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IMPROVING WATER PRODUCTIVITY FOR OPTIMIZING DURUM WHEAT CROP YIELD BY USING SUPER ABSORBENT POLYMER UNDER VARIOUS IRRIGATION REGIMES AND POTASSIUM FRETILIZATION IN TOSHKA

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ABSTRACT

During 2019/2020 and 2020/2021 seasons, the current study was conducted at the experimental farm, Water Studies and Research Complex (WSRC) Station, National Water Research Center, Toshka, Aswan, Egypt. Durum wheat crop (Triticum durum L.) of (Sohag3) used to improve water productivity under different irrigation regimes, potassium fertilization rates and Super Absorbent Polymer in sandy loam soils irrigated with ground water. Twelve treatments were created by combining the three irrigation regimes adequate (100%), moderate (80%) and deficient (60%) from crop evapotranspiration (ET_C), Super Absorbent Polymer (SAP) in the form of hydroxyethylcellulose at the rate of (6 g/kg soil) application rates (compared with control) by mixing with soil and two potassium fertilization in the form of potassium sulphate (48% K_2O) rates (50 and 100 % K). These were then replicated five times and put in a completely random pattern (split-split) in both seasons.

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The results proved that biological, grain and straw yields for durum wheat crop gave significant results. All interactions effects among the studies factors were insignificant indicating that the tested crop were similarly responded to both the irrigation regimes, adding Super Absorbent Polymer (SAP) and potassium treatment except the interaction between irrigation regimes and super absorbent polymer (SAP) in some factors were significant. The data revealed that 100% ET_C + adding SAP + 100% potassium exhibited the highest durum wheat crop productivity. However 60% ET_C without adding SAP + 50% potassium recorded the lowest durum wheat crop productivity. It was found that the durum wheat crop productivity under water level of (60%) of crop evapotranspiration (ET_C) + 100% K + adding SAP is equivalent to the durum wheat crop productivity under water level of 80% of crop evapotranspiration + 50% K without polymer. It was found that the durum wheat crop productivity under water level of 80% of crop evapotranspiration (ET_C) + 100% K + adding SAP is equivalent to the durum wheat crop productivity under water level of 100% of crop evapotranspiration (ET_C) + 100% K without polymer. It was found that the durum wheat crop productivity under water level of 80% of crop evapotranspiration + 50% K + adding SAP is equivalent to the durum wheat crop productivity under water level of 100% of crop evapotranspiration + 50% K without polymer.
Keywords: Toshka, Wheat, Potassium, Irrigation Water Use Efficiency, Super Absorbent Polymer.

INTRODUCTION

Egypt is one of the countries with limited water resources, which requires not only calculating and adding plants water requirements accurately, but also improving water productivity for optimizing crop yield. The desert lands of Egypt suffer from the poverty of water and in addition to the nutrient poverty of agricultural soils. Therefore, with all these challenges, attention should be paid to raising the irrigation water use efficiency and rationalizing the crop water consumption by some treatments and innovative techniques in this regard, which in turn is reflected in the maximizing of crop productivity (Kirda, 2000).

In addition to using of soil conditioners as an important and helpful factor in rationalization the crop water consumption (Bakass, *et al*., 2002) , which are products added to the soil to improve its mechanism, fertility and physical properties, the term soil conditioners can often include a wide range of fertilizers and inorganic materials.

Potassium is one of the essential macro elements required by plants for their growth and development. It promotes the control of stomata opening, enzyme activation in plants, especially those responsible for energy transfer and formation of sugars, starch and protein (Yawson, *et al*., 2011).

The major limitation for plant growth and crop production in arid and semi-arid regions is soil water availability. Plants that are continuously exposed to drought stress can form, which leads to leaf damage (Cakmak, 2005) and ultimately, decreases crop yield. The resulting lower potassium concentrations can further depress the plant resistance to drought stress, as well as potassium absorption. Maintaining adequate plant potassium is, therefore, critical for plant drought resistance.

