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## RESEARCH ARTICLE

### IMPACT OF WATER QUALITY AND AUTOMATION CONTROLLER DRIP IRRIGATION SYSTEMS ON POTATO GROWTH AND YIELD

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#### Manuscript Info      Abstract

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Potato (*Solanum tuberosum* L.) response to different water qualities and automation controllers surface, subsurface drip irrigation in sandy soil conditions, it's the major importance in production planning where limited water resources. This study aims to determine the effect of different water qualities and different automation drip irrigation systems on potato yield in sandy soil. Field experiments were carried out at NRC Farm, El-Noubaria Governor, Egypt, during 2011 and 2012. Potato plants grown under automation controller drip surface and subsurface drip irrigation systems. The main factor of this study were two irrigation water sources: Fresh water (FW) and Agricultural treated wastewater (ATW) and the treatments of automation drip irrigation systems: automation drip surface (DS), Automation drip subsurface 15 cm depth (DSS<sub>15</sub>), and automation drip subsurface 30 cm depth (DSS<sub>30</sub>). From the results under current study it could be concluded that using subsurface automation drip system in case depth of 30 cm below the sandy soil DSS<sub>30</sub> and at the same time using ATW were the best condition for maximum potato productivity, we can recommend using DSS<sub>30</sub> for keeping moisture content under sandy soil to avoid drought where that potato plants is very sensitive to drought conditions, and using (ATW) as a source of irrigation water because it contains the best nutrients for plant growth and should bear in mind that the salinity in the allowable limits.

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## Introduction

Subsurface automation drip irrigation systems may increase water use efficiency due to reduced soil and plant surface evaporation and because only the root zone or the partial root zone is irrigated as opposed to sprinkler irrigation where the entire field area is wetted. **Sammis (1980)** compared sprinkler, surface drip, subsurface drip, and furrow irrigation for the production of potato and lettuce in New Mexico. Sub-surface automation drip irrigation (SDI) with a 20-kPa irrigation criterion was among the most productive irrigation systems. **Shae et al. (1999)** studied four options for managing automation drip irrigation of potatoes in North Dakota. Automation of the irrigation based on a soil water tension irrigation criterion at 30kPa had relatively high water use efficiency. **Smajstrla et al. (2000)** compared automated controlled SDI irrigation with the conventional semi-closed seepage sub-irrigation in Florida. The conventional irrigation system is under criticism because of surface runoff and nutrient contamination of adjoining waterways. The SDI system required more electrical energy but used 36% less water to obtain the same potato yield. **Steyn et al. (2000)** examined irrigation-scheduling options for drip-irrigated potatoes.

Irrigation requirements differ with locations, soil types, and cultural practices. Under the condition of limited water supply, higher benefits may be achieved by adopting suitable irrigation and planting techniques

(Sharma et al., 1993). Furrow and sprinkler irrigation methods are widely used in early potato production in Mediterranean cropping system.

Onder et al. (2005) states that automation dripirrigation has not been widely used in potato production in this region, because of the higher cost of the automation dripline installation. In recent years, cost of installation has relatively decreased with improving technology. Also, the use of automation dripirrigation has been increased in most crop commodities, mainly for vegetables and fruits, to improve water use efficiency and nutrition supply in Mediterranean cropping system. Nowadays, subsurface automation dripirrigation is also under evaluation to improve water use efficiency since water is getting scarcer and more valuable year by year. Therefore, the automation dripirrigation practices will possibly be increased in early potato production in Mediterranean region. In the last few years, increasing number of UK growers have been carrying out small on-farm trials of trickle irrigation on potatoes (Weatherhead and Knox, 1997). There have been many reports on the effects of water stress and irrigation regimes on potato crop in Mediterranean-type environments Faberio et al., 2001) as well as other parts of the world. However, little information is available about the water use efficiency, growth, and yield of potato crop with on farm automation dripand subsurface automation dripirrigation.

For sprinkler-irrigated potato, extensive work has been done on potato responses to N fertilizer and N losses, but relatively few studies have studied potato N fertilization and loss under automation dripirrigation. Sprinkler irrigation at different irrigation criteria was compared to surface automation dripand buried automation dripirrigation (with a range of fertilization treatments), for potato yield and grade in Minnesota (Waddell et al., 2000). Less water was required using either automation dripirrigation system. Surface automation dripand buried automation dripwere among the most productive systems for total and marketable yield. Furthermore, automation dripirrigation or sprinkler irrigation (at relatively dry soil criteria) reduced nitrate leaching under potato compared to normal sprinkler irrigation (Waddell et al., 1999). Neibling and Brooks (1995) reported that reduced nitrogen rates did not affect potato yield, when irrigated with a subsurface automation dripsystem.

