Evaluation of Ultra-low Drip Irrigation and Relationship between Moisture and Salts in Soil and Peach (*pruns perssica*) Yield

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Abstract: Research study was carried out for two successive seasons 2012 and 2013 on seven years old Florida prince peach trees (*Purnus perseca* L.) budded on Nemagard rootstock. The experiment was conducted at the experimental farm, Modern reclamation lands, Situated in Bader City, South Al-Tahrir, Al-Beharia Governorate, Egypt. Peach trees (seven years) were planted at 5 x 4 m^2 in sandy soil, this investigation aimed to study the effect of irrigation using four techniques of drip irrigation systems: Gr surface drip (SD) 4 l/h., Gr subsurface drip (SSD), surface ultra-low drip (SUD) 1.0 l/h, and subsurface ultra-low drip (SSUD) under three amounts of applied water (60, 80, 100% of calculated applied water called T_1, T_2 and T_3) on yield, fruit quality and some leaf parameters peach trees. The obtained results indicated that, the amount of applied water for T_2 under SUD irrigation system gave the best effect on tree yield and fruit quality, except fruit volume, fruit length, T.S.S. and total acidity % where the highest significant values were obtained with T_2 under SD irrigation systems. On the other hand, yield, fruit weight and T.S.S. recorded the highest significant values with T_3 under SSUD. Moreover, the same treatment increased leaf area and total chlorophyll contents, as well as mineral content (N, P and K) in both seasons. During the first season, the recommended water treatment and system that gave the highest yield is (T_2 and T_3) under (SUD) irrigation systems, so the irrigation water saving for SUD irrigation systems and water treatment T2 was 20%, while in the second season, the interaction between the two studied factors, proved that (T_3) with the (SSD) and (T_2 and T_3) with (SSUD) had the highest significant values. So the best irrigation water save was 20% for T2 under all of SUD and SSUD irrigation system, on the other hand, T_1 under SUD irrigation system in both of first and second years saved irrigation water by 40%. The greatest value of soil moisture content was concentrated at the depths of 40-60 and 60-80 cm specially, at 10 and 18 hours after the irrigation finish process, and this increasing the deep-percolation (effective root zone for peach was 60 cm) and so water loss increased and irrigation system efficiency was reduced. Distribution of SSUD moisture contents was more ideal than SD in X, Y, and Z directions. Soil moisture content of SSUD is higher than SUD irrigation systems due to the water loss by evaporation at subsurface drip irrigation that was less than the SUD irrigation system. The high salt concentration distribution at the upper soil layer 0- 40 cm was under SUD and SSUD irrigation while under the SD and SSD irrigation systems the high salt concentration was distributed at the lower soil layer 40- 80 cm. The (SUD) had highest significant value. Concerning irrigation treatments, (T_2 and T_3) gave the highest insignificant value. The interaction between the two studied factors revealed that treatment of (T_2 and T_3) with (SUD) irrigation system had the highest significant value in the first season. During the second season, concerning irrigation systems, insignificant of yield, regarding amounts of water applied, (T_3) gave the highest yield. The interaction between the two studied factors, provided that (T_3) with the (SSD) and (T_2 and T_3) with (SSUD) had the highest significant values.
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1. Introduction

Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources. It is a sub-set of water cycle management. Agriculture is the largest user of the world's freshwater resources, consuming 70 percent. As the world's population rises and consumes more food, industries and urban development's expand, and the emerging bio-fuel crops trade also demands a share of freshwater resources, water scarcity is becoming an important issue.

Water is life and food security its back one. Irrigation affects soil water availability and consequently, plant water status, shoot growth, productivity and fruit size **Naor, (1999). Mead, (2002**) defined Ultra- low irrigation is usually 10 times less than common emitters. **Lubars,** (**2008**) minted advantages of system are **1)** Optimum growth conditions due to the ability to maintain, **2)** Optimum balance of air, water and nutrients in the soil, 3) Better utilization of available space, plant density can be increased, **4)** Quicker turnaround of plant materials reducing growth cycles, **5)** Higher yields, **6)** Minimize leaching of nutrients that occurs with excess water flow, **7)** The ultra- low rate system is much cheaper than the common micro-irrigation systems, smaller P.V.C. tubes size reduced horse power requirements, **8)** No runoff on heavy soils, **9)** No water loss through the root zone on very sandy soils, **10)** Water and fertilizer saving up to (40-50) %, **11)** Better quality, and **12)** Water could be applied efficiently on shallow soils in hilly areas.

Gilead, G. (2012) mention that, maximal horizontal water distribution, Because the Ultra-Low Drip Emission from "ULDI" emitters is lower - than the soil infiltration capacity, the horizontal water movement to the sides as well as that upwards reaches the maximum distance from the emission point and is wider than with conventional drip irrigation "CDI". Vertical wetting pattern front in sandy soil increased more than vertical in clay by 36.07%, but the horizontal wetting pattern front in clay soil increased more than horizontal in the sand with 13.08%. **Abdou *et al*, (2010)** mentions that by comparing traditional trickle flow 8 L/h and ultra-low rate system 0.4 L/h for the same water quantity 2.4 Liter. Wetting pattern front for sand and clay soils at traditional trickle flow were faster than wetting pattern front at ultra-low rate system. Which led to a significant loss in the amount of water by deep percolation in a short time, in traditional trickle flow the vertical wetting pattern fronts in sandy soil, increase more than vertical in clay by 646.15%, but the horizontal wetting pattern front in clay soil increase more than horizontal in the sand with 8.8%.

Peach is considered as one of the most important fruit crop in Egypt with 76693 fed. Dedicated to its cultivation produced 332.487 ton according to **Ministry of Agriculture and Land Reclamation (2011).**

Abrisqueta et al. (2010) they found the continuous deficit and regulated deficit irrigation treatments of Florida star peach showed a lower fruit diameter than the control. **Pliakoni and Nanos, (2010)** reported the deficit irrigation with 50% of Etc of “Royal Glory” peach and “Caldesi 2000” nectarine trees had increased total soluble solid (TSS) under and higher acidity than fruit from control trees. However **Rufat et al. (2010)** in a study of peach found that irrigation restriction of 28% Etc during stage III caused a clear yield reduction in comparison with T_1 (100%Etc) due to a direct effect on fruit weight and increasing of total soluble solids and soluble sugar with 30% Etc. Regulated deficit irrigation (35%Etc) during stage II of peach fruit developing and post-harvest had increased the total soluble solids and the ratio soluble solids/acidity in comparison to the control, this may attributed to increase light interception inside canopy tree which results in an increase in the photosynthetic rate and production of more carbohydrates. Furthermore, from 75%, up decreed water amount applied by using irrigation regime from75% up to 25% of field capacity significantly decreased average leaf area (cm^2) of Ne plus Ultra almond as compared with control which was irrigated with 100% of field capacity **(Mohy, 2011).** However, **Khattab et al. (2011)** indicated that, increment in irrigation rate was concurrent with an increase in chlorophyll a, b and carotenoids in both seasons of pomegranate trees. However, leaf nitrogen and phosphorus content significantly decreased with decreasing the level of water irrigation in almond leaves. While, irrigation by 100% or 75% of field capacity were able to achieve the maximum level of leaf potassium content during both seasons of study **(Mohy, 2011).**

This investigation aimed to study the effect of irrigation using four techniques of drip irrigation systems: Gr surface drip (SD) 4 l/h., Gr subsurface drip (SSD), surface ultra-low drip (SUD) 1.0 l/h, and subsurface ultra-low drip (SSUD) under three amounts of applied water (60, 80, 100% of calculated applied water called T_1, T_2 and T_3). On yield, fruit quality and leaf parameters of peach trees.

2. Materials and Methods

A research study was carried out through two successive seasons 2012 and 2013 on seven years old Florida prince peach trees (*Purnus perseca* L.) budded on Nemagard rootstock. The experiment was conducted at the experimental farm, Modern reclamation lands, Situated in Bader City, South Al-Tahrir, Al-Beharia Governate, Egypt.

Peach trees were planted at 5 x 4 m^2 in sandy soil, and they were irrigated by using four techniques of drip irrigation systems: Gr surface drip (SD) 4 l/h, Gr subsurface drip (SSD) with 15 cm depth, surface ultra low drip (SUD) 1.0 l/h, and subsurface ultra low drip (SSUD) with 15 cm depth under three amounts of applied water (60, 80, 100% of calculated applied water called T_1, T_2 and T_3). Seventy two experimental trees were chosen of normal growth with uniform in. The experimental design was split plot, where water amount is in the main plot and irrigation system were in sub main plot with three replicates and two trees for each. The obtained results were statistically analyzed using analysis of variance and Duncan‘s multiple range test was used to differentiate means according to **Snedecor and Cochran (1980).**

Fertilization program:

For peach trees, amounts of fertilizers were applied according to the recommendations of the Field Crop Institute, ARC, Egypt, Ministry of Agricultural and Land Reclamation for Peach trees

Some soil and water chemical and physical analysis:

Soil and irrigation water were analyzed at the Central Lab., Desert Research Center. The results are presented in Tables (1,2 and 3).

