J. Agric. Sci. Mansoura Univ., 34 (5): 5609 - 5622, 2009

USING DRIP IRRIGATION FOR PRODUCING TOMATO UNDER DIFFERENT IRRIGATION WATER LEVELS IN SANDY SOILS

El-Adl, M.A.
Agric. Eng. Dept., Fac. of Agric., Mansoura Univ.

ABSTRACT

Field experiments were carried out in the environmental conditions of Dakahleya governorate. The effect of irrigation levels (100%, 85% and 70% of ETcrop), fertilization methods (traditional and fertigation) and drip irrigation systems (surface and subsurface) on tomato were investigated in this study.

The main aims of this study are:

- Study the effect of irrigation system and amount of irrigation water on total yield.
- Effect of using fertigation system.
- Effect of studying factor on emitter clogging.

The results show that:

- Irrigation level has strong effect on yield.
- The highest yield (5411 kg/fed) obtained with treatment $L_1F_2D_2$ (irrigation with 100% ETcrop with fertigation method under using subsurface drip irrigation system).
- Maximum water use efficiency (4.96 kg/m^3) obtained with treatment $L_3F_2D_2$ (irrigation with 70% ETcrop with fertigation method under using subsurface drip irrigation system).

INTRODUCTION

Tomato is important and popular crop in the world and also in Egypt. The cultivated area of tomato reached about 537208.0 fed. during 2007, which produced about 8639024 metric tons of yield according to Agric. Statistics (2008).

Using the suitable amount of irrigation water, effective fertilization method and good irrigation system help to produce high yield and good quality.

Singh and Kalra (1983) reported that, increasing P_2O_5 up to 60 kg/ha improved seed yield and improve most of peanut characters.

Hamada et al. (1988) Geweifel and Ali (1990), Jain et al. (1990) found that, phosphorus increased number of pods/plant and also total yield.

Mahmoud (1996) indicated that increasing NaCl concentration to 3000 ppm in the irrigation water, resulted in increasing both total soluble solids and acidity in tomato fruits.

Arnaout (1999) studied effect of fertigation method through different irrigation systems on beans and reported that fertilizer can be successfully applied through irrigation systems (surface drip, subsurface drip and sprinkler) because it has low cost, high efficiency, and high productivity.

El-Gindy (1988) reported that, fertigation of N fertilizer increase yield of tomato by about 16.1%, 23.8% and 35.1% under furrow, sprinkler and drip irrigation methods respectively, in compare to traditional methods of fertilizer application.

Rubino and Tarantino (1988) reported that, irrigation with amount equals to 100% of calculated evapotranspiration produce the highest yield of tomato.

The basic irrigation is to supply plants with water as needed to obtain optimum yield and quantity of a desired plant constituent (Haise and Hagan, 1967).

Efficient irrigation implies complete control of the available soil moisture reservoir. Such control requires knowledge of the soil water content at all times (Berry et al., 2003).

Irrigation with 75% of pan evaporation on sandy loam, sandy clay and clay soils resulted in a high depletion of soil water to a depth of 1600 mm under drip irrigation with weekly interval (Fisher, 1989).

Gomma et al. (2000) reported that water use efficiency (WUE) decreased by increasing the frequent intervals of irrigation for tomato and cucumber. The highest values of WUE were 5.87 and 6.65 kg/m^3 (for tomato and cucumber resp.).

The main objects of this work were to study the effect of irrigation water levels, fertilization methods and irrigation systems on soil moisture distribution, vegetative growth, total yield, fruit quality and water use efficiency.

MATERIALS AND METHODS

1. Experimental site:

Field experiments were conducted at the college new established farm in Kalabsho Zyan area – Dakahleya governorate. The field experiments were done during winter season of 2008/2009.

Soil texture is sandy in the top layer (90 cm). Soil physical properties and the soil classification (according to Soil and Water Analysis Lab. Fac. of Agric. Mansoura Univ.) are shown in table (1).

Table (1): Soil physical properties and classification.

Depth cm	Mechanical analysis %			Soil classification	pH 1/2.5	F.C. %	W.P. %
	Clay	Silt	Sand				
0 – 30	2.30	8.10	89.60	Sandy	8.45	9.20	4.40
30 – 60	2.20	8.05	89.75	Sandy	8.46	9.20	4.50
60 – 90	2.20	8.00	89.80	Sandy	8.50	9.25	4.40

2. Irrigation water levels (L):

Three irrigation water levels were investigated in this study. It were 100%, 85% and 70% of ETcrop. ETcrop (crop evapotranspiration) was calculated according to Doorenbos and Pruitt (1977) as follow:

$$ETo = Kp \cdot Epan$$

Where

ETo: Reference evapotranspiration (mm/day).

Kp: Pan coefficient (equals to 0.7).

Epan: Pan evaporation (mm/day).

3. Fertilization methods (F):

Two fertilization methods were tested. The first was traditional method and the second was fertigation method, which use irrigation water as a carrier of fertilizers through irrigation network.