Simone et al. (2002) showed that automation dripirrigation had potential as an economically viable potato production method in the southeastern United States. Optimized irrigation rates 99% to 86% of the water called for in their irrigation model. Zartman et al. (1992) examined tape depth and emitter spacing on tuber yield and grade of Norgold Russet potato in Lubbock, Texas. Tape depth or emitter spacing did not influence potato yield, but the proportion of misshaped tubers were greater when the tape buried at 0.2 m than with shallower placement. Soil temperature greater with the tape at 0.2 m than at 0.1 m or 0.025 m. DeTar et al. (1996) studied on automation driptape depths of 0.08 m (above the seed piece) and 0.46 m (below the seed piece) performed better than intermediate and greater depths. Fabeiro et al. (2001) used 10 automation dripirrigation treatments to examine the effect of the timing of irrigation deficits on potato yield and water use efficiency in Spain. Irrigation deficits occurring during mid- and late-season tuber bulking were particularly damaging to yield. High yield combined with high water use efficiency when irrigation deficits restricted to early in the season. Shock et al. (2002a) investigated the performance of 'Umatilla Russet' under automation dripirrigation in silt loam. The factors considered in the study on tape placement (one tape per row or one tape per two rows) and four soil water tension levels for automatically starting irrigation (15, 30, 45, and 60 kPa). They concluded that automation driptape placement had a significant effect on every variable except total marketable yield and bud-end fry color for which interactions of irrigation criteria with tape number were significant. Tape placement and irrigation criterion interacted to influence total yield, total marketable potatoes, and US No. 2 yield. Results indicated potato should be irrigated at 30 kPa, given the silt loam soil and 2.5 mm water applied at each irrigation episode. The irrigation criterion considered alone only influenced the total US No.1 and over-340- g tuber size categories. Potato cultivars gave very different in their performance under automation dripirrigation (Eldredge et al., 2003).

The objectives of the current study determine the effect of fresh and agricultural treated wastewater and automation controller automation dripsurface and sub-surface irrigation systems on vegetative growth, potato yield and WUE.

## Material and Methods

A field experiment conducted during the years 2011 and 2011 in Field experimental Farm, El-Nobaria Governor, Egypt, in sandy soil to study the effect of tillage machine, water quality on vegetative growth, yield and water use efficiency WUE of Potato (*Solanumtuberosum*, L.), Diamond Variety. The main factor of this study for two irrigation water sources (Fresh & Treated waste water) and the treatments of automation controller automation dripirrigation systems automation dripsurface (DS),Automation dripsubsurface 15 cm depth (DSS 15) and automation dripsubsurface 30 cm depth (DSS 30).Some soil physical, chemical and water properties of the studied soil carried out in tables 1, 2 and 3. The Moisture retention at field capacity and wilting point had been recorded.

Soil in the investigated site was sandy loam in texture. Some soil chemical characteristics of the studied site recorded in Table (2).

All plots irrigated at 3-4 days interval. Amount of irrigation water measured at the entrance of each line of automation dripirrigation by a connected-flow-meter. Irrigation operation stopped two weeks before harvested the potato yield. Leaf area measured by digital plan meter in  $\text{cm}^2$ , whereas LAI (Leaf area index) calculated by dividing the total leaf area with the corresponding land area. A split-plot design with two qualities of irrigation water and three replications was used for three different automation dripirrigation methods as subplots (DS, DSS<sub>15</sub> and DSS<sub>30</sub>). Each subplot had six rows with 4.2 m width and 10.0 m length (42  $\text{m}^2$ ). The rows were 0.70 m apart from each other. The medium-early potato cultivar 'Diamond' was planted with 0.25 m row spacing and 0.10 m depth by hand on 5 March in 2011 and 25 February in 2012. Plots were fertilized with 90 kg N, P, K per ha before planting and an additional nitrogen dose of 60 kg per ha was side-dressed at the beginning of tuber bulking (Onder et al, 2005). Subsurface (DSS<sub>15</sub> and DSS<sub>30</sub>) automation driplateral lines were installed 0.15 and 0.30 m, on the ranking, below the soil surface (Camp, 1988) in each row at preplant. Cumulative evapotranspiration (ET) and Irrigation Water Requirement (IWR) of potato during growing season for agricultural seasonal period respectively 83.2 and 76.1  $\text{m}^3/\text{ha}$  for El-Nobaria, Egypt. Doorenbos and Pruitt, (1977).

