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Influence of Irrigation Treatments and Humic Acid (HA) Application on Vegetative Growth, Yield, Tuber Quality Water Requirements and Water Utilization Efficiency (WUE) of Potato Plants.

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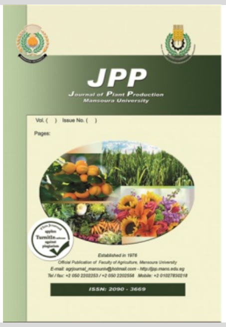

ABSTRACT

The present investigation were carried out in the two successive summer growing seasons 2018 and 2019 on potato plant, CV. Sponta, at South El- Tahrir district, newly reclaimed sandy soils at the experimental station farm, Horticulture Research station Beheira Governorate to study the influence of irrigation treatments and humic acid (HA) application at different growth stages on vegetative growth, yield potential, tuber quality, water requirements and water utilization efficiency (WU_tE) of potato plants. Nine irrigation treatments were applied at three periods, (S_1) vegetative growth, (S_2) tuber formation and (S_3) tuber bulking. Results revealed that there were significant effects due to the irrigation and humic acid treatments and their interactions on potato production in both growing seasons. T1 irrigation treatment gave the mean highest values of vegetative growth traits (plant height, number of branches, fresh and dry weight of plant, yield/plant, and number of tubers plant^{-1}, average tuber weight, yield/feddan, and tuber diameter). Application of humic acid (HA) resulted in improving vegetative growth characters, in both seasons. Water stress treatments at S1 generated the lowest mean values of all vegetative growth characters, which illustrated that this stage is sensitive to water stress treatments. The interaction between irrigation treatments and HA reflected significant differences on the studied vegetative growth parameters. The interaction of T1 treatment and HA application showed superior influence on vegetative growth traits, in both growing seasons. On the other hand, the highest mean values for tuber content of starch were obtained by Ta and HA application.

Keywords: Irrigation treatments, Humic acid, water utilization efficiency (WUE), potato plants.

INTRODUCTION

Potato (*Solanum tuberosum L.*) is one of the most important vegetable crops panted in Egypt; Potato is gained a considerable importance as an export crop to European Markets and it is one of the national income resources. Potato belongs to the family Solanaceae and it is a major food crop in the world and by far the most important vegetable crop in terms quantities produced and consumed worldwide (El-Zohiri *et al*, 2009). Drought stress is considered as one of the most important factor which limits production of potatoes. It can decrease the plant growth (Deblonde and Ledent, 2001) and affect negatively on the number and size of producing tubers (Eiasu *et al*, 2007). Furthermore, the exposing to short period of water deficit during tuber bulking led to many defects and deformities such as dumbbell-shaped and knobby tubers (Mackerron and Jefferies, 1988). In general, there were several conges at the physiological, biochemical and molecular levels associated with drought stress. Among these responses, decline the photosynthetic, stomatal conductance, chlorophyll concentration and modify the balance of water statues, phytohormones, reactive oxgen species (ROS) and activities of antioxidants in plant tissues (Ibrahim and Huda, 2016). Potato plants are critical to changes in soil moisture content, particularly during (tuber initiation and tuber formation) which may result in yield decrease (Al-Aubiady, 2005). Wright and Stark (1990) recorded that some draught water stress can be tolerated during early vegetative growth and late tuber Maturation stages under water stress condition. However, at tuber formation the plants are mainly sensitive to drought, which result in decreased tuber number and low yield (Havarkont *et al*, 1990 and Thornton, 2002). For high product, Steyn *et al* (2007) illustrated that water stress from tuber initiation until tuber Maturation should be avoided.

Humic acid (HA) is deem as a media for delivering essential nutrients for better potato plant growth and increase yield (Sanli *et al*, 2013). Many researchers reported the importance of HA addition for increasing potato yield and refinement tuber quality. Mohmoud and Hafez (2010) found higher tuber yield and tuber quality with increased levels of humic acid application. The stimulatory effects of humic acid on plant vegetative growth yield and nutrient uptake have been studied in a lot of economic crop including potato plants. However, the potential of HA to refinement tolerance to drought (water stress) has recently started and it needs more investigation (Calvo *et al*, 2014). Humic acid (HA) subjoin essential

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organic material necessary for water retention thus refinement root growth and enhancing the sandy soils ability to retain and not leach out vital plant nutrients (LL.C, 2013). Therefore, this investigation was conducted to clarify the effect of water stress applied at different growth period on plant vegetative growth, tuber development and water utilization efficiency (WUE) of potato. The effects of HA application in increasing significantly the ability of potato plants to tolerate water stress is also, deemed.

