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SAVING 50% IRRIGATION WATER, ENERGY, REDUCING OF SOIL SALTS ACCUMULATION AND WEEDS GROWTH BY A NEW AND SIMPLE METHOD FOR CULTIVATION IN SMALL PIECES OF PVC PIPES

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Abstract

Saving 50% irrigation water, energy, reducing soil salts accumulation and weeds growth under drip irrigation system is the main objective of all researchers specialized in sustainable water management under dry lands conditions. Although the drip irrigation system is the most efficient irrigation system in water conservation, it has some disadvantages, including the accumulation of salts in the soil, weed growth …etc especially under arid zones. Two trials were conducted to reach the study objective during two seasons 2017 and 2018 for cultivating sweet pepper in Al-Nubariya Region, Al-Buhayrah Governorate, Egypt. After determining the best dimensions of small piece of PVC pipe (110 mm diameter X 100 mm length) with pulse irrigation to avoid the exit of irrigation water from the surface of the upper small PVC pipe. The effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation, and deficit irrigation (Full irrigation "FI", 75%FI, 50%FI) on the following evaluation parameters: water stress inside root zone, application efficiency of irrigation water *"AEIW*" at initial growth stage, soil salts accumulation "SSA", weeds growth, yield of sweet pepper, Ysp, water productivity "WP sweet pepper" and some of fruit quality of sweet pepper crop were evaluated. There were positive effects for applying CPC method compared to traditional method of drip irrigation. The values of Ysp, WP sweet pepper and some of fruit quality of sweet pepper crop improved and increased under CPC method. This means under CPC method, the irrigation water was added in a small size to the soil around the roots of the cultivated plant, which led to a very low water stress even when adding 50% FI. The AEIW also increased due to the addition of water quantity within the root propagation area, while in TM, the amount of water ran horizontally and vertically out of the root zone. In addition to the use of the CPC method resulted in a decline in grass growth due to the lower surface wet area of sandy soils compared with the traditional method that increased wet soil area around the plant. The values of Ysp, WP sweet pepper and some of fruit quality of sweet pepper crop decreased by decreasing amount of applied irrigation water under TM method. This is due to the above mentioned reasons, while the reverse occurred when the irrigation water was added with the CPC method. This may have resulted in increasing the fertilizer elements and concentrating them with less water quantities and not leaving part of them outside the root spread area.

Keyword: Saving irrigation water, Soil salts accumulation, Weeds growth, Drip irrigation system, PVC Pipe cuts, Sweet pepper.

Introduction

In arid, high-density and limited freshwater areas, there is considerable pressure on the agricultural sector, reduced water consumption and access to fresh water for both urban and industrial sectors (Abdelraouf and Abuarab 2012). The agricultural sector in Egypt faces a major challenge: to produce the largest crop with as little irrigation water as possible, which can be achieved by increasing the water productivity of crops (Abdelraouf *et al*., 2013 c). Large population growth requires increased crop production, which is an important national target under dryland conditions (Bakry *et al*., 2012). In Egypt, due to limited irrigation water due to limited rainfall, crop water productivity is of major importance (Hozayn *et al*., 2013). One of the major and serious problems facing crop production and agricultural production in general is water scarcity. The development of new irrigation technologies is necessary to reduce the consumption of irrigation water and can help to make full use of these limited water resources and use them effectively (Abdelraouf *et al*., 2013b). The application of advanced and modern irrigation methods is an important concept to be followed in dry areas such as Egypt to provide part of irrigation water due to the limited water resources (El-Habbasha *et al*., 2014).

As Abdelraouf *et al*., (2013a and b) noted there is an urgent need to improve irrigation water consumption through the development of new techniques and methods to use such limited water resources more effectively. Non-traditional methods are also required to alleviate the scarcity of irrigation water and increase the efficiency of water use to increase agricultural productivity. Climate projections indicate that demand for irrigation water will increase in the coming years (www.cropwat.agrif.bg.ac.rs). To increase food production to cope with the growing population, more efforts have been made to develop agriculture in marginal and new reclaimed land and to use water-saving irrigation techniques (Gerges, 2006).

Although the drip irrigation system is the most efficient irrigation system in water conservation, it has some disadvantages, including the accumulation of salts in the soil, especially under arid zones. In order to reach an effective solution to reduce the accumulation of salts in the soil under drip irrigation system, It was found that the main reason for the accumulation of salts in the soil is to increase the wet surface area of the soil under the points, so the goal is how to reduce this area under the points and it was used during the cutting of plastic pipes used and the result of maintenance and repair within Farm and planting the seed or seedling inside these pieces.

Sweet Pepper (*Capsicum annuum L.*) Known as sweet peppers or green peppers, peppers belong to the family of spinach. Pepper is one of the most preferred and cultivated

vegetables in most parts of the world, especially in temperate climates. Pepper is known as an excellent source of bioactive compounds such as ascorbic acid, carotenoids and phenolic compounds, which are major antioxidant components, as well as minerals such as calcium, vitamins, fluorines and carbonates (Marin *et al*., 2004).

The aim of this study was investigating cultivation in small pieces of PVC pipes "CPC method": as a new and simple method to reduce the surface and size of wet soil around the plant under drip irrigation system for saving 50% irrigation water, energy, reducing of soil salts accumulation and weeds growth under drip irrigation system.

Materials and Methods

Location and climate of experimental site: The field experiments were conducted during 2017 and 2018 seasons at the research farm station of National Research Centre (NRC) (latitude 30° 30' 1.4"N, longitude 30°19' 10.9" E, and 21 m + MSL (mean sea level) at Al-Nubariya Region, Al-Buhayrah Governorate, Egypt. The experimental area has an arid climate with cool winters and hot dry summer. The data of average temperature, relative humidity and wind speed were obtained from the the meteorological data of the Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center for El-Nubaryia region, as shown in Figure 1.