The automation controller system consists of moisture sensors, temperature sensors, Signal conditioning circuit, Digital to analog converter, LCD Module, Relay driver, solenoid control valves, etc. The unit is expressed in Fig. (1) above. The important parameters to be measured for automation of irrigation system are soil moisture and temperature. The entire field is first divided in to small sections such that each section should contain one moisture sensor and a temperature sensor. RTD like PT100 can be used as a temperature sensor while Densitometer can be used as the moisture sensor to detect moisture contents of soil showed in Fig. (2). These sensors are buried in the ground at required depth. Once the soil has reached desired moisture level the sensors send a signal to the micro controller to turn off the relays, which control the valves of surface and subsurface automation dripirrigation systems used.

Surface automation dripirrigation lines were installed after emergence. Surface automation dripirrigation laterals were 16 mm in diameter. The drippers were inline type (GR) from each other and had 4 l/h flow rate at 1.0 bar pressure. The subsurface (DSS<sub>15</sub> and DSS<sub>30</sub>) automation dripirrigation was 1000 l/h per 100 m of hose at 1.0 bar pressure. Drippers were 0.20 m apart from each other in the subsurface (DSS<sub>15</sub> and DSS<sub>30</sub>) automation dripmethod. One automation dripline for each crop line was used in the experiments. The middle four rows in each plot were harvested by hand on 14 June and 9 June in 2011 and 2012, respectively.

The number of tubers per plant, tuber yield per plant, and mean tuber weight (g) were determined from 10 randomly selected plants in each subplot prior to harvest. After harvesting, tubers of each plot were graded into three size categories (>45, 28–45 and <28 mm unmarketable) and weighed. The potato yield of unmarketable tubers was generally very low and excluded from the data (Islam et al., 1990). This classification has also been used by the Egyptian firms that processed the early potato.

LAI = total leaf area / unit land area

The data were subjected to analysis of variance (ANOVA) using M-Stat. The significant differences between treatments were determined using least significant difference.

**Table (1): Physical and Hydro-physical properties of the soil.\***

Depth, cm	Particle Size distribution, %				Texture class	$\theta_s$ % on weight basis			HC ( $\text{cmh}^{-1}$ )	BD ( $\text{g}/\text{cm}^3$ )	P ( $\text{cm}^3$ voids/ $\text{cm}^3$ soil)
	C. Sand	F. Sand	Silt	Clay		F.C.	W.P.	AW			
0-15	8.4	77.6	8.5	5.5	Sandy	14.0	6.0	8.0	6.68	1.69	0.36
15-30	8.6	77.7	8.3	5.4	Sandy	14.0	6.0	8.0	6.84	1.69	0.36
30-45	8.5	77.5	8.8	5.2	Sandy	14.0	6.0	8.0	6.91	1.69	0.36
45-60	8.8	76.7	8.6	5.9	Sandy	14.0	6.0	8.0	6.17	1.67	0.37

\* Particle Size Distribution after (Gee and Bauder, 1986) and Moisture retention after (Klute, 1986)

F.C.: Field Capacity, W.P.: Wilting Point, AW: Available Water, HC: Hydraulic conductivity ( $\text{cmh}^{-1}$ ), BD: Bulk density ( $\text{g}/\text{cm}^3$ ) and P: Porosity ( $\text{cm}^3$  voids/ $\text{cm}^3$  soil).