MATERIALS AND METHODS

Two field investigations were conducted at Aly Mubark experimental Farm El-Bustan area, South El-Tahrir region in 2017 and 2018 summer growing seasons. The experimental site represents the newly reclaimed sandy soils where modern irrigation systems are introduced to farmers of the area. The drip irrigation system used in the experimental farm contains an irrigation pump and a fertilizer injector. A 63 out diameter PVC sub- main line connected it lateral poly ethylene lines of 16 mm out diameter. Each lateral is 30m long and 0.8m apart with standard 4L/h due to pressure drop. The class a pan in the experimental farm was used to determine the quantity of applied irrigation water to the tested irrigation treatments. Imported certified potato seed tubers of cv. Spunta were purchased from Daltex Company, El-Tawfikia, Behira Governorate.

The potato seeds were planted on January 30th, in both seasons, Table (1) shows the Physical and chemical Ingredients of experimental soil.

Table1. Physical and chemical proprieties of the experimental soil site in 2018 and 2019 seasons.

Properties	Sand %	Silt %	Clay %	Texture Class	O.M %	Caco3	PH (1.25)	N	P	K	Fe	Zn	Mn
								Mg kg^{-1}					
2018	94.7	3.3	2.0	Sand	0.07	1.15	7.8	0.06	3.91	9.61	3.15	1.9	1.5
2019	94.1	3.7	2.2	Sand	0.05	1.12	8.4	0.05	3.82	10.71	3.11	1.6	1.8

These analyses were carried out at the laboratory of plant nutrition Section; Soil Water and Environment Research institute.

Nine water irrigation treatments were studied during three stages of potato growth as Follows: (1) (S_1) Stage 1: vegetative growth; up to 40 days after planting (DAP), (2) (S_2) Stage 2: tuber formation; started from 41 to 74 DAP, (3) (S_3) Stage 3: tuber bulking; started from 75 up to 110 DAP, (Steyn *et al*, 2007).

The nine irrigation water treatments depends on crop evapotranspiration (ETc), were included into the three developmental stages of potato plants as follows: (1) T_1: 100% ETc during the growing periods, (2) T_2: 20% stress of water (80% ETc) during the growing periods, (3) T_3: 40% stress of water (60% ETc) during the growing period, (4) T_4: 20% stress of water at (Stage 1) and 100% ETc throughout (S_2) and (S_3), (5) T_5: 20% stress of water at (Stage 2) and 100% ETc throughout (S_2) and (S_3), (6) T_6: 20% stress of water at (Stage 3) and 100% ETc throughout (S_1) and (S_2), (7) T_7: 40% stress of water at (Stage 1) and 100% ETc throughout (S_2) and (S_3), (8) T_8: 40% stress of water at (Stage 2) and 100% ETc throughout (S_1) and (S_3), (9) T_9: 40% stress of water at (Stage 3) and 100% ETc throughout (S_1) and (S_2).

Irrigation scheduling was calculated from Equation:

$$ET_c = ET_p \times K_c$$

(Allen *et al*, 1998).

Irrigation water was applied in 3 and 6 days interval, and irrigation water quantities were based on ETP value to ensure the proper germination. The adopted irrigation regimes were applied after complete plant establishment. Potential evapotranspiration (ETp) values were calculated based on class A pan records as follows:

$$ET_P = E\ pan * K\ pan$$

(Doorenbos and Pruitt, 1984)**where:**

E pan= measured class A pan evaporation values (mmd^{-1}).

K pan= Pan Coefficient that equals 0.75 for the experimental site.

The amounts of irrigation were calculated according to the equation outlined by Vermetren and Jopling (1984) as follows:

$$AIW = (ETp*Kc*I) /(Ea (I-LR)).$$

Where:

(1) AIW= depth of irrigation water (mm), (2) ET_P= tension evapotranspiration (mmd^{-1}), (3) Kc= crop coefficient values at the experimental site, (3) I= irrigation term (days), (4) Ea= irrigation implementation efficiency of the drip irrigation systems, (5) LR= leaching requirements, not considered under the present experiment.