4. Irrigation systems (D):

Two irrigation systems were tested in this study (surface and subsurface drip irrigation systems). Subsurface irrigation lines were at 15 cm depth under soil surface.

5. Fertilizers program:

- **Traditional method:**

The following amount of fertilizers were added/fed:

- 80 kg nitrogen, about 40 kg P_2O_5 and about 100 kg potassium sulfate K_2O.
- Fertilizers were added in three doses 50%, 25% and 25% (from NPK). The 1st dose (50%) was added 20 days after transplanting, the 2nd and the 3rd (25%, 25%) were added 45 and 65 days after transplanting. Also about 20 m^3/fed manure was applied before planting to the surface layer of soil.

- **Fertigation method:**

The same amount of fertilizer units (NPK) were added 20 days after transplanting in 15 doses through irrigation system.

6. Experimental design:

Drip irrigation systems (surface and subsurface) inclodued (every one) three levels of applied irrigation water and two fertilization methods. Fig (1) shows the experimental layout and irrigation network. The experimental basic unit area included four ridges, each of them has 0.70 m width and about 30.00 m length (every unit area about 84.00 m^2 = 1/50 fed). The distance between emitters was 0.50 m.

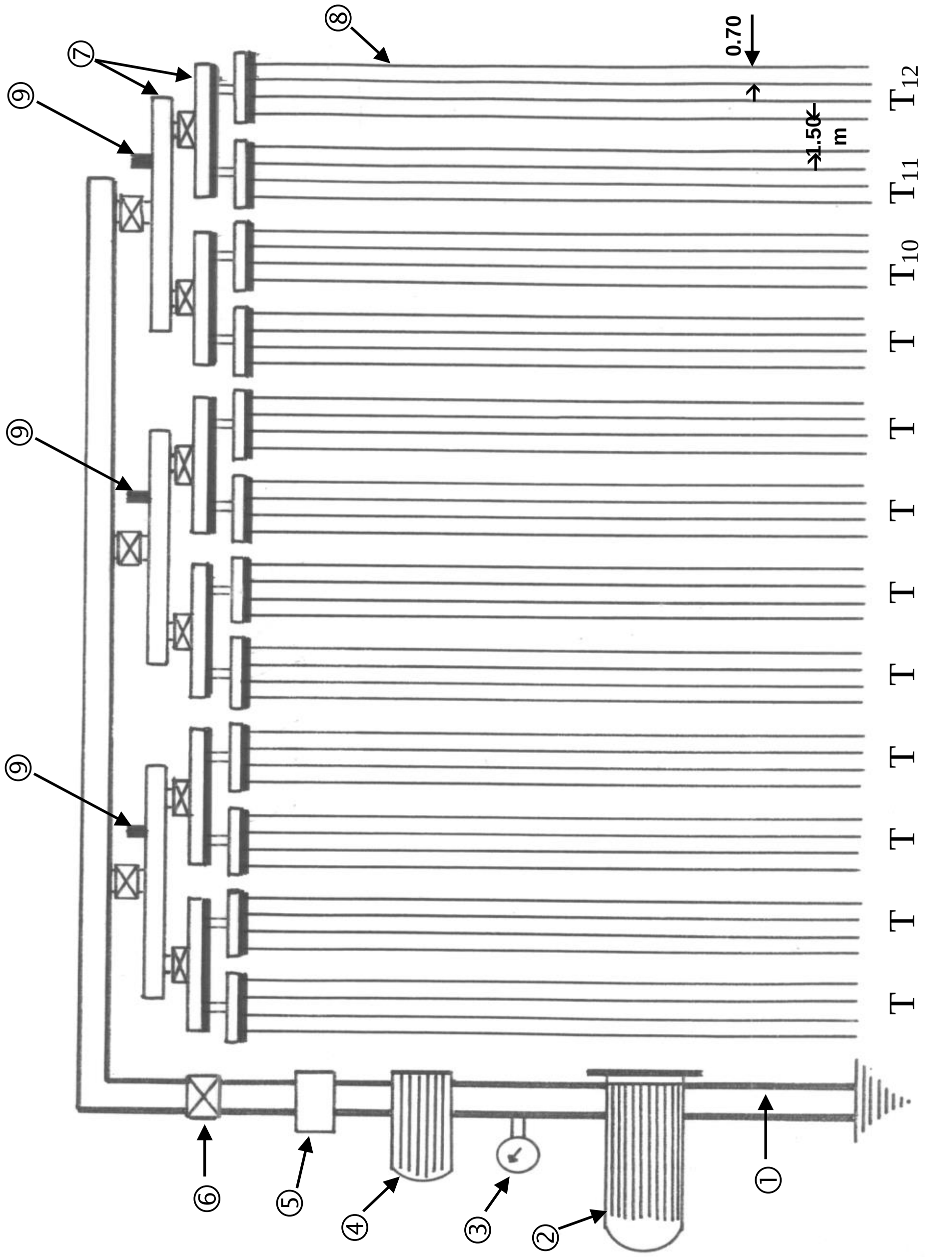
7. Treatments:

Experimental study included:

- Three irrigation water levels (L): 100% of ETcrop (L_1), 85% of ETcrop (L_2) and 70% of ETcrop (L_3).
- Two fertilization methods (F): traditional (F_1) and fertigation method (F_2).
- Two irrigation systems (D): surface drip (D_1) and subsurface drip irrigation system (D_2).