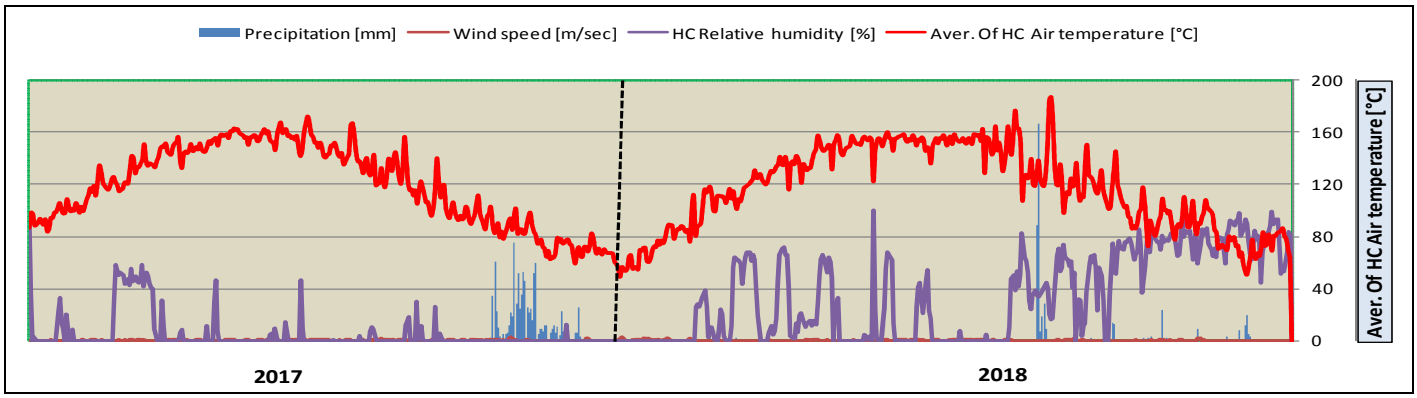


Fig. 1 : The data of average temperature, relative humidity and wind speed were obtained from the meteorological data of the Central Laboratory for Agricultural Climate (CLAC), weather station for El-Nubaryia region

Physical and chemical properties of soil and irrigation water: Irrigation water source was an irrigation channel passing through the experimental area, with an average pH of 7.36 and 0.42 dS m^{-1} as electrical conductivity (EC). The main physical and chemical properties of the soil are shown in table (1).

Table 1: Physical and chemical properties of the soil of the experimental area

Physical properties			
Soil layer depth (cm)	0–15	15-30	30-45
Texture	Sandy	Sandy	Sandy
Course sand (%)	48.62	54.77	42.64
Fine sand (%)	48.80	41.55	53.46
Silt+ clay (%)	2.58	3.68	3.90
Bulk density (t m^{-3})	1.68	1.66	1.65
Chemical properties			
$EC_{1:5}$ (dS m^{-1})	0.46	0.50	0.65
pH (1:2.5)	8.51	8.50	8.82
Total $CaCO_3$ (%)	7.11	2.44	4.65

Experimental design: Two trials were conducted to reach the study objective.

The first experimental design without cultivating was to determine the best dimensions for the small pipes that will be cultivated. Also, the method of adding the irrigation water is continuous drip irrigation or pulsed drip irrigation to ensure that irrigation water is released when the water needs are out of pipes as shown in figure (2).

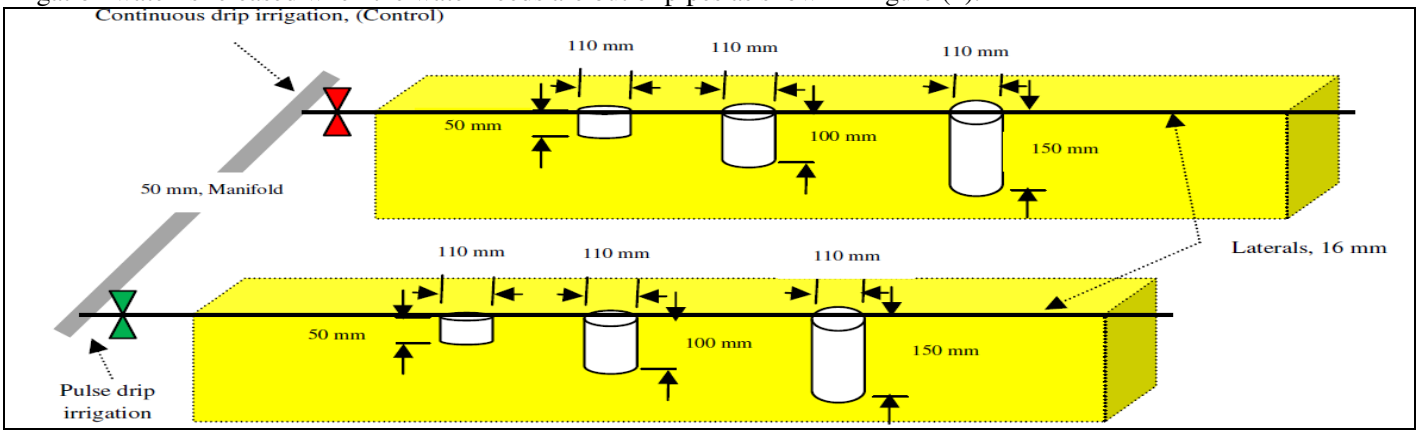


Fig. 2 : Layout of the first experimental design.

The second experimental design: Experimental design and treatments was split plot with three replications. Deficit irrigation [Full Irrigation, FI, 75% FI and 50% FI] were used in main plots and method of irrigation [cultivation in small pieces of PVC pipes "CPC method" and traditional method of drip irrigation, TM (control) and the both methods were with pulse irrigation system] were used in sub main plots as shown in figure (3)

Estimation the seasonal irrigation water for sweet pepper: Seasonal irrigation water was estimated according to the meteorological data of the Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center, Dokki, Egypt depending on Penman-Monteith equation. Seasonal irrigation water requirement for sweet pepper (*Capsicum annuum L.*) Crop were 5760 m^3ha^{-1} for 2017 and 6000 m^3ha^{-1} for 2018. Daily irrigation water was calculated by following equation (1) for two seasons 2017 and 2018 under drip irrigation system:

$$IRg = [(ET_O \times Kc \times Kr) / Ei] - R + LR \quad (1)$$

Where: IRg = Gross irrigation requirements, mm/day, ET_O= Reference evapotranspiration, mm/day, Kc = Crop factor (FAO-56), Kr = Ground cover reduction factor, Ei = Irrigation efficiency, %, R = Water received by plant from sources other than irrigation, mm (for example rainfall), LR = Amount of water required for the leaching of salts, mm

All agricultural practices were carried out according to the recommendations of Ministry of Agriculture for sweet pepper production in El-Nobaria region.

Evaluation parameters:

Water stress inside root zone: Measuring soil moisture content in effective root zone before and after irrigation and taking field capacity and wilting point as evaluation lines is considered as an evaluation parameter for exposure range of the plants to water stress "WS" (Abdelraouf, 2014). Soil moisture content was measured by simple sensor device.