Irrigation time for drip Irrigation systems was estimated before an Irrigation event by measuring the emitter discharges (Lh^{-1}) AIW= applied Irrigation water (cm).

Ingredients of Humic acid: Humic acid 86%+6% (Huma K, Humic acid 56%, Fulvic acid 30% and potassium 6%) in black granule was applied as soil application at rate of control and 2.5 g/L, 10 days at the start of tuber formation (45 DAP). Humic acid granules were melting well in the water and spray on the plant.

Experimental design: the used experimental layout design was randomized complete block (R.C.B.D) with four replicates arranged in split plot system. Irrigation water treatments were laid at the main plots and humic acid soil applications were laid in sub- plots within the main plots.

The plot area was 15 m (length) × 3 m (width) with 70 cm between rows and 30 cm plants spacing.

During soil preparation, 40 kg P_2O_5/fed (as calcium super phosphate (15.5% P_2O_5) and 20 m^3/ fed of chicken manure were added. During the growing seasons, 100 kg N /fed (as ammonium nitrate (33.5% N). And 96 kg K_2O (as potassium sulphate, 50% K_2O) were injected through the irrigation water in eight doses. The other cultural practices for potato plant production such as fertilization addition and pest control were achieved based on the recommendations by the Ministry of Agriculture and land reclamation in Egypt.

Data recorded: at the final of tuber formation period (70 DAP), aerial parts of the five plants present in middle three rows of each plot were cut. Plant height, number of branches, plant fresh weight and plant dry weight were measured. At harvest time five plants from the three inner rows of each plot were harvest.

The following characters were estimated: yield plant^{-1}, number of tuber plant^{-1}, average tuber weight and yield fed^{-1}. For evaluating tuber quality, the tuber diameters were measured by caliper and percentage of starch content was particular in dry weight of potato tubers as substantive in AOAC (2000) methods.

Water utilization efficiency (WUtE) was calculated according to Jensen (1983) as follows: WUtE = potato tuber yield (kg/fed) **/** water requirements (m^3/ fed)

Statistical analysis: All data were subject to analysis of variance (ANOVA) using the Statistical Analysis Software (SAS). A revised least significant difference (LSD) test at the 0.05 probability levels was used to measure statistical differences between irrigation treatments and humic acid treatments mean (Steeland Torrie, 2000).

RESULTS AND DISCUSSION

Vegetative growth characters:

Data presented in Table 2 indicated that the vegetative growth traits of potato plants (plant height; number of branches, plant fresh weight and plant dry weight) were significantly affected by the irrigation treatments, in both seasons. It was, also, clear that T_1 gave the highest mean values of plant height, number of branches, fresh and dry weight. However the lowest values of these characters were created under T_4, T_5 and T_7. The later treatment showed that the vegetative growth period is critical to drought of water stress treatment than the other periods. This result supported the findings of Flesher *et al*. (2008), who recorded that water stress mainly reduction potato canopy expansion. Plant height was affected by drought of water stress since it arrive its maximum value under full irrigation (100% ETC) than under water stress treatment. Number of branches plant^{-1} illustrated the same tendency. These findings were agreed with King *et al.* (2003), who showed that water stress during the vegetative growth stages reduction vine expansion, plant height and delays canopy development. Moreover, in curlier vegetative growth stage, full irrigation (100% ETC) treatment can supply enough water to plants and thus maintain adequate turgor pressure which leads to improve development and growth stem of plant and branches (Shiri-e-Janagard *et al*., 2009). A full water application permitted and optimum transpiration and higher growth of the aerial plants (Quezada *et al*., 2011).

Additions of humic acid permitted superiority in vegetative growth characters than control plant (Table 2). That might be referring to the effect of humic acid which supplies nutrients for plant bioactivities which finally lead to growth induction (Sarhan 2011and Risk *et al*., 2013). In addition, humic acid significantly increase root respiration and penetration in soil and improves growth of the system which result in and significantly increase in shoot growth characters (Garcia *et al*., 2008; Sarhan *et al*., 2011 and Mona *et al*., 2017). Referring to the interaction affects between irrigation treatments and HA on the studied vegetative growth characters of potato plants; the gained results in Table 2 reflect significant differences for vegetative growth characters. Full irrigation (100% ETC) (T_1) plus humic acid (HA) application reflected superior influence on vegetative growth traits i. e. plant height, number of branches, plant fresh weight and plant dry weight, in both growing seasons. Similar results were gained by Ibrahim and Huda, (2016).