Thus there were 12 treatments in four replicates (4 rows) as follow:

1. $L_1F_1D_1$: 100% of ETcrop + traditional fertilization + surface drip irrig.
2. $L_1F_1D_2$: 100% of ETcrop + traditional fertilization + subsurface drip irrig.
3. $L_1F_2D_1$: 100% of ETcrop + fertigation + surface drip irrig.
4. $L_1F_2D_2$: 100% of ETcrop + fertigation + subsurface drip irrig.
5. $L_2F_1D_1$: 85% of ETcrop + traditional fertilization + surface drip irrig.
6. $L_2F_1D_2$: 85% of ETcrop + traditional fertilization + subsurface drip irrig.
7. $L_2F_2D_1$: 85% of ETcrop + fertigation + surface drip irrig.
8. $L_2F_2D_2$: 85% of ETcrop + fertigation + subsurface drip irrig.
9. $L_3F_1D_1$: 70% of ETcrop + traditional fertilization + surface drip irrig.
10. $L_3F_1D_2$: 70% of ETcrop + traditional fertilization + subsurface drip irrig.
11. $L_3F_2D_1$: 70% of ETcrop + fertigation + surface drip irrig.
12. $L_3F_2D_2$: 70% of ETcrop + fertigation + subsurface drip irrig.



1- Main line 2- Pump 3- Pressure gauge
4- Filter 5- Flow meter 6- Valve
7- Submain line 8- Drip laterals (Ø= 16 mm) 9- Fertigation inlet

Fig (1): The experimental layout and irrigation network.

8. Data recorded:

1- Crop evapotranspiration (ETcrop).
2- Seasonal irrigation water (SIW).
3- Soil moisture distribution:

Soil moisture distribution in root zone was tested for each treatment. Soil samples were collected from the different depth (0, 15, 30, 45 and 60 cm) in 5 points across plants rows (0 cm “plant”, 15 and 30 cm distance in the two sides of plant). Soil samples were collected directly before irrigation during mid-season stage. Moisture content was measured using gravimetric method (Michael, 1978).

4- Vegetative growth:

Four plants from each treatment were randomly taken at 65 days after transplanting and the following data were determined;

- Plant height.
- Dry weight of plant.
- Leaf area/plant which was calculated as a relation between area unit and dry weight of leaves according to Koller (1972) using the following formula:

$$LA = \frac{DW\text{-}L}{DW\text{-}D} \,.\, (\text{No. of disks}) \,.\, (\text{disk area})$$

Where:

DW-L and DW-D, refer to dry weight of plant leaves and disks resp.

5- Fruit quality:

Five ripe fruits were taken randomly to determine total soluble solids (TSS%) using Karl Zeiss hand refreactometer, moisture content %, vitamin C (ascorbic acid) and acidity according to A.O.A.C. (1970).

6- Mineral contents:

After 65 days from transplanting, the leaves of five plants in each treatment were taken and dried at 70ºC for 48 hours. From the dry materials minerals were determined:

- Nitrogen was estimated according to Pregle (1945).
- Phosphorus was determined colorimeterically according to Jakson (1967).
- Potassium was determined using flam photometer according to Black (1965).

7- Total yield:

Total yield was collected during all harvesting time for each treatment.

8- Emitters clogging:

After harvesting time in the end of season lateral lines were collected and tested using water flow (one bar operating pressure) to know and calculate mean ratio of clogging emitters/line.

9- Water use efficiency (WUE):

It was determined using the following equation:

$$\text{WUE} = \frac{\text{average yield (kg/fed)}}{\text{total applied irrigation water } (m^3/\text{fed})} \ kg/m^3$$

10- **Statistical analysis:**

Statistical analysis was carried out using "Three Factor Randomized Complete Block Design".

RESULTS AND DISCUSSION

1. Crop evapotranspiration (ETcrop):

Reference evapotranspiration "ETo" and crop evapotranspiration "ETcrop" are presented in table (2).

Table (2): Crop evapotranspiration (ETcrop) during growth season.

Month	ETo mm/day	Kc	ETcrop		
			mm/day	mm/month	m^3/month
October	3.5	0.61	2.13	64.05	269.01
November	2.6	0.90	2.34	70.20	294.84
December	2.1	1.10	2.31	69.30	291.06
January	2.0	2.54	5.08	152.40	640.08
Total ETcrop/season				355.95 mm/day	1494.99 m^3/fed

2. Seasonal irrigation water (SIW):

Fig (2) shows the calculated SIW during growth season. Values of SIW were 1494.99, 1270.74 and 1046.49 m^3/fed for 100% ETcrop, 85% ETcrop and 70% ETcrop resp.

