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Effect of Intelligent Irrigation Technique on Water Use Efficiency for Cucumber and Pepper Crops in New Salhia Area

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THE INTELLIGENT irrigation technique is a valuable tool for scheduling irrigation and quantifying water required by plants to achieve water savings. Field experiments were carried out in New Salhia area, El- Sharqia Governorate, Egypt, at (30° 18` N: 31° 23` E. 27 m a.s.l) during the summer season of 2015.The main objectives were to investigate the effectiveness of the intelligent irrigation technique (IIT) (Hunter Pro-C (H)) which was irrigated automatically on water use efficiency (WUE) and irrigation water use efficiency (IWUE) for irrigation scheduling of cucumber (*Cucumis sativus Hayle*) and pepper *(Capsicum annuum*) crops. The intelligent irrigation technique, (IIT) was implemented and tested under surface, (SDI) and sub-surface drip irrigation systems, (SSDI). The results obtained with these systems were consequently compared to that of the irrigation control technique (ICT), which was irrigated manually based on crop evapotranspiration (ETc) values. The results revealed that cucumber and pepper growth parameters except *pH* of juice were significantly increased by IIT under SSDI. In addition; IIT under SSDI conserved 34 and 24% of total applied irrigation water for cucumber and pepper respectively. Moreover, the results showed that the IIT under SSDI recorded significant increase 12 and 13% for marketable yield Ym of cucumber and pepper respectively. While, the results reported that the WUE values using IIT under *SSDI* were significantly increased by about 30 to 33% for cucumber and pepper respectively. The results confirmed also that the values of IWUE at IIT under SSDI were significantly increased by about 49 to 39 % for cucumber and pepper respectively. The intelligent irrigation technique may provide a valuable tool for scheduling irrigation in cucumber and pepper farming and may be extendable for use in other similar agricultural crops. These results show that this IIT could be a flexible, practical tool for improving scheduled irrigation. Hence, this technique can therefore be recommended for efficient automated irrigation systems that produces higher yield and conserves large amounts of irrigation water.

Keywords: Intelligent irrigation, Water use efficiency, Cucumber, Pepper, Drip irrigation

Water scarcity and drought are the major factors constraining agricultural crop production in arid and semi-arid zones of the world; therefore innovations for saving water in irrigated agriculture and thereby improving water use efficiency are of paramount importance in water-scarce regions. In Egypt farmers have been using manual control techniques for irrigation. In this process, plants didn't receive the same amounts of irrigation water all over the field. Therefore, adoption of modern irrigation techniques is needed to increase water use efficiency and high productivity while minimizing irrigation water needed (Acar *et al.,* 2010). In the past 10 years, intelligent irrigation technique (IIT) has been developed by a number of manufacturers and has been promoted by water purveyors in an attempt to reduce over-irrigation (Michael and Dukes, 2008). The irrigation controller regulates the desired moisture level in agricultural soil by making the irrigation pump on or off based on the sensor readings. It provides science basis for using water resources under the technologies of soil moisture sensors, temperature sensors, precise irrigation equipment, intelligent fuzzy controller, and computer-controlled devices, so that agricultural irrigation get the best part out of water utilization (Patil *et al.,* 2012). Meanwhile, the amount of water given to the plants depends on its size, and moisture control of soil. The moisture of soil is affected by temperature of environment, evaporation due to wind velocity and the water budget. Accordingly we need to monitor the parameters like atmospheric temperature, humidity, wind speed and direction, water radiation, soil temperature, sunshine and rain fall, etc., Based on these parameters, needed water should to given for the plants, based on its growth stages (Anand and Perinbam, 2014). There were many intelligent irrigation techniques (IIT) available and were used to compute crop water requirements based on climatic data. Usually, intelligent irrigation was integrated with smart controllers and using microclimatic data to schedule irrigation water (Nautiyal *et al.,* 2010). Currently, there were a number of intelligent irrigation systems that can operate without human intervention. The smart controllers integrate many disciplines to produce a significant improvement in crop production and resource management (Norum and Adhikari, 2009). Intelligent irrigation technologies were evaluated and results indicate up to 43% (average 38%) water savings over conventional irrigation control methodologies (Dassanayake *et al.,* 2009). Intelligent irrigation IIT treatments of tomato yield were 39 and 40.08 ton h^{-1} for both seasons, respectively. Moreover, the amounts of applied irrigation water were 5947.6 and 6337.6 m^3 h^{-1} for actual evapotranspiration *ETa* seasons, respectively. However, the results indicate that irrigation water was used more effectively through *IIT* treatment. The comparison of the *IIT* with the *ICS* shows that the increases in IWUE were 39% and 47% for the 2010 and 2011 seasons, respectively. In contrast, the smallest amount of irrigation water used was 594.76 mm in case of *IIT*; while the largest amount applied *IR* was 854.79 mm in the *ICS* treatment. (Mohamed *et al.,* 2013 and Al-Ghobari *et al.,* 2013).