Table (1): Some physical properties of soil.

Soil depth cm	Particle size distribution				F.C %	W.P %	B.D g/cm^3
	C. Sand%	F. Sand%	Silt %	Clay %			
0-30	92.8	3.7	2.0	1.5	10	4.8	1.83
30-60	91.5	1.8	0.2	6.5	11	6.3	1.79
60-90	93.1	0.6	0.4	5.9	13	5.5	1.72

Table (2): Some chemical properties of soil.

Soil depth cm	pH	EC ds/m	Soluble Cations, meq/L				Soluble Anions, meq/L			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3^{--}	HCo_3^{-}	So_4^{--}	CL^{-}
0-30	8.8	2.8	9.1	9.6	8.61	0.69	--	2.34	12.06	13.6
30-60	8.4	0.21	0.82	0.28	0.8	0.2	--	0.73	0.47	0.9
60-90	8.8	0.757	1.8	1.28	3.65	0.84	--	1.47	2.5	3.6

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

pH	EC ds/m	Soluble Cations, meq/L				Soluble Anions, meq/L			
		Ca^{++}	Mg^{++}	Na^{++}	K^{+}	Co_3^{--}	HCo_3^{-}	So_4^{--}	CL^{-}
6.9	1.634	2.55	1.61	11.9	0.28	-	2.25	2.79	11.3

Irrigation system:

The irrigation system consisted of the following components:

a- Control head:

Control head consisted of centrifugal pump 5 /5 inch (20 m lift and 80 m^3/h discharge), driven by diesel engine (50 Hp), pressure gauges, control valves, inflow gauges, water source in the form of an aquifer, main line then lateral lines and dripper lines. For traditional drip irrigation, Gr dripper was used by 8 l/h/m, discharge, and two hoses for one tree row, where ultra-low drip irrigation was the quarter of traditional drip discharge, for one hose for one tree row and eight dripper with 2 l/h/m for one tree, in Gr drip irrigation systems, the total dripper discharge for one tree was 64 l/h (16 dripper*4l/h) while for ultra-low drip irrigation systems, the tree discharge was 16 l/h (16 dripper*1l/h).

Irrigation requirements:

Irrigation water requirements for peach trees were calculated according to the local weather station data at Al-Beharia Governorate, belonged to the Central Laboratory for Agricultural Climate **(C.L.A.C.),** Ministry of Agriculture and Land Reclamation.

Irrigation process was done by calculating crop consumptive use (mm/day) according to **Doorenbos and Pruitt (1977).**

Water requirements for Peach trees were calculated according to the following equation as recommended by **Keller and Karmeli (1975).** Table (4) and table (5).

Table (4): Calculated consumptive use (mm/day) of peach trees.

Growth stage	month	ET_o mm/day	K_c	Et_c mm/day	I_t (L/tree/ day)	I_d (m^3/ha/ day)
Initial	January	2.4	0.48	1.152	11.5	5.78
	February	3.2	0.48	1.536	15.4	7.72
	march	4.2	0.48	2.016	20.2	10.11
Mid-season	April	5.6	0.79	4.424	44.2	22.20
	May	6.6	0.79	5.214	52.1	26.17
	June	7.3	0.79	5.767	57.7	28.94
	July	7.2	0.79	5.688	56.9	28.54
Season end	Augusts	6.7	0.75	5.025	50.3	25.21
	September	5.6	0.75	4.2	42.0	21.08
Total (I_y)	5781.44 (m^3/ha/season).					

Where: I_t=Irrigation requirements for tree per day (L/ha/day),
I_d=Irrigation requirements for ha per day (m^3/ha/day),
I_y=Irrigation requirements for ha per season (m^3/ha/season).

Table (5): Calculated water amounts versus irrigation systems for peach trees.

Characters	Irrigation requirements per season for ha (m^3/ha/season)

60% ETC = (T_1)	3468.86
80% ETC = (T_2)	4625.15
100% ETC = (T_3)	5781.44

$$IR = \left[\frac{K_c \times Et_o \times A \times C_F}{10^7 \times Ea}\right] + LR \quad \text{------ (1)}$$

Where:

IR=Irrigation water requirements, m^3/ha/day.
E t_o =Potential evapo-transpiration, mm day^{-1}
Kc=Crop factor of peach,
A=Area irrigated, (m^2)
Ea=Application efficiency, %, where 90% drip irrigation.
LR=Leaching requirements.
C_F=Covering factor, for peach trees 45%.

The crop factor of peach was used to calculate Etcrop values, according to **FAO (1984).**

Measurements and calculations:

- **Irrigation water saving percentage**
Water saving was estimated according to the following equation

Water saving = (I_f – I_n) / I_f x 100 ------------------(2)

Where:

I_f=Water use for control treatment (m^3/ha), and
I_n=Water use of various treatments (m^3/ha).

-Soil measurements:

Soil samples were taken by a screw auger at three spaces from beginning of the drip main line, the space between samples were 20 cm, and at three depths (20,40, and 60cm) at two direct X and Y where the horizontal and vertical space of the sample was 20 cm. Samples were analyzed for determining both soil moisture and salt accumulation. The results were drawn by SURFER, ve. 11 under on a color scale for soil moisture 1-50 and for soil salt distribution from1-100, under windows program, and the "Kriging" regression method as the base model for analysis and contour map development.

Crop measurements:

Following parameters were assessed during the study:

- **Yield and fruit quality measurements**: total yield (kg/tree)
- **Fruit physical characteristics**: A representative sample of 20 matures fruits was harvested from each considered tree to determine average fruit weight (g), volume (cm^3), pulp weight (g), fruit length (cm) and width (cm).
- **Fruit chemical characteristics**, juice total solid percentage (TSS%) was determined by using a hand refractometer, titratable tuice acidity percentage (as malic acid) andTSS%/ acid ratio, in **AOAC (1995).**
- **Leaf Area (cm^2)**: twenty mature leaves as the third one of the base of the previously tagged non-fruiting shoots from spring cycle were taken randomly from each replicate, and measured by the planimeter in mid June.
- **Leaf total chlorophyll content**: concentration per unit leaf area was estimated in the field by using SPAD 502 meter (Minolta Co., and Osaka).
- **Leaf NPK content:** at first week of July of both seasons, 20 matures leaves from the middle portion of current year shoots of each replicate, leaves were collected to determine macro elements in dry leaf samples, nitrogen percentage was estimated by micro-Keldahl according to (**Pregel 1945**), phosphorus percentage was determined using atomic absorption spectrophotometer parking Elmer3300 according to **Chapman and Pratt (1961)**, and potassium was estimated according to **Brown an Lilleland (1966**).

Water use efficiency (CWUE) (kg/m^3).

Water use efficiency calculated according to **Viets (1962),**

Crop water use efficiency = [fruit yield / crop water consumption] ---------(3)

3. Results and Discussions

- **Irrigation water saving percentage:**

In the first season**,** the recommended water treatments and system that gave the best growth parameters and highest yield were (T_2 and T_3) under (SUD) irrigation system, so the irrigation water saving for the SUD irrigation system and water treatment T_2 is 20%, while in the second season, the interaction between the two studied factors, provided that (T_3) with the (SSD) and (T_2 and T_3) with (SSUD) had the highest significant value. So the best irrigation water save is 20% for T_2 under all of SUD and SSUD irrigation system, on the other hand, T_1 under SUD irrigation system in both of first and second years is had accepted irrigation water saving ratio of 40%.

Abrisqueta et *al.* (2000), in Spain, showed that it is possible to save irrigation water with the respect to **FAO (1984)** recommendation. **Rawash et *al.* (2000)**, in Egypt, studied the response of apple trees to some water treatment in new reclaimed soils. They found that water saving reached approximately 50%.

- **Spatial and temporal distribution of soil moisture and salt concentration:**

- **Spatial and temporal distribution of soil moisture for ultra-low flow drip and drip irrigation systems:**

Fig. (1) showed counter map for soil moisture distribution before irrigation process. As a known, the soil moisture distribution depends on soil texture, slopes, and climate. Soil moisture distribution under SUD and SD were presented in Fig (1), according to patterns of soil moisture distribution.

Two hours after irrigation:

It's so clear that the greatest soil moisture percentage is in the SUD irrigation system, it's 38%, while the SD irrigation system is 11.5% besides the soil moisture distribution under SUD irrigation system increased gradually at X, Y, and Z axes compared to that in an SD irrigation system where was so sharply distributed at the direction Y at 50 cm depth.

Ten hours after irrigation:

Regards to the patterns of soil moisture distribution by ten hours after irrigation process, the greatest soil moisture content was 18 % under SUD while under SD the greatest soil moisture content was 9.5%. The soil distribution under SUD was more available at effective root zone of peach trees, where the peach trees effective root zone is 60 cm, besides the mean of moisture content of SUD was double that of SD specially in the effective root zone. And color evidence showed this difference in Fig (1).

