SPACING AND DEPTH EFFECTS OF SUBSURFACE DRIPPERS ON GREENHOUSE HOTPEPPERS

Aboamera, M.A [1] Gomaa, A.H [1] Abed – El wahab, H.M [2]

ABSTRACT

The effect of both emitter spacing and depth of lateral irrigation line was evaluated as a function of the performance of subsurface drip irrigation system. The experimental work was conducted on hot pepper cultivated in plastic green house in Inshas Experimental Station, Sharkiya Governorate, Egypt. Operating the subsurface drip irrigation system with a depth of lateral line beneath the soil surface, not more more than 20 cm, resulted in a uniform distribution of soil moisture and lower concentration of salts in soil profile. The best distribution of roots was observed with 30cm of emitter spacing and 20cm depth of lateral line. The highest values of both water use efficiency (44.39 kg/m^3) and fertilizer use efficiency (104.5 kg fruits/kg NPK) were recorded when the lateral line lied at the soil surface (i.e., zero depth) with 30 cm of emitter spacing.

Keywords: *subsurface drip irrigation system, irrigation in green houses, vegetable cultivated in green houses, depth of drip lateral line, emitter spacing*

INTRODUCTION

As land and water resources become increasingly limited for agriculture in many parts of the world and in the urban areas in particular, there has been a rapid upsurge in the production of high value crops under plastic and glass green houses. Intensive systems are more and more requested in order to get maximum yield with minimum use of these resources. Protected agriculture has enabled many countries to greatly extend their food production capability. Nearly 200000 ha are under off-season protected cultivation. This protected area is equivalent to one million ha or more in terms of horticulture production of open field area and to the output of some ten million ha in terms of crop value. The greenhouses area in Egypt is about 126 ha (300feddan) FAO,1990.

1) Associate professor, (2) Grad. Stud., All in Agric. Eng. Dept. Faculty of Agric. Minufiya University.

Evaporation decreased with increasing drip line depth and evapotranspiration from drip irrigation could be reduce to 40% when the drip line is buried at a depth of 15 cm compared with surface drip line, with sorghum crop. Sorghum growth increased by 69% by weight under subsurface drip compared with surface drip (El-Awady et al., 2003).

Tomato yield was not influenced significantly by irrigation treatments in the green house, although the irrigation treatment of low soil water tension (less than or equal to 50kPa), maintained throughout the growing season, gave higher yield (Kidera et al., 2003).

Ayars et al. (1999) pointed out that the use of subsurface drip irrigation system requires that the bed size and the spacing of crops in the rotation should conform to the drip lateral spacing. They also added that crop yields were not affected when the drip tubing was not centered under the bed.

For both surface and subsurface drip irrigation systems, most of tomatoes root system was concentrated at the top 40cm of soil profile, where root length density ranged between 0.5 and 1.5 cm/cm^3. Commercial yields were 87.6 and 114.2 Mg/ha for surface drip irrigation system during seasons 1997 and 1998 respectively, and were 107.5 and 128.1 Mg/ha for subsurface drip irrigation system with 20 cm depth of lateral line beneath the soil surface during seasons 1997 and 1998 respectively. Meanwhile, yields were 105 and 124.8 Mg/ha for subsurface drip irrigation system with 40 cm depth of lateral line beneath the soil surface during seasons 1997 and 1998 respectively (Machado et al., 2003)

Maroueli and Silva (2002) reported that marketable yield of surface drip irrigated tomato (124 Mg / ha) was 32% higher than subsurface drip tomato with 40 cm depth of lateral and was 15 % larger than sprinkler irrigated tomato. Yield increments were basically due to a larger number of fruits per plant since final stand and mean fruit mass were not affected by treatments. Rotten fruit rates for the sprinkler treatment were 112% and 453 % larger than for the treatments irrigated by surface and subsurface drip irrigation systems respectively

Al-Jalouid et al. (2000) pointed out that drip irrigation of 1.5 and 2.5 lit/plant for tomato and cucumber in green house which was applied on the control plants was reduced by 20,30 and 40 % giving a corresponding irrigation of 80,70 and 60% of the control. Lowering irrigation resulted in sustained production and increased water use efficiency without significantly decreasing the growth and yield components (plant height and yield per plant) of cucumber and tomato. However, irrigation of less than 7000 m^3/ha (2800 m^3/fed) reduced the yield without increasing water use efficiency. They also added that soil moisture at 0-15 cm depth was not substantially affected by the irrigation treatments.

Phene et al., (1992) reported that yields of red tomatoes exceeding 200 Mg/ha (80Mg/fed) were achieved in large yield plot experiments with subsurface drip irrigation system. Commercial yield of 150Mg/ha (60Mg/fed) was also achieved in large scale field applications with less degree of control

Location of emitters had major effects on incidence of diseased pepper plants, severity of root symptoms, yield, shoot dry weight, level of soil moisture and plant leaf water potential. Disease levels were highest with emitters at the soil surface. The subsurface (15cm deep) position gave the most efficient control in the field without reducing yields in no infested plots (Café and Duniway ,1996).

Over a three years period, higher yields (approximately 10.6 Mg/ha) (4.25Mg/fed) were obtained with the application of trickle irrigation in comparison with gravitational surface irrigation. The beginning with tomato maturity was reached earlier and the percentage of first class products was higher (Iljovski et al., 1997).

The main objective of this work was to evaluate the performance of subsurface drip irrigation system at different lateral depths and emitter spacing in irrigating hot pepper in plastic green houses. The evaluation was based on the following parameters at each lateral depth and emitter spacing:

(1)Actual seasonal water consumption and its values throughout the growing stages.

(2)Distribution of roots in soil profile.

(3)Total yield and both water and fertilizer use efficiency.

(4)Moisture distribution and salts accumulation in soil profile.