The effect of three irrigation methods [subsurface drip (SSD), surface drip (SD) and furrow irrigation (FI)] on yields; water saving and irrigation water use efficiency (IWUE) on corn. The highest yield was obtained with SSD and the lowest was obtained with the FI method (Hassanli *et al*., 2009).

The main objectives were to investigate the effectiveness of the intelligent irrigation technique which was irrigated automatically on water use efficiency and irrigation water use efficiency compared to traditional technique for irrigation scheduling of cucumber and pepper crops under surface and sub-surface drip irrigation systems and show any technique give maximum production with minimum applied irrigation water.

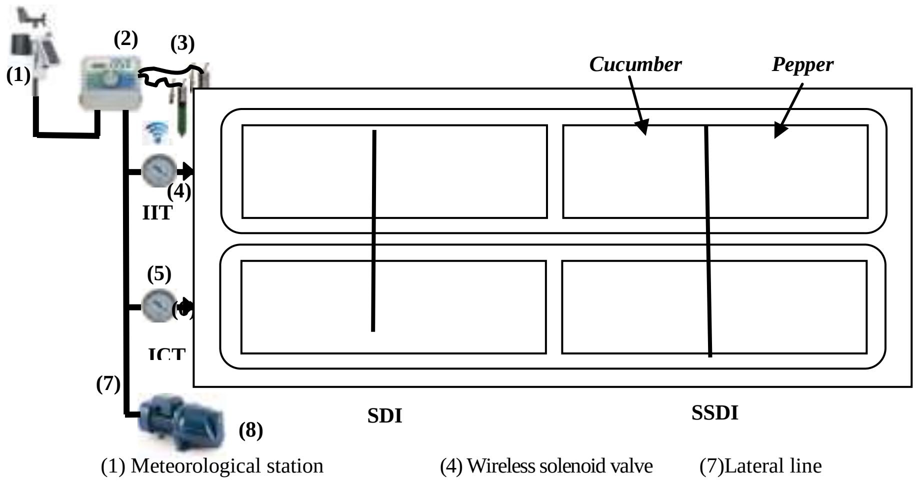
Materials and Methods

Experimental

Field experiments were carried out in New Salhia area, El- Sharqia Governorate, Egypt, at (30° 18` N: 31° 23` E. 27 m a.s.l) during the summer season of 2015. In split plot design with three replicates, the experimental was divided into 40 m^2 plots; each bounded by 1.5 m wide barren to avoid horizontal infiltration. The obtained data were subjected to statistical analysis according to Snedecor and Cochran (1989) using Co-state software program. Figure (1). Shows the cucumber (*Cucumis sativus Hayle*) and pepper *(Capsicum annuum*) cultivated using two irrigating techniques namely, 1). Intelligent irrigation (Hunter Pro-C (H)) IIT, which was irrigated automatically, based on soil moisture sensors for all depths and automatic weather station; 2). Irrigation control ICT as irrigation water was applied manually based on crop evapotranspiration (ETc) values, calculated using metrological data from weather station of the area, taking in to consideration that leaching requirements and drip irrigation efficiency were added. All techniques were tested under surface (SDI) and sub-surface drip irrigation systems (SSDI).

Soil management practices were applied using doses of fertilizer as recommended by the Ministry of Agriculture and land reclamation.

The leaf area LA (cm^2), fruit length L (cm), fruit diameter D (cm), total soluble solid TSS (%), pH of juice and marketable yield Ym (Mg fed^{-1}) were determined. Water use efficiency WUE (kg m^{-3}), irrigation water use efficiency IWUE (kg m^{-3}) and actual evapotranspiration ETa (mm), were calculated for different applied irrigating techniques and irrigation system under cucumber and pepper plots.