Eighteen hours after irrigation:

According to soil moisture patterns, and eighteen hours after irrigation, it can be noted that the same case, soil moisture content of the SUD irrigation system is greater and double the soil moisture content of the SD, beside the moisture contents were distributed gradually at X, Y, and Z direction more than SD, in Fig. (1), distribution of SUD moisture contents is more ideal than SD at X, Y, and Z direction and this agreed with **Elmesery (2011)** and **Abdou *et al.* (2010).**

By soil depths, and noting that, effective root zone of peach trees is 60 cm, every soil moisture contents after 60 cm under soil surface will be considered deep-percolation and water loss, beside it's so clear that the greatest value of soil moisture contents was concentrated at the depths 40-60 and 60-80 cm specially, at 10 and 18 hours after irrigation finish process, and this increased the deep-percolation and then water loss would be increased and irrigation system efficiency would be reduced.

- **Spatial and temporal distribution of soil moisture for subsurface ultra-low flow drip and sub surface drip irrigation systems:**

One of the main advantages of SSUD and SSD over other irrigation methods is that it has the potential to be the most efficient irrigation systems available today. The word potential is stressed because irrigation efficiency not only depends on the irrigation system itself, but also on its proper design, installation and management. Only when designed, installed and managed correctly it could be more efficient than any other irrigation systems.

Fig.(2) showed counter map for soil moisture distribution before irrigation process. As known that, soil moisture distribution depends on soil texture, slopes, and climate.

Two hours after irrigation:

It can be noted that soil moisture percentage under SSUD and SSD irrigation systems was similar at the highest content value, but soil moisture distribution under SSUD irrigation system is increased gradually at X, Y, and Z axes than the soil moisture distribution in SSD irrigation system where so sharply distributed at direction Y at 50 cm depth. Fig.(2)

Ten hours after irrigation:

According to the patterns of soil moisture distribution by ten hours after irrigation process, the greater soil moisture content was 55 % under SSUD while under SSD the greatest soil moisture content was 11%, and the soil distribution under SUD is more available at effective root zone of peaches trees, where the peach trees effective root zone is 60 cm, beside the mean of moisture content of SSUD was almost four times of SSD moisture content specially in effective root zone. And color evidence showed this difference in Fig (2)

Eighteen hours after irrigation:

Soil moisture patterns, and eighteen hours after irrigation, it can be noted that the same case, Soil moisture content of SSUD irrigation system was greater than that SSD, beside the moisture content was distributed gradually at X, Y, and Z direction more than SSD. Fig.(2)

Finally, distribution of SSUD moisture content was more ideal than SD at X, Y, and Z directions and this result agreed with **Abdou *et al.* (2010).** Soil moisture content of SSUD is higher than SUD irrigation systems due to the water loss by evaporation at subsurface drip irrigation less than that of the SUD irrigation system.

Salt concentration distribution:

Under irrigated conditions in arid and semi-arid climates, the build-up of salinity in soils is inevitable. The severity and rapidity of build-up depends on a number of interacting factors such as the amount of dissolved salt in the irrigation water and the local climate. However, with proper management of soil moisture, irrigation system uniformity and efficiency, local drainage, and the right choice of crops, soil salinity can be managed to prolong field productivity.

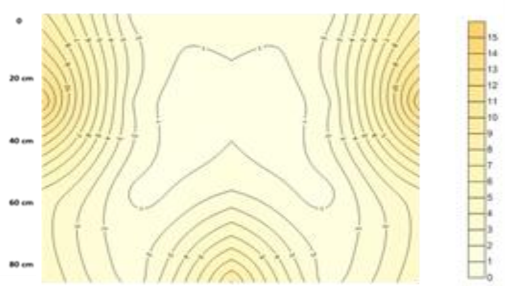
Fig.(3 and 4) showed soil salt concentration distribution under SUD and SD irrigation systems before irrigation process.

- **Spatial and temporal distribution of salt concentration distribution:**

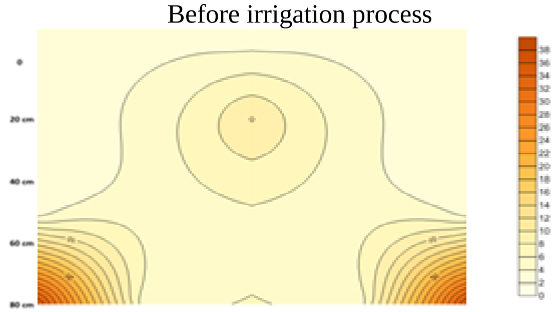
Fig.(3 and 4) showed soil salt concentration distribution under SUD and SD irrigation systems before irrigation process.

Two hours after irrigation:

It can be noted that soil salt under SUD, SSUD and SSD irrigation systems was distributed gradually and homogeneously but soil salt distribution under SD irrigation system suffered from high concentration at the lower soil layers 40-80 cm, this means that nutrients were exposed to a un-intention leaching process, Fig.(3 and 4).

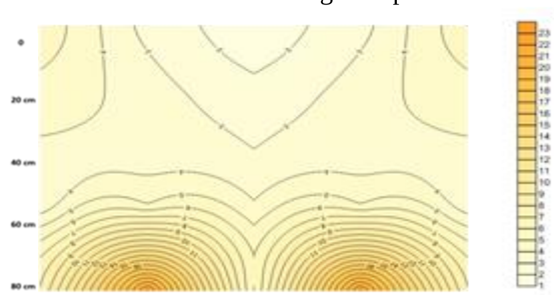


Before irrigation process



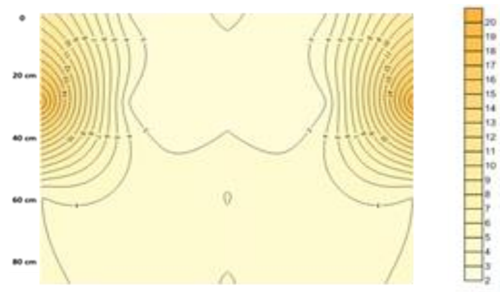
2 Hours after irrigation process

10 Hours after irrigation process

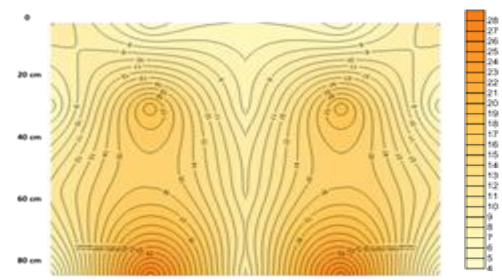


18 Hours after irrigation process

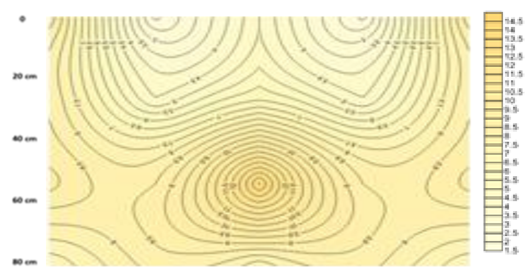
Surface ultra-low drip irrigation systems (SUD)



Before irrigation process



2 Hours after irrigation process



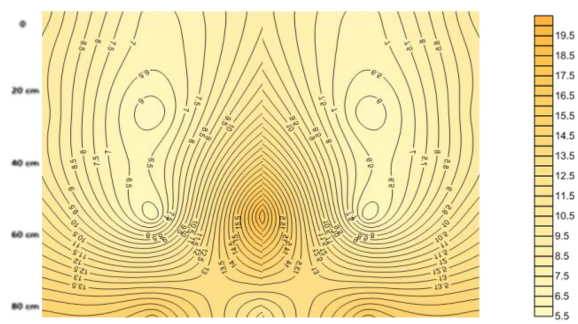
10 Hours after irrigation process

18 Hours after irrigation process

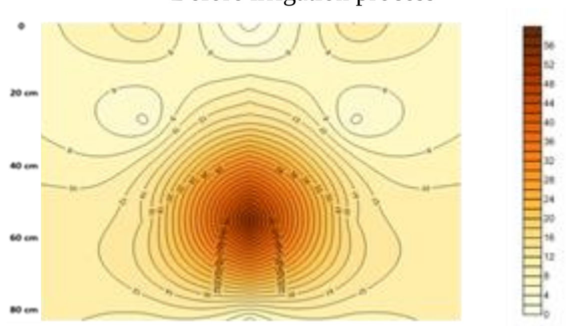
Surface drip irrigation system (SD)

Fig. (1) The patterns of soil moisture distribution under surface drip and surface ultra-low drip irrigation systems.