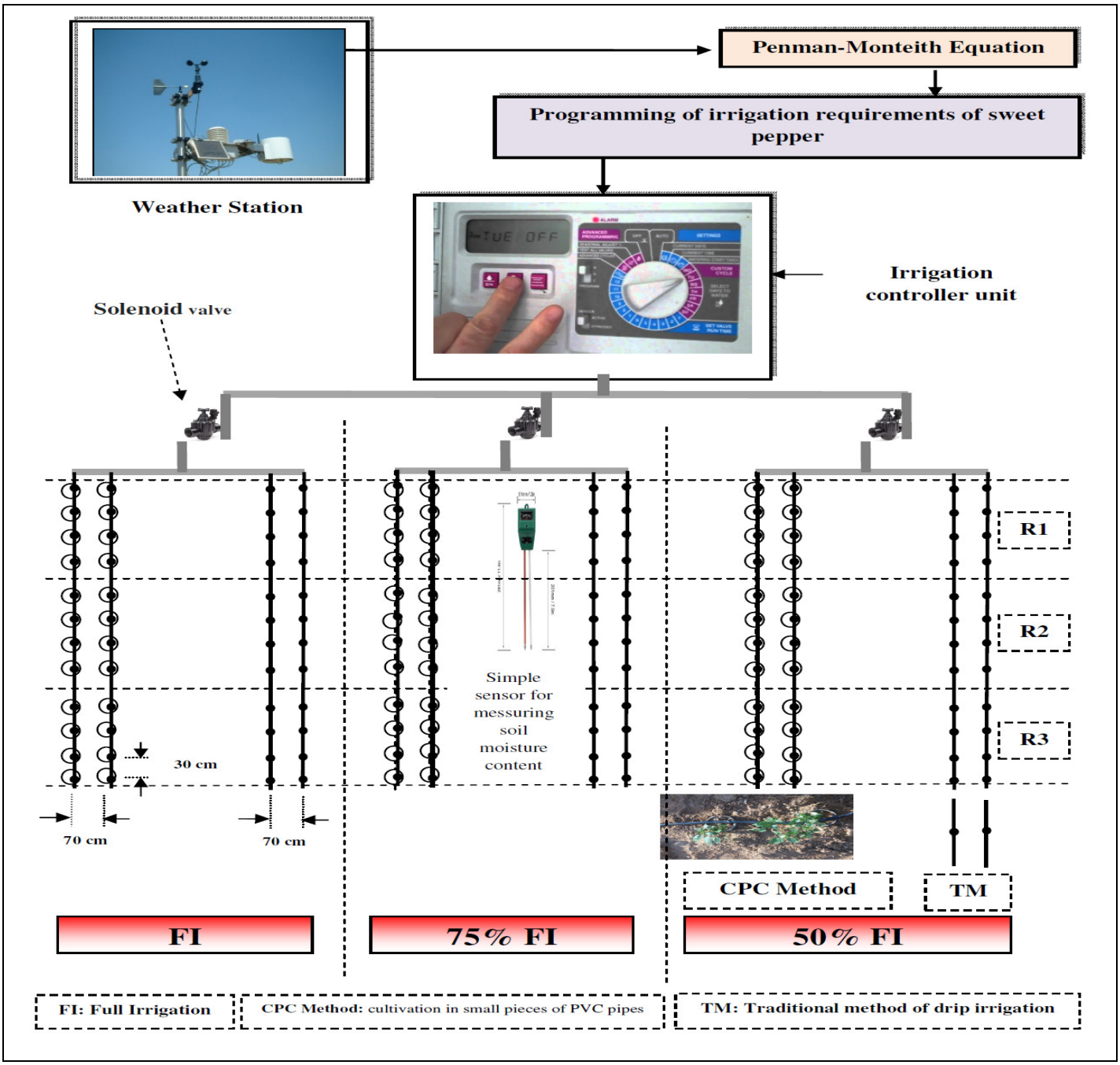


Fig. 3 : Layout of the second experimental design.

Application efficiency of irrigation water *"AE_{IW}"* at initial growth stage of sweet pepper plant: Soil moisture content "SMC" was determined were taken at maximum actual water requirements at initial growth stage of sweet pepper plant by simple sensor device before and 2 hours after irrigation and from different locations inside effective root zone (20 cm depth) on the X-Y directions, SMC were collected from different depths from soil surface. According to El-Meseery, (2003) application efficiency "AE_{IW}" was calculated using the following relation (2):

$$AE_{IW} = Ds/ Da \quad ....(2)$$

Where: AE_{IW} = Application efficiency of irrigation water, (%), Ds = Depth of stored water in root zone (cm) calculated by equation (3) where:

$$Ds = (\theta1 - \theta2) * d * \rho \quad ....(3)$$

Da = Depth of applied water (cm), d = Soil layer depth (cm), θ1 = Soil moisture content after irrigation (%), θ2 = Soil moisture content before irrigation (%), ρ = Relative bulk density of soil (dimensionless).

Salt accumulation in side root zone: measuring the total soil salts in the root zone before cultivation and after harvesting the sweet pepper.

Weeds growth: Weeds were hand pulled from 1 m^2 of each experimental unit at 80 days after sowing, then the collected weeds were first air dried in the sun and then in an electric oven for 72 hours maintaining a constant temperature of 70°C. Consequently, the dry weights were recorded.

Yield of sweet pepper: At harvest time of sweet pepper, total weight of fruits in each treatment were recorded by harvesting pepper as Kg per 1 m^2 were calculated, fruits twice weekly and then the total yield as ton/hectare was calculated.

Water productivity of sweet pepper "$WP_{sweet\ pepper}$" was calculated according to James (1988) by equation (4) as follows:

$$WP_{sweet\ pepper} = Ey/Ir \quad ....(4)$$

Where: WP sweet pepper is water productivity of sweet pepper (kg sweet pepper / m^3 irrigation water), Ey is the economical yield (kg sweet pepper / hectare/season); Ir is the applied amount of irrigation water (m3irrigation water /hectare/season).

Fruit quality of sweet pepper: At harvesting time, samples of green pepper fruits were randomly harvested from each sub-plot to measure fruit length, fruit diameter, average fruit weight and vitamin C.

Statistical analysis: All the obtained data in the two combined seasons of the study were statistically analyzed using the analysis of variance method according to Snedecor and Cochran (1980) while, the values of least significant differences (L.S.D. at 5 % level) were calculated to compare the means of different treatments.

