EVALUATION OF USED EXUDATIVE IRRIGATION TUBES AND DRIP IRRIGATION FOR SOME SOIL WATER PARAMETERS AND CONSUMPTIVE USE OF CUCUMBER

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ABSTRACT

A field experiment was conducted during the spring season of 2017 at AL-Ramadi district, AL-Anbar Governorate, Iraq. The research was conducted in a silty Loam soil, to evaluate of the performance and used exudative irrigation tubes for previous season compared to drip irrigation in some hydraulic parameters: Irrigation systems, moisture distribution, Application efficiency cucumber crop factor of the and cucumber yield. The experiment was conducted according to randomized complete block design (RCBD) with three replicates. Results showed an increase in uniformity coefficient at drip irrigation as it reached 97% compared with 96.2% for exudation, with variation percentage of 8.33% for drip irrigation and 11.32% for irrigation of exudative. Moisture content decreased with distance from emitters horizontally for the three growth stages and irrigation methods. Cucumber water consumptive use was 356.32 mm for exudative irrigation compared with 456.6 mm for drip irrigation with decrease 21.96 %. Exudative irrigation method significantly increased in WUE as it reached to 15.29 kg m^{-3} compared with 13.13 kg m^{-3} for drip irrigation with an increase of 12.82%. The result showed an increment in irrigation efficiency giving 89.12% for drip irrigation compared with 85.88% for exudative irrigation with an increase 3.64%. The crop factor was 0.61, 0.66, 0.77, and 0.51 for the initial vegetative growth stage, second vegetative growth stage, start of flowering and fruit set and end flowering and fruit set respectively.

Key words: Exudation, drip irrigation, cucumis sativus, moisture distribution, water consumptive use.

تقييم أداء انابيب الري النضحي المستعملة والري بالتنقيط في بعض المعايير المائية للتربة والاستهلاك المائي للخيار

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المستخلص

نفذت تجربة حقلية خلال الموسم الربيعي 2017 في الرمادي / محافظة الأنبارفي تربة مزيجة غرينية بهدف تقييم أداء ومقارنة تأثير طريقة الري بالنضح والري بالتنقيط السطحي في بعض الصفات المائية، تقييم منظومات الري والتوزيع الرطوبي وكفاءة الإضافة وكفاءة استعمال الماء والاستهلاك المائي ومعامل محصول الخيار عند الري بالنضح وحاصل الخيار. نفذت التجربة على وفق تصميم القطاعات الكاملة المعشاة RCBD وبثلاثة مكررات. بينت النتائج ان معامل التجانس عند الري بالتنقيط بلغ 97% مقارنة بـ 96.2% عند الري بالنضح، اما نسبة التغاير فقد كانت 8.33% عند الري بالتنقيط و11.32 % عند الري بالنضح، ولوحظ انخفاض المحتوى الرطوبي للتربة كلما ابتعدنا عن المنقطات افقياً ولمراحل النمو الثلاث ولطريقتي الري، ان الاستهلاك المائي لمحصول الخيارعند الري بالنضح بلغ 356.32 مم مقارنة بـ 456.6 مم للري بالتنقيط بنسبة انخفاض مقدارها 21.96%. وقد ادى اتباع طريقة الري بالنضح الى زيادة معنوية في معدل كفاءة استعمال الماء إذ بلغ 15.29 كغم م$^{-3}$ مقارنة بـ 13.13 كغم م$^{-3}$ عند الري بالتنقيط بنسبة زيادة مقدارها 12.82 %، أما كفاءة إضافة المياه فكانت 89.12 % عند الري بالتنقيط مقارنة بـ 85.88 % عند الري بالنضح بزيادة 3.64 % تم الحصول على معامل المحصول ولأول مرة لمحصول الخيار عند الري بالنضح والذي كان 0.61، 0.66، 0.77 و 0.51 لمرحلة النمو الخضري الأولى، مرحلة النمو الخضري الثانية، مرحلة بداية التزهير وعقد الثمار ومرحلة نهاية التزهير وعقد الثمار، على الترتيب.

الكلمات المفتاحية: ناضحات، الري بالتنقيط، محصول الخيار، التوزيع الرطوبي، كفاءة استعمال الماء.