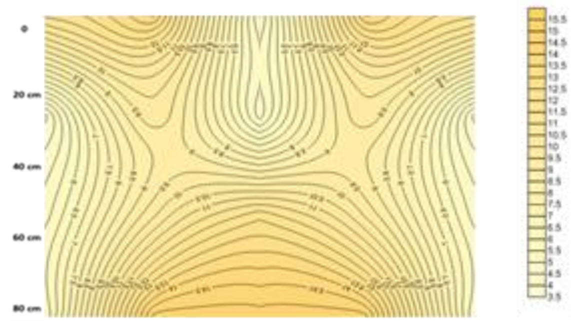
Before irrigation process



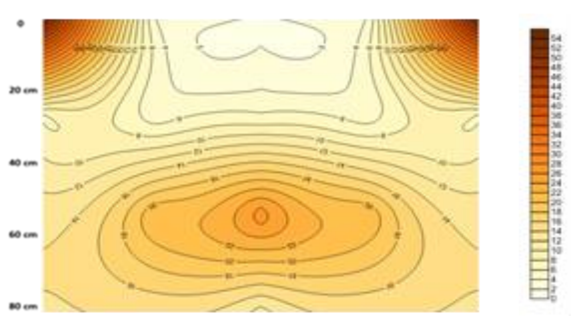
Before irrigation process



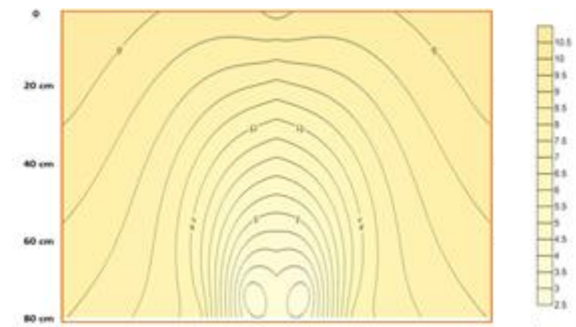
2 Hours after irrigation process



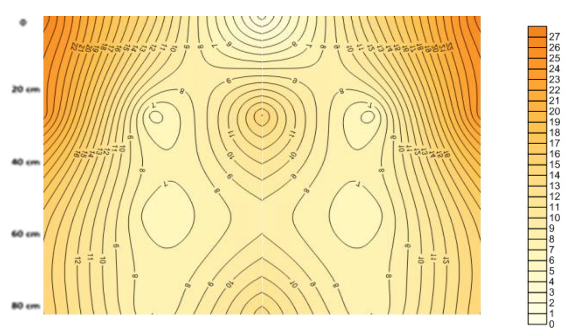
2 Hours after irrigation process



10 Hours after irrigation process



10 Hours after irrigation process



18 Hours after irrigation process

18 Hours after irrigation process

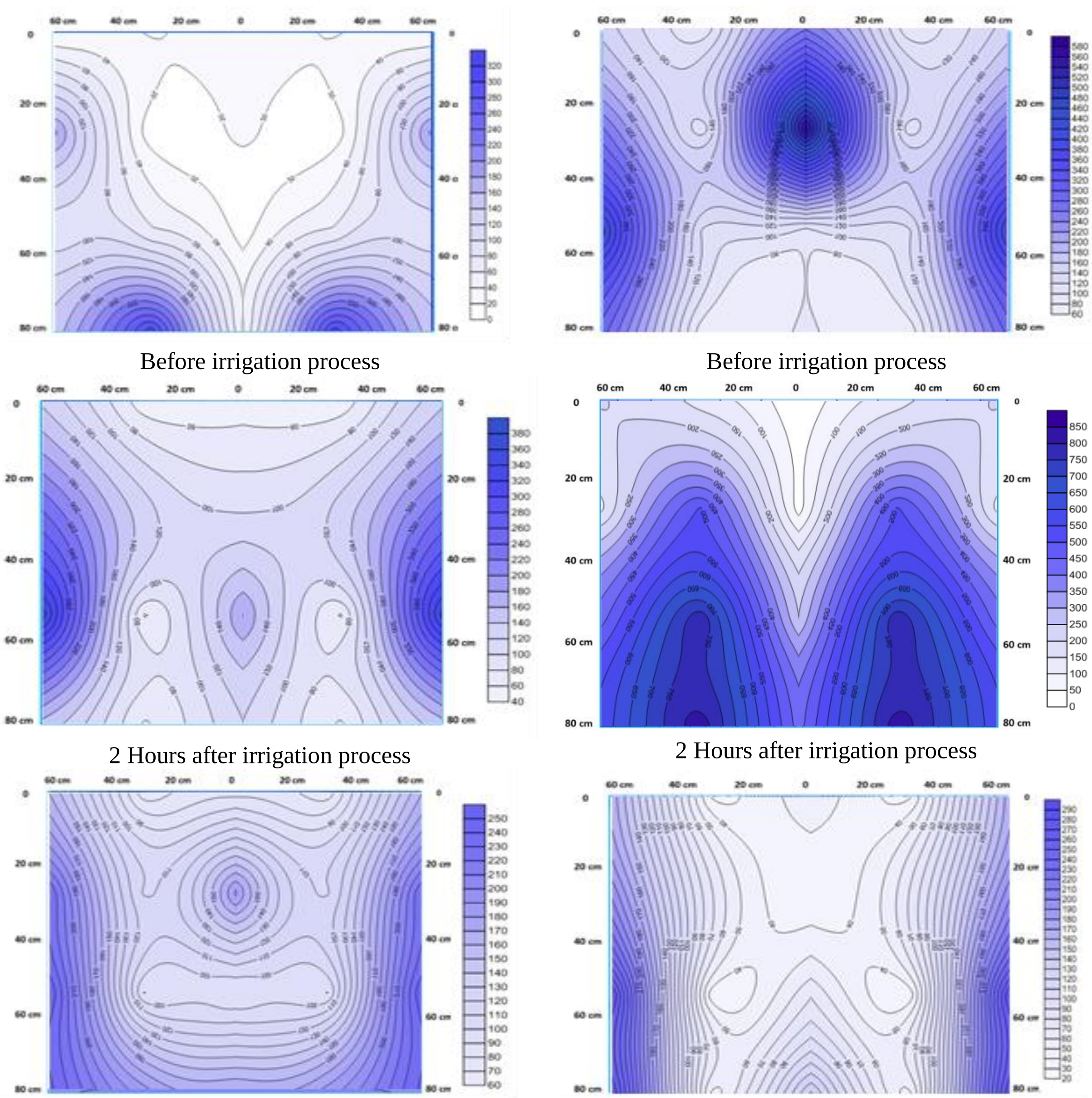
Subsurface ultra-low drip irrigation (SSUD) **Subsurface drip irrigation system (SSD)**

Fig. (2) The patterns of soil moisture distribution under subsurface drip and subsurface ultra-low drip irrigation systems.

Ten hours after irrigation:

According to the patterns of salt moisture distribution by ten hours after irrigation process, the highest salt concentration distribution was at the upper soil layer 0- 40 cm under SUD and SSUD irrigation while under the SD and SSD irrigation systems the highest salt concentration distribution was at the lower soil layer 40- 80 cm. Figs. (3 and4).

Due to the high dripper flow (4 l/h) compared with SUD flow (1 l/h) the vertical movement of water (Y direction) was higher more than the horizontal movement of water (X direction), as a result of water seepage by gravity at direction Y and then nutrient loss was happened by deep-percolation under effective root zone. For SSUD and SSD, It is a logic for the salt concentration of surface soil layers to be higher than the surface soil layer under the SD and SUD irrigation systems because of water evaporation of surface soil, which would be less under subsurface drip irrigation systems, and this result agreed with **Trooien *et al.* (2000).**