Table 2. Plant height, number of branches, plant fresh and dry weight of potato plants as affected by irrigation and HA treatments and their interaction treatments during the summer growing seasons of 2018 and 2019.

Treat.	Plant height (cm)						Number of branches					
	2018			2019			2018			2019		
	HA_0	HA_1	means	HA_0	HA_1	means	HA_0	HA_1	means	HA_0	HA_1	means
T1	82.67	84.67	83.67	81.00	83.67	82.33	6.73	7.07	6.90	6.38	6.88	6.63
T2	80.33	82.0	81.17	80.00	81.00	80.50	6.28	6.41	6.35	6.15	6.25	6.21
T3	72.67	73.00	72.83	71.0	72.00	71.50	5.72	5.81	5.76	5.26	5.61	5.44
T4	70.00	71.0	70.5	69.00	70.0	69.50	5.9	5.34	5.26	5.03	5.21	5.12
T5	75.33	76.67	76.00	74.33	75.67	75.00	5.08	5.12	5.100	5.01	5.09	5.05
T6	80.33	81.3	80.83	79.33	80.33	79.83	6.20	6.33	6.26	6.09	6.21	6.15
T7	70.00	71.0	70.50	69.0	70.0	69.50	5.02	5.11	5.06	5.00	5.05	5.03
T8	71.00	72.0	71.5	70.0	71.0	70.5	5.07	5.23	5.15	5.01	5.13	5.07
T9	75.67	76.67	76.17	74.67	75.67	75.17	5.87	5.97	5.92	5.72	6.81	6.26
Means	75.33	76.48		74.26	75.48		5.68	5.82		5.52	5.81	
$LSD_{0.05}$	A 1.194	B 0.56	AXB 1.7	A 1.24	B 0.58	AXB 1.75	A 0.14	B 0.07	AXB 0.19	A0.48	B0.23	AXB 0.6812
	Plant fresh weight (g)						Plant dry weight (g)					
T1	573.3	577.0	575.2	571.0	573.7	572.3	79.33	80.33	79.83	78.33	78.67	78.50
T2	570.7	572.3	571.5	569.7	571.3	570.5	74.00	75.00	74.50	73.00	74.00	73.50
T3	545.7	558.0	551.8	543.0	555.7	549.3	70.33	71.33	70.83	69.00	71.33	70.17
T4	510.7	517.0	513.8	509.0	514.3	511.7	61.67	63.00	62.33	61.33	62.00	61.67
T5	490.3	494.0	492.2	489.3	492.3	490.8	60.00	61.33	60.67	58.00	61.33	59.67
T6	544.0	547.0	545.8	540.7	546.3	543.5	68.00	69.00	68.50	67.00	68.00	67.50
T7	475.0	499.3	487.2	475.7	497.7I	486.7	59.67	60.67	60.17	59.00	60.00	59.5
T8	478.3	500.3	489.3	477.0	502.7	489.8	59.00	60.00	59.50	58.33	60.33	59.33
T9	507.7	511.7	509.7	502.0	507.3	504.7	66.33	67.33	66.83	65.67	66.67	66.17
Means	521.7	530.8		519.7	529.0		66.48	67.56		65.52	66.93	
$LSD_{0.05}$	A3.571	B1.683	AXB5.050	A3.52	B1.661	AXB4.982	A0.834	B0.3933	AXB1.180	A1.493	B0.704	AXB2.112