Research evidences suggest that when the soil is treated with super absorbent polymers, the water volumetric content of the soil increases significantly and as the soil dries, the stored water is released back slowly

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into soil. Further, fertigation is also possible by the application of super absorbent polymer to the soil as the same is capable of absorbing the fertilizer and releasing the same with water (Rajiv *et al*., 2014). The application of polymers in arid and semi–arid regions improve soil properties, increases the water holding capacity of the soil, enhance of the soil water retention, improving irrigation efficiency, increasing the growth of various crops, and enhancement water productivity of the crop. It also provides a conducive atmosphere for the better growth of roots in soils and ultimately increases yield. According to chemical and physical structures of polymers, it can be used as an absorbent in environment preservation in the agricultural sector as water retention, soil conditioners, and nutrient carriers (Abrisham *et al*., 2018).

The main target of this study is improving water productivity for optimizing durum wheat crop yield by using Super Absorbent Polymer as a soil conditioner under various irrigation regimes under the agro-climatic conditions in Toshka region.

MATERIALS AND METHODS

Experimental study: During the two successive growth seasons of 2019/2020 and 2020/2021 the study was carried out at the experimental farm of the Water Studies and Research Center, Toshka, Aswan, Egypt, which is located at 22^o, 24`.11` N longitude of 31^o, 35`.43` E longitude. The altitude of the area is 188m above sea level. Using sprinkler irrigation system for the durum wheat crop

(Triticum durum L.) of (Sohag3). Toshka agrometeorological data was used during the period from 2015-2019 to calculate crop water requirements.

Calculation of irrigation water requirement: CROPWAT is a decision support system developed by FAO to evaluate the degree to which crop water requirements are fulfilled either by rain or irrigation during the growing season (Bhat *et al*., 2017). CROPWAT uses weather parameters to estimate the most reliable values for crop evapotranspiration (ETc) and Crop Water Requirement (CWR) and to schedule an appropriate irrigation program for single and multi-crop fields (Manjunatha *et al*., 2013; Martyniak *et al*., 2007). CROPWAT 8.0 (the latest version) estimates the reduction in crop yield due to water stress using water balance method (Allen *et al*., 1998). CROPWAT algorithms for estimating evapotranspiration (ET) and irrigation needs used the FAO56-PM equation (Allen *et al*., 1998) along with climate, soil, and crop characteristics.

Irrigation Water Use Efficiency (IWUE): Regulated deficit irrigation defined as irrigation practice whereby a crop is irrigated with an amount of water below the full requirement for optimal plant growth, this is to reduce the amount of water used for irrigation crops, improves the response of plant to certain degree of water deficit in positive manner, and reduce irrigation amounts or increase the Water Use Efficiency (WUE). (Chai *et al*., 2014)

Irrigation Water Use Efficiency (IWUE) was measured in this section of the study as a ratio between total dry matter (kg/fed) and irrigation water

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consumed (m^3/fed). The (IWUE) dropped in both growing seasons after increasing irrigation water from (60% to 100%) ET_C (Simonne *et al*. 2006; Elmaloglou and Diamantopoulos, 2007; Elmaloglou and Diamantopoulos, 2009).

Irrigation Water Use Efficiency (IWUE) was calculated according to (James, 1988) as follows: IWUE (kg grain/ m^3 water), Total yield (kg grain/fed.) Total applied irrigation water, (m^3 water/fed./ season).

$$IWUE = \frac{Grain\ \ yield\ (Kg\ /\ fed.)}{Irrigation\ water\ requirements\ (m^3\ /\ fed.)}$$

<u>Wheat experimental design</u>: In the winter seasons of 2019/2020 and 2020/2021, wheat grains of (Sohag 3) cultivar were sown on November 28th in both seasons, with a rate of 60 kg grains / fed. Wheat plants were harvested on 5,6th April in first and second season, respectively. Nitrogen as ammonium nitrate (33.5% N) and phosphorus as a super phosphate (15.5% P_2O_5) were added according to the recommended levels while potassium in the form of potassium sulphate (48% K_2O) was added in two equal portions at 2 levels of potassium (50, 100% K) during the early growth stage.

A field experiment was carried out in twelve treatments which created by combining the three irrigation regimes, adequate (100%), moderate (80%), and deficient (60%) (main plot) and adding super absorbent polymer (SAP) in the form of hydroxyethylcekkulose application rates at the rate of (6 g/kg soil) as recommended by (Shooshtarian *et al*., 2011) (sub plot) (with and

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without or control) and with two levels of potassium sulphate (48% K_2O) (50 and 100%) (sub-sub plot) under sprinkler irrigation system, in two seasons of 2019/2020 and 2020/2021.