(1) Meteorological station
(2) IIT control panel (Hunter Pro-C)
(3) Moisture sensors
(4) Wireless solenoid valve
(5) Pressure gauge
(6) ball valve
(7)Lateral line
(8) Pump

Fig. 1. Field experiment layout

Soil characteristics

Soil samples were collected for some physical and chemical soil characteristics The methodological procedures were according to methods described by Page *et al.* (1982) and Klute (1986) (Tables 1&2)

TABLE 1. Some physical characteristics of experimental soil

Soil depth (cm)	Particle size distribution %					Textural class	OM %	ρ_b g/cm^3	Ks cm/h	FC %	WP %	AW %
	C. sand	M. sand	F. sand	Silt	Clay							
0-15	4.51	78.37	12.89	2.71	1.52	S	0.47	1.57	15.43	10.21	3.56	6.65
15-30	5.34	76.05	13.64	3.34	1.63	S	0.44	1.59	15.49	9.98	3.51	6.47
30-45	5.42	73.42	15.49	4.03	1.64	S	0.38	1.61	14.74	9.70	3.36	6.34
45-60	5.84	71.75	15.77	4.91	1.73	S	0.27	1.63	14.07	9.54	3.32	6.22

TABLE 2. Some chemical characteristics of experimental soil

Soil depth (cm)	ECe (dS/m)	pH	$CaCO_3$ %	CEC cmole kg^{-1}	Soluble ions (meq/l) in the saturated soil paste extract								Exchangeable cations cmole kg^{-1}			
					Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	HCO_3^-	CO_3^{--}	SO_4^{--}	Na^+	K^+	Ca^{++}	Mg^{++}
0-15	2.15	7.62	2.44	6.79	9.94	1.23	5.91	4.42	10.31	2.91	-	8.28	1.99	0.15	1.37	1.7
15-30	2.38	7.50	2.41	6.20	9.41	2.9	6.63	4.86	11.49	2.77	-	9.54	1.69	0.31	1.36	1.68
30-45	2.91	7.47	2.34	6.10	9.29	4.11	8.61	7.09	14.24	2.59	-	12.27	1.37	0.36	1.46	2.00
45-60	2.95	7.41	2.29	6.08	9.18	4.16	8.85	7.31	14.46	2.58	-	12.46	1.34	0.37	1.47	2.03

Quality of irrigation water

Chemical analyses of the irrigation water were measured according to methods described by Ayers and Westcot (1994).

TABLE 3.Some chemical analysis for irrigation water

Sample	pH	EC dS/m	SAR	Soluble cations, meq/l				Soluble anions , meq/l			
				Na^+	K^+	Ca^{++}	Mg^{++}	CL^-	HCO_3^-	$CO_3^=$	$SO_4^=$
mean	7.46	1.69	1.04	2.64	1.36	12.51	0.39	6.61	2.02	0	8.27

Irrigation water requirements

The amounts of applied irrigation water shown in Tables (5&6) were calculated by using the equation:

- Applied irrigation water $IR_{100\%} = (ETc - pe)Kr / Ea) + LR$ (mm / period) (Keller and Karmeli , 1974)

where: *Kr* : correction factor for limited wetting at cucumber and pepper percent round coverage by canopy 80%, *Kr* = 0.90. (Smith, 1992).
Ea : irrigation efficiency for surface drip (85%) (Allen *et al.*, 1998).
Pe : effective rainfall, 0 mm.
LR : leaching requirements, for cucumber and pepper (16 and 15%) (0.16 and 0.15 x ETc), mm.

- Crop evapotranspiration $ETc = Kc_{FAO} . ETo$ (mm day^{-1})
  Allen *et al.*, 1998)

where: Kc_{FAO} : crop coefficient from FAO No.(56).
ETo : reference crop evapotranspiration, mm day^{-1}.

TABLE 4. Calculation reference evapotranspiration (mm/day) through cucumber and pepper growth period

Month	August	September	October	November	December
ETo, mm/day	7.27	5.00	3.98	3.15	2.43

- Leaching requirement $LR = EC_w / (5 (EC_e) - EC_w) x 100$ (%)
  (Allen *et al.*, 1998)

where: ECw : electrical conductivity of the irrigation water, dS m^{-1}.
ECe : average electrical conductivity of the soil solution extract, dS m^{-1}.