MATERIALS AND METHODS

Field experiment was conducted in Inshas Experimental Station, Water Systems Research Institute, National Water Research Center, Ministry of Water Resources and Irrigation, Sharkia Governorate (محطة تجارب أنشاص، معهد بحوث الري، الشرقية), Egypt. Hot pepper (*Calcium Annul*) plants were transplanted in green house and irrigated by subsurface drip system at an operating pressure of 100kPa with three different levels of lateral depth (0; 20 and 25 cm) and two levels of emitter spacing (30 and 50 cm). The applied water was calculated according to the value of water evaporation from the free water surface with the help of Pan evaporation (class A) installed inside the green house and located at the its center.

1 Experimental system

The used irrigation system was constructed and installed inside the green house before pepper transplanting. It consisted of water source (surface well feeding from Shrkia canal), centrifugal pump operated at 30 kW, two screen filters (each 120 mesh) fitted on the pump delivery pipe to provide the adequate filtration required for processing water entering the system, fertilizer injection pump (fertilizer injector), main line (Ø 75mm),submain line (Ø 63mm), two manifolds (Ø 50mm) and six lateral lines (Ø 16mm). The laterals were provide with the required number of emitters either at 30cm or 50 cm spacing according to the level of emitter spacing as shown in figure (1) . The used system was tested hydraulically and the average values of the hydraulic parameters at an operating pressure equal to 100 kPa were:

emitter discharg 3.8lit/h, application efficiency, E_a, 98.9%, distribution niformity,DU, 93.0 % and the emission uniformity,EU, 99.8%.

2 Experimental procedure

Hot pepper (*Calcium Annul*) plants were transplanted on 5 January 2005. The seeds were prepared in a small area, as a nursery for 40 days where the seedlings became homogeneous and of the same height. The seedlings were planted 25 cm apart on the row and the spacing between rows was50 cm. The studied treatments were:

(1) D_0d_{30} = zero lateral depth, 30 cm emitter spacing,

(2) D_0d_{50} =zero lateral depth, 50 cm emitter spacing,

(3) $D_{20}d_{30}$ =20cm lateral depth, 30 cm emitter spacing,
(4) $D_{20}d_{50}$ =20cm lateral depth, 50 cm emitter spacing,
(5) $D_{25}d_{30}$ =25cm lateral depth, 30 cm emitter spacing: and
(6)$D_{25}d_{50}$ =25cm lateral depth, 50 cm emitter spacing.

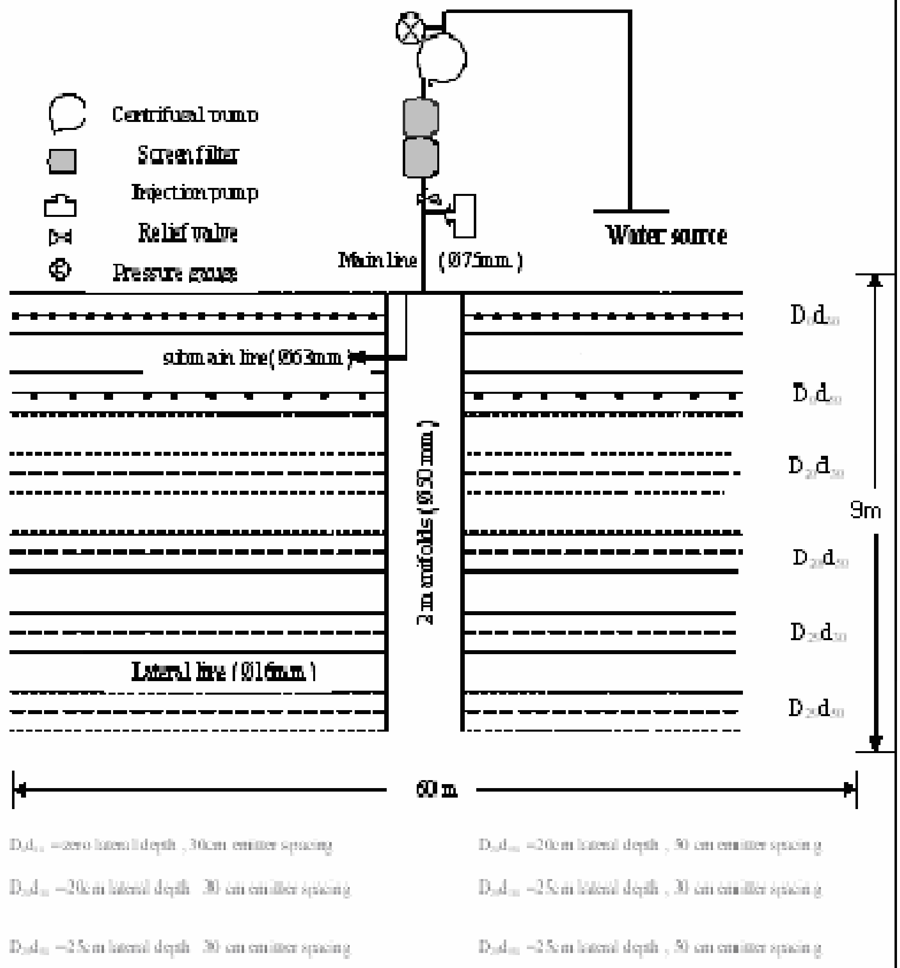


Fig. (1): Components and dimensions of the experimental irrigation system used in green house

The irrigation water was applied daily according to the recorded reading from class A evaporation pan and the potential evapotranspiration (ETp) was calculated considering the pan coefficient is 0.7and it has been used in calculating the gross irrigation requirements (IRg) using the following equation given by FAO, 1980 :

$$\mathbf{IRg = (A.ETp.\ K_c.\ K_r + L_r) / E_a}\text{-----------------}(1)$$

Where:

IRg = gross irrigation requirements (Lit/day);

A = total area allocated for each plant (m^2/plant);

ETp = average potential evapotranspiration (mm /day);

K_c = crop factor according to the month within the growing season;

K_r = reduction factor of minimum Gs/ 0.85 (Gs is the area shaded by the crop as a percentage of the total area which was taken as 100%);

L_r = extra amount of water needed for leaching which can be calculated from the following equation:

$$\mathbf{L_r = E_{cw} / \max E_{ce}}\text{ ----------- }(2)$$

Where:

E_{cw} = salinity of the applied irrigation water and E_{ce} = average soil salinity tolerated by the crop as measured on a soil saturated extract (in this work E_{cw}=0.38ds/m & E_{ce}=0.51ds/m) and E_a = irrigation efficiency in %.