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INTRODUCTION

The world has seen in the last decades significant reached in a lot of good water as made it a real challenge for competitors to find the amount effective means to address this complex, the percentage of unusable brine for human consumption use has reached 97% which makes 1% fresh water is usable after deducting percentage of ground water (11). International institute for water management even put in expectation that one third of world population will live in areas of severe water scarcity at 2225 (10). Surely areas of arid and semi-arid climates would be the high affected, as well as high of population growth rates (29). The water problem is exist, but exist, and we have deal with how to use the water in agriculture and environment system, this from one hand, and also to see how the water effects on human activities as using a good quality of water in another hand (23). Researchers invented multiple ways to find solution of lack water complex continue keeping agriculture productivity of which use defect irrigation of all types (6), The use of drip irrigation system would be one of the important methods leads to rationalization of added water amount compared to traditional irrigation, the drip irrigation is known as adding water directly to the soil in a small quantities by emitters, The water added in quantity equivalent to evapotranspiration, move from these emitters horizontally and vertically in soil profile without big loss because the water applied less than range of infiltration rate in soil (27). The irrigation methods with high efficiencies applied to using irrigation water included drip irrigation, Irrigation efficiency has reached more than compared with the traditional method at conditions in middle of Iraq (2), the crop can be exposed to water stress during growth season or during limited growth stages would be high bearing to this stress and this can be provided quantities from irrigation water although it reduces the yield in a limited degree leading enter adding agriculture areas without necessary to provide a new sources to the water (20). The water management is one of suitable way in arid and semi-arid areas, and it is an excellent style in controlling the amount of water according to needs of soil and plants during the growth stages to reach a high productivity. In a fewer losses of water, one of most prominent methods is the add style using the drip irrigation, it`s one of the new management styles to add the net irrigation depth, using the half-add or fragmentation of net irrigation depth into two parts separate then equal intervals to control the water losses in the side bar soil, as well as reduce the loss of water from the soil by evaporation during keeping a part from irrigate depth to times may be evaporation rate on soil surface be low, so can be reducing the risk of high moisture stresses on the plant, and to increase the efficiency of the water unit, partial addition style's benefit is lie in keeping humidity for ages in the root zone (3). As for the irrigation of exudation method it is from the ways that it is old in its meaning, modern by its development and its original home in middle of Asia, excepted agriculture lands area irrigated in this way represents a small part as for the area that irrigated in the traditional irrigation, because their need to specific natural conditions for success may not be available sometime, one of material used in this method is the irrigation exudation (16). the existence of exudation in the markets in a cheap prices and local made are considered on encouraging factor to this method, one of the main advantages of this method and may be make it in the forefront of irrigation methods because it doesn't need commitment or monitoring of irrigation dates, that is the irrigate continuous maturity from the beginning of the season even to be end, and may be away to the agriculture and gypsiferous soils and one of the modern ways to water codified (7). The aim of this research is to compare the performance of used exudative irrigation tubes and surface drip irrigation in some soil water parameters and consumptive water use of cucumber plant.

Materials and methods

A field experiment was carried out at Ramadi district, Al-Anbar Governorate, Iraq. At spring season 2017 to evaluate of used exudations performance and compare it with surface drip irrigation in some soil water parameters and water consumption of cucumber crop. A samples taken from study site of depth 0-30 cm and dried aerobic then crushed and passed in sieve it's diameter slots 2 mm. Some soil properties (Table 1 and 2) were determined according to methods described in black (1965) and page *etal* (1982). The field was plowed by plough plow, smoothing and adjustment it then divided the field into three blocks each of them contains two treatments the distance between them 2.25 m, and randomized complete block design (RCBD) (8).

Table1. Some physical soil properties

Property	Units	Value
Sand		440
Silt	g kg $^{-1}$	512
Clay		48
Soil texture		Silty loam
Bulk density	Mgm m^{-3}	1.19
Particle density		2.60
Porosity		54.23
Moisture content at 33kps	%	35.02
Moisture content at 1500 kps		12.10
Available water		22.92

cucumber seeds (Beit alpha) American and the seedling were transferred to the field on 30/3/2017 at formation of two real leaf's stage (25), transplanting on one side from emitter and exudations at distance of 10 cm, crop management services were done to disease control of which combat the fusarium wilt by pesticide "DEVIMIL MZ 72%" and the absorbent insects By pesticide "Chemex DP 1%", the jungles combat manually done and chemical fertilizers added according the fertilizer recommendation (25).