Data presented in Table 3 showed that, yield of plant and its components i.e number of tuber plant^{-1}, average weight of tuber, yield fed^{-1} and diameter of tuber were significantly influenced by different irrigation treatments. (T_1) full irrigation affords the highest mean values of all studied characters of yield, yield components and quality of tubers, in both seasons. On the other hands, starch content (%) of tuber was significantly affected with (T_9), (40% drought of water stress at (S_3) and 100% ETc during (S_1) and (S_2)). These results were agreed with Hassan *et al*, (2002) who reported that the Stalinization and tuberization stage were more critical to water stress bulking and tuber enlargement stage. Application of humic acid (HA) significantly increased in potato yield, yield components and quality in both growing seasons (Table 3). These results are similar to the finding of Ghannad *et al*, (2014) and Mona *et al*. (2017). Data in Table 3 reported that the interaction effect of irrigation treatments and HA application was significantly for yield of plant, number of tuber plant^{-1}, and average weight of tuber, yield fed^{-1}, tuber diameter and content (%) of tuber starch in both seasons. T_1 plus humic acid application recorded superior in affected on all these traits of potato yield, in both growing seasons. Further, the highest mean values for tuber content of starch were application. In general (Humic acid) HA Application on combined with water stress treatments at different growth stages increased potato yield and WUE in comsparison with control treatments (Monghadam *et al*., 2014).

Table 3. yield/plant (Kg), number of tubersplant^{-1}, average tuber weight (g), yieldfed^{-1}., tuber diameter (cm) and tuber starch content (%) as affected by irrigation and HA treatments and their interaction treatments during summer growing seasons 2018 and 2019.

Treat.	Yield/plant (Kg)						Number of tubers/Plant					
	2018			2019			2018			2019		
	HA_0	HA_1	means	HA_0	HA_1	means	HA_0	HA_1	means	HA_0	HA_1	means
1	0.931	0.940	0.935	0.910	0.938	0.924	7.503	7.663	7.583	7.437	7.583	7.510
T2	0.871	0.771	0.821	0.862	0.867	0.864	7.363	7.440	7.402	7.323	7.317	7.320
T3	0.713	0.728	0.720	0.706	0.727	0.717	7.170	7.383	7.277	7.137	7.217	7.177
T4	0.549	0.559	0.553	0.547	0.557	0.552	5.940	5.933	5.937	5.683	5.800	5.742
T5	0.562	0.567	0.564	0.556	0.562	0.559	5.933	5.933	5.933	5.610	5.777	5.693
T6	0.717	0.726	0.721	0.709	0.718	0.714	5.933	6.990	6.930	6.610	6.777	6.693
T7	0.535	0.540	0.537	0.534	0.537	0.537	5.940	6.450	6.195	5.803	6.237	6.020
T8	0.543	0.548	0.545	0.543	0.543	0.543	6.133	6.387	6.260	6.067	6.190	6.128
T9	0.688	0.680	0.683	0.677	0.664	0.670	7.163	7.280	7.222	7.300	7.203	7.252
Means	0.679	0.673		0.672	0.679		6.669	6.829		6.552	6.678	
$LSD_{0.05}$	A0.052	B0.024	AXB0.073	A0.037	B0.017	AXB0.052	A0.142	B0.067	AXB0.200	A0.160	B0.075	AXB0.228
	Average tuber weight (g)						Yield/fedd (Ton)					
T1	142.0	143.0	142.5	140.0	140.3	140.2	18.62	18.88	18.75	18.25	18.77	18.51
T2	140.3	142.0	141.2	138.0	140.3	139.2	17.35	17.43	17.39	17.25	17.35	17.30
T3	137.3	136.7	137.0	136.0	135.3	135.7	14.27	14.60	14.43	14.19	14.53	14.36
T4	108.0	114.0	111.0	105.3	107.3	106.3	10.97	11.31	11.14	10.93	11.16	11.05
T5	105.0	108.3	106.7	102.7	102.3	102.5	11.23	11.35	11.29	11.15	11.27	11.21
T6	135.3	131.7	133.5	131.0	129.7	130.3	14.37	14.53	14.45	14.17	14.37	14.27
T7	100.3	103.3	101.8	100.0	103.0	101.5	10.72	10.83	10.77	10.71	10.75	10.71
T8	109.0	114.0	111.5	104.7	111.0	107.8	10.91	10.99	10.95	10.75	10.87	10.86
T9	121.7	121.7	123.3	119.7	122.3	121.0	13.76	13.60	13.68	13.53	13.27	13.40
Means	122.1	124.2		119.7	121.3		13.58	13.72		13.45	13.59	
$LSD_{0.05}$	A3.511	B1.655	AXB4.965	A2.877	B1.356	AXB4.069	A0.1418	B0.067	AXB0.201	A0.112	B0.055	AXB0.164
	Tuber diameter (cm)						Tuber starch content (%)					
1	6.907	6.937	6.922	6.870	6.907	6.888	16.59	16.25	16.42	16.64	16.32	16.48
T2	6.823	6.897	6.860	6.820	6.850	6.835	17.33	17.43	17.38	17.44	17.46	17.45
T3	6.617	6.687	6.652	6.597	6.643	6.620	17.47	17.40	17.43	17.43	17.34	17.38
T4	6.110	6.187	6.148	6.097	6.143	6.120	17.26	17.31	17.28	17.40	17.54	17.47
T5	6.153	6.190	6.172	6.130	6.137	6.133	17.12	16.58	16.85	17.33	16.76	17.04
T6	6.737	6.800	6.768	6.707	6.770	6.738	16.28	16.50	16.39	16.53	16.73	16.63
T7	6.150	6.200	6.175	6.133	6.167	6.150	16.49	16.44	16.47	16.57	16.60E	16.59
T8	6.157	6.223	6.190	6.123	6.193	6.158	16.37	16.98	16.67	16.46	17.02	16.74
T9	6.733	6.780	6.757	6.733	6.737	6.735	18.33	18.53	18.43	18.44	18.56	18.50
Means	6.487	6.544		6.468	6.505		17.03	17.05		17.14	17.15	
$LSD_{0.05}$	A0.037	B0.017	AXB0.052	A0.037	B0.017	AXB0.052	A0.23	B0.109	AXB0.326	A0.142	B0.067	AXB0.201

