EFFECT OF IRRIGATION SYSTEMS ON LETTUCE CROP

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ABSTRACT

Field experiment were executed at Gemmiza Agricultural Research Station during season 2009 /2010, to study effect of irrigation systems, drip (surface and subsurface) irrigation and traditional irrigation. Levels of nitrogen fertilizer inputs and row width on lettuce fresh weight (gm) , lettuce fresh tall (cm) , The objectives of study are evaluation trickle irrigation systems on lettuce crop. Surface drip (DI), subsurface drip irrigation(SDI) compared with surface irrigation (SI) and the interactions of water and nitrogen fertilizer inputs on crop yield and quality

The effect of irrigation systems, the results indicated that .increase the lettuce fresh weight (gm) , lettuce fresh tall (cm) , number of fresh leaf, lettuce stem weight (gm) and lettuce stem tall(cm). By using subsurface irrigation (SDI) by 5,42 %; 28.43 %; 5.77 % ; 15.73 % ; 13.20 % ;33.72 %; 13,03 ; 14.39 % and 33.62 % compared with surface drip (DI)and surface irrigation ((SI) systems resp.

The highest values were on double row under subsurface drip irrigation, the values were 570.01; 33.60; 49.00; 260.95 and 15.01 resp.

The data revealed that, the highest values of lettuce fresh weight (gm) , lettuce fresh tall (cm) , number of fresh leaf, lettuce stem weight (gm) and lettuce stem tall (cm). under double row and by using 45 u N/ fed., the values were 709.92;, 34.70 ; 51.07; 283.78 and 16,17 resp.

The highest values of crops and field water use efficiency (2271.58 kg and 2.40 kg/ m^3) were obtained under subsurface trickle irrigation system. While the modified furrow irrigation system treatment induced the lowest values (1768.75 kg and 1.31 kg/ m^3).

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INTRODUCTION

The water requirement of a given crop is represented by its evapotranspiration (ETc), basically defined as the rate of transfer of water vapor from plant and soil surfaces to atmosphere. This is a key element for the implementation of irrigation management strategies for crop production at both farm and irrigation scheme levels and for the study of leaching of agrochemicals towards ground waters. In the agricultural areas of Arizona, irrigation plays an essential role in the production of grains, cotton, fruits, alfalfa, and vegetables **(Irrigation Journal, 2001) Barber and Raine (2002)** .reported that Soil-water availability is a major determinant of crop yield and is often highly correlated with the uniformity of irrigation application. Uneven watering has been found to affect crop growth for a range of crops including cauliflower and lettuce **Fox et al. (1992)** incorporated the lettuce water use data from **Erie et al. (1965)** into the AZSCHED (AriZona SCHEDuling) irrigation program. The estimates of head lettuce ET obtained by **Erie et al. (1965)** were based on gravimetric measurements of soil water content in furrow-irrigated lettuce fields. They concluded that the crop seasonal water use was about 216 mm for a three and a half month growing season with time of planting around September 15. The peak water use was observed to occur in the head development stage and they also showed that 56% of seasonal soil moisture depletion by crop water use occurred in the top 30 cm. More recently**.**

Gallardo et al. (1996) and **Grattan et al. (1998)** reported that, Surface irrigation is still the most widely used method for irrigating lettuce in the US. But pressurized irrigation systems like sprinkler and subsurface drip have gained a lot of importance due to their ability to achieve higher irrigation efficiency and uniformity when compared to traditional surface systems. Considering the facts related to the importance of the drip irrigation systems for crop production in arid and semi-arid areas and the lack of more updated information on lettuce water use in Arizona grown under that irrigation method, a field study was conducted to determine the seasonal water use of subsurface-drip irrigated lettuce and to derive crop coefficients to be used in irrigation scheduling programs.