Table 2. Some chemical soil properties

Property	Units	Value
$_pH$	-	7.30
EC	dSm^{-1}	1.70
Ca^{+2}		7.61
Mg^{+2}		6.12
Na^{+}		3.10
K^{+}	meq L^{-1}	0.17
Cl^{-}		0.20
SO_4^{-2}		13.90
CO_3^{-2}		Nil
HCO^{-}		2.90

Components of Irrigation systems

The system is composed from water tank (capacity 273 liter) installed on it a transparent plastic tube with a tape measure to calculate the quantity of water consumed daily from the tank to the exudations, main delivery tube, hydrant to tie the part of the main delivery tube with lateral lines, connecter of plastic with plastic rings with a silicone, exudation machine was made in Baghdad at the same time and so on avoid the difference in temperature and the exudation period and therefore difference in the discharge, and the exceptions of it were excluded whether increase or decrease in the discharge, as in figure (1), as for the irrigation system for surface drip consists of water tank (capacity 2000 liter), water pump, operational pressure gage, main line, sub-lines 16 mm and emitters with discharge 4 Lh^{-1} type "Turbo".

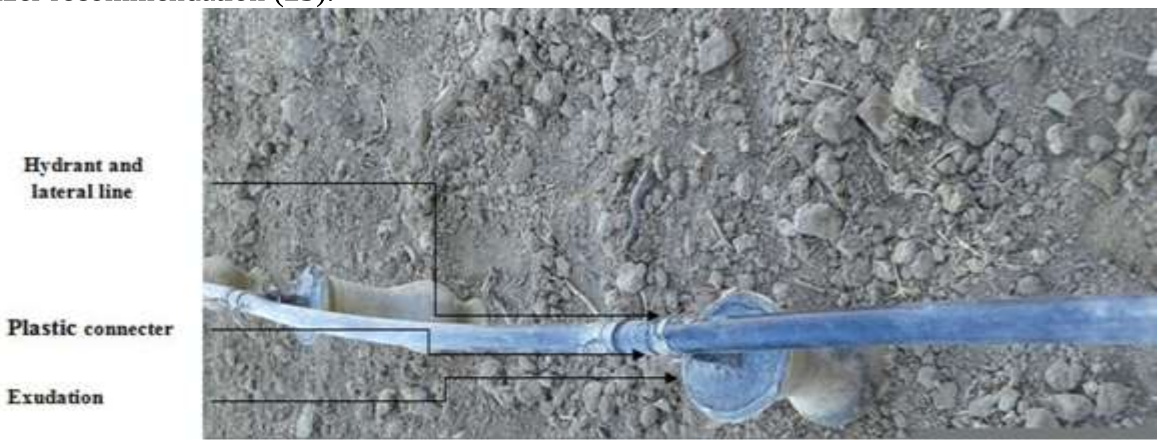


Figure 1. Part from irrigation of exudation system before burying the exudations

Calibration of drip irrigation systems and exudative irrigation

Drip irrigation system evaluation was done before cultivation to choose the best operational pressure to adopt it during the season, under three operational pressures 30, 40, 50 kps, pressure was measured by mechanical gage and parameters used in the evaluation were:

1. **Emitters discharge**: the discharge was measured for a system's emitters of type Turbo using a group of cans (capacity 1 liter), it was put down the emitters with time valued 15 min and discharge was transferred into unit Lh^{-1} and so on the emitters discharge was found as a range for the three lines 4 Lh^{-1} at operational pressure 40 kps.

2. Uniformity coefficient: the uniformity coefficient was calculated depending on actual discharge 4 Lh^{-1} at operational pressure 40 kps to give it the best uniformity coefficient (13):

$$CU = 100[1 - \frac{\sum X}{Mn}] - - - (1)$$

Where

CU: Uniformity coefficient (%).

ΣX: Total deviations from discharges rate (Lh^{-1}).