Water requirements (WR):

Data in Table 4 indicated that the highest monthly value of water requirements occurred during April in both seasons for the all irrigation treatments. The sessional water requirements for all treatments were 44.1, 35.3, 26.5, 42.5, 41.7, 40.1, 40.8, 39.3, 36.0 cm respectively in the first season, and they were 42.6, 34.1, 25.6, 41.0, 40.1, 38.6, 39.4, 37.6, 34.5 cm respectively in the second season, respectively. The obtained agreed with those reported by Ayas and Korukeu (2010).

Table 4. Monthly and seasonal potato irrigation requirements (cm) during 2017 and 2018 growing seasons.

Seasons	2017						2018					
Treatment	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Total**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Total**
T1	2.2	4.7	10.6	16.8	9.8	44.1	2.0	4.4	10.4	16.7	9.1	42.6
T2	2.2	4.7	8.5	13.4	6.5	35.3	2.0	4.4	8.3	13.4	6.0	34.1
T3	2.2	4.7	6.4	10.1	3.1	26.5	2.0	4.4	6.2	10.0	3.0	25.6
T4	2.2	3.8	9.9	16.8	9.8	42.5	2.0	3.5	9.7	16.7	9.1	41.0
T5	2.2	4.7	9.1	15.9	9.8	41.7	2.0	4.4	9.1	15.5	9.1	40.1
T6	2.2	4.7	10.6	15.0	8.2	40.1	2.0	4.4	10.4	13.4	8.4	38.6
T7	2.2	2.8	9.2	16.8	9.8	40.8	2.0	2.6	9.0	16.7	9.1	39.4
T8	2.2	4.7	7.8	14.8	9.8	39.3	2.0	4.4	7.7	14.4	9.1	37.6
T9	2.2	4.7	10.6	12.6	5.9	36.0	2.0	4.4	10.4	12.2	5.5	34.5

Water utilization efficiency (WU_tE)

Results in Table5 represent the effect of irrigation and humic acid treatments on water utilization efficiency (WU_tE) expressed as kg of potato yield/m^3 of water requirements. Comparing the values of WU_tE under different irrigation and humic acid treatments reveals that maximum values were obtained by T_3 irrigation treatments and with humic acid in 1st and 2nd seasons. While the lowest values of WU_tE were obtained by T_4 irrigation treatments and without humic acid in both growing seasons. These results were concord with those reported by Yuan *et al.* (2003) and Erdem *et al.* (2006).

Table 5. water utilization efficiency in kgm-3 water requirements as affected by irrigation and humic acid treatments in 2017 and 2018 growing seasons.