Irrigation water applied: Irrigation treatments were started after completion of germination, 14 days after planting. Wheat plants were irrigated day after day in the morning using the calculated amount of water based on reference evapotranspiration (ET_o) and crop factor for each growth period as summarized in Table (1).

Table (1): The meteorological data used to calculate the reference evapotranspiration (ET_0)

Element / Month	Rain mm/day	W.S (m/sec)	Sunshine hours/day	RH (%)	Temperature Minimum (ºc)	Temperature Maximum (ºc)	ET_0 (mm) Penman-Monteith
Winter season 2019/2020							
November	0.0	2.74	10.9	33.67	16.47	31.41	5.83
December	0.0	3.0	10.6	40.5	10.6	25.0	4.66
January	0.0	2.78	10.7	32.44	8.76	23.71	4.69
February	0.0	3.48	11.17	35.38	9.42	25.12	5.64
March	0.0	2.90	11.7	26.10	14.85	30.86	7.16
Winter season 2020/2021							
November	0.0	2.80	10.9	36.6	16.09	29.17	5.51
December	0.0	3.3	10.6	42.41	8.04	23.21	4.55
January	0.0	2.4	10.7	42.12	8.6	24.66	4.28
February	0.0	2.5	11.17	29.8	13.25	28.84	5.7
March	0.0	3.3	11.7	22.36	15.5	31.3	7.77

RH: Relative Humidity; WS: Wind Speed; ET_0: Reference Evapotranspiration

Calculation of irrigation water applied: Irrigation water applied were added to different irrigation regimes during the growth seasons 2019/20 and 2020/21 and some climatic data are presented in tables (2 & 3).

Table (2): Irrigation water applied of wheat crop under various irrigation regimes in season 2019/2020

Growing period	Growing Season 2019/2020										
	ET_0 mm/period (10days)	ET_0 mm/day	K_c	ET_c mm/period	I.E (%)	CWR (mm/ period)			Irrigation Water m³/fed/period		
						60%	80%	100%	60%	80%	100%
28/11-7/12/2019	43.7	4.4	0.3	13.1	0.75	10.5	14.0	17.5	44.0	58.7	73.3
8-17/12/2019	39.1	3.9	0.3	11.7	0.75	9.4	12.5	15.6	39.4	52.5	65.6
18-27/12/2019	31.8	3.2	0.3	9.5	0.75	7.6	10.2	12.7	32.0	42.7	53.4
(28/12/19)-(6/1/2020)	26.5	2.6	0.5	12.2	0.75	9.7	13.0	16.2	40.9	54.5	68.2
7-16/1/2020	26.0	2.6	0.7	19.2	0.75	15.4	20.5	25.6	64.6	86.1	107.6
17-26/1/2020	28.6	2.9	1.0	29.1	0.75	23.3	31.1	38.8	97.8	130.5	163.1
27/1-5/2/2020	28.5	2.9	1.2	32.8	0.75	26.2	35.0	43.7	110.2	146.9	183.6
6-15/2/2020	29.9	3.0	1.2	34.3	0.75	27.5	36.6	45.8	115.3	153.8	192.2
16-25/2/2020	33.8	3.4	1.2	38.9	0.75	31.1	41.5	51.9	130.7	174.2	217.8
26/2-6/3/2020	41.0	4.1	1.2	47.1	0.75	37.7	50.3	62.9	158.4	211.2	264.0
7-16/3/2020	50.2	5.0	1.0	49.7	0.75	39.8	53.1	66.3	167.1	222.8	278.5
17-26/3/2020	57.4	5.7	0.7	40.8	0.75	32.6	43.5	54.4	137.0	182.6	228.3
27/3-5/4/2020	53.8	5.4	0.4	23.2	0.75	18.5	24.7	30.9	77.8	103.7	129.6
Total water						289.3	385.8	482.2	1215.2	1620.2	2025.3