M: Average discharge of emitters (Lh^{-1}).

n: Number of emitters

3. Variation percentage between emitters: the variation percentage was calculated according to the suggested equation by Wu and Gitlin (28):

$$q\,\text{var} = \frac{q\max - q\min}{q\max} \times 100 - - - - (2)$$

Where

qnet: variation percentage discharges of emitters (Lh^{-1}).

q_{max}: high discharge of emitters (Lh^{-1}).

q_{min}: low discharge of emitters (Lh^{-1}).

When the value of variation percentage is less or equal 10% it is favorite be acceptable when it is between 10-20%, and if it exceeded 20% it would consider unacceptable. As for the exudative irrigation the uniformity coefficient has been calculated and variation percentage in discharge of exudation would be follow all the ways mentioned above except for putting the exudations in a plastic bags and record water volume at a certain time and the three lines excluded the irregular exudations with the less or high discharge. The discharge was controlled by raising or lowering the tank to get the required discharge from the exudations that changes according to the water consumption reverse the drip irrigation state, as the discharge is constant and the time changes and the obtained discharge from the tank during calibration of the system was at high 1m.

Moisture distribution

The moisture distribution was estimated for the root zone in three stages: the initial vegetative growth stage, moisture distributions were the second vegetative growth stage with differences of the root zone depth and moisture distributions were the stage of flowering and fruits set to change in the crop factor and difference the irrigation time, and that by taking soil samples and in two towards horizontal 15,30,45 cm from emitter and vertical on depths 20,40 cm from soil surface, and the samples taken after 24 hour of irrigation.

The irrigation and water consumption

The drip irrigation operation was done according to 50% depletion from available water and correcting root depth with growth stage (Table 3).

Table 3. Depth of roots and stage dates depending of growth stages for cucumber crop

Growth stage	Depth (cm)	Stage period (day)	dates
1- Initial vegetative growth	10	20	30/3 - 18/4/2017
2- Second vegetative growth	15	13	19/4 - 1/5/2017
	20	12	2/5 – 13/5/2017
3- The start flowering and fruits set	30	20	14/5 – 2/6/2017
4- The end flowering fruits set	30	15	3/6 – 17/6/2017

The added water depth was calculated depending on the equation that mentioned (18):

$$d = \frac{WFc - Ww}{100}\rho bD - - - - - - - - (3)$$

Where

d: the depth of water to be added (cm).

WFC: Moisture content at F.C (%).

Ww: Available moist before irrigation (%).

pb: bulk density (Meq m^{-3}).

D: depth of root zone (cm).

As for the irrigation scheduling for growth season in drip irrigation state it was calculated depending measure the evaporation pan type A, and the pan factor was used 0.77 (22), while crop factor used according to the growth stages, as it was 0.80 initial vegetative growth stage, 0.95 second vegetative growth stage to the end of the flowering start and fruits set stage, and 0.75 end of flowering and fruits set stage (15), The efficiency of irrigation used was 0.86 (9), and was calculated as:

$$ETa = ETo \times Kc \rightarrow ETo = \frac{ETa(d)}{Kc} - - - - - - - - (4)$$

$$ETo = Ep \times Kp \rightarrow Ep = \frac{ETo}{Kp} --------(5)$$

Where:
ET_o: evapotranspiration potential (mm day^{-1}).
ET_a: actual evapotranspiration (mm day^{-1}).
Kp: pan factor.
E_{pan}: evaporation from pan (mm).
Kc: crop factor

When evaporation arrives from evaporation pan to the product number from equation above the irrigated would be done, as for the estimated of daily water consumption at irrigation of exudation and compensate it by daily exudation quantity it has been during the calibration according that consumption estimate from evaporation pan and then catching the operational pressure for the exudations at the beginning of each stage commensurate with the daily discharge required of this exudations.

Water Use Efficiency (WUE)

Water use efficiency was estimated according to the suggested equation by Craicum (14):

$$WUE = \frac{Y}{WA} --------(6)$$

Where:
WUE: water use efficiency (kg m^{-3}).
Y: yield (kg).
WA: water added (m^3).

Water Application Efficiency

Water applied efficiency was calculated at the drip irrigation according to equation (9):

$$Ea = \frac{Ws}{Wf} \times 100 ---(7)$$

Where:
Ea: Water application efficiency (%).
Ws: quantity of water stored at root zone (m^3).
Wf: quantity of water reached to the field (m^3).