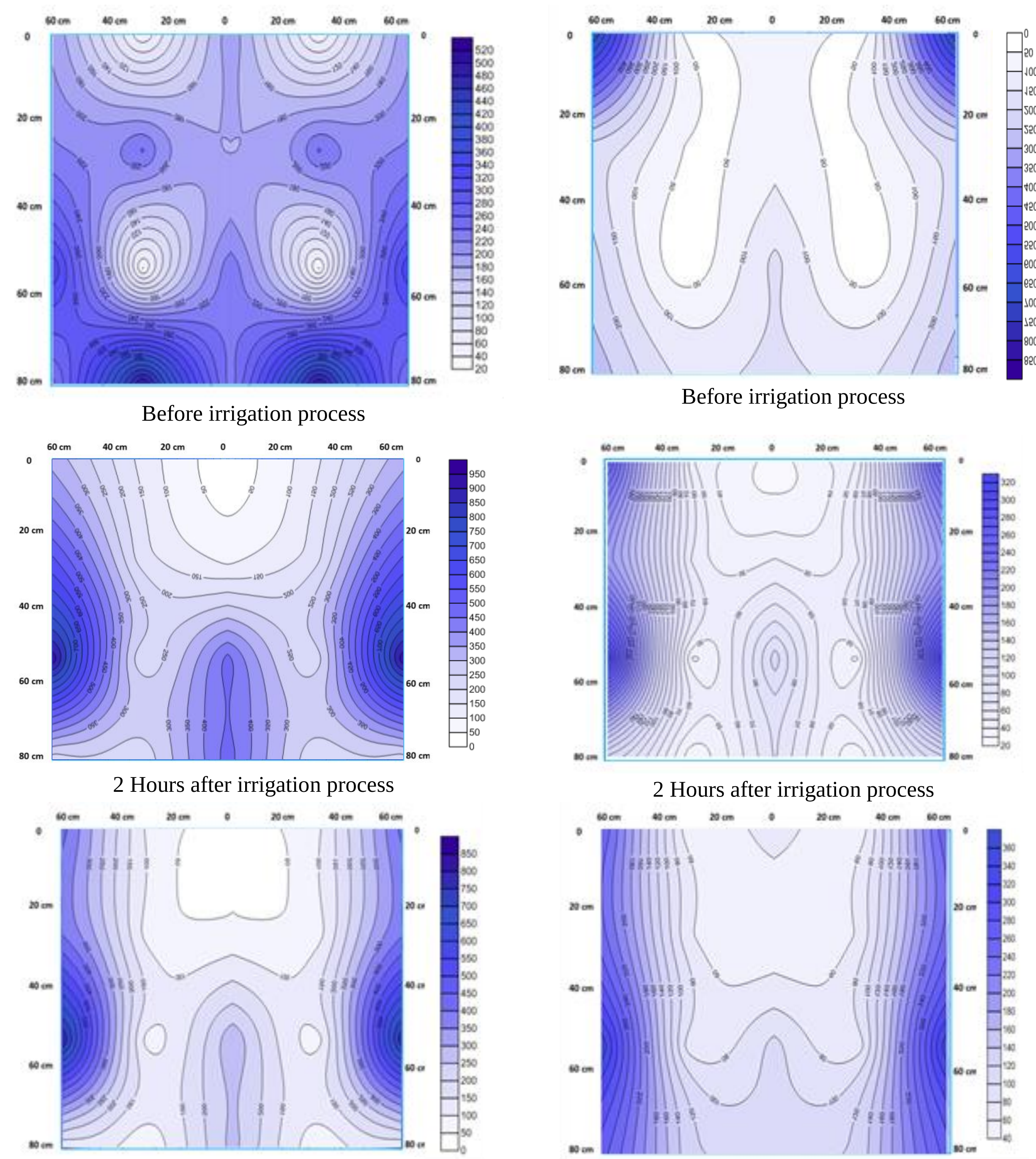
Before irrigation process — Before irrigation process

2 Hours after irrigation process — 2 Hours after irrigation process

24 Hours after irrigation process — 24 Hours after irrigation process

Surface ultra-low drip irrigation (SUD) systems — **Surface drip irrigation system (SD)**

Fig.(3) The patterns of soil salt conc. distribution under surface drip and surface ultra-low drip irrigation systems.



Before irrigation process

Before irrigation process

2 Hours after irrigation process

2 Hours after irrigation process

24 Hours after irrigation process

Subsurface ultra-low drip irrigation systems (SSUD)

24 Hours after irrigation process

subsurface drip irrigation system (SSD)

Fig. (4) The patterns of soil salt conc. distribution under sub-surface drip and sub-surface ultra-low drip irrigation systems.

- **Crop measurements:**

The effect of irrigation systems, water amounts and their interaction on yield (kg/tree) and fruit quality of Florida prince peach in 2012 and 2013 seasons:

A-Yield (kg/tree):

The data in table (6) showed that, regarding irrigation systems, the (SUD) had the highest significant value. Concerning irrigation, treatments, (T_2 and T_3) gave the higher significant values than the first one. The interaction between the two studied factors revealed that treatment of (SUD) with (T_2 and

T_3) irrigation system had the highest significant value in the first season.

During the second season, concerning irrigation systems, insignificant of yield, regarding amounts of water applied, (T_3) gave the highest yield. The interaction between the two studied factors, provided that (SSUD) with (T_2 and T_3) had significant higher values than most of the other treatments.

Table (6) effect of irrigation systems, water amounts and their interaction on yield (kg/tree) of Florida prince peach in 2012 and 2013 seasons.

Characters	Yield (kg/tree)							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	17.98f	20.18de	22.23bcd	20.13C	20.08ab	21.00ab	21.65ab	20.91A
SSD	18.65ef	20.87cd	22.08bcd	20.53C	20.93ab	21.88ab	22.75a	20.86A
SUD	24.10ab	24.68a	24.97a	24.58A	20.40ab	20.97ab	21.68ab	21.02A
SSUD	20.72cd	22.43bc	23.03ab	22.06B	18.53b	22.97a	23.93a	21.81A
Mean	20.36B\	22.04A\	23.08A\		19.99B\	21.70AB\	22.50A\	

WT = Water treatments; **IS** = Irrigation systems.
Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

B- Fruit physical characteristics:

1) Fruit weight (g):

Data tabulated in table (7) revealed that in the first season; the (SSD) recorded the lowest significant value concerning water treatments, but insignificant differences could be noticed among water treatments. The interaction between the two studied factors, proved that (SUD) with (T_3) and (SSUD) has significant higher values than most of the other treatments.

Regarding irrigation systems, the (SSD) had the highest significant value. Concerning water treatments insignificant differences could be noticed among treatments. The interaction between the two studied factors, revealed that (SSD) with (T_3) had the higher significant value than all treatments in the second season.

Table (7) Effect of irrigation systems, water amounts applied and their interaction on fruit weight (g) of Florida prince peach in 2012 and 2013 seasons.

Characters	Fruit weight (g)							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	58.85abc	62.94a	58.00abc	59.93A	67.04c	74.45bc	85.38ab	75.62AB
SSD	51.24bcd	48.83cd	47.14d	49.07B	74.12bc	73.28bc	91.78a	79.73A
SUD	60.30ab	58.65abc	63.56a	60.84A	71.72bc	70.30c	69.80c	70.61B
SSUD	50.82bcd	59.73abc	63.57a	58.04A	78.14abc	69.53c	75.27bc	74.31AB
Mean	55.31A\	57.54A\	58.07A\		72.75A\	71.89A\	80.56A\	

WT = Water treatments; **IS** = Irrigation systems
Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

2) Fruit volume (m^3):

It is obvious from the data presented in table (8) that (SSD) recorded the lowest significant value.

Concerning water treatments, insignificant value could be noticed. The interaction between the two studied factors, revealed that (SD) with (T_2) had the highest in the first season.

During the second season, the irrigation systems showed insignificant differences among treatments, concerning water treatments, (T_3) gave the highest significant value. The interaction between the two studied factors revealed that treatment (SSD) with (T_3) had higher significant value than most of the other treatments.

The results were in some line with several reports as **Rufat *et al.* (2010)** who reported that deficit irrigation during stage III reduced fruit size and weight of peach fruit which are major attributes to fruit quality. In this respect **Maria *et al.*, (2010)** and **Ranbir Singh et al. (2002),** observed that, fruit size, weight and yield increased with increased irrigation.

Table (8) effect of irrigation systems, water amounts applied and their interaction on fruit volume (ml^3) of Florida prince peach in 2012 and 2013 seasons.

Characters	Fruit volume (ml^3)							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	56.90ab	60.30a	55.73ab	57.98A	64.37d	71.30bcd	81.70ab	72.46A
SSD	48.03cd	45.83d	42.17d	45.34B	70.83bcd	68.77bcd	88.43a	76.01A
SUD	56.17ab	55.00abc	57.50ab	56.22A	68.43cd	66.60cd	77.77abc	70.93A
SSUD	53.03bc	55.67ab	58.87ab	55.86A	75.67bcd	66.80cd	73.03bcd	71.83A
Mean	53.53A\	54.45A\	53.57A\		69.82B\	68.37B\	80.23A\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

3) Fruit length (cm):

It is obvious from the table (9) in the first season, that (SD) recorded the higher significant value. Concerning amounts of water applied, (T_2) gave the highest significant value. The interaction between the two studied factors, proved (SD) with (T_2) had higher significant value than some of the other treatments.

In The second season, concerning irrigation systems amounts of water applied and the interaction between the two studied factors there was no insignificant difference among them.

Table (9) effect of irrigation systems, water amounts and their interaction on fruit length (cm) of Florida prince peach in 2012 and 2013 seasons.

Characters	Fruit length (cm)							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	4.27abc	4.53a	4.43ab	4.41A	4.97a	5.10a	5.37a	5.14A
SSD	4.03c	4.23abc	4.13bc	4.13C	5.17a	5.17a	5.63a	5.32A
SUD	4.10bc	4.30abc	4.20abc	4.20BC	5.10a	5.00a	4.93a	5.01A
SSUD	4.20abc	4.40abc	4.43ab	4.34AB	5.50a	5.03a	5.10a	5.21A
Mean	4.15B\	4.37A\	4.30AB\		5.18A\	5.08A\	5.26A\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

4) Fruit width (cm):

The data in table (10) showed that, concerning the first season, the (SSD) recorded that lowest significant value. Regarding amounts of water applied insignificant differences among treatments could be noticed. The interaction between the two studied factors revealed that treatment of (SUD) with (T_3) had higher significant value than some of the other treatments.