(ET_0): Reference Evapotranspiration; (Kc): Crop Coefficient; (ET_C): Crop Evapotranspiration; (I.E) : Irrigation Efficiency; (CWR): Crop Water Requirements

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Table (3): Irrigation water applied of wheat crop under various irrigation regimes in season 2020/2021

Growing period	Growing Season 2020/2021										
	ET_0 mm/period (10 days)	ET_0 mm/day	K_c	ET_c mm/period	I.E (%)	CWR (mm/ period)			Irrigation Water m^3/fed/period		
						60%	80%	100%	60%	80%	100%
28/11-7/12/2020	42.1	4.2	0.3	12.6	0.75	10.1	13.5	16.8	70.7	56.6	70.7
8-17/12/2020	37.5	3.8	0.3	11.3	0.75	9.0	12.0	15.0	63.0	50.4	63.0
18-27/12/2020	30.2	3.0	0.3	9.1	0.75	7.2	9.7	12.1	50.7	40.6	50.7
(28/12/20)-(6/1/2021)	24.9	2.5	0.5	11.4	0.75	9.2	12.2	15.3	64.1	51.3	64.1
7-16/1/2021	24.4	2.4	0.7	18.1	0.75	14.4	19.3	24.1	101.1	80.9	101.1
17-26/1/2021	27.0	2.7	1.0	27.5	0.75	22.0	29.4	36.7	154.1	123.3	154.1
27/1-5/2/2021	26.9	2.7	1.2	31.0	0.75	24.8	33.0	41.3	173.5	138.8	173.5
6-15/2/2021	28.3	2.8	1.2	32.5	0.75	26.0	34.7	43.4	182.1	145.7	182.1
16-25/2/2021	32.3	3.2	1.2	37.1	0.75	29.7	39.6	49.5	207.7	166.2	207.7
26/2-7/3/2021	39.4	3.9	1.2	45.3	0.75	36.3	48.4	60.4	253.9	203.1	253.9
8-17/3/2021	48.7	4.9	1.0	48.2	0.75	38.5	51.4	64.2	269.8	215.9	269.8
18-27/3/2021	55.9	5.6	0.7	39.7	0.75	31.7	42.3	52.9	222.1	177.6	222.1
28/3-6/4/2021	52.3	5.2	0.4	22.5	0.75	18.0	24.0	30.0	125.9	100.7	125.9
Total water						277.0	369.3	461.6	1163.2	1551.0	1938.7

(ET_0): Reference Evapotranspiration; (Kc): Crop Coefficient; (ET_C): Crop Evapotranspiration; (I.E): Irrigation Efficiency; (CWR): Crop Water Requirements

Soil sampling: Soil physical (Klute,1986) and chemical properties (Jackson, 1973) were determined and recorded in Tables (4 - A and B). The chemical analysis of the ground water were measured and recorded by Toshka Laboratories unit as shown in table (4 - C).

Table (4): Some analytical data of the studied soil and ground water of the experimental farm before cultivation

Table (4.A): Some physical properties of the cultivated soil

Soil depth (cm)	Particle size distribution (%)			Tex. class	S.P. (%)	F.C (%)	W.P (%)	A.W. (%)
	Sand	Silt	Clay					
0-20	85.73	5.56	8.71	L. S	28.5	13.5	0.2	13.3
20-40	83.19	5.12	11.69	L. S	30.6	13.5	0.2	13.3
40-60	83.26	12.89	3.85	L. S	28.4	12.6	2.1	10.5

L.S = Loamy Sand; S = Sand; S.P = Saturation Percent; F.C = Field Capacity;

W.P = Wilting Point; A.W = Available Water

Table (4.B): Some chemical properties of the cultivated soil

Soil depth (cm)	$CaCO_3$ (%)	OM %	pH (1:2.5) Soil extract	EC (dS/m) (1:5) Soil extract	Soluble ions (meq/l)						
					Anions			Cations			
					CO_3^{-2}+ HCO3	SO_4^{-2}	Cl^-	Ca^{+2}	Mg^{+2}	Na^+	K^+
0-20	14.6	0.63	6.45	0.64	2.0	1.1	3.3	5.3	0.4	0.5	0.2
20-40	14.6	0.54	6.85	0.59	1.9	2.8	1.2	5.2	0.2	0.2	0.3
40-60	15.0	0.46	6.53	0.67	1.9	1.7	3.1	4.8	1.3	0.4	0.2