(Titley 2000). This paper considers if modifications to SDI can improve the establishment of lettuce which SDI depends on capillary water movement from buried emitter to seedlings, evaporation, soil texture, structure and hydraulic conductivity of soil. Bed shape, number of tapes per bed and tape depth can also be important when establishing with SDI . **Nassar and Aou ElAzem (2006)** concluded that the subsurface trickle system treatment had singnicantly favored total fresh yield comparing with trickle and modified furrow treatments . The total fresh yields were 1660 .0 ,1260 .0and 930.0 kg /fed . with irrigation by subsurface trickle ,surface trickle and modified furrow irrigation systems treatments resp.

Also ,the subsurface treatment exhibited sufficient available water in the soil layers , where the plants consumed most of water demand as well as surface trickle treatment ,followed by modified furrow treatment .Moreover, the highest water application efficiency 92.67 %was recorded by subsurface trickle irrigation system treatment .Also, this treatment gave the highest water application efficiency .

Phone et al. (1993) reported that many commercial crops irrigated by subsurface trickle include tomato ,potato cantaloupe ,strawberry , lettuce ,cotton , sugarcane ,grapes , hips ,apple . They also demonstrated hat the subsurface trickle maximized water use efficiency and yield of these crops ,reduced evaporation at the soil surface and maintained constant soil water and cased upward hydraulic to minimize deep percolation and NO3 N leaching .

Ghali and Svehlik (1988).Plants responded to both increased crop factor (CF), that is increased irrigation amount, and irrigation frequency (IF). However, for every combination of CF and IF, the growth of plants with modified SDI was greater than with conventional SDI. To maintain an optimal soil water regime on sandy soils, short, frequent pulses of water were required More frequent water application through SDI. Was also better in work reported by **El-Gindy and El-Araby (1996)** and **Silber et al. (2003).** Whilst the present results agree with the earlier findings on 'pulse irrigation', also showed that with a modified SDI either fewer pulses, or less irrigation water, may be used to achieve a similar results. Further work is needed to quantify this and develop management guidelines.

Thomas et al (2002) Maximum marketable broccoli yields occurred at N rates of 300 to 500 kg ha^{-1}. There were no SWT x N interactions for marketable yield, and very f

Stivers et al. (1993) reported that Western broccoli growers may apply as much as 400 kg N ha^{-1}. Other researchers have noted a positive broccoli yield response to N rates

El Farrah (2001) showed that sorghum growth increased under subsurface drip line compared with surface drip line irrigation. Spinach gave a similar trend of enhanced growth with optimum drip line depth of 20 cm .

Lamm ,et al . (1995) repotted that, careful management of subsurface drip irrigation systems reduced net irrigation needs by nearly 25 %while still maintaining top yields of 12-15 t /ha. Soil type drip line installation depth, crop type and reliability and amount of in- season precipitation are the major factors which determine the maximum spacing.

MATERIALS AND METHOD

The field experiments were performed at Gemmeza Agricultural Research Station Farm (Gharbeia Government) inseason2009-2010(4mouths)to study the effect of the irrigation systems (surface ;subsurface drip compared with furrow irrigation) ;width of row (60 and 120 cm with planted on each side) ; nitrogen rates on amount of irrigation water ; water use efficiency and yield of lettuce. The soil of the experiment site is clayey in texture and particle size distribution and some of soil water constants are shown in Table (1)

Table (1) :Mechanical analysis and some soil moisture contents of the studied soil experimental.

Depth cm	Fine sand%	Coarse sand%	Silt%	Clay%	Soil texture	F C.%	W.P.%
0-15	3.7	20.3	26.3	49.7	Clay	42.50	21.10
15-30	3.6	20.55	27.30	48.45	Clay	42.90	20.70
30-45	3.65	20.55	28.25	47.55	Clay	43.60	21.90
45-60	4.25	20.75	28.45	46.55	Clay	44.00	22.30

The transplanting date of lettuce seedlings were 21 of December 2009, by using surface irrigation, transplanting at 25 cm between seedlings, the

area of experiment 120 x 18 m divided to three replicates each one 40 x 18 m, the distance between lateral 60 cm and its long 18 m. surface(DI); subsurface drip irrigation (SDI) put at depth 15 cm , both drip types used 2 L / h emitters at 50 cm spacing as shown in fig. (1) .