During the second season, concerning irrigation systems, amounts of water applied and the interaction between the two studied factors insignificant differences among treatments could be noticed.

The obtained results are in line with **Layne et al., (2002**), who reported that drought conditions negatively impacted tree fruit yield and led to substantial increase in un-marketable fruit. Also, the continuous deficit and regulated deficit water treatments of Florida star peach showed lower fruit diameter than the control **Abrisquents et al., (2010)**.

Table (10) effect of irrigation systems, water amounts and their interaction on fruit width (cm) of Florida prnice peach in 2012 and 2013 seasons.

Characters	fruit width (cm)							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	4.90a-d	4.97ab	4.97ab	4.94A	5.07a	5.30a	5.60a	5.32A
SSD	4.57d	4.60cd	4.57d	4.58B	5.13a	5.07a	5.60a	5.27A
SUD	4.70bcd	4.80a-d	5.07a	4.86A	5.27a	5.23a	5.47a	5.32A
SSUD	4.73a-d	4.93abc	4.97ab	4.88A	5.27a	5.37a	5.30a	5.31A
Mean	4.73A\	4.83A\	4.89A\		5.18A\	5.24A\	5.49A\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

C- Fruit chemical characteristics:

1) TSS%:

Results in table (11) clearly indicated that, TSS% in the first season was insignificantly affected by irrigation systems. Regarding water treatments, insignificant differences among treatments could be noticed. The interaction between the two studied factors, showed in constant trend among treatments in the first season.

During the second season, concerning irrigation systems, the (SSUD) had the highest significant value. Regarding water treatments, insignificant differences among treatments were recorded. The interaction between the two studied factors, provided that (SSUD) with (T_3) had the higher significant value. Similar results were recorded by **Pliakoni and Nanos (2010)** on "Royal Glory" peach and "Caldesi 2000" nectarine and **Mercier et al. (2009)** in peach trees (CV. Alexandra). Also, deficit irrigation (30%Etc) during stage III, **Rufat, et al. (2010)** or (35%Etc) during stage II of fruit developing and post-harvest of peach trees **Sotiropoulos et al., (2010)** increased total soluble solids, it means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

Table (11) effect of irrigation systems, water amounts and their interaction on TSS% of Florida prince peach fruit in 2012 and 2013 seasons.

Characters	TSS%							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	12.10a	11.80a	11.00ab	11.63A	12.00bc	12.67abc	11.67bc	12.11B
SSD	11.33ab	11.77a	11.43ab	11.51A	12.67abc	13.00abc	12.67abc	12.78AB
SUD	12.13a	12.10a	10.23b	11.49A	11.33c	11.67bc	12.67abc	11.89B
SSUD	11.33ab	11.33ab	10.87ab	11.18A	13.33ab	13.00abc	14.33a	13.56A
Mean	11.73A\	11.75A\	10.88A\		12.33A\	12.58A\	12.83A\	

WT = Water treatments; **IS** = Irrigation systems

2) Total acidity %:

As shown in table (12) regarding irrigation systems, the (SD) had highest significant value in both season. Concerning water treatments, (T_1) gave the highest value in both season. The interaction between the two studied factors, revealed that the treatments of (SD) with (T_1, T_2 and T_3) in the first season and (T_1) in second season had the highest significant values.

Table (12) effect of irrigation systems, water amounts and their interaction on total acidity (%) of Florida prince peach fruit in 2012 and 2013 seasons.

Characters	Total acidity (%)							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	0.93a	0.98a	0.92a	0.96A	1.06a	0.98ab	0.91bc	0.98A
SSD	0.83b	0.81b	0.78bc	0.81B	0.99ab	0.95bc	0.89c	0.94AB
SUD	0.78bc	0.75bcd	0.71cd	0.74C	0.79d	0.78d	0.79d	0.79C
SSUD	0.81b	0.78bc	0.69d	0.76C	0.94bc	0.92bc	0.93bc	0.93B
Mean	0.85A\	0.83AB\	0.78B\		0.95A\	0.91AB\	0.88B\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

3) TSS% / acid ratio:

Results in table (13) clearly indicated that, the lowest significant value of the TSS / acid ratio in the first season was recorded with (SD). Regarding water treatments, insignificant differences among treatments could be noted. The interaction between the two studied factors, proved that the (SUD) with the (T_2) had the higher significant value than some other treatments in the first season. During the second season, concerning irrigation system, the (SUD) had higher significant value than first and second treatments. Regarding water treatments, (T_3) gave higher significant value than (T_1). The interaction between the two studied factors, revealed that (SUD) with (T_3) had the highest significant value than some other treatments.

These results agreed with those found by **Pliakoni and Nanos (2010)**, who found that deficit irrigation with 50% of Etc of "Royal Glory" peach and "Caldesi 2000" nectarine trees had higher acidity and total phenols than fruit from control trees. On the other hand, regulated deficit irrigation (35%Etc) during stage II of peach fruit developing increased the ratio soluble solids/acidity in comparison to the control.

Table (13) effect of irrigation systems, water amounts and their interaction on T.s.s/acid ratio (%) of Florida prince peach fruit in 2012 and 2013 seasons.

Characters	TSS/acid ratio (%)							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	12.31cde	12.25de	11.96e	12.17B	11.38d	13.00bcd	12.81cd	12.39C
SSD	13.64b-e	14.59abc	14.69ab	14.31A	13.02bcd	13.73a-d	14.17abc	13.64BC
SUD	15.62a-e	16.21a	14.42a-d	15.42A	14.24abc	15.04abc	16.10a	15.13A
SSUD	14.05a-e	14.53a-d	15.68ab	14.75A	14.18abc	14.07abc	15.46ab	14.57AB
Mean	13.90A\	14.39A\	14.19A\		13.21B\	13.69AB\	14.63A\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

4) Total sugars:

Regarding irrigation systems, the (SUD) had the highest significant value in both seasons. Concerning water treatments, insignificant difference among treatments could be noticed in the first season. While, in the second seasons (T_2) gave the highest significant value. The interaction between the two studied factors revealed that treatment (SUD) with (T_2) had the highest significant value in both season. Table. (14).

Several reports were in accordance with those results such as **Gelly et al. (2004)**, they reported that an increase in fruit sugar concentration had generally been associated with moderate water stress in peach trees. Also, **Kobashi et al. (2000)** documented an increase in sorbitol, sucrose and total sugars with moderate but not severe water stress. In this respect, deficit irrigation (30%Etc) during stage III of peach trees increased fruit total soluble sugars **Rufat, et al. (2010).**

Table (14) effect of irrigation systems, water amounts and their interaction on Total sugars (gm glucose/100ml^3 juice) of Florida prnice peach fruit in 2012 and 2013 seasons.

Characters	Total sugars (gm glucose/100ml^3 juice)							
Season	2012				2013			
IS \ WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean
SD	3.43e	3.97c	4.003c	3.80B	3.90f	4.32cd	3.80f	4.02B
SSD	3.85cd	4.09c	3.617de	3.85B	3.91f	4.26cde	3.98ef	4.05B
SUD	4.55b	4.97a	4.417b	4.65A	4.75b	5.22a	4.48bc	4.82A
SSUD	3.92cd	4.03c	3.950cd	3.97B	3.97ef	4.39c	4.03def	4.13B
Mean	3.94A\	4.26A\	3.997A\		4.13B\	4.55A\	4.08B\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

D- The effect of irrigation systems, water treatments and their interaction with leaf peach trees in 2012 and 2013seasons.

1) Leaf area (cm^2):

Regarding irrigation systems, the (SUD) and (SSUD) had the highest significant values. Concerning water treatments, insignificant difference could be noticed among treatments. The interaction between the two studied factors revealed that treatment (SUD) with (T_2) had higher significant value than most of other treatments in the first season. Table (15).

During the second season, concerning irrigation systems, the (SUD) had higher significant value. Regarding water treatments (T_2 and T_3) gave the highest leaf area than (T_1). The interaction between the two studied factors, provided that (SUD) with (T_3) gave the highest significant value except (SUD) with (T_2) treatment.

The obtained results of the present study are confirmed by the previous finding of **Mohy (2011)**, who reported that decreasing water irrigation by using irrigation regime from 95% up to 25% of field capacity significantly decreased average leaf area (cm^2) as compared to control treatment that was irrigated by 100% of field capacity.

Table (15) effect of irrigation systems, water amounts and their interaction in leaf area (cm^2) of Florida prince peach trees in 2012 and 2013 seasons.