OM = Organic Matter

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Table (4.C): Some chemical analysis of the ground water irrigation

Date	pH	EC (dS/m)	TDS mg/l (ppm)	Cations (meq/l)				Anions (meq/l)				SAR
				Na^{+}	K^{+}	Mg^{+2}	Ca^{+2}	Cl^{-}	CO_3^{-2}	HCO^{-3}	SO_4^{-2}	
Nov.2019	6.7	0.75	480	3.4	0.3	1.2	2.6	3.3	1.8	1.6	0.76	2.46
Nov.2020	6.7	0.77	493	3.4	0.3	1.4	2.6	3.3	1.9	1.65	0.85	2.4

TDS = Total Dissolved Solids; SAR = Sodium Adsorption Ratio

RESULTS AND DISCUSSION

The data in tables (5 and 6) revealed that the irrigation water use efficiency in (2019-2020 and 2020-2021) seasons used (60 %) ET_C treatment plus Super Absorbent Polymer (SAP) treatment and (100%) potassium sulphate (50% K) was (1.64 - 1.69) kg/m^3, while the irrigation water use efficiency was (1.24 - 1.52) kg/m^3 in (2019-2020 and 2020-2021) seasons used (60 %) ET_C treatment without adding (SAP) and (50%) potassium .Thus, it is clear that the irrigation water efficiency increases with adding Super Absorbent Polymer and increasing potassium levels.

Table (5): Yield and irrigation water use efficiency (IWUE) of wheat crop grown under irrigation regimes in season of 2019-2020 for wheat crop

Factor		Crop Water Requirements in Season of 2019-2020								
		Grain yield (kg/fed.)			Irrigation water applied (m^3/fed.)			Irrigation water use efficiency (kg/m^3)		
Irrigation regime (I)	Potassium (K)	Super Absorbent Polymers (SA P)		Mean	Super Absorbent Polymers (SAP)		Mean	Super Absorbent Polymers (SAP)		Mean
		with	without		with	without		with	without	
60 %	100%	1995.0	1848.0	1921.5	1215.2	1215.2	1215.2	1.64	1.52	1.58
	50%	1701.0	1502.0	1601.5	1215.2	1215.2	1215.2	1.40	1.24	1.32
		1848.0	1675.0	1761.5	1215.2	1215.2	1215.2	1.52	1.38	1.45
80 %	100%	2541.0	2237.0	2389.0	1620.0	1620.0	1620.0	1.57	1.38	1.47
	50%	2331.0	2006.0	2168.5	1620.0	1620.0	1620.0	1.44	1.24	1.34
		2436.0	2121.5	2278.8	1620.0	1620.0	1620.0	1.50	1.31	1.41
100 %	100%	2562.0	2520.0	2541.0	2025.3	2025.3	2025.3	1.26	1.24	1.25
	50%	2541.0	2373.0	2457.0	2025.3	2025.3	2025.3	1.25	1.17	1.21
		2551.5	2446.5	2499.0	2025.3	2025.3	2025.3	1.26	1.21	1.23
Mean		2278.5	2081.0	2179.8	1620.2	1620.2	1620.2	1.43	1.30	1.36

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Table (6): Yield and irrigation water use efficiency (IWUE) of wheat crop grown under irrigation regimes in season of 2020-2021 for wheat crop