TABLE 5. Applied irrigation water *IR* (mm/period) based on *ETc* technique for cucumber

Stages	Initial	Develop.	Mid	Late	Seasonal
Period length (day)	20	30	40	15	105
Kc_{FAO}	0.60	0.80	1.00	0.75	--------
ETo (mm)	145.4	156.81	159.03	46.95	508.19
ETc (mm)	87.24	125.45	159.03	35.21	406.93
IR (mm)	106.14	152.62	193.48	42.84	495.08

Convert mm to m^3 = water per mm depth * Area (3.57 not 4.2 for drip irrigation)

TABLE 6. Applied irrigation water *IR* (mm/period) based on *ETc* technique for pepper

Stages	Initial	Develop.	Mid	Late	Seasonal
Period length (day)	30	35	40	20	125
KcFAO	0.6	0.83	1.05	0.9	--------
ETo (mm)	202.21	163.78	142.2	54.9	563.09
ETc (mm)	121.33	135.94	149.31	49.41	455.98
IR (mm)	146.61	164.27	180.43	59.71	551.02

- Actual evapotranspiration $ETa = (M_2 \% – M_1 \%) /100. d_b . D$ (mm)
  (Doorenbos and Pruitt, 1984)

where: M_2 : moisture content after irrigation %.
M_1 : moisture content before irrigation %.
d_b : specific density of soil .
D **:** mean depth, mm.

Irrigation efficiency

• Water use efficiency *WUE*, (kg m^{-3}) = Ya / *ETa* (Howell, 2001)

where: Ya : economic yield of the crop, (kg fed^{-1}).

• Irrigation water use efficiency *IWUE*, (kg m^{-3}) = Ya / *IR* (Michael, 1978)
where: *IR* : seasonal amount of applied irrigation water, (m^{3})

Results and Discussion

Effect of IIT technique under SDI and SSDI on some growth parameters

Data in Table 7 presented that the intelligent irrigation technique IIT under sub-surface drip irrigation SSDI recorded the maximum values of LA (142.35 cm^2), L (19.87 cm), D (13.82 cm) and TSS (7.37%) except pH of juice (3.52) for cucumber, LA (116.40 cm^2), L (14.68 cm), D (7.15 cm) and TSS (11.12%) except pH of juice (4.49) for pepper. While the irrigation control technique ICT under surface drip irrigation SDI recorded the minimum values of LA (126.71 cm^2), L (16.62 cm), D (11.59 cm) and TSS (5.75%) except pH of juice (4.21) for cucumber, LA (98.26 cm^2), L (11.62 cm), D (5.68 cm) and TSS (8.19%) except pH of juice (5.55) for pepper. The results indicated that the IIT under SSDI significantly increased of LA, L, D and TSS by 5, 11, 7 and 12% for cucumber, 8, 13, 9 and 15% for pepper respectively. On the other hand, pH of juice which decreased by 8 and 11% for cucumber and pepper compared to that under ICT at the same treatment. These results are in agreement with Yazar *et al.* (1999) and Al-Ghobari *et al.* (2013).

TABLE 7. Effect of IIT under SDI and SSDI on some growth parameters of studied crops

Crops	*IS*	*AIT*	*LA (cm^2)*	*L (cm)*	*D (cm)*	*TSS (%)*	*pH*
Cucumber	*SDI*	*IIT*	130.69	17.89	12.21	6.24	3.98
		ICT	126.71	16.62	11.59	5.75	4.21
	SSDI	*IIT*	142.35	19.87	13.82	7.37	3.52
		ICT	134.94	17.90	12.91	6.59	3.79
LSD (0.05)		*IS*	**11.67**	**0.75**	**1.34**	**0.47**	**0.30**
		AIT	**5.57**	**1.34**	**1.00**	**0.43**	**0.37**
		IS X AIT	**7.87**	**1.90**	**1.42**	**0.61**	**0.53**
Pepper	*SDI*	*IIT*	103.58	12.73	6.14	9.25	5.13
		ICT	98.26	11.62	5.68	8.19	5.55
	SSDI	*IIT*	116.40	14.68	7.15	11.12	4.49
		ICT	107.70	12.95	6.54	9.69	4.97
LSD (0.05)		*IS*	**4.88**	**1.92**	**0.09**	**0.69**	**0.67**
		AIT	**7.43**	**1.34**	**0.31**	**0.59**	**0.25**
		IS X AIT	**10.51**	**1.89**	**0.44**	**0.84**	**0.36**