Fig. (1) illustrated layout of experimental field of lettuce .

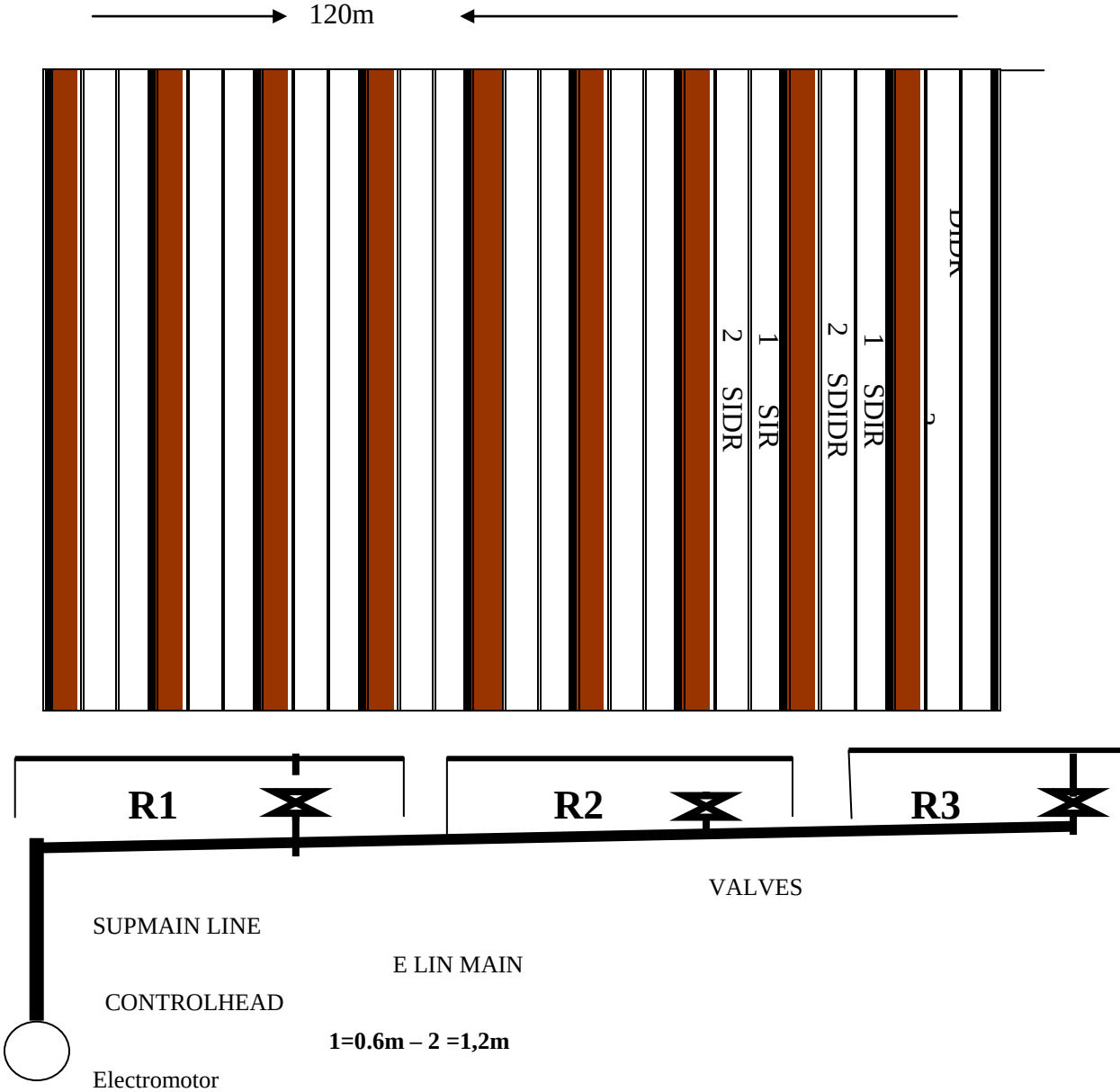

Fig. (1):Layout of experimental field of lettuce (120m x20m)

General agronomic management ensured conditions were favorable to plant growth.