Results

To achieve the goal of the study, two experiments were conducted. The first experiment without planting was only to determine some of the engineering factors required for the second experiment. In the first experiment, the appropriate length of the PVC piping cuts was examined, in which no soil moisture from the bottom to the top of the soil surface with capillary properties occurs and at the same time, it is not expensive. The applying method of irrigation water has also been tested whether it will be continuous drip irrigation (normal method) or pulse drip irrigation in order to avoid water buoyancy of cutting pipes, especially when adding the maximum water requirements during the stages of plant growth. After determining the average water requirements of vegetables for the previous year computationally in the study area, it was added to this experiment in order to determine, as mentioned above, the length of the appropriate pipe cut. Also, will the pulse irrigation be the best in the process of adding irrigation water or not.

After the experiment was repeated three times, the appropriate dimensions of the PVC pipes cuts were reached. Also, the method of adding irrigation water eight times a day was preferable to avoid the floating irrigation water outside the top of the pipes cuts where the pepper plant was planted as shown as in figure (4), where the diameter of PVC pipes cuts was 110 mm (Suitable for the size of the farmer's hand when planting the seedlings inside the PVC pipe cuts) and the length was 100 mm.

Fig. 4 : The best dimensions of PVC pipes cuts with pulse drip irrigation

Water stress inside root zone

Figure 5 shows the effect of CPC method and deficit irrigation with pulse irrigation technique on the water stress inside root zone of the sweet pepper plant. Minimum water stress occurred under CPC method compared to TM. Water stress was increased by decreasing in the amount of irrigation water where, water stress at full irrigation was smaller than 75%FI and 50%FI respectively. The volume of water stress when using CPC method was much lower when applying TM. Consequently, the treatments were arranged in ascending order from the smaller water stress to the higher ones CPC,FI· CPC,75%FI· CPC, 50%FI· TM, FI· TM, 75%FI· TM, 50%FI.

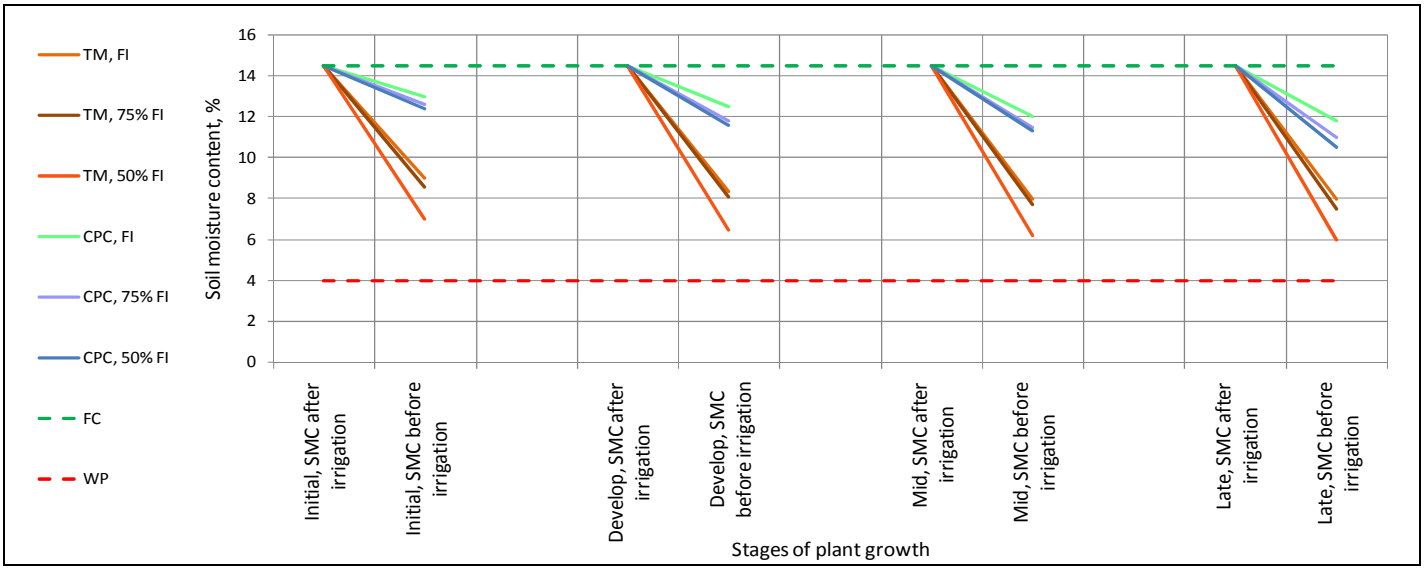


Fig. 5 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation (Full irrigation "FI", 75%FI and 50%FI) with pulse irrigation technique on water stress within the root zone of the sweet pepper plant during all growth stages 2017

Application efficiency of irrigation water "AE_{IW}" at initial growth stage of sweet pepper plant

Application efficiency of irrigation water "AE_{IW}" is a measurement of how effective the irrigation system is in storing irrigation water in the crop root zone. It is expressed as the percentage of the total volume of irrigation water delivered to the field that is stored in the root zone to meet crop evapotranspiration (ET) needs. Figure 6 shows the effect of CPC method and deficit irrigation with pulse irrigation technique on the AE_{IW} at initial growth stage of sweet pepper plant. Minimum AE_{IW} occurred under TM compared to CPC method. AE_{IW} was increased by decreasing in the amount of irrigation water where, AE_{IW} at full irrigation was smaller than 75%FI and 50%FI respectively. Consequently, the treatments were arranged in ascending order from the smaller AE_{IW} to the higher ones TM, FI· TM, 75%FI· TM, 50%FI· CPC, FI· CPC, 75%FI· CPC, 50%FI.

