1_{A}
I3	100%N	474_{DE}	85_{EF}	6_{BCDE}	473_{FGH}	46.7_{GHI}	2212_{DE}	4412_{CD}	6624_{EF}	52.2_{BCD}
	KH	339_{G}	65_{H}	3_{G}	339_{J}	43.3_{I}	1472_{F}	2836_{F}	4308_{I}	44.2_{F}
	75%N+ KH	512_{BCD}	90_{BCD}	7_{BCD}	511_{CDEF}	55.0_{BC}	2787_{C}	5336_{A}	8123_{C}	51.3_{BCDE}
	50%N+ KH	483_{CDE}	87.7_{DE}	6_{DEF}	480_{EFGH}	48.0_{EFGH}	2300_{D}	4437_{C}	6737_{EF}	52.2_{BCD}
	25%N+ KH	408_{EFG}	81.7_{F}	5_{EF}	453_{HI}	47.0_{FGHI}	1900_{E}	3537_{E}	5437_{GH}	49.0_{DEF}
Mean of I3		443_{B}	81.9_{C}	6_{B}	451_{B}	48.0_{B}	2134_{B}	4112_{A}	6246_{C}	49.8_{A}
					Mean of treatments					
100%N		515_{A}	90_{B}	7_{AB}	511_{B}	50.9_{B}	2973_{A}	4654_{B}	7627_{B}	54.4_{AB}
KH		358_{C}	68_{D}	4_{D}	354_{D}	45.1_{C}	2023_{D}	3122_{D}	5145_{D}	45.9_{C}
75%N+ KH		554_{A}	93_{A}	7_{A}	552_{A}	57.2_{A}	3665_{A}	5210_{A}	8874_{A}	55.5_{A}
50%N+ KH		541_{A}	88.8_{B}	6_{BC}	505_{B}	50.1_{B}	2947_{B}	44100_{B}	7447_{B}	52.7_{AB}
25%N+ KH		436_{B}	85_{C}	6_{C}	451_{C}	49.6_{B}	2500_{C}	3940_{C}	6440_{C}	51.7_{B}

Zhang *et al*. (2008) added that the amount of applied nitrogen in plants must be carefully managed to ensure that N will be available throughout the growing season and the vegetative and reproductive development will be not restricted. Mineral nitrogen fertilizer has a good effect on plant productivity. Also, Seadh and El-Metwally (2015) showed that the highest values of wheat plants were obtained at 80.0 kg N/fed nitrogen fertilizer.

4. Total content of N, P and K in wheat crop.

Results in Tables (10 and 11) indicated the effect of potassium humate in combination with different rates of nitrogen fertilizer under influences irrigation scheduling on total content of nitrogen, phosphorus and potassium in wheat crop (straw and grains) at two successive seasons. Results showed significant increase total content of nitrogen, phosphorus and potassium for grain and straw of wheat crop under influences of 75% N + KH treatment as compared to other treatments. Obtained results agreement with Mojid, *et al*. (2009) who found that the additional of potassium humate produced significantly increased of N, P and K concentration in wheat plant. Also, Ayuso *et al*. (1996) studied the effect of humic substances on nutrients uptake whereas, the nutrients are absorbed by an active metabolic process humic substances could inhibit absorption since they tend to complex the ions but if the same ions are absorbed by means of passive mechanism like diffusion through plant tissues humic substances do not intervene at all in the absorption or it could even have a positive effect.

Concerning the effect of water irrigation scheduling, in general, data indicated no significant increases between farmer practices (I1) and irrigation with 100% of ET_o (I2), but there were significant increases between 100% of ET_o (I2) and irrigation with 75% of ET_o (I3), on nitrogen total content in grain and straw for both first and second season.

On the other hand, total phosphorus content was superior under irrigation with 100% ET_0 (I2) for both seasons. Applied irrigation treatment 75%% ET_0 (I3) was recorded no significant values for both grains and straw as compared to 100% of ET_o (I2) for first and second season. However, total content of K show a similar trend to P for both grains and straw for the two studied seasons.

Finally, applied K- humate in combination with 75%N under 100% of ET_o (I2) irrigation treatment was recorded high value of total nitrogen, phosphorus and potassium content in wheat crop (straw and grains) at first and second seasons. This probably due to that irrigation plays a vital role for good growth and development of wheat (Razzaque *et al*., 1992). Therefore, practices that increase water use efficiency and reduce excessive amount of water applied to the field are important in water management. Also, applied potassium humate in combination with 75% nitrogen fertilizer may be more suitable to achieve the highest efficiency of irrigation water added to clay soil. This result may be due to humic acid playing role in the soil aggregates which influences many properties of soil such as hydraulic conductivity, water holding capacity, aeration, susceptibility to erosion , soil structure and soil tilt (Van Wambeke, 1992).