RESULTS AND DISCUSSION

1 Water application depth

The growing season of hot pepper plant which cultivated in greenhouse was divided into three stages, first was initial stage, the second was development stage and the third was harvesting stage. Table (1) presents water application depth applied for each stage for all the tested treatments. The presented data in table (1) showed that emitter spacing did not effect the required depth for each stage. However, the required depth of water for each stage was affected by the depth of lateral line beneath the soil surface. Increasing the lateral depth led to increase the required water that applied for each stage. The highest percent of water applied was consumed during harvesting stage; this was occurred for all treatments.

The percent of the consumptive water during initial stage was the greatest when the lateral line was buried at a depth of 25 cm below the soil surface, where it was 14.88% from the total water applied. At this depth of lateral line, the percent of water consumption during harvesting stage was lower than that recorded by the other tested depths. Therefore, it can be predicted that this depth results in lowering the obtained fruit at the end of the growing season. The length of the growing season in days was the same for all treatments, although the length of each stage at each treatment differed. The length of the harvesting stage was about two months for all treatments. During this period; the fruits were collected every two weeks. Hence, the plants consumed more water than the other two stages due to the frequent collection of fruits.

Table (1): Water application depth for all treatments along the growing season

Treatment	Seasonal water applied (mm)	Length of the growing season (days)	Water application depth (mm)								
			Initial stage			Development stage			Harvesting stage		
			Length (days)	Depth (mm)	Percent (%)	Length (days)	Depth (mm)	percent (%)	Length (days)	Depth (mm)	Percent (%)
D_0d_{30}	44.84	167		5.30	11.82		9.86	21.98		29.68	66.20
D_0d_{50}	44.84		54	5.30	11.82	44	9.86	21.98	69	29.68	66.20
$D_{20}d_{30}$	44.84	167		6.09	13.58		10.27	22.90		28.48	63.52
$D_{20}d_{50}$	44.84		56	6.09	13.58	45	10.27	22.90	66	28.48	63.52
$D_{25}d_{30}$	44.84	167		6.67	14.88		9.98	22.26		28.19	62.86
$D_{25}d_{50}$	44.84		58	6.67	14.88	44	9.98	22.26	65	28.19	62.86

Figure (2) represents the accumulated irrigation depth applied along the growing season. It shows that the trend of the curve was the same with the two levels of emitter spacing and changed due to the level of lateral line beneath the soil surface. All the tested treatments took the same length of the growing season which was167 days, but the length of each individual stage varied according to the depth of lateral line beneath the soil surface. However, almost all the tested treatments had the same behavior along the growing season.

2 Soil moisture distribution

Values of soil moisture content around the plant reflect the status of soil moisture in root zone. Table (2) represents the average values of soil moisture content at different soil depths and its changes, after irrigation, horizontally at distance of 25 cm from both sides of pepper plant. The highest average value of soil moisture content in soil profile (10.15%)

was observed for the lateral line buried at 20cm depth with 30 cm emitter spacing. This value represents 105.73% of soil moisture content at field capacity. The lowest average value of soil moisture content in soil profile (7.86%) was observed when the lateral line lied at the soil surface (i.e., zero depth) with 50 cm emitter spacing and represents 81.88% of soil moisture content at field capacity.

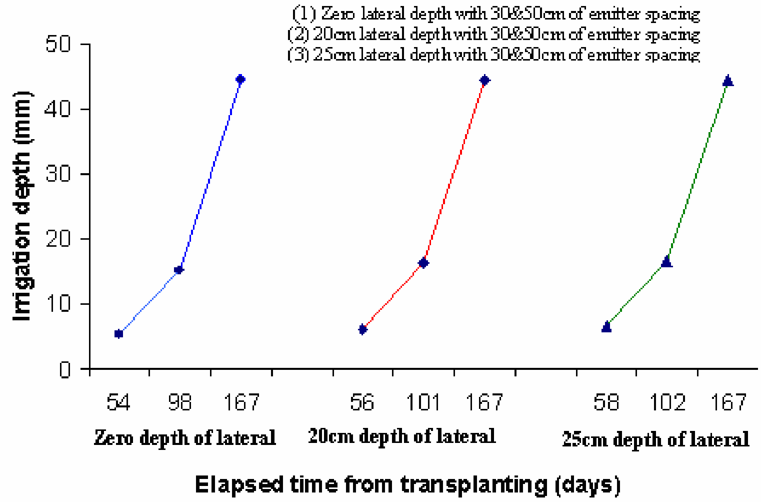


Fig.(2): Accumulated water application depth for all treatments along the growing season

The results also showed that increasing the emitter spacing resulted in increasing the average value of soil moisture content in soil profile. To the contrary, increasing the depth of lateral line beneath the soil surface decreased the average value of soil moisture content in soil profile. This was occurred when the depth of lateral line increased from 20cm to 25cm below the soil surface. The obtained results recommended the 20cm depth of lateral line beneath the soil surface for subsurface drip irrigation system. Emitter spacing of 50cm with 20cm depth of lateral line beneath the soil surface resulted in a uniform and accepted distribution of moisture content in soil profile. The case of zero depth of lateral line with 30 cm of emitter spacing, it gave a remarkable value of the average soil moisture content in soil profile (9.43%) which represents 98.23% of soil moisture content at field capacity.