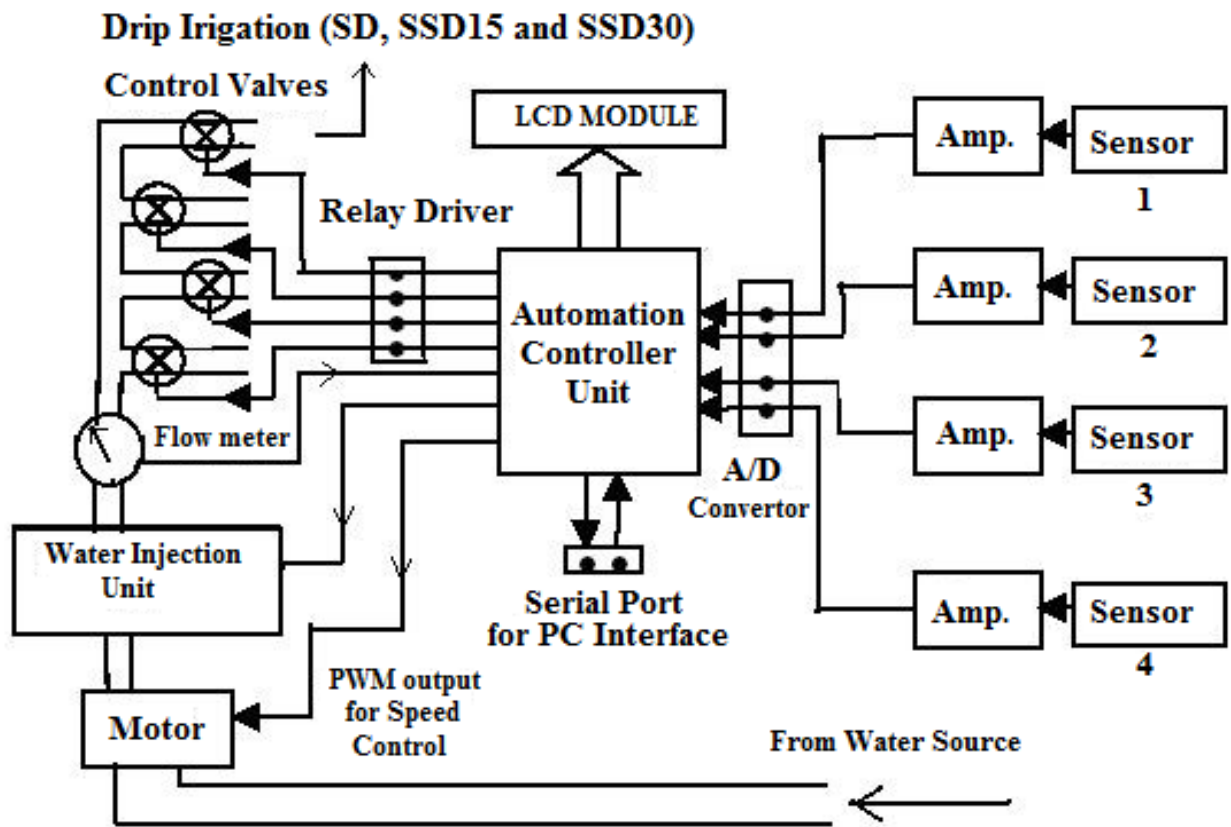


Fig. (1) Automation controller unit

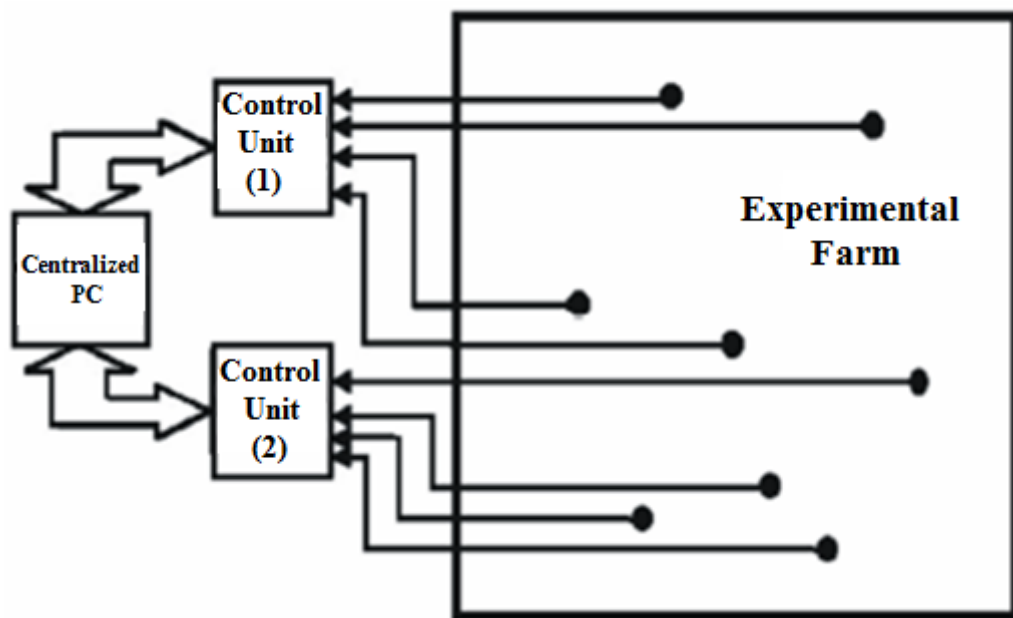


Fig. (2) Application in Field

**Table (2): Some chemical properties of the soil\*.**

Depth, cm	pH 1:2.5	EC dS/m	Soluble Cations, meq/L				Soluble Anions, meq/L			
			Ca <sup>++</sup>	Mg <sup>++</sup>	Na <sup>+</sup>	K <sup>+</sup>	CO <sub>3</sub> <sup>--</sup>	HCO <sub>3</sub> <sup>-</sup>	SO <sub>4</sub> <sup>--</sup>	Cl <sup>-</sup>
0-15	8.3	0.35	0.50	0.39	1.02	0.23	0	0.11	0.82	1.27
15-30	8.2	0.36	0.51	0.44	1.04	0.24	0	0.13	0.86	1.23
30-45	8.3	0.34	0.56	0.41	1.05	0.23	0	0.12	0.81	1.23
45-60	8.4	0.73	0.67	1.46	1.06	0.25	0	0.14	0.86	1.22