Table 10. Nutrients total content of wheat crop at first season of wheat crop as affected by potassium humate in combination with nitrogen rates and irrigation scheduling treatments

Irrigation	Treatments	total content in grains (Kg fed^{-1})			total content in straw (Kg fed^{-1})		
		N	P	K	N	P	K
	100%N	51.6 BCD	12.9 BC	8.13 BC	51.5 BD	9.68 B.D	34.8 DF
	KH	32.6 FG	8.21 C	5.17 DE	29.9 F	7.67 CD	21.7 F
	75%N+KH	66.2 A	15.7 AB	7.16 BE	59.9 AB	10.4 BD	45.2 AB
I1	50%N+ KH	53.5 BC	12.0 BC	7.21 BE	52.5 BC	12.7AC	36.4 BD
	25%N+ KH	42.4 DF	9.55 C	6.25 BE	39.7 DF	10.5 BD	26.8 EF
Mean I1		49.2A	11.67 A	6.78 B	46.7 AB	46.7 AB	32.9 AB
	100%N	53.9 BC	12.0 BC	7.84 BD	58.4 AC	13.8 AB	45.0 AB
	KH	39.8 EG	11.6 BC	5.61 A	47.8 BE	13.0 AC	34.2 CE
	75%N+KH	68.0 A	17.8 A	11.5 B	69.1 A	16.3 A	49.8 A
I2	50%N+ KH	49.1 BE	15.8 AB	8.74 BD	53.3 BC	16.1 A	40.8 AC
	25%N+ KH	44.4 CE	12.3 BC	7.76 BE	50.8 BD	12.1 AD	30.3 DF
Mean I2		51.0 A	13.9 A	8.29 A	55.9 A	55.9 A	40.0 A
	100%N	43.9 CE	11.2 BC	6.22 BE	37.3 EF	11.2 AD	26.9 DF
	KH	30.2G	10.2 C	4.56 E	31.4 F	6.72 D	21.9 F
	75%N+KH	56.6 B	13.1 BC	8.86 B	55.5 BC	12.0 AD	36.5 BD
I3	50%N+ KH	45.7 CE	11.3 BC	7.27 B.E	47.1 CE	12.5 AC	35.1 CE
	25%N+ KH	31.6 G	9.84 C	4.47 E	31.9 F	7.83 CD	21.0 F
Mean I3		41.6 B	11.10 A	6.28 B	40.6 B	40.6 B	28.5 B
Mean of treatments							
100%N		49.8 B	12.0 BC	7.41 BC	49.1 B	11.6 AC	35.9 B
KH		34.2 C	9.98 C	5.12 D	36.4 C	9.14 C	25.9 C
75%N+KH		63.6 A	15.5 A	9.16 A	61.5 A	12.6 AB	43.8A
50%N+ KH		49.4 B	13.0 B	7.74 B	50.9 B	13.8 A	37.4 B
25%N+ KH		39.5 C	10.6 BC	6.16 CD	40.8 C	10.2 BC	26.0 C

Table 11. Nutrients total content of wheat crop at second season as affected by potassium humate in combination with nitrogen rates and irrigation scheduling treatments

Irrigation	Treatments	total content in grains (Kg fed^{-1})			total content in straw (Kg fed^{-1})		
		N	P	K	N	P	K
	100%N	62.9 CD	17.8 B	12.6 DF	42.3 A.C	11.1 A.C	30.1 B.E
	KH	39.2 EF	13.0 DG	9.55 GH	24.1 B.D	9.10 B.D	19.1 C.E
	75%N+KH	85.0 AB	23.3 A	17.4 AB	37.1 G	15.4 E	36.4H
I1	50%N+ KH	62.8. CD	17.1 BC	11.7 EG	34.1 AB	11.9 AB	31.9 A.C
	25%N+ KH	57.3 CD	15.2 BF	9.72 GH	28.9 BD	9.37 CD	26.2 DF
Mean I1		61.4 A	17.3 B	12.2 A	33.3 A	11.4 A	28.8 A
	100%N	71.5 C	16.2 BE	15.5 GH	42.0 G	13.8 E	32.4 H
	KH	52.9 DE	14.8 BF	11.7 BC	32.7 EF	15.5 CD	28.2 FG
	75%N+KH	87.0 A	24.3 A	18.3 EG	45.4 A	19.1 A	40.0 A
I2	50%N+ KH	71.5 BC	21.7 A	15.0 A	39.4 A.C	15.1 A.D	37.0 A.D
	25%N+ KH	62.8 CD	17.7 B	13.6 BD	39.4 C.E	14.3 CD	33.41 EF
Mean I2		69.2 A	18.9 A	14.8 A	39.8 A	15.6 A	34.2 A
	100%N	40.5 EF	12.4 EG	8.57 HI	38.1 G	11.9 E	32.6 H
	KH	30.6 F	9.8 G	6.76 I	24.63 F	8.10 D	21.4 G
	75%N+KH	58.3 CD	16.7 BD	12.0 EG	45.8 A.C	14.7 AB	34.2 AB
I3	50%N+ KH	42.2 EF	13.1 CG	9.84 FH	38.9 B.D	12.0 B.D	31.1 A.E
	25%N+ KH	37.2 F	11.2 FG	8.25 HI	28.9 D.F	9.04 CD	22.5 EF
Mean I3		41.8 B	12.6 C	9.08 B	35.28 B	11.2 B	28.4 B
Mean of treatments							
100%N		58.3 B	15.5 BC	12.2 B	40.8 B	12.3 B	31.7 B
KH		40.9 C	12.5 D	9.35 C	27.1 AB	10.9 AB	22.9 B
75%N+KH		76.8 A	21.4 A	15.9 A	42.8 B	16.4 B	36.9 B
50%N+ KH		58.8 B	17.3 B	12.2 B	37.4 C	13.0 C	33.3 C
25%N+ KH		52. 5 B	14.7 C	10.5 C	32.4 A	10.9 A	27.4 A