Table (2): Average soil moisture content with soil depth for all the tested treatments after irrigation.

Treatments	Soil depth (cm)	Soil moisture content (%) Location of soil sample from plant(cm)			Average soil moisture in soil depth (%)	Average value in root zone (%)	
		-25	0	25		In %	% of FC*
D_0d_{30}	0-15	10.44	9.18	9.93	9.85	9.43	98.23%
	15-30	8.27	10.32	9.59	9.39		
	30-45	9.18	8.76	8.90	8.95		
	45-60	9.52	8.85	10.16	9.51		
D_0d_{50}	0-15	8.56	8.83	7.86	8.42	7.86	81.88%
	15-30	7.75	8.24	7.94	7.98		
	30-45	7.81	7.54	7.48	7.61		
	45-60	7.49	6.97	7.86	7.44		
$D_{20}d_{30}$	0-15	9.08	8.51	8.02	8.54	9.10	94.79%
	15-30	9.44	8.17	9.20	8.94		
	30-45	9.11	9.85	10.29	9.75		
	45-60	9.34	9.18	8.97	9.16		
$D_{20}d_{50}$	0-15	11.34	10.65	10.56	10.85	10.15	105.73%
	15-30	10.49	10.73	9.04	10.09		
	30-45	9.75	9.65	10.07	9.82		
	45-60	10.21	9.64	9.64	9.83		
$D_{25}d_{30}$	0-15	9.53	8.79	8.07	8.80	8.42	87.71%
	15-30	8.69	8.38	8.10	8.39		
	30-45	8.10	9.23	8.82	8.72		
	45-60	7.50	7.81	8.00	7.77		
$D_{25}d_{50}$	0-15	8.30	7.66	8.25	8.07	8.65	90.10%
	15-30	8.94	8.07	7.50	8.17		
	30-45	8.80	8.95	10.10	9.28		
	45-60	8.90	9.80	8.53	9.08		

FC means field capacity (average soil moisture content at field capacity = 9.6%)

3 Salts accumulation distribution

Accumulation of salts in root zone is considered a great problem that faces the application of subsurface drip irrigation systems. Table (3) represents the average measured value of electrical conductivity (EC) both downward with soil depth and horizontally around pepper plant before irrigation at the end of the growing season.

Table (3): Accumulation of salts with soil depth before irrigation for all treatments at the end of the growing season.

Treatments	Soil depth (cm)	Electrical conductivity ,EC,(ds/m)			Average ,EC, in soil depth(ds/m)	Average value in root zone (ds/m)
		Location of soil sample from plant(cm)				
		-25	0	25		
D_0d_{30}	0-15	2.57	2.44	2.48	2.50	2.40
	15-30	2.32	2.49	2.44	2.42	
	30-45	2.05	1.91	2.01	1.99	
	45-60	3.03	2.11	2.96	2.70	
D_0d_{50}	0-15	2.63	2.97	2.80	2.80	2.52
	15-30	2.19	2.21	2.01	2.14	
	30-45	2.56	2.04	2.07	2.22	
	45-60	3.04	2.80	2.89	2.91	
$D_{20}d_{30}$	0-15	2.46	2.46	2.97	2.63	2.40
	15-30	1.79	2.68	1.93	2.13	
	30-45	2.56	1.82	1.40	1.93	
	45-60	3.03	2.60	3.04	2.89	
$D_{20}d_{50}$	0-15	3.51	3.45	3.54	3.50	3.27
	15-30	2.23	2.85	2.15	2.41	
	30-45	3.11	1.83	2.35	2.43	
	45-60	4.46	5.01	4.72	4.73	
$D_{25}d_{30}$	0-15	2.90	3.21	3.37	3.16	3.16
	15-30	2.49	2.98	2.06	2.51	
	30-45	4.00	2.32	2.43	2.92	
	45-60	4.07	4.32	3.80	4.06	
$D_{25}d_{50}$	0-15	2.77	2.72	2.34	2.61	2.78
	15-30	2.51	2.61	2.65	2.59	
	30-45	3.16	3.07	1.95	2.73	
	45-60	3.60	3.28	2.67	3.18	

The average lowest value (2.40 ds/m) in soil profile was observed with 30 cm of emitter spacing when the lateral line was at zero depth and 20 cm beneath the soil surface. The highest value (3.27 ds/m) was with 50cm emitter spacing and 20 cm depth of lateral irrigation line. The value of "EC" exactly under the pepper plant decreased with soil depth as one moved downward at zero depth of lateral irrigation line with both 30 and 50 cm emitter spacing. However, this trend did not exist with the other tested treatments, where the value of EC under pepper plant decreased vertically with soil depth up to 30cm, then increased sharply at the deeper lagers. As for the effect of emitter spacing on the value of EC, it was noticed that decreasing the value of emitter spacing from 50 to 30cm led to decreased average value of EC. Therefore, the 30cm emitter spacing might be recommended to achieve the lowest accumulation of salts in root zone, besides having a uniform distribution of salts that can be reflected in increasing the obtained yield. The presented data in table (3) also show that the highest value of EC was observed in deeper layers (45-60cm depth). It was 4.73 and 4.06 ds/m in case of 50cm emitter spacing with 20 cm depth of lateral irrigation line and 30cm emitter spacing with 25 cm depth of lateral irrigation line respectively.

These two treatments ($D_{20}d_{50}$ and $D_{25}d_{30}$) achieved also higher values of EC in the upper layer (0-15cm depth) comparing with the other tested treatments, where they were 3.5 and 3.16 ds/m respectively.