Meanwhile, applied irrigation water by IIT under SSDI significantly increased by 8, 10, 12 and 15% for LA, L, D and TSS of cucumber respectively, and pH of juice which decreased by 11.6% compared to that under SDI. Also, data recorded that the IIT under SSDI significantly increased by 11, 13, 14 and 15 to 17% for LA, L, D and TSS of pepper respectively, and pH of juice which decreased by 12.5% compared to that under SDI. These increases may be attributed to the SSDI lines were covered with soil that decrease the amounts of lost water through compared to that of SDI (Hassanli *et al.*, 2009).

Effect of IIT technique under SDI and SSDI on marketable yield

Data in Table 8 reported that the maximum values of marketable yield Ym for cucumber and pepper were (30.96 and 9.56 Mg fed^{-1}) under IIT and SSDI. While, the minimum values were (24.13 and 7.05 Mg fed^{-1}) for both crops under ICT and SDI. The results showed that the IIT under SSDI significantly increased of Ym by 12 and 13% for both crops compared to that under ICT at the same treatment. These increasing may be attributed to the smart controllers integrate many disciplines that add needed water amounts leading to significant improvement in crop production. In addition the IIT Improved Irrigation scheduling based upon crop water status needed is in. These results are in harmony with the finding of Norum and Adhikari (2009) Al-Ghobari *et al.* (2013) and Mohamed *et al.* (2013). Meanwhile, applied irrigation water by IIT under SSDI was significantly increased of Ym by (15 and 19%) for both crops compared to that under SDI (Hassanli *et al.*, 2009).

TABLE 8. Effect of IIT under SDI and SSDI on IR, ETa, Ym, WUE and IWUE of studied crops

Crops	*IS*	*AIT*	*Ym* (Mg fed^{-1})	*IR* (mm Season^{-1})	*ETa* (mm Season^{-1})	*WUE* (kg m^{-3})	*IWUE* (kg m^{-3})
Cucumber	***SDI***	***IIT***	26.47	402.83	373.71	16.86	15.65
		ICT	24.13	495.08	421.46	13.63	11.60
	SSDI	***IIT***	30.96	370.64	331.97	22.21	19.89
		ICT	27.68	495.08	385.62	17.09	13.31
LSD (0.05)		***IS***	**0.87**	**64.70**	**8.29**	**0.97**	**2.30**
		AIT	**1.76**	**30.94**	**47.95**	**2.14**	**1.29**
		IS X AIT	**2.49**	**43.76**	**67.81**	**3.02**	**1.82**
Pepper	***SDI***	***IIT***	7.79	472.15	421.41	4.40	3.93
		ICT	7.05	551.02	485.28	3.46	3.05
	SSDI	***IIT***	9.56	445.97	367.53	6.19	5.10
		ICT	8.49	551.02	435.85	4.64	3.67
LSD (0.05)		***IS***	**0.54**	**46.31**	**26.90**	**0.17**	**0.68**
		AIT	**0.70**	**29.67**	**48.65**	**0.55**	**0.59**
		IS X AIT	**0.99**	**41.95**	**68.80**	**0.78**	**0.83**

Effect of IIT technique under SDI and SSDI on amount of irrigation water

Data in Table 8 & Fig. 2 for cucumber and pepper crops showed that the minimum values of applied irrigation water IR for Initial, development, mid-season, late-season growth stages and the seasonal were (65.21, 129.56, 151.18, 24.69 and 370.64 mm) for cucumber, (105.12, 141.65, 163.39, 35.81 and 445.97 mm) for pepper respectively, under IIT and SSDI. While, the maximum values of IR for, the same growth stages were (106.14, 152.62, 193.48, 42.84 and 495.08 mm) for cucumber, (146.61, 164.27, 180.43, 59.71 and 551.02 mm) for pepper respectively, under ICT at both irrigation systems. The results reported that the use of IIT under SSDI reduce the amount of irrigation water IR added for cucumber and pepper by 34 and 24% compared to that under ICT at the same treatment.