Characters	Leaf area (cm^2)							
Season	2012				2013			
WT	T_1	T_2	T_3	Mean	T_1	T_2	T_3	Mean

IS								
SD	32.24f	33.42ef	34.46c-f	33.37C	33.55f	35.35def	36.14cde	35.01C
SSD	33.87def	34.89b-e	36.06a-d	34.94B	34.32ef	36.10cde	37.09cd	35.84C
SUD	37.05ab	38.08a	37.17ab	37.43A	38.22bc	39.89ab	40.44a	39.52A
SSUD	35.66a-e	36.69abc	37.23ab	36.53A	37.01cd	37.91bc	38.06bc	37.66B
Mean	34.71A\	35.77A\	36.23A\		35.78B	37.31A\	37.93A\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

2) **Total chlorophyll content:**

According presented data in the table. (16) regarding irrigation systems, the (SUD) had the highest significant value. Concerning water treatments, (T_3) gave a higher significant value than (T_1). The interaction between the two studied factors revealed that treatment of (SUD) with (T_3) had higher significant value than most of other treatments in the first season.

During the second season, concerning irrigation systems, the (SUD) had the highest significant value. Regarding water treatments, (T_2 and T_3) gave higher significant values than (T_1). The interaction between the two studied factors, provided that (SUD) with (T_2 and T_3) had higher significant value than most of the other treatments.

Several reports were in accordance with the obtained results. **Mercier et al. (2009)** cleared that, under severe stress, photosynthesis and vegetative growth are greatly reduced leading to diminished fruit production. Also, photosynthetic pigment content in leaves was significantly higher in the canyon apricot trees grown under high irrigation rate **El-seginy et al., (2006)**. The increment in irrigation rate was concurrent with an increase in chlorophyll a, b and carotenoids, this increment, in leaf pigment concentration, could be attributed to increased micronutrient uptake especially N and Mg as a consequence of improved soil **Khattab et al. (2011).**

Table (16) effect of irrigation systems, water amounts and their interaction with total chlorophyll content of Florida prnice peach trees in 2012 and 2013 seasons.

Characters	Total chlorophyll content							
Season	**2012**				**2013**			
IS \ WT	**T_1**	**T_2**	**T_3**	**Mean**	**T_1**	**T_2**	**T_3**	**Mean**
SD	33.46e	34.35de	34.40de	34.07C	36.46g	37.20g	37.38fg	37.01C
SSD	35.04cd	35.67cd	35.94bcd	35.55B	38.37ef	39.60cd	39.94bc	39.31B
SUD	36.31abc	37.25ab	37.69a	37.08A	40.86ab	41.30a	41.51a	41.22A
SSUD	35.21cd	35.89bcd	35.84bcd	35.64B	38.61de	39.69bcd	40.00bc	39.44B
Mean	35.01B\	35.79AB\	35.97A\		38.58B\	39.45A\	39.71A\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

3) **The leaf macro element's content:**

- N%:

The (SUD) treatments had the highest significant value in both seasons. Concerning, amounts of water applied (T_2) had the highest significant value in the first and second seasons. The interaction between the two studied factors, revealed that treatment of (SUD) with the (T_2) gave the higher significant value in the first season, but, in the second, treatment (SUD) with (T_1 and T_2) gave the higher significant values, table. (17).

Table (17) effect of irrigation systems, water amounts and their interaction on Nitrogen leaf content (%) of Florida prnice peach trees in 2012 and 2013 seasons.

Characters	Nitrogen leaf content (%)							
Season	**2012**				**2013**			
IS \ WT	**T_1**	**T_2**	**T_3**	**Mean**	**T_1**	**T_2**	**T_3**	**Mean**
SD	2.52cd	2.48d	2.41d	2.47B	2.4c	2.41c	2.24c	2.41C
SSD	2.56bcd	2.69a-d	2.46d	2.57B	2.52c	2.74ab	2.25c	2.59B
SUD	2.83ab	2.9a	2.53cd	2.76A	2.86a	2.95a	2.62bc	2.81A
SSUD	2.460d	2.80abc	2.52cd	2.6B	2.43c	2.81ab	2.49c	2.58B
Mean	2.59B\	2.72A\	2.48C\		2.55B\	2.73A\	2.51B\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

- P %:

In both seasons, concern the (SUD) treatment had the highest significant value. Regarding amounts of water applied (T_2) gave the highest significant value. The interaction between the two studied factors, showed that (SUD) with (T_2) had the highest significant value, table. (18).

Table (18) effect of irrigation systems, and water amounts and their interaction on Phosphorus leaf content (%) of Florida prnice peach trees in 2012 and 2013 seasons.

Characters	Phosphorus leaf content (%)							
Season	2012				2013			
IS \ WT	**T_1**	**T_2**	**T_3**	**Mean**	**T_1**	**T_2**	**T_3**	**Mean**
SD	0.103g	0.127f	0.103g	0.111C	0.107g	0.113g	0.103g	0.108D
SSD	0.190d	0.203cd	0.187d	0.193B	0.190ef	0.213cd	0.173f	0.192C
SUD	0.237b	0.267a	0.210c	0.238A	0.243b	0.290a	0.227bc	0.253A
SSUD	0.203cd	0.200cd	0.163e	0.189B	0.197de	0.230bc	0.187ef	0.204B
Mean	0.183B\	0.199A\	0.166C\		0.184B\	0.212A\	0.173C\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

- K%:

Regarding irrigation system, the (SUD and SSUD) had the highest significant values in the first season. But, in the second season the (SUD) gave higher significant value than first and second treatments. Concerning, amounts of water applied in both seasons, (T_2) gave the highest significant value. The interaction between the studied factors revealed that, treatment of (SUD) with (T_2) had the highest significant value table. (19).

Table (19) effect of irrigation systems, water amounts and their interaction on Potassium leaf content (%) of Florida prnice peach trees in 2012 and 2013 seasons.

Characters	Potassium leaf content (%)							
Season	2012				2013			
IS \ WT	**T_1**	**T_2**	**T_3**	**Mean**	**T_1**	**T_2**	**T_3**	**Mean**
SD	1.10de	1.12cde	1.11e	1.11C	1.11e	1.133de	1.12e	1.12C
SSD	1.167bc	1.187b	1.16bcde	1.17B	1.18cd	1.23bc	1.18cd	1.19B
SUD	1.2b	1.27a	1.163bcd	1.22A	1.23bc	1.29a	1.19bcd	1.24A
SSUD	1.19b	1.22ab	1.207b	1.21A	1.22bc	1.24ab	1.19bcd	1.21AB
Mean	1.17B\	1.2A\	1.16B\		1.18B\	1.23A\	1.168C\	

WT = Water treatments; **IS** = Irrigation systems

Means having the same letter (s) in each column, row and interaction are not significant at the 5 % level.

These results are in the same line with several reports as **Mohy (2011),** who found that leaf nitrogen and phosphorus content decreased significantly, by decreasing the level of water irrigation. While, irrigation by 100% or 75% field capacity resulted in the maximum level of potassium content.

- **Crop water use efficiency (CWUE) (kg/m^3).**

Irrigation is an important limiting factor of crop yield, because it is associated with many factors of plant environment, which influence growth and development. Availability of adequate amount of moisture at critical stages of plant growth not only optimizes the metabolic process in plant cells but also increases the effectiveness of the mineral nutrients applied to the crop. Consequently, any degree of water stress may produce deleterious effects on growth and yield of the crop **(Saif et al., 2003).** Surface irrigation method is the most widely used all over the world **(Mustafa et al., 2003).**

It's clear that the high gradation for CWUE under various water amounts, T_1 water treatment had a higher value than T_2 and T_3 under various drip irrigation systems. According to the used water amount, T1 saved more water by 40% than T2 that saved 20% especially at SSUD and SUD. The difference was clear when compared to SD and SSD drip irrigation systems. The difference was due to saving water and nutrients lost by deep-percolation and evaporation, according to (**Lubars, 2008**), allowing time for the plant to absorb nutrients and water beside have a good environment for the process of photosynthesis and respiration which reflects positively on the amount of crop. Fig. (5).

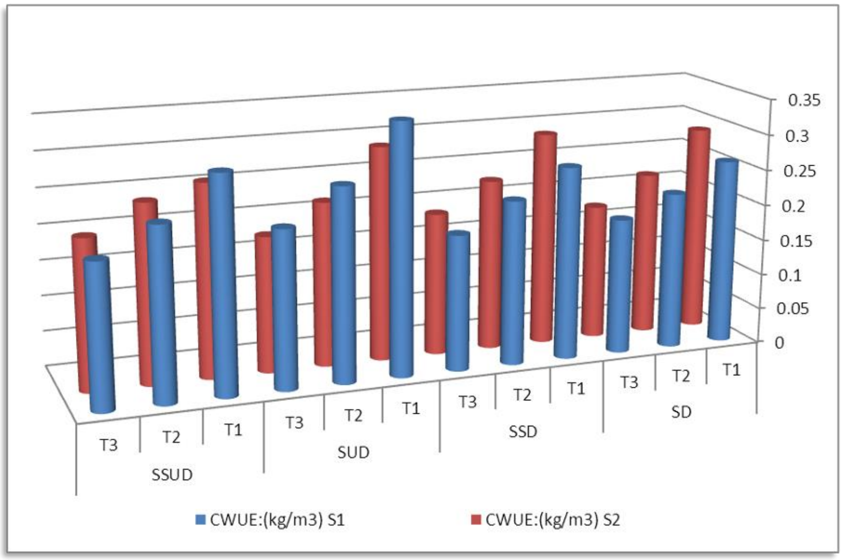


Fig. (5) Crop water use efficiency (kg/m^3), of water applied treatments, under SSUD, SUD, SSD and SD irrigation system.