4 Root system distribution

Distribution of roots in soil profile either on weight basis or by volume basis represents a considerable parameter which can be used in comparing between treatments. Figure (3) represents the distribution of root weight and its percent at each depth of soil profile with 30 cm emitter spacing at the three tested levels of the depth of lateral line beneath the soil surface. The distribution of roots was affected strongly with the average value of both soil moisture content and electrical conductivity (EC) at each soil depth. The presented results show that at the upper depth (0-15cm), the percent of root weight decreased with increasing the value of EC and decreasing of soil moisture content. Percents were 61.09, 59.19 and 57.19% for zero, 20 and 25 cm depths of lateral irrigation line beneath the soil surface respectively. The higher percent of root weight in the upper layer reflects sufficient amount of the available water for plant uptake. Consequently, figure (3) shows that there was no remarkable difference between the three tested depths of lateral irrigation line. However, the 30 cm emitter spacing can be recommended with both zero and 20 cm depths of lateral irrigation line due to average soil moisture content and electrical conductivity. Figure (4) represents the distribution of root weight and its percent at each depth of soil profile with 50 cm emitter spacing at the three tested levels of the depth of lateral line beneath the soil surface.

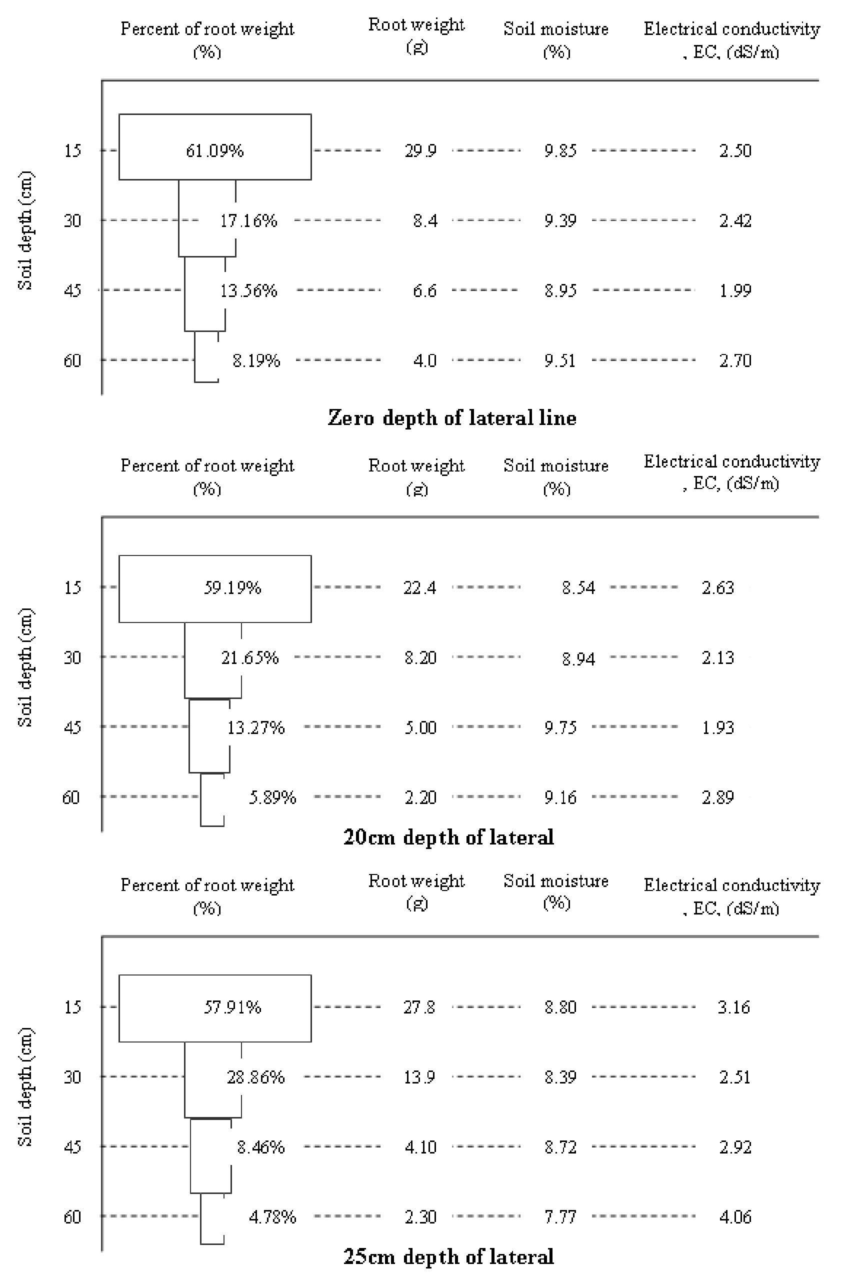


Fig.(3): Distribution of root weight with depth as related to soil moisture content and electrical conductivity for 30 cm of emitter spacing at the different depths of lateral line below the soil surface