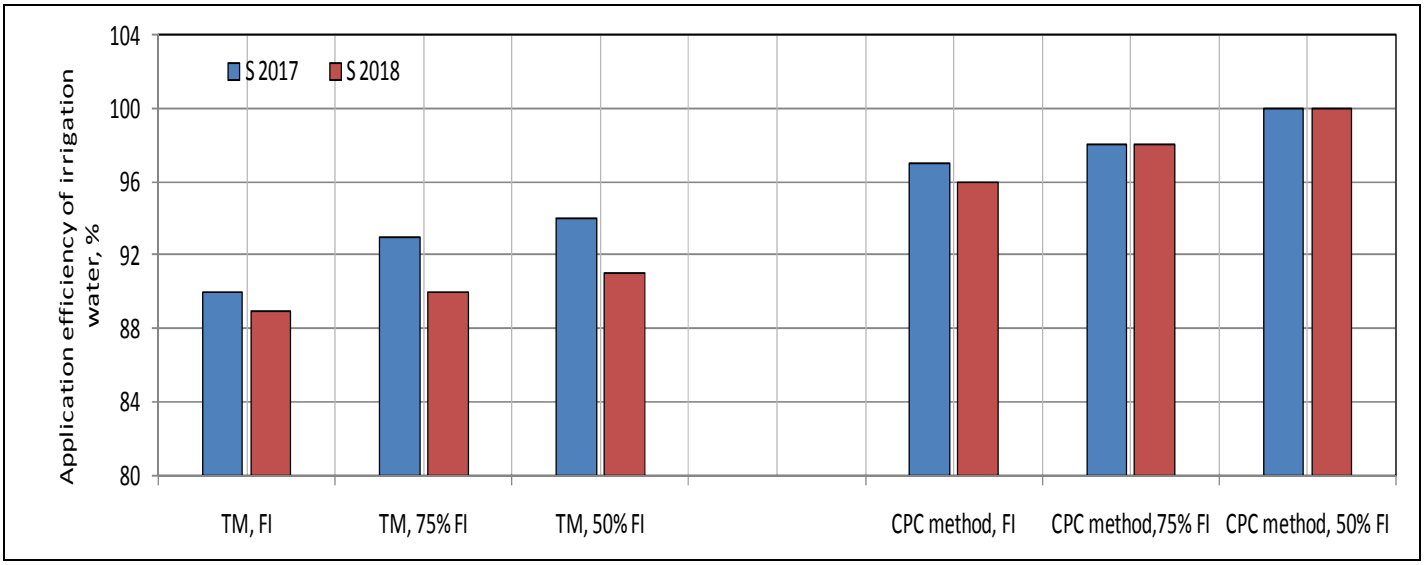
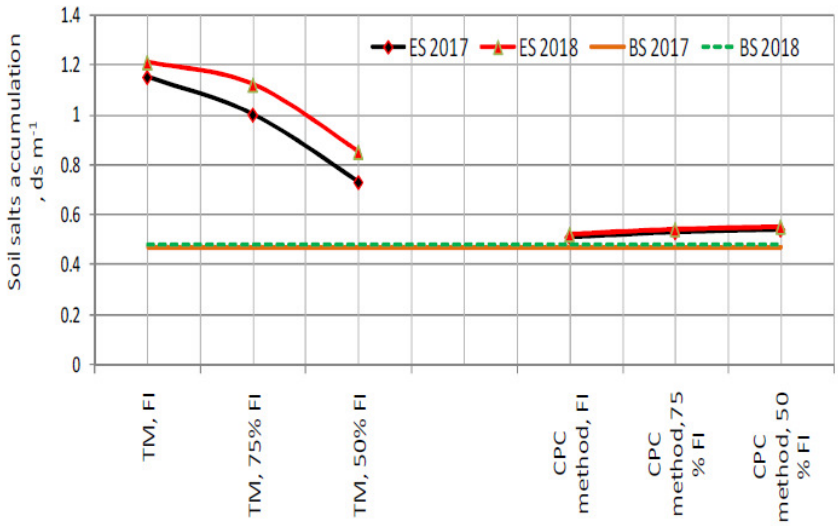
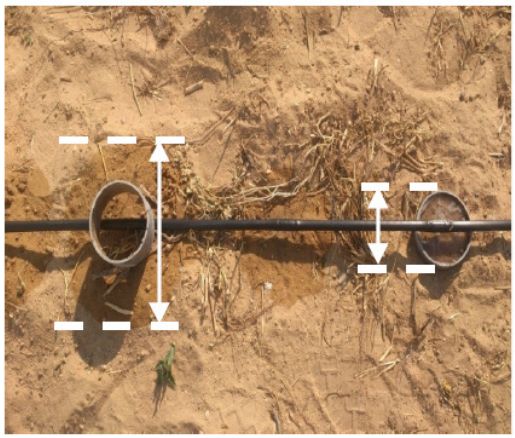


Fig. 6 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation (Full irrigation "FI", 75%FI and 50%FI) with pulse irrigation technique on application efficiency of irrigation water at initial growth stage of plant for seasons 2017 and 2018

Soil Salts Accumulation

Although the drip irrigation system is the most efficient system to provide water, it has some disadvantages, the most important of which is the accumulation of salts in the soil. Figure 7 shows the effect of CPC method and deficit irrigation with pulse irrigation technique on the soil salts accumulation "SSA" in root zone of sweet pepper plant. Minimum SSA occurred under CPC method compared to TM. SSA was increased by increasing in the amount of irrigation water under TM where, SSA at full irrigation was higher than 75%FI and 50%FI respectively but there was a slight increase in SSA by decreasing of amount of irrigation water added with CBC. Consequently, the treatments were arranged in ascending order from the smaller SSA to the higher ones CPC, FI· CPC, 75%FI· CPC, 50%FI· TM, 50%FI· TM, 75%FI· TM, FI.





Effect of CPC method and TM on the wet surface area

Fig. 7 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation (Full irrigation "FI", 75%FI and 50%FI) with pulse irrigation technique on the soil salts accumulation for seasons 2017 and 2018

Weeds growth

It is logical to increase the growth of weeds with increasing wet surface area of the soil, as confirmed by the following results. Figure 8 shows the effect of CPC method and deficit irrigation with pulse irrigation technique on the dry weight of total weeds "DWTW" during the growth of sweet pepper plant. Minimum DWTW occurred under CPC method compared to TM. DWTW was increased by increasing in the amount of irrigation water under TM where, DWTW at full irrigation was higher than 75%FI and 50%FI respectively but there was a slight increase in DWTW by decreasing of amount of irrigation water added with CPC method. Consequently, the treatments were arranged in ascending order from the smaller DWTW to the higher ones, CPC,FI· CPC,75%FI· CPC,50%FI· TM,50%FI· TM, 75%FI· TM,FI.