Seasons	2017		2018	
Treatment	**With humic acid**	**Without humic acid**	**With humic acid**	**Without humic acid**
T1	10.2	10.1	10.5	10.2
T2	11.8	11.7	12.1	10.2
T3	13.1	12.8	13.5	13.2
T4	6.3	6.1	6.5	6.3
T5	6.5	6.4	6.7	6.6
T6	8.6	8.5	8.9	8.7
T7	6.3	6.2	6.5	6.5
T8	6.6	6.6	6.9	6.8
T9	9.0	9.1	9.2	9.3

CONCLUSION

The aforementioned results of this study indicated clearly that the addition of humic acid and irrigation treatment favored the production of high yield of potato with high quality under the condition of this experiment.

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تأثير معاملات الرى وإضافة حمض الهيوميك على مراحل النمو المختلفة لمحصول البطاطس فى الأراضى الرملية تحت نظام الرى بالتنقيط.

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اجريت تجربتان حقليتان بالمزرعة البحثية بقرية على مبارك بمنطقة البستان بغرب النوبارية خلال موسمى النمو 2018 و 2019 . وقد استهدفت الدراسة على مدى استجابة محصول البطاطس عند مراحل النمو المختلفة لمعاملات الرى واضافة حمض الهيومك وتأثيرة على انتاجية المحصول ومكونات المحصول والاحتياجات المائية وكفاءة استخدام وحدة مياه الرى تحت نظام الرى بالتنقيط. وكانت معاملات الرى هى :- (1T) الرى بمعدل 100% من جهد البخر (نتح المحصول) خلال مراحل النمو، (2T) الرى بمعدل 80% من جهد البخر (النتح القياسي) خلال مراحل النمو الثلاثة للنبات(إجهاد 20%)، (3T) الرى بكمية مياه تعادل 60% من جهد البخر النتح القياسي خلال مراحل النمو الثلاثة للنبات(إجهاد 40%)، (T4) تعريض النبات لإجهاد مائي 20% خلال مرحلة النمو (الإنبات) الأولى من حياة النبات وثم الري بكمية مياه تعادل 100% من البخر نتح خلال مرحلة تكوين الدرنات ومرحلة نضج الدرنات، (5T) تعريض الدرنات لإجهاد مائي 20% خلال مرحلة تكوين الدرنات ثم الرى بكمية مياه تعادل 100%من البخر نتح القياسي خلال مرحلة الإنبات ومرحلة نضج الدرنات، (6T) تعريض النبات لإجهاد مائي 20% خلال مرحلة نضج الدرنات ثم الرى بكمية مياه تعادل 100% خلال مرحلتى الإنبات وتكوين الدرنات، (7T) تعريض الدرنات لإجهاد مائي 40% خلال مرحلة الإنبات ثم الرى بكمية مياه تعادل 100%من جهد البخر نتح خلال مرحلتى تكوين الدرنات ونضج الدرنات، (8T) تعريض الدرنات لإجهاد مائي 40% خلال مرحلة تكوين الدرنات ثم الرى بكمية مياه تعادل 100% من جهد البخر نتح خلال مرحلتى الإنبات ونضج الدرنات، (9T) تعريض الدرنات لإجهاد مائي 40% خلال مرحلة نضج الدرنات ثم الرى بكمية مياه تعادل 100% من جهد البخر نتح خلال مرحلتى الإنبات وتكوين الدرنات. وقد كانت معاملات حمض الهيومك هى اضافة حمض الهيومك و بدون اضافة حمض الهيومك، وقد أوضحت النتائج المتحصل عليها مايلى:- 1- هناك تأثير معنوى لمعاملات الرى واضافة حمض الهيومك كل على حدة على المحصول ومكوناتة والنمو الخضرى. 2- هناك تأثير معنوى للتفاعل بين معاملات الرى وحمض الهيومك على المحصول ومكوناتة. 2- الاحتياجات المائية لمحصول البطاطس تتراوحت بين 26.5 – 44.1 سم فى الموسم الأول وبين 25.6 - 42.6 سم فى الموسم الثانى. 3- أعلى كفاءة استعمالية لمياه الرى كانت 13.1 و 13.5 كجم بطاطس لكل متر مربع مياه مضافة وذلك للتفاعل بين معاملة الرى 3T واضافة حمض الهيومك للموسم الأول والثانى على التوالى.

الكلمات الدليلية: معاملات الرى- الهيوميك أسيد - كفاءة استخدام المياه – محصول البطاطس.