Factor		Crop Water Requirements in Season of 2020-2021								
		Grain yield (kg/fed.)			Irrigation water applied (m^3/fed.)			Irrigation water use efficiency (kg/m^3)		
Irrigation regime (I)	Potassium (K)	Super Absorbent Polymers (SAP)		Mean	Super Absorbent Polymers (SAP)		Mean	Super Absorbent Polymers (SAP)		Mean
		with	without		with	without		with	without	
60 %	100%	1963.5	1890.0	1926.8	1163.2	1163.2	1163.2	1.69	1.62	1.66
	50%	1837.6	1764.0	1800.8	1163.2	1163.2	1163.2	1.58	1.52	1.55
		1900.5	1827.0	1863.8	1163.2	1163.2	1163.2	1.63	1.57	1.60
80 %	100%	2352.0	2236.5	2294.3	1551.0	1551.0	1551.0	1.52	1.44	1.48
	50%	2352.0	2131.5	2241.8	1551.0	1551.0	1552.0	1.52	1.37	1.44
		2352.0	2184.0	2268.0	1551.0	1551.0	1551.5	1.52	1.41	1.46
100 %	100%	2478.0	2352.0	2415.0	1938.7	1938.7	1938.7	1.28	1.21	1.25
	50%	2404.0	2163.0	2283.5	1938.7	1938.7	1938.7	1.24	1.12	1.18
		2441.0	2257.5	2349.3	1938.7	1938.7	1938.7	1.26	1.16	1.21
Mean		2231.2	2089.5	2160.3	1551.0	1551.0	1551.1	1.47	1.38	1.43

Durum wheat yield:

Biological yield: Table (7) shows that the biological yield of durum wheat crop was recorded a significant effect at all treatments, whereas the highest values (1.46 kg/m^2) in both seasons at (100%) ET_C when adding Super Absorbent Polymer (SAP) in the form of Hydroxyethylcellulose and (100%) potassium sulphate. While the lowest values of the biological yield was recorded (0.85 and 1.0 kg/m^2) at (60%) ET_C without polymer and with (50%) potassium sulphate.

Finally, all interactions effects among the studies factors were insignificant indicating that the tested crop were similarly responded to both the various irrigation regimes and adding (SAP), potassium sulphate treatment except for the interaction between irrigation and (SAP). These results are agree with those obtained by Almasian *et al*., (2006) and Mohammed, (2007).

Table (7): Effect of irrigation regimes, Super Absorbent Polymer (SAP) and potassium sulphate treatments on biological yield (kg per m^2) during the two seasons 2019/2020 and 2020/2021 for wheat crop

Factor		2019/2020 Super Absorbent Polymer (SAP)		Mean	2020/2021 Super Absorbent Polymer (SAP)		Mean
Irrigation (I)	Potassium (K)	with	without		with	without	
60 %	100%	1.11	1.02	1.07	1.16	1.05	1.11
	50%	0.94	0.85	0.90	1.11	1.00	1.06
		1.03	0.94	0.98	1.14	1.03	1.08
80%	100%	1.42	1.26	1.34	1.39	1.29	1.34
	50%	1.30	1.12	1.21	1.31	1.26	1.29
		1.36	1.19	1.28	1.35	1.28	1.31
100 %	100%	1.46	1.42	1.44	1.46	1.42	1.44
	50%	1.42	1.35	1.39	1.44	1.41	1.43
		1.44	1.39	1.41	1.45	1.42	1.43
Mean		1.28	1.17	1.22	1.31	1.24	1.28
LSD 0.05		I =0.11 K = 0.11 SAP =0.05 I x SAP=0.08			I = 0.09	K = 0.01	SAP = 0.02
					I x SAP	= 0.04	

Grain yield: Table (8) shows that irrigation regimes, SAP in the form of Hydroxyethylcellulose and potassium sulphate all treatments had a substantial impact on wheat grain yield, which increased significantly as irrigation regimes water was increased. In the first season, when adding polymers data recorded 13.3-16.9-17.1 ardab/fed., at 60, 80 and 100 % ET_C , respectively

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for 100% potassium, while 50% potassium sulphate gave 11.3-15.5-16.9 ardab /fed., at 60, 80 and 100 % ET_C, respectively and the treatment without adding SAP data recorded 12.3-14.9 and 16.8 ardab/fed., at 60, 80 and 100% ET_C, respectively for 100% potassium sulphate, while 50% potassium sulphate gave 10.0-13.4 and 15.8 ardab /fed., at 60, 80 and 100 % ET_C, respectively. In the second season, when adding SAP data recorded 13.1-15.7 and 16.5 ardab /fed., at 60, 80 and 100 % ET_C, respectively for 100% potassium sulphate, while 50% potassium sulphate gave 12.3-15.7 and 16.0 ardab /fed., at 60, 80 and 100 % ET_C, respectively and the treatment without adding SAP. The data recorded 12.6-14.9 and 15.7 ardab /fed., at 60, 80and 100 % ET_C, respectively for 100% potassium sulphate, while 50% potassium sulphate gave 11.8-14.2 and 14.4 ardab /fed., at 60, 80 and 100 % ET_C, respectively. These results are in harmony with those obtained by Aly, (2005), Mohammed, (2007) and Hefzy, (2009). Moreover all studied interaction were not significant in both seasons.