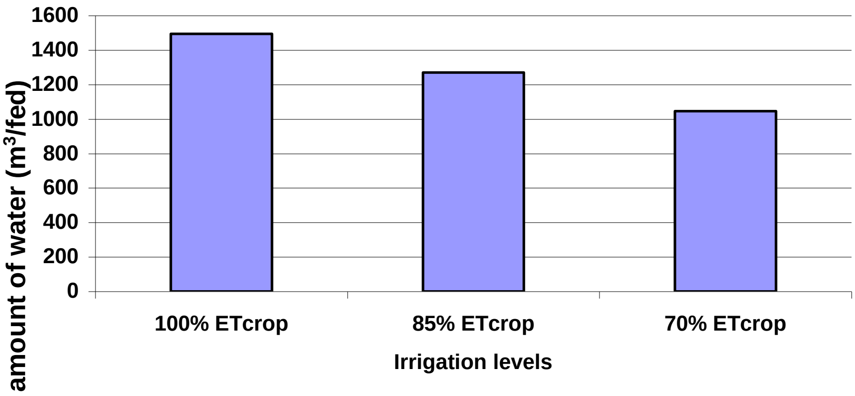


Fig (2): Seasonal irrigation water (SIW) for the different irrigation levels.

3. Soil moisture distribution:

Data in Fig (3) show the soil moisture distribution for the different treatments. Soil moisture content were classified to three range as follows:

- More than 50% of F.C.
- Between 50% of F.C. and W.P.
- Less than W.P.

Data indicated that, the highest wetted area (more than 50% of F.C.) presented with all treatments. The highest wetted areas (more than 50% of F.C.) increased by increasing level of irrigation water, also it were larger under subsurface drip irrigation compared with surface drip irrigation system.

On the other hand the lowest wetted areas which represented less than 50% of F.C. were larger under surface irrigation and low irrigation water level.

It can be concluded that, the irrigation water level and irrigation system have strong effect in soil moisture distribution.

4. Vegetative growth:

Average plant height (cm):

The average plant height varied between 31.1 and 40.8 cm. The maximum height was obtained with treatment 4 ($L_1F_2D_2$) which irrigate with 100% of ETc using fertigation method under subsurface drip irrigation method. While the minimum value of plant height was obtained with treatment 9 ($L_3F_1D_1$) which irrigate with 70% of ETc using traditional fertilization method under surface drip irrigation system. Table (3) shows values of plant height for the different treatments. From this data, it can be said that using high amount of irrigation water and fertigation method help plants to give high length and high vegetative growth.

Average dry weight (g/plant):

Values of average dry weight for plants are presented in table (3). Data indicated that maximum value (23.1 gr/plant) obtained with treatment $L_1F_2D_2$ "100% irrigation level + fertigation method + subsurface drip irrigation system". While minimum value (16.2 gr/plant) was obtained with treatment $L_3F_1D_1$ "70% irrigation level + traditional fertilization method + surface drip irrigation system". It means that, average dry weight/plant has the same trend such as plant height for the different treatments.

Average leaf area (cm^2/plant):

Data in table (3) indicated that, the highest value of leaf area (405.3 cm^2/plant) obtained with treatment $L_1F_2D_2$ (100% of ETcrop, fertigation method and subsurface drip irrigation system). This means that leaf area increased by increasing irrigation water, and using fertigation method with subsurface drip irrigation system. Meanwhile, minimum leaf area (209.8 cm^2/plant) was obtained with treatment $L_3F_1D_1$ (70% of FTcrop, traditional fertilization and surface drip irrigation system.

Generally, it can be said that, when the plant received much water and good fertilizers distribution in soil, the plant was encouraged towards the vegetative growth which increased the leaf area.