Were controlled before field preparations by spraying HarbaZ 48%

(1L/fed.); weeds Fertilizers were ten days after transplanting

The adopted treatments were arranged in split split – plot experimental design with 3 replicates as follows.

Main – plot (irrigation system)

1 - subsurface drip irrigation (SDI)

2 – Surface drip irrigation (DI)

3 - Surface irrigation (SI)

Sub main – plot (width of row)

1 - width of row 60 cm with transplanting at mid row (R)

2- Width of row 120 cm with transplanting on each side (Dr)

Sub –sub main –plot (nitrogen rates)

1 - fertilizer by 15 u N /fed .

2 - fertilizer by 30 u N/ fed.

3- fertilizer by 45 u N/ fed .

At harvest in March 2010 average fresh weigh (gm), fresh tall (cm) ,number of leave ,stem weigh (gm)and stem tall (cm) of area m^2

2.1 -Irrigation water calculations:

2. 1. 1- Furrow irrigation

The irrigation water was supplied through a circular orifice of 10 cm diameter and its discharge rate was calculated by using the equation of James (1988) as follows:

$Q = 0.61\ KAH^{1/2}$ **1**

Where,

Q = orifice discharge (l/s)

A = the area of orifice opening (cm^2)

H = head, (m)

K = unit constant. (K = 0.443 for Q in l/s, A in cm^2, and H in m)

2 1.2 .drip irrigation.

* Pan evaporation management.

Reference evapotranspiration (ETo) was calculated according to (Doorenbos and Prutt (1977): as follow:

ETo = Kp x Epan **2**

Where :

ETo = reference evapotranspiration (mm / day)

Kp = pan coefficient

Epan = pan evaporation (mm)

Eta crop = ETo x kc **3**

Where:

ETa crop = crop consumptive use (mm/day).

Kc = crop coefficient, (dimension less).

The agro climatology data for Gambia Governorate ETo mm / day , Kc of lettuce and ETa mm / day, as shown in table (2) .

Table (2) : values for Kc , Eto and Eta mm /day for the location of Kator .

Months.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.
Kc	0.75	1.0	0.95					
Eto.	1.54	2.39	3.52					
Eta	1.25	3.6	4.28					

2.1.3- Leaching requirements

Leaching requirement (LR) estimated according to (Doorenbos and pruit,1977) by the following equation.

$$LR = \frac{ECw}{Max\ ECe - ECw} \quad \textbf{4}$$

where:

ECw = electrical conductivity of irrigation water, dS/m.

ECe = electrical conductivity of the soil saturation extract dS/m.

Max ECe = maximum tolerable electrical conductivity of the soil saturation extract.

$$QS = \frac{D \times A}{H \times EA} \quad \textbf{5}$$

Where:

QS = is the supply rate in l/h

D = depth rate irrigation water requirement in mm/day

A = area being irrigated in m^2.

H = net irrigation operational time in h/day

Ea = application efficiency.

2.2 Fresh Yield:

Lettuce fresh wt. (kg), calculated the yield per Fadden.

2. 2.1 Water use efficiency (WUE)

was calculated by dividing the yield by the total applied water according to the equation of Vitas (1965) as follows.

$$WUE = \frac{Cy}{AW} \qquad \mathbf{6}$$

Where:

WUE = water use efficiency kg/m^3

Cy = the Lettuce fresh wt. (kg**)**.

Aw = the amount of the applied water m^3/fad.