\*Chemical properties after Rebecca, (2004)

**Table (3): Some chemical properties of irrigation water used.**

Water quality Used	pH	EC dS/m	Soluble cations, meq/L				Soluble anions, meq/l				SAR
			Ca <sup>++</sup>	Mg <sup>++</sup>	Na <sup>+</sup>	K <sup>+</sup>	CO <sub>3</sub> <sup>--</sup>	HCO <sub>3</sub> <sup>-</sup>	SO <sub>4</sub> <sup>--</sup>	Cl <sup>-</sup>	
FW	7.3	0.37	0.76	0.24	2.6	0.13	0	0.9	0.32	2.51	4.61
AWT	8.2	0.47	0.83	0.37	3.1	0.25	0	1.3	0.46	2.5	4.82

FW: Fresh water and ATW: Agricultural treated wastewater

## Result and Discussion

Data tabulated in Table (4) and plotted in Fig. (3) Show the effect of Fresh water (FW), Agricultural treated wastewater (ATW) and different automation drip irrigation systems: surface automation drip irrigation (DS), subsurface automation drip irrigation by 15 cm depth (SSD<sub>15</sub>) and subsurface automation drip irrigation by 30 cm depth (SSD<sub>30</sub>) on number of plants per square meter, number of branches and plant length.

Number of plants per square meter at the 1<sup>st</sup> season 2011 as show in Table (4) and Fig. (3) underFW, the highest value (24.7) by using DS, then came SSD<sub>15</sub> value (24). The lowest value (23.2) achieved under SSD<sub>30</sub>. Whereas under ATW, the highest value (25.5) by using DS, followed by SSD<sub>15</sub> value (24.4). The lowest value (23.8) achieved under SSD<sub>30</sub>. The differences were significant at the 5% level in number of plants per square meter between irrigation systems. In the 2<sup>nd</sup> season 2012 as shown in Table (4) and Fig. (3) underFW, the highest value (26.6) by using DS, followed by SSD<sub>15</sub> value (24.8). The lowest value (24.5) achieved under SSD<sub>30</sub>. On the other hand Under ATW, the highest value (26.2) by using DS, then came SSD<sub>15</sub> value (25.3). The lowest value (24.8) achieved under (SSD<sub>30</sub>). There significant differences at the 5% level in number of plants per square meter between any two irrigation systems.

The increases in number of plants per square meter under FW of 2<sup>nd</sup> season 2012 were 3.5, 3.2 and 5.3 %. While under ATW recorded 2.7, 3.6 and 4.0 % in comparison with season 2011 under DS, DSS<sub>15</sub>, and DSS<sub>30</sub>, respectively.

The mean of branches number under FW as show Fig. (4) up to 3.3, 3.5, and 3.6 (season 2011) and 3.4, 3.6 and 3.7 (season 2012) under DS, DSS<sub>15</sub>, and DSS<sub>30</sub>, respectively. In both seasons the difference in leaf dry weight between any two irrigation systems were significant at the 5% level. The increases in branches number under FW of season 2012 recorded 2.9, 2.8 and 2.7 %. Whereas under ATW were 2.6, 2.6 and 7.1 % in comparison with season 2011 under DS, DSS<sub>15</sub>, and DSS<sub>30</sub>, respectively. Plant length under FW in cm as shows Table (4) and Fig. (5) were 45.3, 45.6; 46.3 and 45.2, 45.4; 46.8. Whereas under ATW as show Table (4) and Fig. (5) values were 46.3, 46.5; 46.6 and 46.4, 46.8; 47.3 by using DS, DSS<sub>15</sub>, and DSS<sub>30</sub>, of the 1<sup>st</sup> season (2011) and the 2<sup>nd</sup> (2012) seasons, on the rank. The increase in mean of plant length (cm) recorded 0.4 % under when the 2<sup>nd</sup> season was compared with the 1<sup>st</sup> one. The difference in plant length factors and treatments under study were significant at the 5 % level o at the 1<sup>st</sup> and 2<sup>nd</sup> season. The production yield of potato in the 1<sup>st</sup> season (year 2011) as shows Fig. (6) and Table (5) under FW, the highest values by using DSS<sub>30</sub> up to (10.7 ton/ha), followed by DSS<sub>15</sub> (9.3 ton/ha), while the lowest value of potato yield (8.2 ton/ha) when DS used. On the other hand potato yield of the 2<sup>nd</sup> season (year 2012) as shows Table (5) also under DSS<sub>30</sub>, the highest values (10.5 ton/ha), followed by the DSS<sub>15</sub> value (9.5 ton/ha) while the lowest value of potato yield (8.5 ton/ha) under DS.