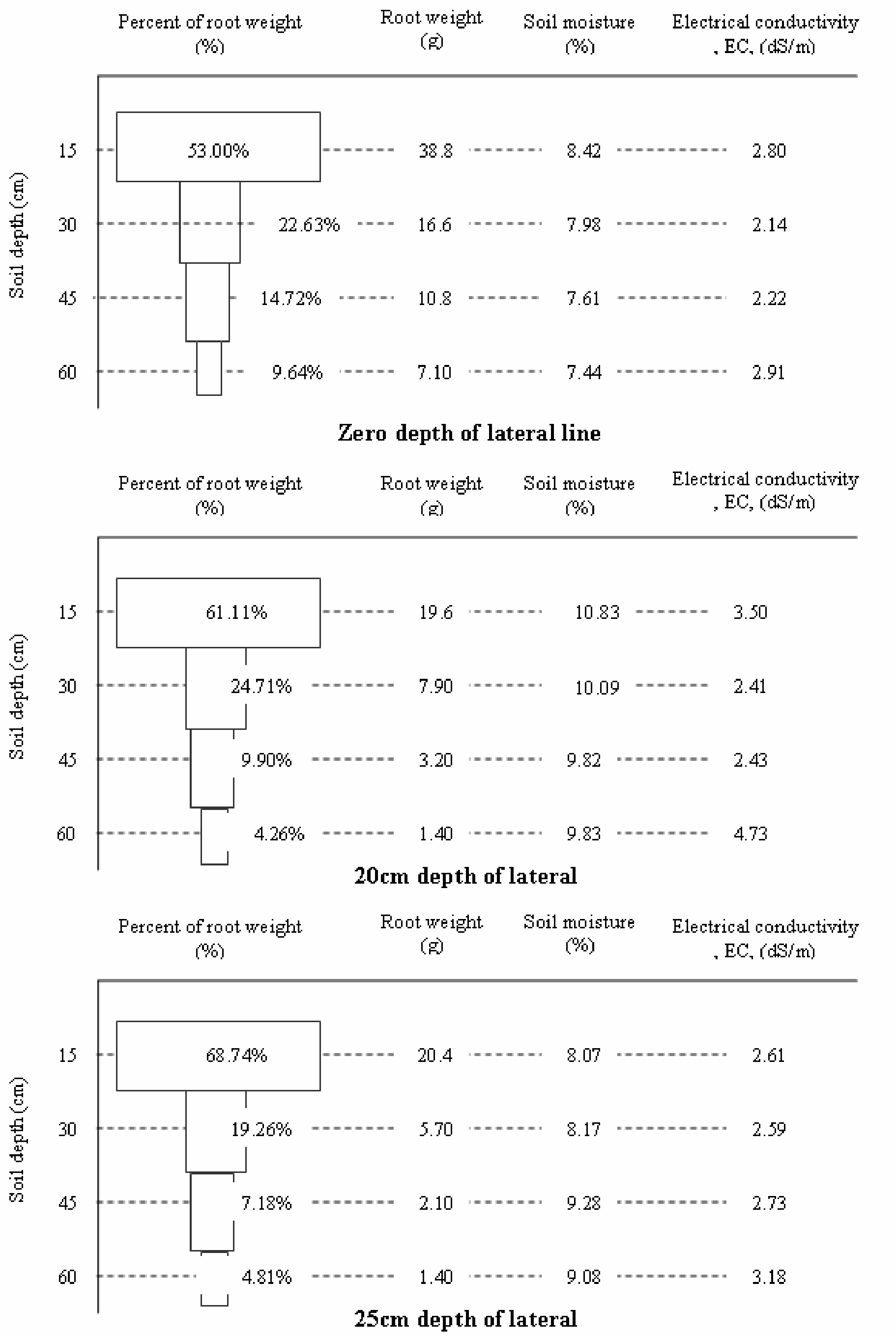


Fig.(4): Distribution of root weight with depth as related to soil moisture content and electrical conductivity for 50 cm of emitter spacing at the different depths of lateral line below the soil surface

The results showed that the 25 cm depth lateral irrigation line gave the best distribution of root comparing with the other depths. At this depth, the percent of root weight in the upper layer (0 -15cm) was the highest (68.74%), although the average value of the electrical conductivity was slightly higher besides the lower value of soil moisture content at the upper layer. This may be due to the horizontal expansion of lateral roots which effect on the concentrated weight of root in the upper surface layer. Whereas the 20 cm depth lateral line can not be recommended, because of its higher values of electrical conductivity at all soil layers, yet it gave a higher value of soil moisture content in the upper layers. Finally, it can be noticed that the interaction of both lateral depth and emitter spacing plays a considerable role in distribution of plant root uniformly. Therefore, using the closer distance between emitters and lateral irrigation line buried at a medium depth below the soil surface will result in a uniform and accepted distribution of plant root in soil profile.

5 Fruit yield, water and fertilizer use efficiency

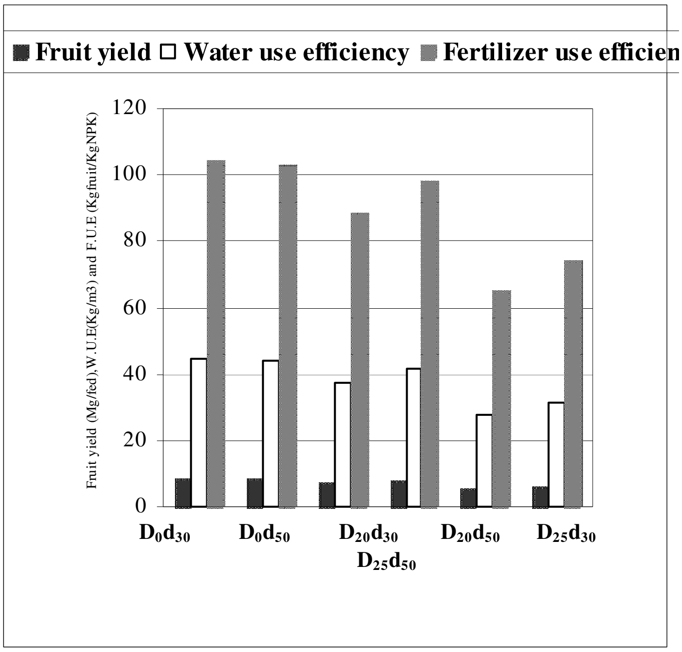
Fruit yield and both water and fertilizer use efficiency can de used in differentiation between treatments by the variation of the studied factors. Table (4) represents pepper fruit yield (Mg/fed), water use efficiency, W.U.E (kg/m^3) and Fertilizer use efficiency, F.U.E (kg fruit /kg NPK) for all the tested treatments. The highest obtained yield (8.36 Mg/fed) was observed with 30 cm emitter spacing with zero depth of lateral irrigation line. The zero cm depth of lateral irrigation line either with 30 cm or with 50cm of emitter spacing resulted in the highest water use efficiency ,W.U.E, and the highest fertilizer use efficiency ,F.U.E, where they were 44.39 kg/m^3 and 104.50 kg fruit /kg NPK respectively. Lateral irrigation line buried at a depth of 25cm beneath the soil surface with 30cm emitter spacing, achieved the lowest fruit yield (5.23 Mg/fed), lowest water use efficiency (27.77 kg/m^3) and lowest fertilizer use efficiency (65.38 kg fruit /kg NPK). The 20 cm depth of lateral irrigation line with 50cm emitter spacing resulted in a considerable values of both fruit yield (7.84 Mg/fed), water use efficiency W.U.E (41.63 kg/m^3)and fertilizer use efficiency F.U.E,(98.0 kg fruits/kg NPK). The 30cm emitter spacing with20 cm depth of lateral irrigation line, gave a lower value of fruit yield (7.09 Mg/fed), water use efficiency (37.65 kg/m^3) and fertilizer use efficiency (88.63 kg fruite /kg NPK) comparing with the 50cm of emitter spacing at the same depth of lateral irrigation line.