Actual water consumptive use (Et actual) was calculated according to Bondok computer program. , data in table (3) shown input data of pan evaporation under drip irrigation system .

Table (3): input data of pan evaporation management under drip irrigation system (data Jan.)

No	Site	Gemezza station.
1	Crop name.	Lettuce.
2	Soil type.	Clay.
3	Growth period.	21dec to 20 mr
4	Evaporation pan (Epan) mm/day.	-
5	Pan coefficient (KP).	-
6	Reference evaporation (ETo) mm/day.	1.54
7	Crop Coefficient (KC) dimension less.	0.75
8	Coefficient of reduction (KR) %.	0.85
9	Electrical conductivity of irrigation water (Ecw) ds/m	0.38
10	Maximum electrical conductivity extract (Ece) ds/m.	0.66
11	Irrigation area (IA) m2.	0.3
12	Emitter discharge (EQ) l/h	2
13	System efficiency (SE) %.	90

Data in table (4) shown that , out put data of pan evaporation under drip irrigation system

Table (4): out put data of pan evaporation management under drip irrigation system (data jan)

14	Site	Gemezza station
15	Crop .	Lettuce.
16	Actual evapotranspiration per day (Eta) mm/day.	0.98
17	Net leaching requirement (LR)%	0.28
18	Actual evapotranspiration+ Net leaching (requirements)(Rc) mm/day.	1.25
19	Net time (duration) (Tn) h/day.	0.2

Data in table (5) shown that , the irrigation duration daily mm / day of lettuce crop under trickle irrigation with average discharge of emitter 2 l /h .

Table (5): Irrigation duration (min. / day) of lettuce under trickle irrigation .

Crop	Growth Period	Jan.	Feb.	Mar.	Average discharge of emitter l/h
lettuce	21Dec-20Mar.	12 min /day	36 min /day	43 min /day	2.00

RESULTS AND DISCUSSION

Relation between irrigation systems and fertilizer on lettuce yield

The differences in fresh weigh (gm) , fresh tall (cm),number of leave ,stem weigh(gm) and stem tall (cm) and were substantial data in table (6),reveal that , with the subsurface drip irrigation (SDI) recording increase of fresh weigh by 5.42% and 28.43 %compared with Surface drip irrigation (DI) and Surface irrigation (SI) resp. ,also found increasing in lettuce stem tall by 5.77 %and 15.73 %compared with DI and SI irrigation systems resp.. the same trend fond with both number of leaves ,stem weigh and stem tall under SDI irrigation the increasing by 13.20 % and 33.72 %, 14.39 % and 33.62 % compared with DI and SI irrigation systems resp.

Data in table (6) showed effect levels of fertilization under irrigation systems, the data showed that, increasing levels of fertilization from 15 , 30 and 45 u N / fed . lead to increase fresh weigh , fresh tall , number of leaves ,stem weigh , stem tall and under all irrigation systems .The highest increase of fertilization with 45 u N /fed. under subsurface drip irrigation compared by drip irrigation and surface irrigation .

This result could be attributed to uniform distribution of sufficient available water, fertilizers directly in the root zone all time because the subsurface drip irrigation depends on capillary water movement from buried emitter to seedlings. The lowest values under furrow irrigation , this may be due to insufficient water to reach the root zone in particular early growth stage where a small root system could not extend enough to reach the water at least time for interval of irrigation.