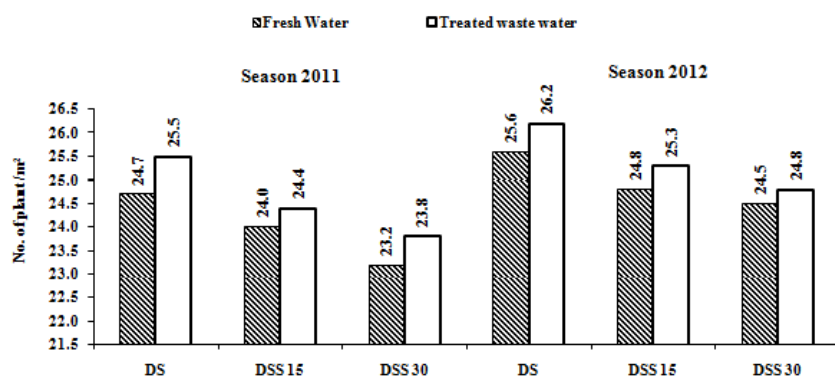
On contrast the production yield of potato at the 1<sup>st</sup> season (year 2011) under ATW, the highest values by using DSS<sub>30</sub> up to (10.8 ton/ha), followed by DSS<sub>15</sub> (9.5 ton/ha), while the lowest value of potato yield (8.6 ton/ha) when DS used. Whereas potato yield of the 2<sup>nd</sup> season (year 2012) as shows Table (5) also under DSS<sub>30</sub> were the

highest values up to (10.9 ton/ha), followed by the DSS<sub>15</sub> value (10.2 ton/ha) while the lowest value of potato yield (8.8 ton/ha) under DS.

**Table (4): Effect of water quality, automation drip surface and subsurface on vegetative growth of potato.**

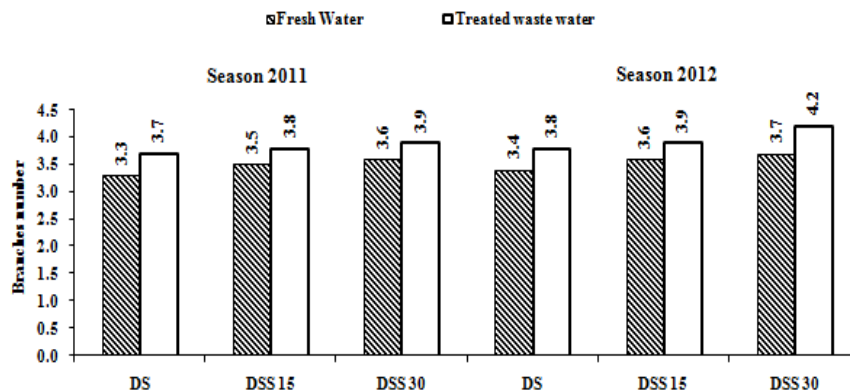
Year	Water quality	Irrigation system	Number of plants/m <sup>2</sup>	Number of branches	Plant length (cm)
2011	FW	DS	24.7	3.3	45.3
		DSS <sub>15</sub>	24.0	3.5	45.6
		DSS <sub>30</sub>	23.2	3.6	46.3
	ATW	DS	25.5	3.7	46.3
		DSS <sub>15</sub>	24.4	3.8	46.5
		DSS <sub>30</sub>	23.8	3.9	46.6
<b>Mean</b>			<b>24.3</b>	<b>3.6</b>	<b>46.1</b>
2012	FW	DS	25.6	3.4	45.2
		DSS <sub>15</sub>	24.8	3.6	45.4
		DSS <sub>30</sub>	24.5	3.7	46.8
	ATW	DS	26.2	3.8	46.4
		DSS <sub>15</sub>	25.3	3.9	46.8
		DSS <sub>30</sub>	24.8	4.2	47.3
<b>Mean</b>			<b>25.2</b>	<b>3.8</b>	<b>46.3</b>
<b>LSD 0.05</b>			0.07	0.06	0.04
<b>Interactions</b>			0.06	0.04	0.05