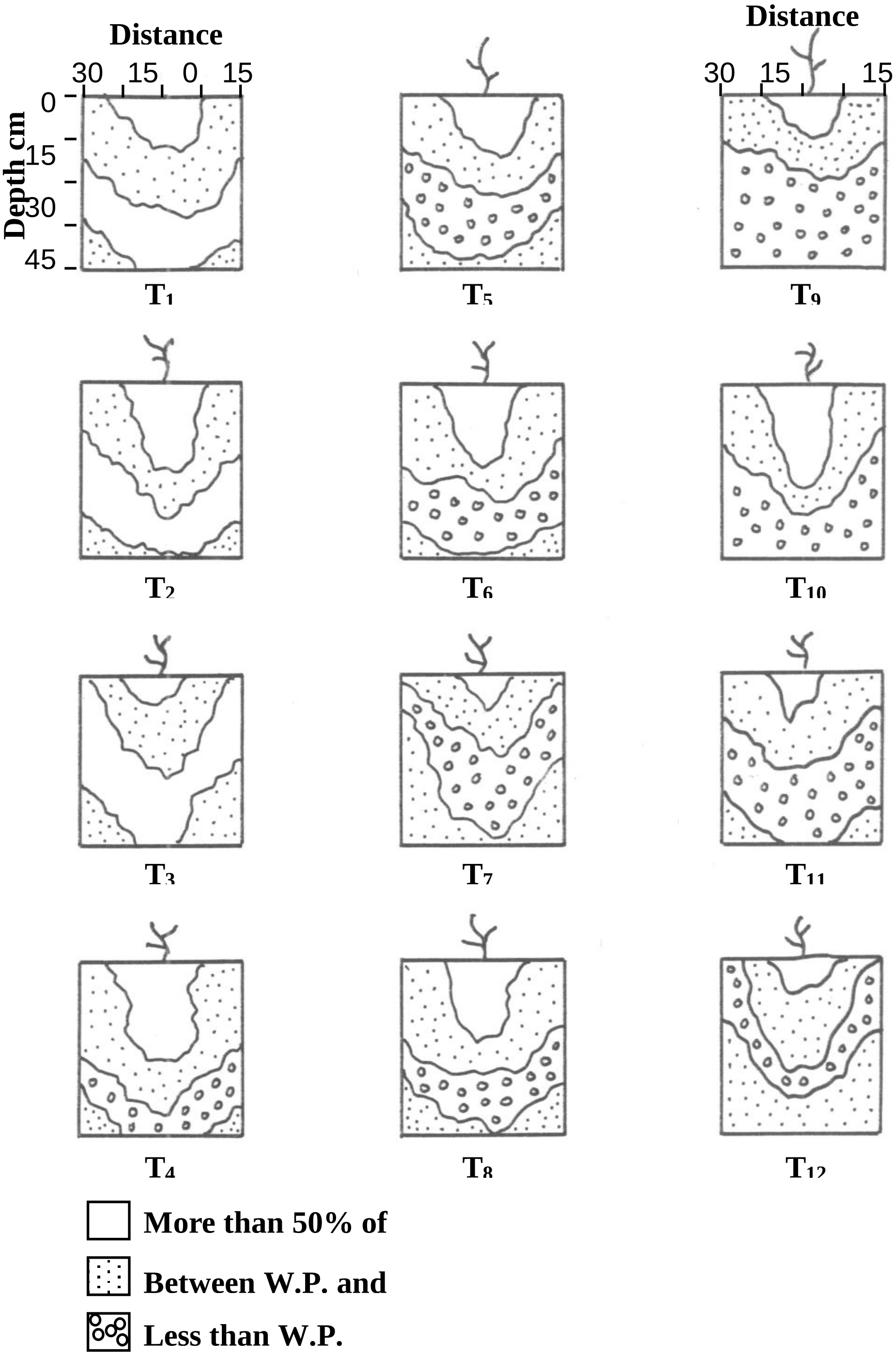


Fig (3): Soil moisture distribution for the different treatments.

Table (3): Vegetative growth for different treatments.

Treatment		Vegetative Growth		
		Plant height (cm)	Dry weight (g/plant)	Leaf area (cm^2/plant)
1	$L_1F_1D_1$	37.1	20.7	380.5
2	$L_1F_1D_2$	38.5	20.9	382.4
3	$L_1F_2D_1$	40.2	22.5	391.1
4	$L_1F_2D_2$	40.8	23.1	405.3
5	$L_2F_1D_1$	35.2	22.7	370.4
6	$L_2F_1D_2$	36.1	22.8	372.5
7	$L_2F_2D_1$	34.7	21.9	349.0
8	$L_2F_2D_2$	31.3	22.1	350.4
9	$L_3F_1D_1$	31.1	16.2	209.8
10	$L_3F_1D_2$	31.8	16.5	255.4
11	$L_3F_2D_1$	32.0	16.4	253.2
12	$L_3F_2D_2$	32.0	16.9	260.9

3.5. Fruit quality:

Table (4) shows values of TSS%, vitamin C, acidity % and tomato moisture content for the different treatments.

TSS%:

Data indicated that, the highest value (6.3%) was obtained with treatments: 11 and 12, while the lowest value (4.6%) was obtained with treatment: 1. This means that TSS decrease by increasing level of irrigation water.

Vitamin C:

Values of vitamin C varied between 34.02 and 22.30 mg/100g F.W. "fresh weight". Maximum value was obtained from treatment: 12, while minimum was obtained from treatment: 1. It can be said that values of vitamin C increased by decreasing irrigation level and soil moisture content.

Acidity %:

Values of acidity % were varied between 0.401 and 0.451. The highest value was obtained with treatment (11) but the smallest value was obtained with treatment (1).

It can be concluded that, TSS, vitamin C and acidity have the same trend and decrease by increasing soil moisture content or level of irrigation water.

Table (4): Effect of the different treatments on tomato TSS, vitamin "C", acidity % and moisture content.