Table (6): Relation between irrigation systems and fertilizer on lettuce yield:

Irrigation Systems.	Levels of fert. .uN /fed	Lettuce fresh wt. (gm)	Lettuce fresh. Ta.(Cm.)	Number of leaves	Lettuce Stem wt. (gm)	Lettuce stem ta. (Cm.)
SDI	15uN /fed	365.00	28.22	34.29	167.22	10.24
	30uN/fed	524.47	31.55	46.95	257.17	14.79
	45uN /fed	733.07	36.47	53.55	334.82	17.27
X		540.85	32.08	44.93	253.07	14.15
DI	15uN /fed	345.82	26.97	27.77	147.82	9.95
	30uN/fed	483.84	30.62	41.72	230.55	12.22
	45uN /fed	713.2	33.42	49.57	293.32	14.94
X	1	514.29	30.43	39.69	223,90	12.37
SI	15uN /fed	291.47	23.87	24.43	112.77	7.49
	30uN/fed	345.24	27.59	35.65	166.08	10.37
	45uN /fed	626.67	31.70	40.71	205.35	13.92
X		421.13	27.72	33.60	161.40	10.59

X: The average value.

Effect of both irrigation systems and width of row on lettuce yield.

Data in table (7) illustrated that , the effect of both irrigation systems and width of row on lettuce fresh weight (gm) , lettuce fresh tall (cm) , number of fresh leaf, lettuce stem weight (gm) and lettuce stem tall(cm). Data showed that the highest values under subsurface drip irrigation ,the values were 540.85 ,32.08, 46.59, 253.07 and 14.13for both lettuce fresh tall (cm) , number of fresh leaf, lettuce stem weight (gm) and lettuce stem tall(cm)resp. .Followed by the values under surface drip irrigation, the values were 514.24 ,30.33, 39.68, 207.23 and 12.37 resp. The lowest values under furrow irrigation the values 421.13, 27.72, 33.59, 161.40 and 11.09 resp. . Data also showed that ,affected both lettuce fresh weight (gm), lettuce fresh tall (cm) , number of fresh leaves, lettuce stem weight (gm) and lettuce stem tall(cm).by row and double row under irrigation systems .The highest values were on double row under subsurface irrigation ,the values were 570.01, 33.60, 49.00, 260.95 and 15.01 resp. The values under double row higher than the values under row ,that may be return to double row leading to irregular distribution of moisture

Table (7) : Effect of irrigation systems and width of row on lettuce . production

Irrigation Systems.	furrow width	Lettuce fresh wt. (g)	Lettuce fresh. Ta.(Cm.)	Number of leaves	Lettuce Stem wt. (g)	Lettuce stem ta. (Cm.)
SDI	Dr	570.01	33.60	49.00	260.95	15.01
	R	511.68	30.56	44.19	245.19	13.25
	x	540.85	32.08	46.59	253.07	14.13
DI	Dr	535.62	31.13	41.70	212.15	13.33
	R	492.95	29.53	37.67	202.31	12.68
	x	514.28	30.33	39.68	207.23	13.01
SI	Dr	444.24	28.31	34.84	171.30	11.40
	R	398.01	27.12	32.35	151.50	9.50
	x	421.13	27.72	33.59	161.40	10.45

R: row width 60 cm ; Dr; : row width 120 cm .; x: : the average value

Effect of fertilization levels on lettuce yield

Data in table (8)illustrated that, lettuce fresh weight (gm) , lettuce fresh tall (cm) , number of fresh leaf, lettuce stem weight (gm) and lettuce stem tall(cm). affected by nitrogen fertilization levels .The data revealed that, when increasing nitrogen levels from15 – 45uN / fed. ,lead to increase yield with row and double row .The highest values of , lettuce fresh weight (gm) , lettuce fresh tall (cm) , number of fresh leaf, lettuce stem weight (gm) and lettuce stem tall (cm) under 45uN/ fed. ,the values were 690.98, 33.86, 49.44, 277.80 and 15.38 resp followed by the values under 30 uN / fed. ,the values were 451.18 ,29.92, 41.44, 217.93 and 12.40 resp. `The latest values by using 15 N/fed . values were 334.10 ,26.35 , 28.83 , 142.60 and 9.23 rsp. These results my be related to increase water consumptive when increase fertilizer and increasing the green yield. Also data showed that , when planted on double row lead to increasing yield compared by row with all fertilization levels ,the highest values under double row and by using 45 u N / fed. Values were 709.92, 34.70 , 51.07, 283.78 and 16,17 resp.. these results my be related to under subsurface drip irrigation the amount of water was little and buried emitter to seedlings ,so the crop useful from all fertilizer .while under surface irrigation the amount of water was much, fertilizer drainage after root zoon and the crop unuesful from all fertilizer.