Crop Factor

Crop factor of cucumber was calculated at exudative irrigation for the first time according to the equation of water consumption

RESULTS AND DISCUSSION

Calibration of irrigation systems

Table 4 shows the effect of operational pressure 40 kps for drip irrigation system in discharge rate of emitters and uniformity coefficient and variation percentage, as the discharge rate of emitters and the three lines 4 Lh^{-1}, while it was obtained an uniformity coefficient amount 97% and variation percentage between emitters 8.33% and this percentage is within the preferred and this agree with (5, 19). As for exudative irrigation. Table 5 shows effect of operational pressure at a height of 1m for the tank in rate of exudations discharge which is changing according to water consumption of the plant, uniformity coefficient and variation percentage between exudations, as the uniformity coefficient reached 96.2% and variation percentage between exudations 11.32%, That can be seen whenever the uniformity coefficient increased the variation percentage decreased between emitters and exudations that is the relationship is inverse.

Table4. Effect of operational pressure at 40 kps for drip irrigation system in discharge rate and uniformity coefficient and variation percentage

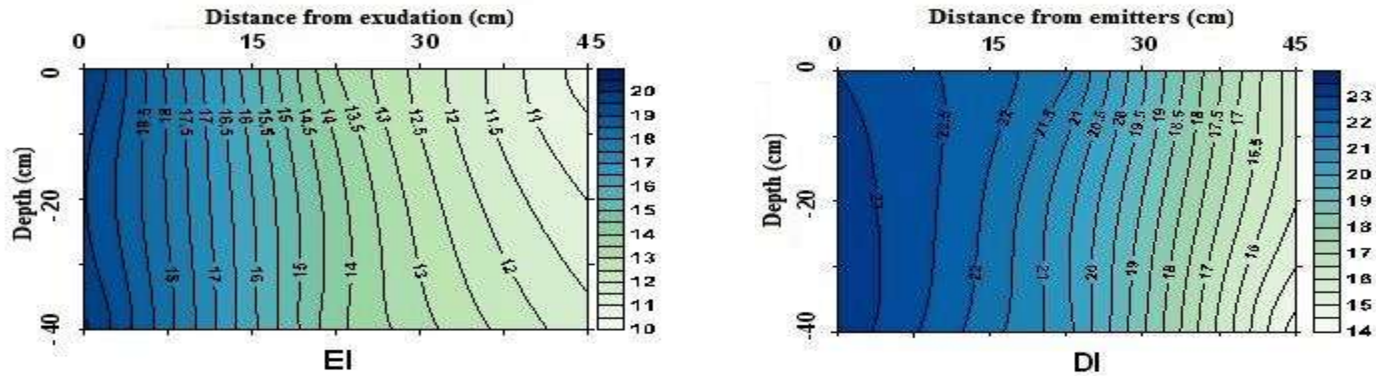
Discharge Rate (Lh^{-1})	Observation	Discharge Rate*Replication	Numerical deviation (Lh^{-1})	Numeral deviation * Replication	Application of Christiansen equation and Wu and Gtilin
4.20	2	8.4	0.20	0.40	
3.90	3	11.7	0.10	0.30	$CU = 100[1 - \frac{\sum X}{Mn}]$
4.00	1	4.0	0.00	0.00	$CU = 100[1 - \frac{1.2}{4 \times 10}]$ $CU = 97\%$
4.10	2	8.2	0.10	0.20	
3.85	2	7.7	0.15	0.30	$q\,var = \frac{q\max - q\min}{q\max} \times 100$
	N = 10	M=40/10=4		∑X=1.2	$q\,var = \frac{4.20 - 3.85}{4.20} \times 100$ $q\,var = 8.33\%$

Table 5. Effect of operational pressure at height 1m for exudative irrigation system in discharge rate and uniformity coefficient and variation percentage