Figure (5) represents the comparison between all the tested treatments from the point of view of average fruit yield, water use efficiency and fertilizer use efficiency. It shows that the treatment that gave the higher fruit yield gave the higher value of water use efficiency and the higher value of fertilizer use efficiency. It also shows that there was no significant difference between the 20cm depth of lateral irrigation line with 50cm emitter spacing and zero depth of lateral line at the same emitter spacing (50cm). However, the value of average fruit was slightly lower (7.84 Mg/fed) comparing with its value at zero depth lateral and 50cm emitter spacing, where it was 8.26Mg/fed.

Table (4): Pepper fruit yield (Mg/fed), water use efficiency (kg/m3) and fertilizer use efficiency (kg fruit /kg NPK) for the different tested treatments.

Treatments	Average fruit yield (Mg/fed)	Seasonal water application rate (m^3/fed))	Water use efficiency W.U.E (kg/m^3)	Total fertilizer added (NPK) Kg /fed	Fertilizer use efficiency F.U.E (kg fruit /kg NPK)
D_0d_{30}	8.36	188.33	44.39	80	104.50
D_0d_{50}	8.26	188.33	43.86	80	103.25
$D_{20}d_{30}$	7.09	188.33	37.65	80	88.63
$D_{20}d_{50}$	7.84	188.33	41.63	80	98.00
$D_{25}d_{30}$	5.23	188.33	27.77	80	65.38
$D_{25}d_{50}$	5.93	188.33	31.49	80	74.13

D_0d_{30} = zero lateral depth, 30cm emitter spacing
D_0d_{50} = zero lateral depth, 50cm emitter spacing
$D_{20}d_{30}$ = 20cm lateral depth, 30cm emitter spacing
$D_{20}d_{50}$ = 20cm lateral depth, 50cm emitter spacing
$D_{25}d_{30}$ = 25cm lateral depth, 30cm emitter spacing
$D_{25}d_{50}$ = 25cm lateral depth, 50cm emitter spacing



D_0d_{30} = zero lateral depth, 30cm emitter spacing
D_0d_{50} = zero lateral depth, 50cm emitter spacing
$D_{20}d_{30}$ = 20cm lateral depth, 30cm emitter spacing
$D_{20}d_{50}$ = 20cm lateral depth, 50cm emitter spacing
$D_{25}d_{30}$ = 25cm lateral depth, 30cm emitter spacing
$D_{25}d_{50}$ = 25cm lateral depth, 50cm emitter spacing

CONCLUSION

The objectives of this study was to evaluate the suitability and performance of both surface drip and sub-surface drip irrigation systems at different depths of lateral line beneath the soil surface (0, 20 and 25cm) and at different spacing between emitters (30 and 50cm) in greenhouses. The obtained results can be summarized as follows:

1- The highest percent of water consumption was 66.02% occurred during the harvesting stages for both surface and sub-surface drip irrigation systems.
2- The best uniformity distribution of water was achieved with subsurface drip irrigation system when the lateral line buried at 20cm depth beneath the soil surface and at 50cm of emitter spacing.
3- The lowest value of EC in soil profile was 2.4ds/m observed with both surface and subsurface drip system but when the lateral line buried at 20cm from the surface with 30cm of emitter spacing.

4- The highest fruit pepper yield was 8.36Mg/fed achieved with both surface and sub-surface drip irrigation system at 30 and 50cm of emitter spacing.
5- The values of crop water use efficiency (WUE) were approximately equal for all treatments except in case of surface drip system when the lateral buried at 25cm from the soil surface where the value of (WUE) was lowest.
6- It can be concluded to use sub-surface drip irrigation system to be applied in plastic greenhouses but with a depth not exceed the soil surface.

REFERENCES

Al-Jaoloud, A.A; C.T. Ongkingco; W. l-Askar; S. Al-Aswad; S. Karimulla; P.C. Robert; R.H. Rust and W.E.Larson, 2000. Water requirement of drip fertigated green house grown cucumber and tomato during winter and summer cropping. Proc. of the 5th I. Con. on Precision Ag., Bloomington, Minnesota, USA.

Ayars,J.E.; C.J. Phene; R.B. Hutmacher; K.R. Davis; R.A. Schoneman; S.S. Vail and R.M.Mead, 1999. Subsurface drip irrigation of row crops: a review of 15 years of research at Water Management Res. Laboratory, Ag. Water Mang., 42 (1):1-27.

Café, F.A. and Duniway, 1996. Effect of location of drip irrigation emitters and position of phytophthora capsici infections in roots on phytophthora root of pepper. Phytopathology, 86(12): 1364-1369.

El-Awady, M.N; M.F.Abd-Elsalam; M.M.El-Nawawy and M.A.El-Farrah.2003. Surface and subsurface irrigation effects on spinach and sorghum. The 11th Annual Conf. of Misr Soc. of Agric.Eng., 118-130.

FAO, 1990. Protected cultivation in the Mediterranean climate plant production and protection: 90 -313.