Table (8) : Effect of fertilization levels on lettuce yield

Fertilization	Furrow width	Lettuce fresh wt. (g)	Lettuce fresh. ta.(Cm)	Number of leave	Lettuce Stem wt. (g)	Lettuce stem ta.(Cm)
15u N /fed	D.r	353.87	27.10	29.63	163.26	9.86
	R	314.32	25.60	28.02	121.94	8.59
	X	334.10	26.35	28.83	142.60	9.23
30 uN /fed	D.r	486.08	31`.24	44.84	230.69	14.00
	R	416.26	28.59	38.08	205.18	10.80
	X	451.18	29.92	41.44	217.93	12.40
45. uN/fed	D.r	709.92	34.70	51.07	283.78	16.17
	R	672.03	33.02	47.81	271.82	14.58
	X	690.98	33.86	49.44	277.80	15.38

Effect of row and double row on lettuce fresh yield

Data in table (9) the general average of both row and double row under all irrigation systems to explain the effect of row width on lettuce yield . The values revealed that , the effected of row and double row on lettuce fresh weight (gm) , lettuce fresh tall (cm) , number of fresh leaf, lettuce stem weight (gm) and lettuce stem tall(cm). ,data in table showed that the double row lead to increase both lettuce fresh weight (gm) , lettuce fresh tall (cm) , number of fresh leaf, lettuce stem weight (gm) and lettuce stem tall(cm). Compared with row ,the percentage of increasing were 10.50, 6.67, 9. 93, 13.14 and 17.56 % resp.

Table (9) : Effect of row and double row on lettuce fresh yield .

Furrow Width.	Lettuce fresh wt. (g)	Lettuce fresh. ta.(Cm.)	Number of leave	Lettuce Stem wt. (g)	Lettuce stem ta. (Cm.)
Dr	774.94	46.52	62.77	338.86	20.07
R.	701.32	43.61	57.10	299.50	17.07

Water use efficiency (WUE)

Water use efficiency for crop affected by irrigation systems of lettuce crop the data showed that in table (10) higher values of crops and field water use efficiency (2271.58 kg and 2.40 kg// m^3)) were obtained under subsurface trickle irrigation system. While the modified furrow irrigation system treatment induced lower values (1768.75 kg and 1.31 kg/ m^3).

The highest value return to divided yield Kg by the amount of the applied water m^3/fad.,the amount of water under drip irrigation was lower compared with surface irrigation

Table (10): Fresh yield , amount of irrigation water and water use efficiency

Irrigation systems	SDI	DI	SI
Lettuce fresh kg / fed	2271.58	2159.98	1768.75
Amount of water m^3/ fed	945	945	1350
Water use efficiency Kg / m^3	2.40	2.29	1.31

SUMMARY AND CONCLUSIONS

The main results in the present work can be summarized and concluded in the following points .

1-The highest values of lettuce fresh weight (gm) ,lettuce fresh tall(cm) , number of leaves, lettuce stem weight(gm) and lettuce stem tall(cm) under subsurface drip irrigation the values were 540,85 , 32,08 , 44,93 ,253,07 and 14,15 resp.

2- -The highest values of lettuce fresh weight (gm) ,lettuce fresh tall(cm) , number of leaves, lettuce stem weight(gm) and lettuce stem tall(cm) .under fertilization level 45 u N /fed ., the values were 690,98, 33,86 , 49,44, 277,80 and 15,38 resp.

3- Due to transplanting on double row with planted in each side , increasing lettuce fresh weight (gm) ,lettuce fresh tall(cm) , number of leaves, lettuce stem weight(gm) and lettuce stem tall (cm),the values were 774,94 ,46,52, 62,77 , 338,86 and 20,07 resp.