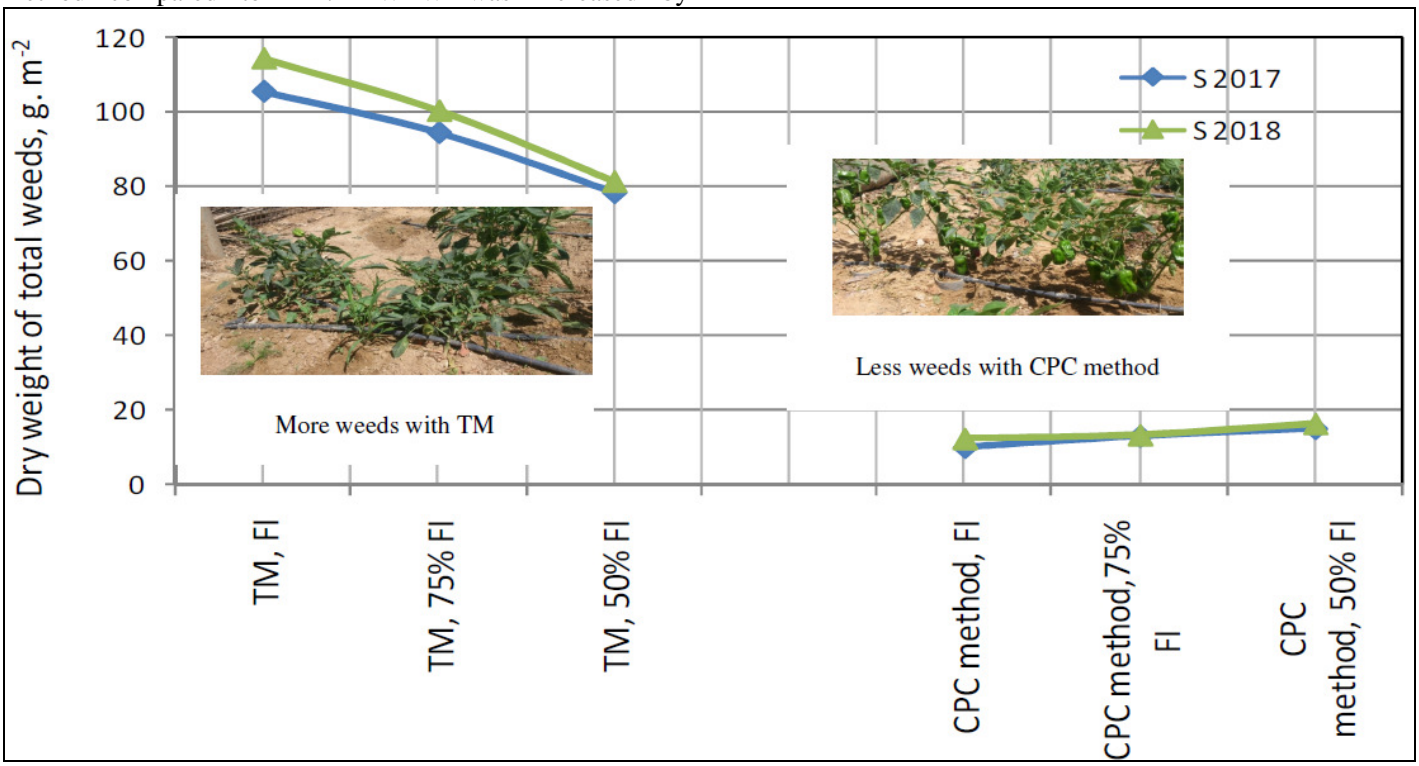


Fig. 8 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation (Full irrigation "FI", 75%FI and 50%FI) with pulse irrigation technique on the dry weight of total weeds during growing of sweet pepper plant for seasons 2017 and 2018

Yield of sweet pepper, Ysp

Figure 9 and table 2 shows the effect of CPC method and deficit irrigation with pulse irrigation technique on the yield of sweet pepper "Ysp". Maximum Ysp occurred under CPC method compared to TM. Ysp was decreased by decreasing in the amount of irrigation water under TM where, Ysp at full irrigation was higher than 75%FI and 50%FI respectively but there was a slight increase in Ysp by decreasing of amount of irrigation water added with CPC method. Consequently, the treatments were arranged in descending order from the higher Ysp to the smaller ones, CPC, 50%FI· CPC, 75%FI· CPC, FI· TM, FI· TM, 75%FI· TM, 50%FI.

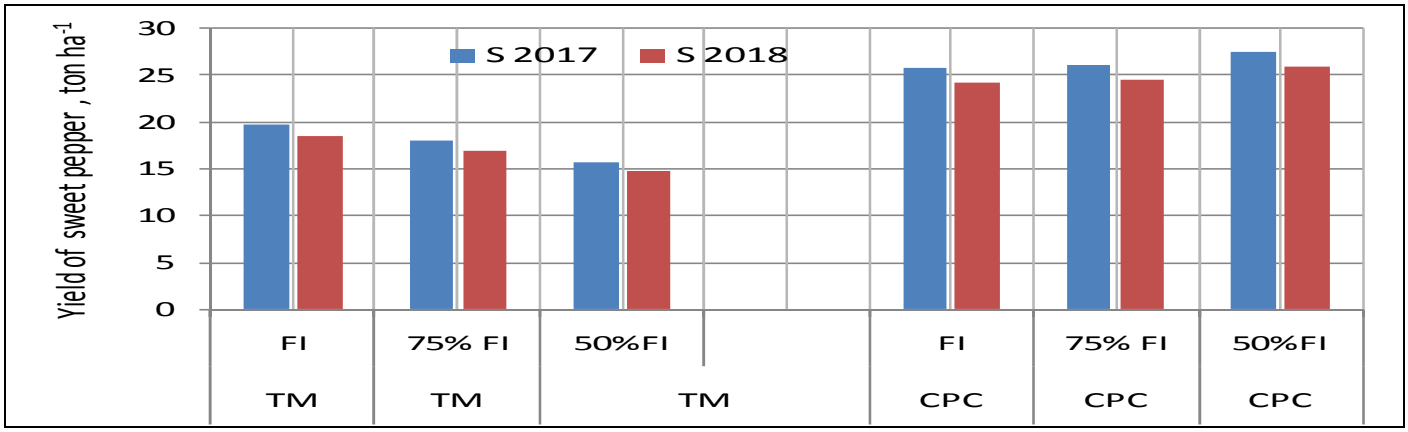


Fig. 9 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation (Full irrigation "FI", 75%FI and 50%FI) with pulse irrigation technique on the yield of sweet pepper for seasons 2017 and 2018

Water productivity "WP $_{\text{sweet pepper}}$"

Figure 10 and table 2 shows the effect of CPC method and deficit irrigation with pulse irrigation technique on the water productivity "WP $_{\text{sweet pepper}}$". Maximum WP $_{\text{sweet pepper}}$ occurred under CPC method compared to TM. WP $_{\text{sweet pepper}}$ was increased by decreasing in the amount of irrigation water under both TM and CPC methods where, WP $_{\text{sweet pepper}}$ at full irrigation was smaller than 75%FI and 50%FI respectively. Consequently, the treatments were arranged in descending order from the higher WP $_{\text{sweet pepper}}$ to the smaller ones, CPC,50%FI، CPC,75%FI، CPC,FI، TM,50%FI، TM, 75%FI، TM,FI.