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Table (8): Effect of irrigation regimes, Super Absorbent Polymer (SAP) and potassium sulphate treatments on grain yield (ardab/fed) during the two seasons 2019/2020 and 2020/2021 for wheat crop

Factor		2019/2020 Super Absorbent Polymer (SAP)		Mean	2020/2021 Super Absorbent Polymer (SAP)		Mean
Irrigation (I)	Potassium (K)	with	without		with	without	
60 %	100%	13.3	12.3	12.8	13.1	12.6	12.9
	50%	11.3	10.0	10.7	12.3	11.8	12.1
		12.3	11.2	11.7	12.7	12.2	12.5
80%	100%	16.9	14.9	15.9	15.7	14.9	15.3
	50%	15.5	13.4	14.5	15.7	14.2	15.0
		16.2	14.2	15.2	15.7	14.6	15.1
100 %	100%	17.1	16.8	17.0	16.5	15.7	16.1
	50%	16.9	15.8	16.4	16.0	14.4	15.2
		17.0	16.3	16.7	16.3	15.1	15.7
Mean		15.2	13.9	14.5	14.9	13.9	14.4
$LSD_{0.05}$		I = 1.32 K = 0.29 SAP = 0.65 I x SAP = 1.13			I = 1.9 K = 0.34 SAP = 0.6 I x SAP = NS		

Straw yield: Table (9) shows that irrigation, SAP and potassium sulphate treatment exerted a significant effect on straw yield in both seasons, where the highest values were 3.46 and 3.61 ton/fed. without SAP application and (3.58 and 3.63 ton/fed.) with SAP application in both seasons, respectively in 100% ET_C combined with 100% potassium sulphate and (3.28 and 3.76 ton/fed.) without SAP application and (3.42 and 3.64 ton/fed.) with SAP application in both seasons, respectively in 100% ET_C, 50% potassium

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sulphate. It is clear from these results that all studied interaction effects were not significant in both seasons except for the interaction between irrigation and SAP in the second season. These results are in line with those obtained by Almasian *et al*., (2006), Mohammed (2007) and Hefzy (2009).

Table (9): Effect of irrigation regimes, super absorbent polymers (SAP) and potassium sulphate treatments on straw yield (ton/ fed.) during the two seasons 2019/2020 and 2020/2021 for wheat crop

Factor		2019/2020 super absorbent polymer (SAP)		Mean	2020/2021 super absorbent polymer (SAP)		Mean
Irrigation (I)	Potassium (K)	with	without		with	without	
60 %	100%	2.65	2.45	2.55	2.92	2.53	2.73
	50%	2.26	2.07	2.17	2.83	2.44	2.64
		2.46	2.26	2.36	2.88	2.49	2.68
80%	100%	3.40	3.07	3.24	3.49	3.18	3.34
	50%	3.11	2.69	2.90	3.14	3.15	3.15
		3.26	2.88	3.07	3.32	3.17	3.24
100 %	100%	3.58	3.46	3.52	3.63	3.61	3.62
	50%	3.42	3.28	3.35	3.64	3.76	3.70
		3.50	3.37	3.44	3.64	3.69	3.66
Mean		3.07	2.84	2.95	3.28	3.11	3.19
$LSD_{0.05}$		I = 0.25 K = 0.09 SAP = 0.13 I x SAP = NS			I = 0.52 K = 0.07 SAP = 0.1 I x SAP = 0.18		

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CONCLUSION

It could be concluded that adding Super Absorbent Polymer and increase in the level of potassium has an effective on increasing durum wheat crop productivity in Toshka, in addition to the role of polymers in providing about 20% from water requirements of durum wheat crop.