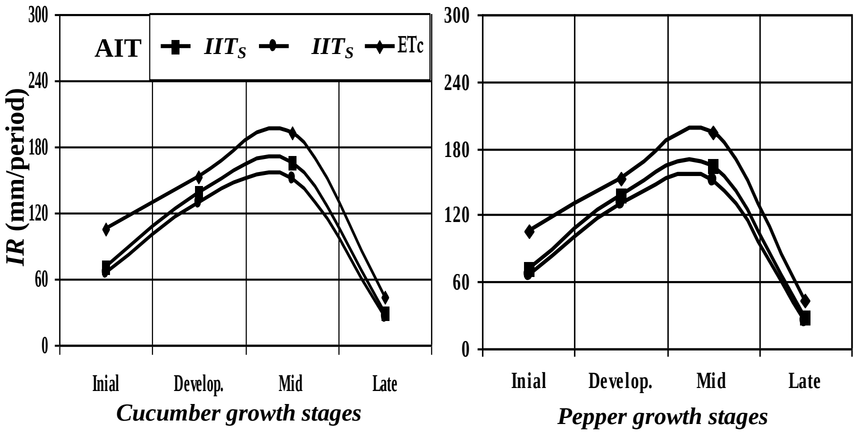


Fig. 2. Effect of IIT technique under SDI and SSDI on amount of irrigation water

The results reported that the use of IIT under SSDI reduce the amount of irrigation water IR added for cucumber and pepper by 34 and 24% compared to that under ICT at the same treatment. These reduction may be attributed to the intelligent irrigation technique (IIT) as it change irrigation frequency stage could significantly affect the available soil water during vegetables growing seasons. In addition to that for saving water in the irrigation system based on the climatological parameters, needed water can be given for the plants, based on its growth stages are in. These results agreement to with (Ghobari *et al.* (2013) Mohamed *et al.* (2013) and Anand and Perinbam (2014). Meanwhile, applied irrigation water by IIT under SSDI was reduced by about 8 and 6% for cucumber and pepper compared to that under SDI (Hassanli *et al.,* 2009).

Effect of IIT technique under SDI and SSDI on actual evapotranspiration

Data in Table 8 & Fig. 3 and 4 for cucumber and pepper crops showed that the minimum values of the actual evapotranspiration ETa for, Initial, development, mid-season, late-season growth stages and the seasonal were

(49.61, 117.45, 143.12, 21.97 and 331.97 mm) for cucumber, (56.23, 129.47, 154.19, 27.64 and 367.53 mm) for pepper respectively, under IIT and SSDI. While, the maximum values of ETa for, the same growth stages were (61.37, 147.75, 172.53, 39.81 and 421.46 mm) for cucumber, (89.60, 155.46, 187.73, 52.49 and 485.28 mm) for pepper respectively, under ICT and SDI. The results concluded that the IIT under SSDI reduced actual evapotranspiration for cucumber and pepper by 16 and 19% compared to that under ICT at the same treatment. This reduction may be attributed to that the intelligent irrigation technique (IIT) regulates the desired moisture level in agricultural soil by regulating the irrigation pump, on or off, based on the sensor readings. These results agree with that of Patil *et al.,* 2012 and Mohamed *et al.* (2013). In addition, the applied irrigation water by IIT under SSDI reduced the ETa consumed cucumber and pepper by 11 and 13% compared to that under SDI (Hassanli *et al.,* 2009).

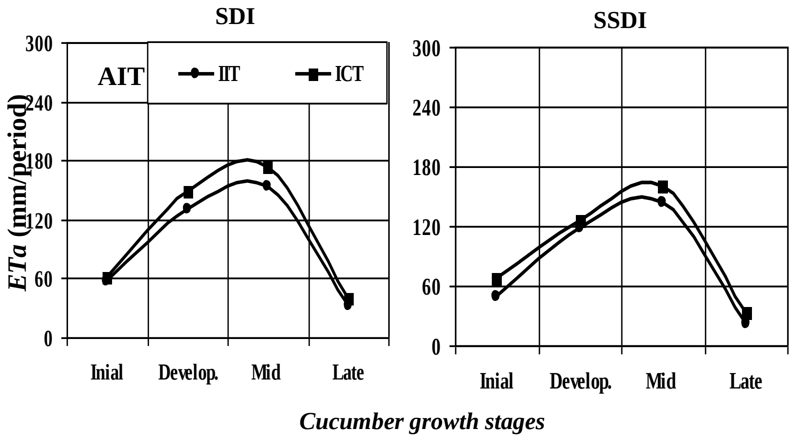


Fig.3. Effect of IIT technique under SDI and SSDI on actual evapotranspiration for cucumber