CONCLUSION

From the above-mentioned results, it could be concluded that the application of potassium humate in combination with the 75% N being favorable for all parameters under irrigation treatment with 100% of reference evapotranspiration (I2). Applied this treatment was improved soil chemical properties which reflected on wheat yield (straw and grains) and its components along with total content of nitrogen, phosphorus and potassium in both straw and grains.

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تاثير بعض محسنات التربة ومعاملات الرى على انتاجية محصول القمح فى مصر الوسطى

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تمت هذة الدراسة على القمح خلال موسمي شتوي ٢٠١٥ و ٢٠١٦ في محطة البحوث الزراعية في ملوي بمحافظة المنيا – مصر. لدراسة فاعلية ثلاثة معاملات للرى (رى مزارع)، الرى بمعدل ١٠٠% من البخر نتح ، الرى بمعدل ٧٥ % من البخر نتح بالاضافة لخمسة معاملات وهى (١٠٠% نيتروجين ، هيومات بوتاسيوم، ٧٥% نتروجين + هيومات بوتاسيوم ،٥٠ % نتروجين + هيومات بوتاسيوم ،٢٥% نتروجين + هيومات بوتاسيوم) .أظهرت نتائج الخصائص الكيمياوية للتربة أنه لم يتم ملاحظة أي متغيرات كبيرة في قيم الأس الهيدروجيني بين جميع المعاملات سواء تم اضافة ١٠٠% نتروجين او اضافة هيومات البوتاسيوم سواء منفردا أو عند اضافته مع معدلات النتروجين المختلفة وذلك فى كل من موسمى الزراعة . بصفة عامة أظهرت القيم المتوسطة زيادة ملوحة التربة عند أضافة معدلات مختلفة من النتروجين ايضا اضافة المعدل الثالث من الرى (I3 ٧٥ %من البخر نتح) سجلت أعلى قيم لملوحة التربة بالمقارنة بمعاملات الرى الاخرى . ولقد زادت قيم المادة العضوية بأضافة هيومات البوتاسيوم بالمقارنة بالكنترول (اضافة النتروجين فقط). بينما يقل محتوى المادة العضوية تحت معاملة الرى الاولى (رى المزارع) بالمقارنة بمعاملات الرى الاخرى .فيما يختص بالعناصر الكبرى الميسرة Nو P وK اظهرت القيم المتوسطة زيادة النتروجين والفوسفور والبوتاسيوم الميسر عند اضافة هيومات البوتاسيوم مختلط مع التسميد النتروجينى وذلك بالمقارنة باضافة النتروجين منفردا . اضافة هيومات البوتاسيوم مع ٧٥ % نتروجين يحقق قيم اعلى عن باقى المعاملات . كما تفوقت معاملة الرى (١٠٠% من البخر نتح) فى قيم Nو P وK بالمقارنة بمعاملات الرى الاخرى . ولقد حققت معاملة رى المزارع أعلى قيم احتياج مائى وكذلك اعلى استهلاك مائى فى كل من موسمى الزراعة وكانت اقل القيم تم الحصول عليها مع معاملة الرى ٧٥ % من البخر نتح . وكانت قيم كفاءة الاستهلاك المائى تقل عند اضافة معدلات النتروجين المختلفة. وكانت القيم المتوسطة لكفاءة الاستهلاك المائى خلال موسمى الزراعة عالية عند معاملة الرى الثانية وايضا عند اضافة هيومات البوتاسيوم مع ٧٥% من التسميد النتروجينى.بالاضافة الى ذلك أظهرت نتائج المحصول ومكوناته زيادة معنوية متاثر باضافة المعاملات بالمقارنة بمعاملة الكنترول وقد أعطت المعاملة ١٠٠% من البخر نتح فى وجود هيومات البوتاسيوم + ٧٥% من معدل النتروجين الموصى به اعلى محصول للقمح ومكوناته بالمقارنة بالمعاملات الاخرى. ونفس الاتجاه تم الحصول عليه للمحتوى الكلى من عناصر النتروجين والفوسفور والبوتاسيوم وذلك لكل من القش والحبوب لمحصول القمح .