Treatment		TSS (%)	Vitamin C (mg/100g F.W.)*	Acidity (%)	Tomato moisture content "w.b." (%)
1	$L_1F_1D_1$	4.6	22.30	0.401	94.1
2	$L_1F_1D_2$	4.8	24.72	0.410	94.3
3	$L_1F_2D_1$	4.7	24.80	0.415	94.2
4	$L_1F_2D_2$	4.9	28.01	0.420	93.9
5	$L_2F_1D_1$	5.1	29.02	0.421	93.5
6	$L_2F_1D_2$	5.4	29.91	0.420	93.4
7	$L_2F_2D_1$	5.4	30.40	0.431	93.1
8	$L_2F_2D_2$	5.8	32.05	0.430	92.9
9	$L_3F_1D_1$	6.0	32.91	0.445	91.8
10	$L_3F_1D_2$	6.1	33.07	0.449	91.7
11	$L_3F_2D_1$	6.3	33.81	0.451	91.4
12	$L_3F_2D_2$	6.3	34.02	0.450	91.4

*** F.W.: Fresh weight**

Tomato moisture content % (w.b.):

Data in table (4) indicated that fruit moisture content value increased by increasing soil moisture content or increasing irrigation level. Moisture content % varied between 94.3% (obtained with treatment “1”) and 91.4% (obtained with treatments “11 and 12”).

3.6. Mineral content (N.P.K) %

Table (5) shows values of dry materials minerals in yield for the different treatments.

Nitrogen “N”:

The highest value (3.59%) was obtained from treatment $L_1F_2D_2$ “100% irrigation level + fertigation method + subsurface drip irrigation system”. On the other hand, the lowest value (3.01%) was obtained from treatment $L_3F_2D_1$.

Phosphorus “P”:

The maximum value (0.49%) was obtained from treatment $L_1F_2D_2$, while the minimum value (0.23%) was obtained from treatment $L_3F_1D_2$.

Potassium “K”:

Potassium sulfate (K_2O) values varied between 1.81% (recorded with treatment $L_3F_1D_1$) and 2.34% (recorded with treatment $L_1F_2D_2$).

This means that, when the plant received much water and good fertilizers distribution in soil increasing fertilizers use efficiency.

3.7. Total yield:

As shown in table (6), total yield varied between 4881 kg/fed (Treatment $L_3F_1D_2$) and 5411 kg/fed (treatment $L_1F_2D_2$). This means that total yield increased by increasing amount of irrigation water and using fertigation method compared with the others.

3.8. Emitters clogging:

Table (7) shows the ratio of clogging emitters with the different treatments after harvesting yield.

Data indicated that, the maximum emitters clogging ratio was 8.30% obtained with treatment $L_3F_2D_2$ (irrigation with 70% of ETcrop, fertigation method and subsurface irrigation system). While the minimum value was 3.33% obtained with treatment $L_1F_1D_1$ (irrigation with 100% of ETcrop, traditional fertilization and surface drip irrigation system). Generally, it can be noticed that fertigation method, subsurface drip irrigation system and low irrigation water level help to clog emitters compared with using high irrigation level, traditional fertilization method and surface drip irrigation system.

3.9. Water use efficiency:

Table (6) shows the values of tomato yield (kg/fed) and water use efficiency (kg/m3) under the different treatments.

Data indicated that, the maximum value of water use efficiency was 4.96 kg/m^3 of irrigation water was recorded with treatment $L_3F_2D_2$ (70% of ETcrop irrigation level, fertigation method and subsurface drip irrigation system). On the other hand, the minimum value of WUE was 3.44 kg/m^3 of irrigation water was recorded with treatment $L_1F_1D_1$ (100% of ETcrop irrigation level, traditional fertilization method and surface drip irrigation system). This means that low irrigation water level with fertigation method and subsurface irrigation system had effect for increasing water-use efficiency.

Table (5): Effect of different treatments on values of dry minerals "N,P,K".

Treatment		Dry minerals %		
		N	P	K
1	$L_1F_1D_1$	3.15	0.38	2.10
2	$L_1F_1D_2$	3.20	0.37	2.12
3	$L_1F_2D_1$	3.35	0.41	2.25
4	$L_1F_2D_2$	3.59	0.49	2.34
5	$L_2F_1D_1$	3.02	0.38	2.08
6	$L_2F_1D_2$	3.09	0.36	2.05
7	$L_2F_2D_1$	3.20	0.37	2.10
8	$L_2F_2D_2$	3.27	0.36	2.19
9	$L_3F_1D_1$	3.02	0.25	1.81
10	$L_3F_1D_2$	3.05	0.23	1.85
11	$L_3F_2D_1$	3.01	0.28	1.89
12	$L_3F_2D_2$	3.05	0.29	1.91

Table (6): Water use efficiency for different treatments.

Treatment		Total yield		Seasonal irrigation water (SIW) m^3/fed	Water use efficiency kg/m^3 WUE
		Kg/treat*	Kg/fed		
1	$L_1F_1D_1$	103.00	5150	1494.99	3.44
2	$L_1F_1D_2$	103.80	5190	1494.99	3.47
3	$L_1F_2D_1$	101.88	5294	1494.99	3.54
4	$L_1F_2D_2$	104.22	5411	1494.99	3.62
5	$L_2F_1D_1$	99.82	4991	1270.74	3.93
6	$L_2F_1D_2$	99.60	4980	1270.74	3.92
7	$L_2F_2D_1$	99.90	4995	1270.74	3.93
8	$L_2F_2D_2$	106.24	5312	1270.74	4.18
9	$L_3F_1D_1$	98.04	4902	1046.49	4.68
10	$L_3F_1D_2$	97.62	4881	1046.49	4.66
11	$L_3F_2D_1$	99.44	4972	1046.49	4.75
12	$L_3F_2D_2$	103.82	5191	1046.49	4.96

*** Data were collected from four ridges (4 X 0.70m) X 30 m length = 84 m^2 = 1/50 fed**

Table (7): Effect of different treatments on clogging emitters ratio %/line.