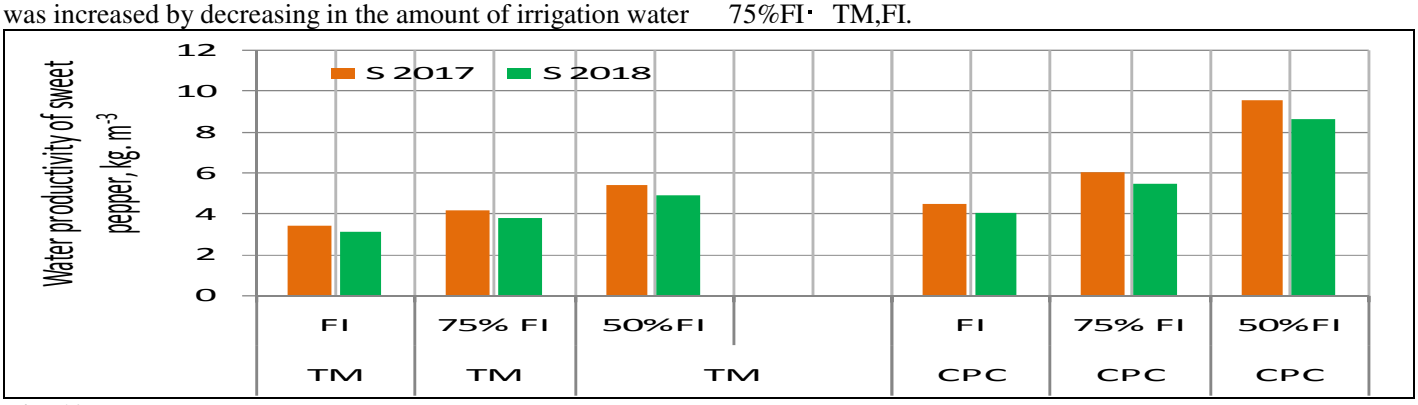


Fig. 10 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation (Full irrigation "FI", 75%FI and 50%FI) with pulse irrigation technique on the water productivity of sweet pepper for seasons 2017 and 2018

Table 2 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation with pulse irrigation technique on the yield and water productivity of sweet pepper for seasons 2017 and 2018.

WP $_{\text{sweet pepper}}$, kg m^{-3}		Yield of sweet pepper , ton ha^{-1}		Deficit irrigation	Method of irrigation
2018	**2017**	**2018**	**2017**		
Effect of the new method (CPC method) on the yield and water productivity of sweet pepper					
3.92	4.35	16.74	17.81		TM, (control)
6.05	6.70	24.92	26.52		CPC method
		0.51	0.54		LSD at 5%
Effect of deficit irrigation on the yield and water productivity of sweet pepper					
3.57	3.95	21.41	22.77	FI	
4.62	5.12	20.78	22.10	75% FI	
6.77	7.50	20.32	21.61	50% FI	
		0.57	0.61	LSD at 5%	
Effect the interaction of the new method (CPC method) and deficit irrigation on the yield and water productivity of sweet pepper					
3.09	3.42	18.53	19.72	FI	TM, (control)
3.77	4.18	16.96	18.05	75% FI	
4.91	5.44	14.72	15.66	50% FI	
4.05	4.48	24.28	25.83	FI	CPC method
5.46	6.06	24.59	26.16	75% FI	
8.64	9.57	25.91	27.56	50% FI	
		0.81	0.86	LSD at 5%	

Fruit quality of sweet pepper

At harvesting time, samples of green pepper fruits were randomly harvested from each sub-plot to measure fruit length, fruit diameter, average fruit weight and vitamin C. Figure 11 and table 3 shows the effect of CPC method and deficit irrigation with pulse irrigation technique on some of fruit quality of sweet pepper "FQsp". Maximum values of FQsp occurred under CPC method compared to TM. The values of FQsp was decreased by decreasing in the amount of irrigation water under TM where, The values of FQsp at full irrigation was higher than 75%FI and 50%FI respectively but there was a slight increase in FQsp by decreasing of amount of irrigation water added with CBC method. Consequently, the treatments were arranged in descending order from the higher FQsp to the smaller ones, CPC,50%FI· CPC,75%FI· CPC,FI· TM,FI· TM,75%FI· TM,50%FI.

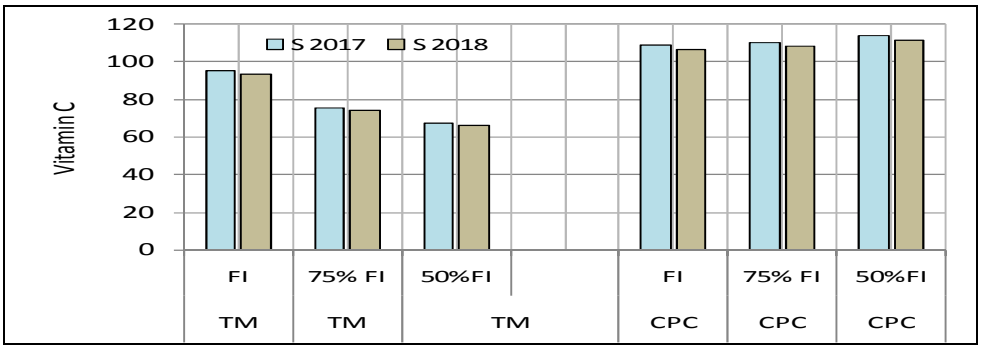


Fig. 11 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation (Full irrigation "FI", 75%FI and 50% FI) with pulse irrigation technique on the vitamin C of sweet pepper for seasons 2017 and 2018.

Table 3 : Effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM (control)" and deficit irrigation with pulse irrigation technique on the fruit quality of sweet pepper for seasons 2017 and 2018.