DS: Surface Drip, DSS<sub>15</sub>: subsurface automation dripunder soil depth 15cm, DSS<sub>30</sub>: sub-surface automation dripunder soil depth 30cm. FW: Fresh water and ATW: Agricultural treated wastewater



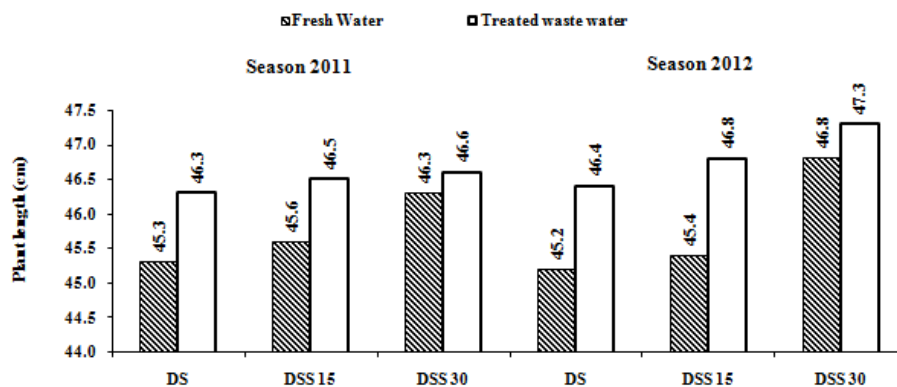
DS: Surface Drip, DSS<sub>15</sub>: sub-surface automation dripunder soil depth 15cm, and DSS<sub>30</sub>: sub-surface automation dripunder soil depth 30cm.

**Fig. (3) Effect of water quality, automation dripsurface and subsurface on number of plan per square meter of potato.**



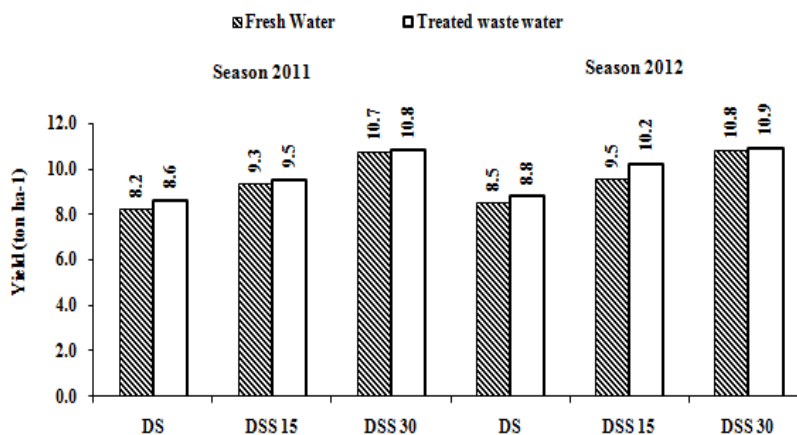
DS: Surface Drip, DSS<sub>15</sub>: subsurface automation dripunder soil depth 15cm, and DSS<sub>30</sub>: subsurface automation dripunder soil depth 30cm.

**Fig. (4) Effect of water quality, automation dripsurface and subsurface on branches number of potato.**



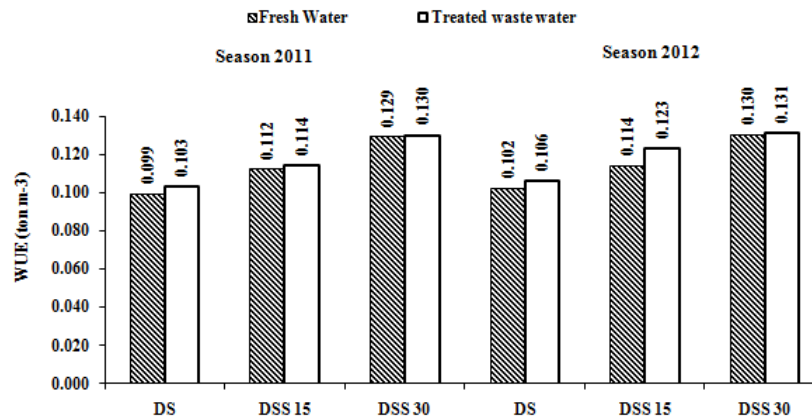
DS: Surface Drip, DSS<sub>15</sub>: subsurface automation dripunder soil depth 15cm, and DSS<sub>30</sub>: sub-surface automation dripunder soil depth 30cm.

**Fig. (5) Effect of water quality, automation dripsurface and subsurface on plant length of potato.**



DS: Surface Drip, DSS<sub>15</sub>: subsurface automation dripunder soil depth 15cm, and DSS<sub>30</sub>: sub-surface automation dripunder soil depth 30cm.