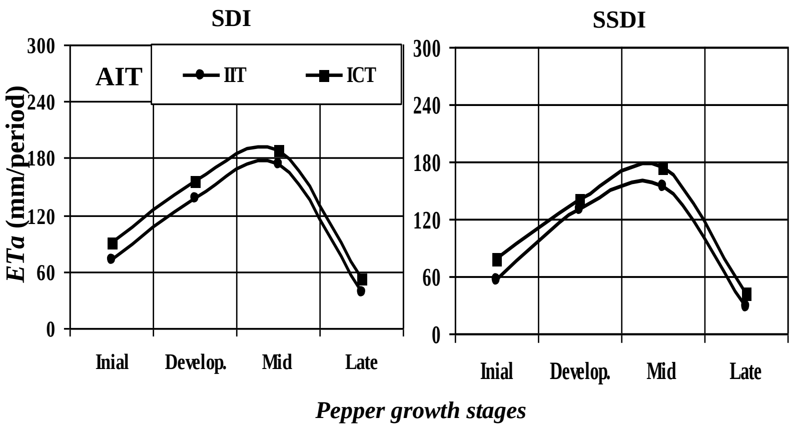


Fig.4. Effect of IIT technique under SDI and SSDI on actual evapotranspiration for pepper

Effect of IIT technique under SDI and SSDI on water use efficiency

Data in Table 8 illustrate that the maximum values of water use efficiency WUE and irrigation water use efficiency IWUE were 22.21 and 19.89 kg m^{-3} for cucumber, 6.19 and 5.10 kg m^{-3} for pepper under IIT and SSDI. While, the minimum values of WUE and IWUE were 13.63 and 11.60 kg m^{-3} for cucumber, 3.46 and 3.05 kg m^{-3} for pepper under ICT and SDI. The results revealed that the IIT under SSDI significantly increased of WUE and IWUE by 30 and 49% for cucumber, 33 and 39% for pepper compared to that under ICT at the same treatment. These results may be attributed to the intelligent irrigation technique which that lead to increased values of marketable yield and reduce the seasonal amount of irrigation water at the same time. These results agree with Mohamed *et al.* (2013 and Al-Ghobari *et al.* (2013) data. Meanwhile, the applied irrigation water by IIT under SSDI significantly increased the WUE and IWUE by about 24 and 21% for cucumber, 29 and 23% for pepper compared to that under SDI (Hassanli *et al.,* 2009).

Conclusions

Conserving water is very important in areas experiencing severe drought, such as Egypt. This study has demonstrated possible modifications and developments to the proposed system for improved and more efficient scheduling control. It can be concluded that an economic amount benefit can be achieved with saving large amounts of irrigation water when applying advance scheduling irrigation techniques such as IIT under arid conditions. So, it can generally recommended to use intelligent irrigation technique under subsurface drip irrigation for saving applied irrigation water by about (34 and 24%) for cucumber and pepper respectively, compared to that under ICT and increasing the production by about (12 and 13%) for cucumber and pepper respectively, under sandy soil conditions.

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تأثير تقنية الرى الذكى على كفاءة الأستهلاك المائى لمحصولى الفلفل والخيار بمنطقة الصالحية الجديدة