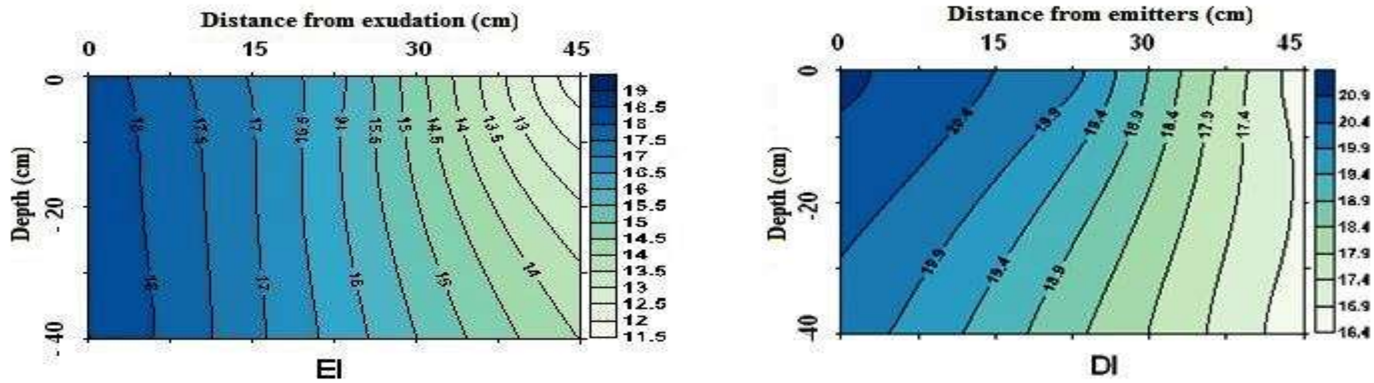
Discharge Rate (Lh^{-1})	Observation	Discharge Rate*Replication	Numerical deviation (Lh^{-1})	Numeral deviation * Replication	Application of Christiansen equation and Gtilin and Wu
0.106	1	0.106	0.0049	0.0049	$CU = 100[1 - \frac{\sum X}{Mn}]$
0.094	1	0.094	0.0071	0.0071	
0.105	2	0.210	0.0039	0.0078	$CU = 100[1 - \frac{0.0388}{0.1011 \times 10}]$
0.103	2	0.206	0.0019	0.0038	$CU = 96.2\%$
0.097	1	0.097	0.0041	0.0041	$q\,\mathrm{var} = \frac{q\max - q\min}{q\max} \times 100$
0.098	1	0.098	0.0031	0.0031	
0.104	1	0.104	0.0029	0.0029	$q\,\mathrm{var} = \frac{0.106 - 0.094}{0.106} \times 100$
0.096	1	0.096	0.0051	0.0051	$q\,\mathrm{var} = 11.32\%$
	N =10	$M = \frac{1.011}{10} = 0.1011$		$\Sigma = 0.0388$	

Moisture distribution for the soil under drip irrigation system

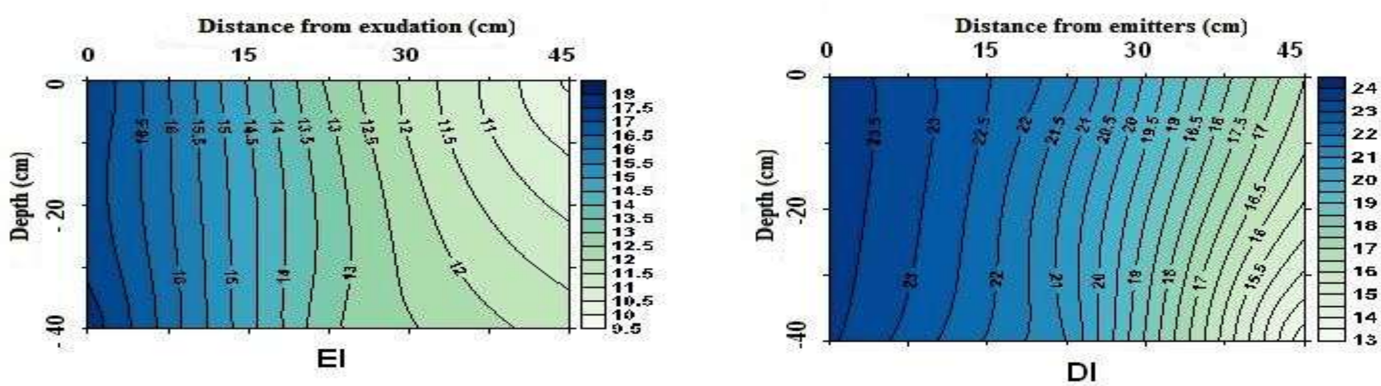
Figure 2 shows treatments effect on moisture distribution for depth 20, 40 cm and for dimensions 15, 30, 45 cm on dripping sources for surface drip irrigation and exudative irrigation after 24 hour from the irrigated operation and for all growth stages of cucumber crop at drip irrigation. As for the exudative irrigation, water flow throughout the growing season. Results showed that moisture content decreased vertically and horizontally away from the drip source. The gradient in soil moisture content may be by keeping away from the emitter in the vertical and horizontal direction back to water movement depending the hydraulic gradient that arising from difference in tension soil moisture between nearby and far points from the emitter, that is the tension increase with the distance from the emitter, added to that the effect of the gravity potential in wetting region. These findings agreed with the findings of other researchers (4, 12). The moisture content was higher at depth 0-20 cm at surface drip irrigation, while at exudative irrigation the moisture content higher was at depth 20-40 cm.