4- Water use efficiency was the highest value 2.40 kg / m^3 under subsurface drip irrigation.

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الملخص العربى

تأثير نظم الري على محصول الخس البلدي

***أمال فتوح الشرقاوى **محمد يسرى بندق**

أجريت تجربة حقلية في محطة البحوث الزراعية بالجميزة – محافظة الغربية خلال موسم ٢٠٠٩ / ٢٠١٠

لدراسة تأثير نظم الري المختلفة مثل نظام الري بالتنقيط السطحي و التحت سطحي والري السطحي التقليدي وكذلك تأثير عرض الخط (٦٠ سم مع الزراعة على ريشة واحدة و ١٢٠ سم مع الزراعة على الريشتين) وكذلك مستويات التسميد النتروجيني (١٥ و٣٠ و٤٥ وحدة نيتروجين / فدان) على وزن الخس الطازج (جم),الطول للخس الطازج (سم) , عدد الأوراق, وزن الساق (جم) وطول الساق(سم)

١- أظهرت النتائج أن نظام الري بالتنقيط التحت سطحي أدى إلى زيادة كلا من وزن الخس الطازج (جم), طول النبات الطازج (سم) , عدد الأوراق, وزن الساق (جم) وطول الساق(سم) بنسب ٥,٤٢ % - ٢٨,٤٣ % و ٥,٧٧ % - ١٥,٧٣ % و ١٣,٢٠ % - ٣٣,٧٢ % و ١٤,٣٩ % - ٣٣,٦٢ % مقارنة بالري بالتنقيط السطحي والري التقليدي

٢- تأثير كلا من نظم الري وعرض الخط ,تظهر النتائج أعلى قيم تحت نظام الري بالتنقيط التحت سطحي وعرض الخط ١٢٠ سم مع الزراعة على الريشتين وكانت النتائج ٥٧٠,٠١ , ٣٣,٦٠ ,٤٩,٠٠ , ٢٦٠,٩٥ و١٥,٠١على التوالي لكل من وزن الخس الطازج (جم),الطول للخس الطازج (سم) , عدد الأوراق, وزن الساق (جم) وطول الساق(سم).

٣- أدى استخدام مستويات التسميد النيتروجينى ١٥ و ٣٠ و ٤٥ وحدة نيتروجين / فدان إلى زيادة الإنتاجية وكانت أعلى إنتاجية مع عرض الخط ١٢٠ سم ٤٥ وحدة نيتروجين / فدان وكانت القيم ٧٠٩,٩٢, **٣٤,٧٠ , ٥١,٠٧ , ٢٨٣,٧٨ و ١٦,١٧** على التوالي لكل من وزن الخس الطازج (جم),الطول للخس الطازج (سم) , عدد الأوراق, وزن الساق (جم) وطول الساق(سم).

٤ – تأثير عرض الخط (٦٠ – ١٢٠ سم) النتائج أظهرت زيادة كلا من وزن الخس الطازج (جم),الطول للخس الطازج (سم) , عدد الأوراق, وزن الساق (جم) وطول الساق(سم) بنسب ١٠,٥٠%و ٦,٦٧% و ٩,٩٣% و ١٣,١٤% و ١٧,٥٦% على التوالي .

٥- توضح النتائج أن أعلى قيمة لكفاءة استخدام المياه تحت نظام الري بالتنقيط التحت سطحي

٦- تحت ظروف الجميزة للحصول على أعلى إنتاجية وأعلى كفاءة استخدام المياه لمحصول الخس والعمل على ترشيد استخدام المياه تحت ظروف الخلاف مع دول حوض النيل نوصى بتطبيق نظام الري بالتنقيط التحت سطحي والزراعة على مسافة بين الصفوف ١٢٠سم مع الزراعة على الريشتين والتسميد ٤٥ وحدة نيتروجين / فدان.

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