Treatment		Total number of emitters/line*	Mean number of clogging emitter/line	Clogging ratio %/line
1	$L_1F_1D_1$	60	2	3.30
2	$L_1F_1D_2$	60	3	5.00
3	$L_1F_2D_1$	60	3	5.00
4	$L_1F_2D_2$	60	4	6.66
5	$L_2F_1D_1$	60	3	5.00
6	$L_2F_1D_2$	60	3	5.00
7	$L_2F_2D_1$	60	4	6.66
8	$L_2F_2D_2$	60	4	6.66
9	$L_3F_1D_1$	60	3	5.00
10	$L_3F_1D_2$	60	4	6.66
11	$L_3F_2D_1$	60	4	6.66
12	$L_3F_2D_2$	60	5	8.30

*** Total emitters/line = 30 m (length) ÷ 0.50 m (distance between emitters) = 60 emitters/line.**

3.10. Statistical analysis:

Table (8) shows ANOVA (analysis of variance) for the effect of different treatments and the interaction between factors on yield.

Table (8): ANOVA for the effect of different treatments and the interaction between factors on yield.

S.V.	D.F	S.S	M.S	F	Significant
Replication	3	2544.2	848.1	15.9275	–
Irrigation system (A)	1	109230.2	109230.2	1823.5	**
Fertilization method (B)	1	292140.2	292140.2	4877.0	**
Interaction (A x B)	1	104006.2	104006.2	1736.2	**
Irrigation level (C)	2	476578.5	238289.2	3978.0	**
Interaction (A x C)	2	8886.5	4443.2	74.2	**
Interaction (B x C)	2	750.5	375.2	6.2	**
Interaction (A x B x C)	2	24328.5	12164.2	203.0	**
Error	33	1317.8	39.9	–	–
Total	47				

**** Highly significant at 1% level.**

Data indicated that the effect of irrigation system (A), fertilization methods (B), irrigation levels (C) and interaction between them on yield were highly significant.

CONCLUSION

The following conclusions may be summarized:

1) Yield:

The highest yield (5411 kg/fed) was obtained with treatment $L_1F_2D_2$ (100% of ETcrop with subsurface drip irrigation and fertigation method).

Maximum value of vitamin C (34.02 mg/100g) was obtained with treatments $L_3F_2D_1$ and $L_3F_2D_2$.

The largest leaf area (405.3 cm^2/plant) was obtained with treatment $L_1F_2D_2$ (100% of ETcrop, fertigation method and subsurface drip irrigation).

2) Water use efficiency (WUE):

Maximum value of WUE was 4.96 kg/m^3 of irrigation water recorded with treatment $L_3F_2D_2$ (70% of ETcrop, fertigation method and subsurface drip irrigation).

3) Emitters clogging (%):

Maximum mean ratio of emitters clogging/line (8.3%) was recorded with treatment $L_3F_2D_2$ (irrigation with 70% of ETcrop, fertigation method and subsurface drip irrigation system).

4) Statistical analysis:

Effect of all studying factors was highly significant on total yield.

Recommendations:

It can be recommended to use treatment $L_3F_2D_2$ (70% ETcrop irrigation level, fertigation method and subsurface drip irrigation system) for producing high yield and saving irrigation water.

REFERENCES

A.O.A.C. (1970). Association of Official Agricultural Chemists Method of Analysis, 11th Edition, Washington D.C.

Agric. Statistics (2008): Study of important indicators of the agricultural statistics. Ministry of Agric. and Land Reclamation, V:2, August 2008.

Arnaout, M.A. (1999). Comparative study between fertigation and conventional methods of fertilizer application through different irrigation systems. Misr J. Ag. Eng. 16(2): 209-217.

Berry A.M., G.A. Sharaf, Azza Hassan and Ebtsam Sebaaee (2003). Irrigation scheduling of sunflower with drip irrigation system in newly reclaimed land. Misr J. Ag. Eng., 20(4): 993-1010.

Black, C.A. (1965). Methods of soil analysis. Part. 1, Physical and mineralogical properties. A.S.A. Madison, Wisc., USA.

Doorenbos, J.S. and W.O. Pruitt (1977). Crop water requirements. Irrigation and Drainage Paper No. 24, FAO, Rome, PP: 144.

El-Gindy, A.M. (1988). “Modern chemigation techniques of vegetative crops under Egyptian conditions”. Misr. J. Ag. Eng. 5(1): 99-110.

Fisher, H., H. Pe-Nel, (1989). Water use, yield and quality of fresh market tomatoes at two frequencies of factor drip irrigation on three soil types. Applied Plant Sci. 3(2): 118-121.