**Fig. (6) Effect of water quality, automation dripsurface and subsurface on potato yield.**



DS: Surface Drip, DSS<sub>15</sub>: sub-surface automation dripunder soil depth 15cm, and DSS<sub>30</sub>: sub-surface automation dripunder soil depth 30cm.

Fig. (7) Effect of water quality, automation dripsurface and subsurface on WUE.

Table (5): Effect of water quality, automation dripsurface and subsurface on yield and WUE of potato.

Year	Water quality	Irrigation system	Water amount (m <sup>3</sup> /ha)	Yield (ton/ha)	WUE (ton/m <sup>3</sup> )	
2011	FW	DS	83.2	8.2	0.099	
		DSS <sub>15</sub>		9.3	0.112	
		DSS <sub>30</sub>		10.7	0.129	
		ATW		8.6	0.103	
		DSS <sub>15</sub>		9.5	0.114	
		DSS <sub>30</sub>		10.8	0.130	
	Mean			<b>9.5</b>	<b>0.115</b>	
	2012	FW		DS	8.5	0.102
				DSS <sub>15</sub>	9.5	0.114
DSS <sub>30</sub>			10.8	0.130		
ATW		DS	8.8	0.106		
		DSS <sub>15</sub>	10.2	0.123		
		DSS <sub>30</sub>	10.9	0.131		
Mean		<b>9.8</b>	<b>0.118</b>			
LSD 0.05				0.08	0.001	
Interactions				0.05	0.001	

WUE: water use efficiency, DS: Surface Drip, DSS<sub>15</sub>: subsurface automation dripunder soil depth 15cm, DSS<sub>30</sub>: sub-surface automation dripunder soil depth 30cm, FW: Fresh water and ATW: Agricultural treated wastewater.

The differences in yield between factors and any two-irrigation systems were significant at the 5 % level in the two seasons. The data agreed well with Simone et al., (2002).

The data shows that increase at the 2<sup>nd</sup> season relative to the 1<sup>st</sup> one for potato yield achieved to maximum under FW and DS (3.5%), followed by DSS<sub>15</sub> (2.2%), while the minimum percentage of increase in potato yield (0.9%) when DSS<sub>30</sub> used. On the other hand under ATW values of increase percentage were 2.3, 6.9 and 0.9% under DS, DSS<sub>15</sub> and DSS<sub>30</sub> treatments, on the rank.

Concerning to WUE, as showed by Fig. (7) and Table (5), the data of 1<sup>st</sup> season shows the treatment DSS<sub>30</sub> is considerably the highest in values of both FW and ATW (0.129 and 0.130 ton/m<sup>3</sup>, on the arrange), followed by the DSS<sub>15</sub> values (0.112 and 0.114 ton/m<sup>3</sup>), while the lowest values of both FW and ATW (0.099 and 0.103 ton/m<sup>3</sup>, respectively) when DS treatment used.

For the 2<sup>nd</sup> season, Table (5), indicated that DSS<sub>30</sub> has the highest values both FW and ATW (0.130 and 0.131 ton/m<sup>3</sup> on the rank). Under DSS<sub>15</sub> those values were (0.114 and 0.123 ton/m<sup>3</sup>, respectively), while the lowest values of FW and ATW were (0.102 and 0.106 ton/m<sup>3</sup>, on the arrange) in the case of using DS as shows in Fig. (7).

LSD and interactions at 5% level, values (0.08, 0.05) and (0.001, 0.001) for yield and WUE under the three different treatments of irrigation systems used in the 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively referring significant differences between all values exception little of similar treatments. The increase in WUE of the 2<sup>nd</sup> season relative to 1<sup>st</sup> season one in both Fresh and Treated wastewater values (2.9, 1.8; 0.8 % and 2.3, 7.3; 0.8 %), respectively.

## Conclusion

Automation controller of automation dripsurface and subsurface irrigation systems has positively effect on the response of potato crop vegetative growth, yield and WUE. in conclusion that under sandy soil conditions, results indicated that the more depth of laterals automation dripsubsurface irrigation system leads to increasing sandy soil ability to keep moisture content greater than the nearest subsurface or surface automation driplateral lines of sandy soil, this helps to increase the potato plants because it's very sensitive to drought conditions, and it can be recommending the use of subsurface automation dripsystem in case depth of 30 cm below the surface of sandy soil (DSS<sub>30</sub>) and at the same time can be recommending to using agricultural treated wastewater (ATW) as a source of irrigation water because it contains the best nutrients for plant growth and should bear in mind that the salinity in the allowable limits.

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