Conclusion

Irrigation efficiency is an important engineering term that involves understanding soil and agronomic sciences to achieve the greatest benefit from irrigation. The enhanced understanding of irrigation efficiency can improve the beneficial use of limited and declining water resources which is needed to enhance crop and food production from irrigated lands. Ultra-low flow technologies are important methods of irrigation to water management that save it from loss by runoff in heavy soils or deep percolation in sandy soils.

There was a high gradation for CWUE under various water amounts; T_1 water treatment had a higher value than T_2 and T_3 under various drip irrigation systems. According to the used water amount, T1 saved more water that saved 40% than T2 by 20% specially at SSUD and SUD where the difference was clear when compared to SD and SSD drip irrigation systems.

Saving water and nutrient applied in sandy soil, can be saved up to 40% of irrigation water applied and so increasing quantity and quality of yield by good management and using ultra-low flow drip irrigation then having more total economical income.

In sandy soil, about 40% of irrigation water applied could be saved and increasing the quantity and quality of peach tree (like fruit physical characteristics and fruit chemical characteristics) by good management and using ultra-low flow drip irrigation. Also avoid the common problems which result from exceeded irrigation like water table rise, aqua fire pollution by loss of nutrients and chemical additions, nutrients and water loss by deep-percolation, non-ideal grow environment to plant due to non-maintain of air balance, and appearance of soil hardpan.

References

1. A.O.A.C. (1995). Official methods of analysis. 15th ed., Association of Official Agriculture Chemists Washington D.C., USA.
2. Abdou S. H, Hegazi, A. M. El-Gindy, and C. Sorlini, (2010). M. M, Performance of Ultra-Low Rate of Trickle Irrigation. Misr J. Ag. Eng., Irrigation and drainage, 27 (2): 549- 564
3. Abrisqueta, I.; L.M. Tapia,; W. Conejero,; M.I. Sanchez-Toribio,; J.M. Abrisqueta,; J. Vera, and M.C. Ruiz-Sanchez, (2010). Response of early peach (Prunus persica)] trees to deficit irrigation. (Special Issue: Solutions to the water deficit in agriculture.) Spanish Journal of Agricultural Research, 8(S2):30-39.
4. Abrisqueta, J. M., J. A. Franco and A. Ruiz Canales (2000). Water balance in apricot (*prunus armeniaca* L.CV. *Bulida*) under drip irrigation. Acta. Horticulture. 537.
5. Brown, J.O. and O. Lilleland, (1966): Rapid determination of potassium and sodium in plant material and soil extracts by Flamephotometery. Proc. Amer. Soc. Hort. Sci. 48:344-346.
6. Chapman, H. D. and P. F. Pratt, (1961). Methods of analysis for soil, plant and water. Div. of Agric. Sci. Univ. Calif., pp: 309. U.S.A.
7. Doorenobs, J. and W.O. Pruitt (1977). Guidelines for predicting crop water requirements .FAO Irrigation. and Drainage. Paper 24. Rome,Italy: p 156.
8. Elmesery. A. A. M. (2011). Water movement in soil under micro trickle irrigation system. Misr J. Ag. Eng., Irrigation and drainage, 28 (3): 590- 612

9. El-Seginy, A.M. (2006). Response of Canino apricot trees to different irrigation and potassium treatments. Alex. Sci. Exchange J., 27:64-75.
10. FAO (1984). Guidelines for predicting crop water requirements. FAO Irrigation and Drainage paper No.24.
11. Gelly, M.; Recasens, I.; Girona, J.; Mata, M.; Arbones, A.; Rufat, J. and Marsal, J. (2004). Effects of stage II and postharvest deficit irrigation on peach quality during maturation and after cold storage. Journal of the Science of Food and Agriculture, 84:561-568.
12. Gilead, G.(2012) (http://www.trickle-l.com/new/archives/uldi.html
13. Keller, J. and D. Karmeli (1975). Trickle irrigation design rain bird sprinkler manufacturing crop. Glendor Calfi, 91740 USA: 24-26.
14. Khattab, M.M.; A.E.Shaban,; A.H. El-Shrief, and A.S.E Mohamed. (2011). Growth and Productivity of Pomegranate Trees under Different Irrigation Levels. III: Leaf Pigments, Proline and Mineral Content. Journal of Horticultural Science & Ornamental Plants, 3(3):265-269.
15. Kobashi, K.; Gemma, H. and Iwahore, S. (2000). Abscisic acid content and sugar metabolism of peaches grown under water stress. Journal of the American Society for Horticultural Science, 125:425-428.
16. Layne, D.r.; D.B. Cox, and E.J. Hitzler, (2002). Peach systems trial: The influence of training system, tree density, rootstock, irrigation and fertility on growth and yield of young trees in South Carolina. Acta Hort., 592.
17. Lubars, P. (2008) http://www.scribd.com/doc/8145273/p13
18. Maria, S.; D. Cornel,; S. Viorel,; B. Ioana,; S. Şcheau Alexandru,; D. Cristian,; B. Radu,; G. Manuel, and V. Adrian, (2010). The influence of the irrigation on peach yield quality in the conditions from peach tree basin Oradea. Analele Universităţii din Oradea, Fascicula:Protecţia Mediului. XV.299-302.
19. Mead, R. (2002) http://www.americanfarm.com/signe%2010-01.htm1
20. Mercier, V.; C. Bussi,; F. Lescourret, and M. Genard, (2009). Effects of different irrigation regimes applied during the final stage of rapid growth on an early maturing peach cultivar. Irrigation Science, 27 (4):297-306.
21. Mohy, A.A. (2011). Effect of some water treatments on growth and chemical composition of almond transplants. M.Sc. thesis, Fac. Agric, Benha Univ., Egypt, 126p.
22. Mustafa et al., 2003 O.S. Mustafa, I.M. Arshad, S.A. Sattar. (2003) Adoption of kostiakof model to determine the soil infiltration for surface irrigation methods under local conditions International Journal of Agriculture and Biology, 1 (2003), pp. 40–42
23. Naor, A. (1999). Water stress and crop level interactions in relation to nectarine yield, fruit size distribution, and water potentials. J. Amer. Soc. Hort. Sci., 124(2):189–193.
24. Pliakoni, E.D. and G.D. Nanos, (2010). Deficit irrigation and reflective mulch effects on peach and nectarine fruit quality and storage ability. Acta Horticulturae, 877:215-222.
25. Pregel, F. (1945). Quantitive organic micro analysis. 4th Ed. J. A. Churchil Ltd., London, p.53.
26. Ranbir Singh; A.R. Bhandari, and B. C. Thakur, (2002). Effect of drip irrigation regimes and plastic mulch on fruit growth and yield of apricot (Prunus armeniaca). Indian Journal of Agricultural Sciences, 72(6):355-357.
27. Rawash, M. A.A., Zienab. H. Behairy Maryum. M. Hegazi and M. Mostfa (2000). Response of apple trees to some water treatments in new reclaimed soils. 6th International micro irrigation congress. Cape Town South Africa 22-27th October 1-8.
28. Rufat, J.; A. Arbones,; P. Villar,; X. Domingo,; M. Pascual, and J. M Villar,. (2010). Effects of irrigation and nitrogen fertilization on growth, yield and fruit quality parameters of peaches for processing. Acta Horticulturae, 868:87-94.
29. Saif et al., 2003 U. Saif, M. Maqsood, M. Farooq, S. Hussain, A. Habib (2003), Effect of planting patterns and different irrigation levels on yield and yield component of maize (*Zea mays*, L.) International Journal of Agriculture and Biology, 1 (2003), pp. 64–66
30. Snedecor, G. A and Cochran. (1980). Statistical methods. Oxford and J.B.H Bub Com. State Univ. press, Iowa U.S.A. 6th .Edition.
31. Sotiropoulos, T.; D. Kalfountzos,; I. Aleksiou,; S. Kotsopoulos, and N. Koutinas, (2010). Response of clingstone peach cultivar to regulated deficit irrigation. Sci. Agric. (Piracicaba, Braz.), 67(2):164-169.
32. Trooien, T. P., F. R. Lamm, L.R. Stone, M.Alam, D.H. Rogres, G.A.Clark, and A.J. Schlegel. (2000). Using subsurface drip irrigation with livestock wastewater. Proceedings of the 4th decennial Symposium, ASAE, Phoenix, 379-384.
33. Vietes, F.G. (1962). Fertilization and efficient of water. Advanced in Argon. 14:223-264.

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