Initial vegetative growth stage



Moisture rate of second vegetative growth stage



Moisture rate of flowering and fruit set stages

Figure 2. Moisture distribution for growth stages of cucumber crop

Cucumber Water consumption

Table 6 and 7 show water consumptive use of cucumber was 356.32mm and 456.6 mm for exudation and drip irrigation, respectively. That as a percentage amount 22%, it was found that added water depth for the first vegetative growth stage at drip irrigation was 81.7 mm then increased in the following stages with an increase in the vegetative growth and rising temperatures then decreased in the end of flowering stage and fruit set as it reached 95 mm and the reason back to low plant need for water to complete the composition its tissues, cells and drought a rate from its parts and this agreed with Abd-Gabbar (1). As for exudative irrigation, it the added water depth at the initial vegetative growth stage was 59.5 mm and increased in the following stages then decreased in the end of flowering stage and fruit set as it reached 70.55 mm and for the same reason above and this agreed with Al-Obeid and Saad (7).

Table 6. Added water depth, roots depth and number of irrigation according to growth stage at drip irrigation

Growth stage	Number of irrigation	Added water depth (mm)	Depth of roots adopted during growth stages (cm)
Initial vegetative growth stage	4	71.7+10 Rain	10
Second vegetative growth stage	3	71.4	15
	2	63+3 Rain	20
The start of flowering and fruit set stage	3	142.5	30
The end of flowering and fruit set stage	2	95	30

Table 7. Calculate the depth water added at exudative irrigation

Growth stage	Irrigation area (cm^2)	Volume of added water (cm^3)	Depth of added water(mm)
Initial vegetative growth stage	58875	291720	49.5 +10Rain
Second vegetative growth stage	58875	541650	92 +3Rain
The start of flowering and fruit set sage	58875	769496.25	130.70
The end of flowering and fruit set stage	58875	415363.12	70.55

Water Application Efficiency

Table 8 shows water application efficiency for drip irrigation and at exudative irrigation, as it reached at drip irrigation 89.12% and may be the reason for this is due to decreased runoff and this agree with the findings of Slatni (26), while at the irrigation of exudation it reached 85.88% and may be the reason back to a decrease during depended stage which is not enough to water consumption for the plant so it compensated from stored water in the soil at field capacity which led to decrease this storage over time relative to the added water. As for its calculated, it's different from what is usual in irrigation methods because of continued exudation throughout growth period, as in the following example:

The first stage:

$Vs = d\pi r^2$

Vs: Volume of soil circle

d = Root zone depth (cm)

π = Constant ratio

r = Radius of circle (cm)

$Vs = 10 \times 3.14 \times 625 = 19625\ cm^3$

Moisture content at field capacity (Pwfc) 35.02%, bulk density 1.19 $Meqm^{-3}$ (pb)

Volumetric moisture at field capacity (Vwfc).

$Vwfc = Mf.c \times Pb \rightarrow 35.02 \times 1.19 = 41.67\%$

Water volume at field capacity (Vwfc).

$Vwfc = Vs \times \theta f.c \rightarrow 19625 \times 0.417 = 8183.63\ cm^3$

Volumetric moisture for the first distance from emitter:

$12.5\ cm = 23.3 \times 1.19 = 27.73$

Volumetric moisture for the second distance from emitter

$25\ cm = 18 \times 1.19 = 21.42$

Rate of volumetric moisture for the two distances (PVav):

$27.73 + 21.42 = 49.15 / 2 = 24.58\%$

Porosity percentage at exudative irrigation for depth 20 cm (50.38%) and it represents saturation ratio at the exudation.