IIjovski, I; O.Cukaliev; B.Stojanov and D. Mukaetov, 1997. Comparison of the results obtained with application of drip irrigation and surface irrigation techniques for tomatoes in greenhouses. Jubilee Year book of the Faculty of Agriculture, Skopje, Public of Macedonia, 42 : 83 - 87.

Kirda, C; N. Baytorun; M.R. Derici; H.Y.Dasgan; C.Tanriverdi and Z. Gumus, 2003. Nitrogen fertilizer recovery and yield response of greenhouse grown and fertigated tomatoes to root- zone soil water tension. Turkish J. of Ag. and Forestry, 27 (6): 323- 328.

Machado, R.M.A; M.D. Rosario; G. Oliveira; C. A. M. Portas; M. Rosario and J. Abe,2003. Tomato root distribution, yield and fruit quality under subsurface drip irrigation. Plant and Soil, 255 (1):333 – 341.

Marouelli, W. A. and W.L. C. Silva, 2002. Drip line placement depth for processing tomatoes crop. Horticulture, Brasilia, 20 (2): 206-210.

Phene, C. J; R.B. Hutmacher; K. R. Davis and R. L. McCormick, 1992. Water- fertilizer management of processing tomatoes. Acta- Hort., 277:137-143.

الملخص العربي

تأثير كل من المسافة بين النقاطات وعمق خط الري الفرعي في الري بالتنقيط التحت السطحي علي محصول الفلفل المنزرع داخل الصوبات الزراعية

د. محمد علي أبوعميرة[1] د. أحمد حسن جمعة [1] حسام محمد عبد الوهاب[2]

أجريت هذه الدراسة بمحطة بحوث وتجارب نظم الري بأنشاص (محافظة الشرقية) التابعة لمعهد بحوث إدارة المياه وطرق الري بالمركز القومي لبحوث المياه التابع لوزارة الموارد المائية والري، حيث كان الهدف منها دراسة تأثير كل من المسافة بين النقاطات وعمق خط الري الفرعي تحت سطح التربة في نظام الري بالتنقيط تحت السطحي علي توزيع الرطوبة، وتراكم الأملاح، ونسب توزيع الجذور في قطاع التربة، وإنتاجية الفدان، بالإضافة إلي اشتقاق قيم كفاءة استخدام مياه الري، وكفاءة استخدام السماد لمحصول الفلفل المنزرع في الصوبات الزراعية تحت تلك المتغيرات. ولتحقيق هذا الهدف، استخدمت ثلاثة أعماق لخط الري الفرعي بالتنقيط هي: (صفر، 20 و 25 سم)، ومستويين للمسافة بين النقاطات هما (30 و50سم). وتم شتل نبات الفلفل داخل الصوبة بمسافة 50 سم بين خطوط الزراعة، 25 سم بين النباتات داخل الخط، وتركت مسافة 1 متر (مشايات) بين المعاملات، واستخدمت النقاطات طويلة المسار والمركبة داخل خط الري الفرعي بالتنقيط. وتم قياس مقدار البخر نتح اليومي بواسطة جهاز حوض البخر (Evaporation pan-class A) وضع داخل الصوبة الزراعية وفي منتصفها. وتوصلت الدراسة إلي النتائج الآتية:

(1) أستاذ مساعد، (2) طالب دراسات عليا (ماجستير) بقسم الهندسة الزراعية كلية الزراعة جامعة المنوفية.

(1) استهلكت مرحلة الحصاد أعلي نسبة من مياه الري المضافة، حيث وصلت إلي 66.02% من كمية مياه الري الكلية والمضافة موسميا عند كل من 30، 50 سم للمسافة بين النقاطات وعند عمق صفر لخطوط الري الفرعية.

(2) تحقق أفضل توزيع للرطوبة في قطاع التربة عند دفن خط الري الفرعي بالتنقيط علي عمق 20 سم تحت سطح التربة وعند مسافة 50 سم بين النقاطات، حيث وصلت قيمة متوسط المحتوي الرطوبي في قطاع التربة إلي 10.15% والتي تمثل 105.73% من قيمة المحتوي الرطوبي عند السعة الحقلية.

(3) تحقق أقل تراكم للأملاح في قطاع التربة من خلال قيمة معامل التوصيل الكهربي(EC)، والتي وصلت إلي 2.4 ديسيسيمنز / متر عند عمق صفر لخط الري الفرعي، وأيضا عند دفن خط الري الفرعي بالتنقيط علي عمق 20 سم تحت سطح التربة وعند مسافة 30 سم بين النقاطات.

(4) تحقق أفضل توزيع لانتشار الجذور في قطاع التربة حتى عمق 60 سم عند دفن خط الري الفرعي بالتنقيط علي عمق 20 سم تحت سطح التربة واستخدام مسافة 30 سم بين النقاطات.

(5) تحققت أعلي كفاءة لاستخدام مياه الري ومقدارها 44.39 كيلو جرام /متر مكعب عندما يوضع خط الري الفرعي بالتنقيط علي سطح لتربة واستخدام مسافة 30 سم بين النقاطات، بينما تحققت أقل كفاءة ومقدارها 27.77 كيلو جرام /متر مكعب عند دفن خط الري الفرعي بالتنقيط علي عمق 25 سم تحت سطح التربة واستخدام مسافة 30 سم بين النقاطات.

(6) أعلي قيمة لكفاءة استخدام السماد ومقدارها 104.5 كيلو جرام ثمار / كيلو جرام سماد تحققت عند مسافة 30 سم بين النقاطات وعند عمق صفر لخط الري الفرعي بالتنقيط، بينما تحققت أقل قيمة لكفاءة استخدام السماد ومقدارها 65.38 كيلو جرام ثمار/ كيلو جرام سماد عند مسافة 30 سم بين النقاطات وعمق 25 سم للخط.