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مما لا شك فيه أن كمية كبيرة من مياه الرى المضافة للتربة الرملية تفقد أما عن طريق التسرب العميق أو بالبخر من سطح التربة لذا أجريت هذه التجربة لمعرفة أنسب تقنيات مياه الرى المضافة تحت نظم الرى المختلفة التى ترفع من كفاءة الأستهلاك المائى والأروائى والحصول على أعلى أنتاجية بأقل وحدة مياه رى مضافة. تمت الدراسة فى منطقة الصالحية الجديدة بمحافظة الشرقية – جمهورية مصر العربية وكانت أحداثياتها كالتالى (30° 18´ شمالا : 31° 23´شرقا) وأرتفاع 27 متر فوق مستوى سطح البحرخلال الموسم الصيفى 2015 تم أستخدام التصميم الأحصائى القطع المنشقة مرة واحدة بثلاث مكررات لكل معاملة وتم زراعة محصولى الخيار والفلفل تحت نظامى الرى بالتنقيط السطحى والتحت سطحى بأستخدام تقنية الرى الذكى والذى يعتمد فيه أضافة مياه الرى أليا عن طريق رصد وتحليل بيانات الأرصاد الفورية لمحطة الأرصاد الزراعية الصغيرة المتصلة بوحدة التحكم مباشرة ويعتمد أيضا على حالة الرطوبة والملوحة الأرضية عن طريق حساسات على أعماق مختلفة لمنطقة نموالجذور متصلة أيضا مباشرة بوحدة التحكم التى تقوم بدورها بفتح وغلق المحبس الكهربائى وبالتالى أضافة مياه الرى على حسب حاجة النبات ويتم مقارنة الرى الذكى بتقنية أضافة كمية مياه الرى يدويا بالطريقة التقليدية (الكنترول) التى تعتمد على ETc المحسوبة من حاصل ضرب البخر نتح المرجعى ETo من خلال بيانات سابقة لمحطات الأرصاد الجوية فى معامل المحصول القياسى الخاص بالخياروالفلفل مضافا اليه الأحتياجات الغسيلية وأخذ كفاءة نظام الرى بالتنقيط فى الأعتباروقد أوضحت النتائج المتحصل عليها الأتى:

1- أستخدام تقنية الرى الذكى تحت نظام الرى بالتنقيط التحت سطحى حققت زيادة معنوية فى قياسات النمووالجودة لكلا المحصولين ماعدا نسبة الحموضة فى عصيرالثمرة أذا ماقورنت بتقنية أضافة مياه الرى التقليدية تحت نفس نظام الرى .

2- أستخدام تقنية الرى الذكى تحت نظام الرى بالتنقيط التحت سطحى حققت زيادة معنوية حوالى 12 ، 13٪ فى أنتاجية محصولى الخيار والفلفل على الترتيب أذا ماقورنت بتقنية أضافة مياه الرى التقليدية (الكنترول) تحت نفس نظام الرى .

3- أستخدام تقنية الرى الذكى تحت نظام الرى بالتنقيط التحت سطحى حققت توفير فى كميات مياه الرى المضافة حوالى 34 ، 24٪ لكلا من محصولى الخيار والفلفل على الترتيب أذا ماقورنت بتقنية أضافة مياه الرى التقليدية (الكنترول) تحت نفس نظام الرى .

4- أستخدام تقنية الرى الذكى تحت نظام الرى بالتنقيط التحت سطحى حققت زيادة فى كفاءة الأستهلاك المائى 30 ، 33٪ لمحصولى الخيار والفلفل على الترتيب أذا ماقورنت بتقنية أضافة مياه الرى التقليدية (الكنترول) تحت نفس نظام الرى .
5- أستخدام تقنية الرى الذكى تحت نظام الرى بالتنقيط التحت سطحى حققت زيادة فى كفاءة الأستهلاك الأروائى على الترتيب حوالى 49 ، 39٪ لمحصولى الخيار والفلفل على الترتيب أذا ماقورنت بتقنية أضافة مياه الرى التقليدية (الكنترول) تحت نفس نظام الرى .
6- تفوق نظام الرى بالتنقيط التحت سطحى على التنقيط السطحى لكلا من تقنية الرى الذكى والطريقة التقليدية لأن خرطوم الرى بالتنقيط التحت سطحى مدفون فى التربة بحوالى 20سم مما يقلل من البخر من سطح التربة ويقلل من كمية مياه الرى المضافة والأستهلاك المائى الفعلى لكلا المحصولين وبالتالى زيادة الأنتاجية .

عموما يمكن التوصية بأستخدام تقنية الرى الذكى تحت نظام الرى بالتنقيط التحت السطحى لأنها تساعد على جدولة مياه الرى بشكل جيد وبالتالى توفير كميات كبيرة من مياه الرى وزيادة أنتاجية الفدان لمحصولى الخيار والفلفل لذا يمكن أعتبارنظام الرى الذكى نظام واعد وأقتصادى ويمكن تطبيقه مع المحاصيل ونظم الرى الأخرى .