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زيادة إنتاجية المياه لتحسين إنتاجية محصول قمح الديورم باستخدام بوليمر فائق الامتصاص تحت مستويات ري وتسميد بوتاسي مختلفة في توشكي

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المستخلص

أجريت هذه الدراسة في مزرعة تجارب الأبحاث الزراعية بمجمع الدراسات والبحوث المائية بتوشكي في الموسم الشتوي لعامي ٢٠٢٠/٢٠١٩، ٢٠٢١/٢٠٢٠ وذلك لدراسة استخدام مستويات مختلفة من الري وبوليمر فائق الامتصاص ومعدلات مختلفة من التسميد البوتاسي لترشيد ورفع كفاءة مياه الري لتحسين إنتاجية محصول قمح الديورم بتوشكى. تم استخدام محصول قمح الديورم صنف (سوهاج ٣) في الدراسة وتم إنشاء اثنى عشر معاملة من خلال الجمع بين مستويات ري مختلفة وهى الكافية (١٠٠%) والمعتدلة (٨٠%) والناقصة (٦٠%) من البخر نتح المحصولى مع استخدام بوليمر فائق الامتصاص متمثل في مادة الهيدروكسي ايثيل سليلوز (مع وبدون) بمقدار (٦ جم/كجم تربة) وتمت الاضافة عن طريق خلط المادة مع التربة بالإضافة إلى استخدام مستويين (١٠٠, ٥٠%) من سلفات البوتاسيوم وتم تكرارها خمس مرات ووضعها في قطع منشقة المنشقة.

كانت النتائج معنوية لجميع المستويات حيث أثبتت التجارب أن كلا من المحصول البيولوجي ومحصول الحبوب ومحصول القش لمحصول القمح أعطت نتائج معنوية بين المعاملات الثلاثة ، أما جميع تأثيرات التفاعلات بين عوامل الدراسة كانت غير معنوية مما يدل على أن المحصول المختبَر كان متماثلاً في الاستجابة مع مستويات الري ووالبوليمرات فائقة الامتصاص ومعالجة البوتاسيوم

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باستثناء التفاعل بين مستويات الري والبوليمرات فائقة الامتصاص كانت النتائج في بعض العوامل معنوية. أوضحت النتائج أن استخدام مستوى مياه ١٠٠% من البخر نتح المحصولى + إضافة البوليمرات فائقة الامتصاص + مستوى ١٠٠ % من البوتاسيوم أعطت أعلى إنتاجية لمحصول قمح الديورم وكذلك استخدام مستوى مياه ٦٠% من البخر نتح المحصولى + بدون إضافة البوليمر + مستوى ٥٠ % من البوتاسيوم أعطت أقل إنتاجية لمحصول قمح الديورم. أوضحت النتائج أن انتاجية مستوى مياه ٦٠ % من البخر نتح المحصولى + ١٠٠ % بوتاسيوم + إضافة البوليمر فائق الامتصاص يعادل إنتاجية مستوى مياه ٨٠ % من البخر نتح المحصولى + ٥٠% بوتاسيوم بدون إضافة البوليمر. أوضحت النتائج أن انتاجية مستوى مياه ٨٠% من البخر نتح المحصولى +١٠٠% بوتاسيوم + إضافة البوليمر فائق الامتصاص يعادل إنتاجية مستوى مياه ١٠٠ % من البخر نتح المحصولى +١٠٠% بوتاسيوم بدون إضافة البوليمر. أوضحت النتائج أن انتاجية مستوى مياه ٨٠% من البخر نتح المحصولى + ٥٠% بوتاسيوم + إضافة البوليمر فائق الامتصاص يعادل إنتاجية مستوى مياه ١٠٠ % من البخر نتح المحصولى + ٥٠% بوتاسيوم بدون إضافة البوليمر. مما سبق يتضح أن إضافة البوليمر فائق الامتصاص وزيادة مستوى البوتاسيوم له تأثير فعال في زيادة إنتاجية محصول قمح الديورم بتوشكى فضلا عن دور البوليمر المضاف في توفيرما يقرب من ٢٠% من الاحتياجات المائية لمحصول قمح الديورم.

الكلمات المفتاحية: توشكي, قمح, بوتاسيوم, كفاءة استخدام ماء الري, بوليمر فائق الامتصاص.