Volumetric moisture rate for the circle from exudation even end of circle (PVav): 50.38+24.58 = 74.96/2 = 37.48%.

Water volume in the soil circle (Vws).=

Vws = Vs×PVav → 19625×0.375 = 7359.38 cm^3

=Water applied efficiency (Ea) for the initial stage:

$Ea= \frac{Vws}{Vwfc} = \frac{7359.38}{8183.63} \times 100 = 89.93\%$

Same ways are followed for the other growth stages

Rate of water volume in soil circle for the three growth stages respectively:

7359.38+14522.5+20311 = 42192.88/3 = 14064.29 cm^3

Rate of water volume at field capacity for the three growth stages respectively:

8183.63+16397.25+24550.88 = 49131.76/3 = 16377.25 cm^3

Water applied efficiency (Ea) for all stages:

$Ea = \frac{14064.29}{16377.25} \times 100 = 85.88\ \%$.

Table 8. Water applied efficiency at drip irrigation and exudative irrigation

Irrigation treatments	Depth rate of the stored water for a one irrigate from each stage(cm)	Depth rate of the added water for a one irrigate from each stage(cm)	Irrigation efficiency (%)
Drip irrigation	**2.825**	**3.17**	**89.12**
	Rate of water volume in the soil circle for a three stages	**Rate of water volume at field capacity for three stages**	
Exudative irrigation	**14064.25**	**16377.25**	**85.88**

Water Productivity

Table 9 shows effect of surface drip irrigation and irrigation of exudation on water use efficiency and the results of Duncan statistical analysis indicate significant differences in water use efficiency, as the rate of water use efficiency at irrigation of exudation reached 15.29 kg m^{-3} compared to 13.33 kg m^{-3} at drip irrigation of an increase rate amount 12.82% although the total yield at the drip irrigation is higher than exudative irrigation but the depth of added water is less at irrigation of exudation, that is the relationship is inverse and this agree with the findings of Al-Obaeid and Saad (7).

Table 9. Effect of drip irrigation and exudative irrigation on water use on water use efficiency

Irrigation treatments	Yield (kg ha^{-1})	Water volume (m^3 ha^{-1})	Water use efficiency (kg m^{-3})
Drip irrigation	**10666.8**	**800**	**13.33 a**
Exudative irrigation	**9511.25**	**622.23**	**15.29 b**

Crop factor for exudative irrigation

Table 10 shows how to calculate the crop factor at exudative irrigation, as noted that the crop factor changed according to growth stages which linked to the water consumption of plant and that was 0.16, 0.66, 0.77, 0.51 for the initial vegetative growth stage, second vegetative growth stage, the beginning of the flowering stage and fruit set, the end of the flowering stage and fruit set, respectively. It was found increased the exudation rate with lack of moisture content in the root zone and that clearly appeared when the temporary wilting didn't show on the irrigated plants in this method as much as it has been exposed to plants of the drip irrigation, crop factor was calculated through the actual daily water consumption (ETc), rate of daily evaporation from American evaporation on pan type A and length of growth stage, the nature of the curve of these values agree in general with the reading of a number from researchers, including Abd-Gabbar (1) and Proffitt *etal*.(24).

Table10. Calculation of crop factor by exudative irrigation method

Growth stages	Ep (mm day^{-1})	Ep (mm $stage^{-1}$)	Kp	ETo (mm $stage^{-1}$)	ETa (mm $stage^{-1}$)	
Initial vegetative growth stage	**6.30**	**126.00**	**0.77**	**97.02**	**59.20**	**0.61**
Second vegetative growth stage	**7.50**	**187.50**	**0.77**	**144.38**	**95.30**	**0.66**
The start of flowering and fruit set stage	**11.03**	**220.60**	**0.77**	**169.90**	**130.82**	**0.77**
The end of flowering and fruit set stage	**12.07**	**181.05**	**0.77**	**139.41**	**71.00**	**0.51**

Conclusions

It can be concluded from these results that the use of the same tubes for exudative irrigation performed well and it gave an water was enough to give a yield with an insignificant difference compared to drip irrigation, although the operational pressure for this exudation was lower than 1 m.

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