Geweifel, H.G.M. and A.A.G. Ali (1990). Response of peanut yield to phosphorus and kylar in newly reclaimed soil. Proc. 4th Conf. Agron. Cairo, 11: 177-189.

Gomma, A.H., M.E. Aboamera and E.M. Ashour (2000). “Irrigation water management in heavy soil for tomato and cucumber under drip irrigation system”. Misr J. Ag. Eng., 17(3): 527-538.

Haise, H.R. and R.H. Hagan (1967). “Soil, plant and evaporative measurements as criteria for scheduling irrigation”. Irrigation of agricultural lands. Agronomy # 11. Am. Soc. Of Agron.

Hamada, A.A.; Babiker, E.A. and F.M. Khalifa (1988). Effect of weeds, nitrogen and phosphorus fertilizers on pod yield and growth of groundnut at Rahad (Sudan) (C.F. Cd. Rom Computer System). Oil Eagineux 43(10): 379-394.

Jain, R.C.; Nema, D.P.; Khandwe, R. and R. Thakur (1990). Effect of phosphorus and potassium on yield, nutrients uptake, protein and oil contents of groundnut (Arachis hypogaea, L.). Indian J. of Agric. Sci. 60(8): 559-561.

Jakson, M.L. (1967). Soil chemical analysis. Pintic Hall of India, PP: 144-167.

Koller, H.R. (1972). Leaf area leaf weight relationship in the soybean canopy. Crop. Sci. 12: 180-183.

Mahmoud, M.H. (1996). Response of various cultivars of tomatoes to salinity. Ph.D. Thesis Fac. Agric. Dept. Hort. Vegetable, Mansoura Univ. Egypt.

Michael, A.M. (1978): Irrigation theory and practice. Skylark. Printers. New Delhi, PP: 515.

Pregle, F. (1945). Quantative organic micro analysis 4th Edit., J.X. Churchil Ltd. London.

Rubino, P.S. and E.M. Tarantino (1988). Influence of irrigation techniques on the behavior of some tomato cultivars. Acta Horticulture No. 228. PP: 109-118.
Singh, P.P. and GS. Kalra (1983). Effect of varying levels of phosphorus, sulfur and plant densities on pod yield of different varieties of groundnut (Arachis hypogaea. L). Indian J. of Agric. Res. 17(3): 171-176.

استخدام الرى بالتنقيط لإنتاج الطماطم تحت مستويات رى مختلفة فى الأراضى الرملية

محسن عبد السلام العدل
قسم الهندسه الزراعيه – كلية الزراعه – جامعة المنصوره

أجريت هذه الدراسة على محصول الطماطم فى أرض رملية بالمزرعة الجديدة بكلية زراعة المنصورة بمنطقة قلابشو وزيان (شمال محافظة الدقهلية – حوالى ١٠كم من شاطئ البحر المتوسط) بهدف استخدام مستويات رى مختلفة (١٠٠% ، ٨٥% ، ٧٠% من البخر نتح المحصولى) وطريقتين لإضافة الأسمدة (التقليدية ، التسميد خلال شبكة الرى) بالإضافة للرى بنظامى التنقيط السطحى والتحت سطحى (على عمق ١٥سم من سطح الأرض).

وتم دراسة تأثير المعاملات على:

- توزيع الرطوبة فى التربة.
- كمية المحصول الناتج.
- تركيز الأسمدة فى النبات.
- انسداد النقاطات.
- كفاءة استخدام مياه الرى.

وقد أظهرت النتائج ما يلى:

- مساحة المحتوى الرطوبى بالتربة الأكبر من ٥٠% من السعة الحقلية زادت مع مستويات الرى الأعلى وكذلك مع نظام الرى بالتنقيط التحت سطحى مقارنة بالمعاملات الأخرى.
- أعلى إنتاجية من الطماطم (٥٤١١ كجم/ف) وكان من المعاملة رقم ٤ ($L_1F_2D_2$) مستوى رى ١٠٠% من البخر نتح المحصولى باستخدام نظام التنقيط التحت سطحى والتسميد مع الرى.
- زادت نسبة الأسمدة (NPK) فى النبات الخضرى مع مستويات الرى العالية والتسميد من خلال شبكة الرى مقارنة بالمعاملات الأخرى.
- أعلى كفاءة لاستخدام المياه (٤,٩٦ كجم/م٣) وكانت من المعاملة رقم ١٢ (مستوى رى ٧٠% من البخر نتح بنظام الرى بالتنقيط التحت سطحى والتسميد مع مياه الرى).
- كانت أعلى نسبة فى انسداد النقاطات (٨,٣٠%) وذلك من المعاملة رقم ١٢ (مستوى رى ٧٠% من البخر نتح بنظام الرى بالتنقيط التحت سطحى والتسميد مع مياه الرى).

التوصية:

- من خلال نتائج الدراسة نوصى باستخدام المعاملة ($L_3F_2D_2$) مستوى رى ٧٠% من البخر نتح والتسميد مع مياه الرى بنظام الرى بالتنقيط التحت السطحى لإنتاج أعلى محصول وتوفير مياه الرى.