2018				2017				Deficit irrigation	Method of irrigation
Vitamin C	Fruit weight, gm	Fruit dia., cm	Fruit length, cm	Vitamin C	Fruit weight, gm	Fruit dia., cm	Fruit lengt, cm		
Effect of the new method (CPC method) on the fruit quality of sweet pepper									
77.95	75.20	5.99	6.98	79.54	77.5	6.2	7.3		TM, (control)
108.6	123.36	7.64	9.65	110.8	127.2	8.0	10.2		CPC method
2.43				2.48					LSD at 5%
Effect of deficit irrigation on the fruit quality of sweet pepper									
100.0	105.73	7.25	8.45	102	109.0	7.6	8.9	FI	
91.10	97.67	6.74	8.07	92.96	100.7	7.0	8.5	75% FI	
88.69	94.44	6.46	8.42	90.50	97.4	6.7	8.9	50% FI	
1.87				1.91				LSD at 5%	
Effect the interaction of the new method (CPC method) and deficit irrigation on the fruit quality of sweet pepper									
93.50	91.2	7.0	7.7	95.41	94.0	7.3	8.1	FI	TM, (control)
74.25	72.1	5.9	6.7	75.76	74.4	6.1	7.0	75% FI	
66.10	62.3	5.1	6.5	67.45	64.2	5.3	6.9	50% FI	
106.5	120.3	7.5	9.2	108.7	124.0	7.8	9.7	FI	CPC method
108.0	123.2	7.6	9.5	110.2	127.0	7.9	10.0	75% FI	
111.3	126.6	7.9	10.3	113.5	130.5	8.2	10.9	50% FI	
2.65				2.70				LSD at 5%	

Discussion

After determining the best dimensions of PVC pipes cuts (110 mm diameter X 100 mm length) and after reaching the importance of pulse irrigation to avoid the exit of irrigation water from the surface of the upper PVC pipe cuts, especially when adding the maximum water needs of plants planted in the small PVC pipe cut embedded in sandy soil, the effect of CPC method (cultivation in small pieces of PVC pipes), traditional method of drip irrigation "TM", and deficit irrigation with pulse irrigation technique on the following evaluation parameters: water stress inside root zone, application efficiency of irrigation water *"AE_{IW}"* at initial growth stage, soil salts accumulation "SSA", weeds growth, yield of sweet pepper, Ysp, water productivity "$WP_{\text{sweet pepper}}$" and some of fruit quality of sweet pepper crop were evaluated.

Minimum water stress occurred under CPC method compared to TM. This may be due to increasing the size of wetness compared to the size of the area of root spread, which led to low soil moisture content in the area of root spread, which led to the exposure of plant roots to high water stress when using the TM, but when applying CPC method, the volume of wet inside the cut pipes closer to the size of the area root propagation, in which the roots of the cultivated plants were not subjected to any water stress even when adding 50%FI required to irrigate these plants.

Lowest values for AE_{IW} occurred under TM compared to CPC method. This may be due to the most difficult period in which the plant is exposed to water stress and the small irrigation water efficiency values is the initial growth period of the plant age, for two reasons. The first is the small size of the root spread area and the second reason is the small size of irrigation water to be added, and then the difficulty of adding the quantity of small irrigation water to the small area of root spread under TM but under CPC method The small size of the irrigation water is added to the small area of the spread of the roots, thus reducing the water stress and increasing the value of the application efficiency.

Minimum SSA occurred under CPC method compared to TM. This may be due to small wet soil surface area with CPC where, this is agreed with the results and logic where the more wet surface area prone to evaporation the more the rate of accumulation of salts in the soil. SSA was increased by increasing in the amount of irrigation water under TM. This may be due to increasing the amount of irrigation water added increases the area of wet soil surface under TM. SSA at full irrigation was higher than 75%FI and 50%FI respectively but there was a slight increase in SSA by water added with CPC.

It is logical to increase the growth of weeds with increasing wet surface area of the soil, as confirmed by the following results. Minimum DWTW occurred under CPC method compared to TM. DWTW was increased by increasing in the amount of irrigation water under TM where, DWTW at full irrigation was higher than 75%FI and 50%FI respectively but there was a slight increase in DWTW by decreasing of amount of irrigation water added with CPC method.

The effect of CPC method and traditional method of drip irrigation with pulse irrigation technique on the following evaluation parameters: water stress inside root zone, AE_{IW} at initial growth stage, SSA, weeds growth, Ysp, $WP_{\text{sweet pepper}}$ and some of fruit quality of sweet pepper crop were studied. There were positive effects for applying CPC method compared to TM. The values of Ysp, $WP_{\text{sweet pepper}}$ and some of fruit quality of sweet pepper crop improved and increased under CPC method. This means under CPC method, the irrigation water was added in a small size to the soil around the roots of the cultivated plant, which led to a very low water stress even when adding 50% of the full irrigation where, in the traditional method, the movement of irrigation water was added to the soil moisture stress in all directions and away from the root spread area The effect of adding irrigation water at the initial stage of plant growth when applying the CPC method was also increased due to the addition of water quantity within the root propagation area, while in TM, the amount of water ran horizontally out of the root zone. The use of the CPC method resulted in a decline in grass growth due to the lower surface wet area of sandy soils compared with the traditional method that increased wet soil area around the plant.

The effect of deficit irrigation with pulse irrigation technique on the following evaluation parameters: water stress inside root zone, AE_{IW} at initial growth stage, SSA, weeds growth, Ysp, $WP_{\text{sweet pepper}}$ and some of fruit quality of sweet pepper crop. The values of Ysp, $WP_{\text{sweet pepper}}$ and some of fruit quality of sweet pepper crop decreased by decreasing amount of applied irrigation water under TM method. This is due to the above mentioned reasons, while the reverse occurred when the irrigation water was added with the CPC method. This may have resulted in increasing the fertilizer elements and concentrating them with less water quantities and not leaving part of them outside the root spread area.

Conclusion

The best dimensions of PVC pipes cuts (110 mm diameter X 100 mm length) and pulse drip irrigation to avoid the exit of irrigation water from the surface of the upper PVC pipe cuts. There were positive effects for applying CPC method (cultivation in small pieces of PVC pipes) compared to traditional method of drip irrigation. The values of Ysp, $WP_{\text{sweet pepper}}$ and some of fruit quality of sweet pepper crop improved and increased under CPC method. This means under CPC method, the irrigation water was added in a small size to the soil around the roots of the cultivated plant, which led to a very low water stress even when adding 50% of the full irrigation. The AE_{IW} also increased due to the addition of water quantity within the root propagation area, while in TM, the amount of water ran horizontally out of the root zone. In addition to the use of the CPC method resulted in a decline in grass growth due to the lower surface wet area of sandy soils compared with the traditional method that increased wet soil area around the plant. The values of Ysp, $WP_{\text{sweet pepper}}$ and some of fruit quality of sweet pepper crop decreased by decreasing amount of applied irrigation water under TM method. This is due to the above mentioned reasons, while the reverse occurred when the irrigation water was added with the CPC method. This may have resulted in increasing the fertilizer elements and concentrating them with less water quantities and not leaving part of them outside the root spread area.

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