Misr J. Ag. Eng., 26(1): 94- 106 IRRIGATION AND DRAINAGE

EFFECT OF FERTILIZATION AND IRRIGATION WATER LEVELS ON SUMMER SQUASH YIELD UNDER DRIP IRRIGATION

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ABSTRACT

A Field experiment was conducted at the Experimental Farm of agricultural Engineering Research Institute, Agricultural Research Center. Ministry of agriculture and Land Reclamation, at Abdel Monem Reyad Village, El Bustan area at Nubaria sector, during the summer season of 1999 and 2000 . The objectives of the study were to test the effect of two methods of applying nitrogen fertilizer (fertigation and broadcasting), two irrigation levels and two irrigation systems surface and subsurface drip on summer squash production in the sandy soils

The main results of the study could be summarized as follow:-

- *Applying the nitrogen fertilizers through two irrigation methods (surface and subsurface drip irrigation) was more efficiency than broadcasting fertilizers.*
- *There are a slightly increase in crop growth, fresh yield, and both of water and nitrogen use efficiency in subsurface drip more than in surface drip.*
- *Subsurface drip irrigation has the best water distribution in the soil.*
- *The highest value of fertilizer use efficiency (35.60 kg) yield/kg nitrogen was obtained with treatment $I_2L_2F_2$.*

INTRODUCTION

Using of modern irrigation and fertilization techniques are becoming a necessary to save water and chemicals for cultivating new areas. The use of modern irrigation methods

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become very important for water and chemicals saving, as well as to optimize water fertilizer use efficiency. To increase the fertilizer use efficiency, up to date techniques had to be considered.

Summer squash (*Cucurbita pepo* L.) is one of the most important cash crops, especially, in newly reclaimed areas of Egypt. About 5.8 thousands feddans represented 8.55 % from the total area allocated for vegetable crops at the newly sandy soil of west Nubaria area (IFAD, 1999).

El-Gindy (1988) said that the using of modern irrigation and chemigation techniques is becoming a necessity to save water for cultivating new areas, solving part of drainage problems, decrease the ground water pollution rate and lower the cost of crop production.

Arnaout (1999) reported that the applied fertilizers through the three selected irrigation methods (surface drip, subsurface drip and sprinkler) are more efficient than broadcasting fertilizer. He also found that the fertigation through surface and subsurface drip and sprinkler reduced the cost of production unit (LE/Mg.) by 38% ,40% and 33.75%, respectively, than broadcasting fertilizer.

El-Berry et al. (1989) found that the water use efficiency was the highest in case of subsurface drip method 5.93 kg/m^3 which was approximately twice and seven times that of sprinkler and basin methods, respectively, in case of alfalfa production under desert conditions.

Rahman et al. (1994) indicated that the head weight, head diameter and leaf weight increased significantly with increasing application rate from 3 to 6 mm per day, with 9 mm per day, yields were maximized and tensions maintained at levels lower than that of available water.

Mohamed (1995) noticed that the use of drip irrigation for cucumber plant highly increased WUE as compared to furrow method.

El-Nagar (1997) stated that water use efficiency was affected by varying amounts of irrigation water. He found that the water use efficiency were decreased by decreasing amounts of irrigation water, for fresh and dry yield of potato tuber production.

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

El-Gindy et al. (1991) estimated the most accurate values of water consumptive use of squash and cucumber. They also, determined the actual daily, monthly and seasonal water consumptive use by soil moisture depletion method. They found that the seasonal consumptive use was 267.0, 242.4 and 226.0 mm under soil moisture tension of 0.35, 0.45, 0.55 bar respectively.

Helmy et al. (2000) reported that increasing the applied water volume tends to increase the soil moisture content in both direction of vertical and horizontal under drip irrigation system and in vertical direction only under furrow irrigation system.

El-Gendy (1988) noted that the chemigation methods reduced the cost of production unit (LE/t.) by 35%, 34.9 and 42.0% for furrow, sprinkler and drip irrigated tomato and by 43.3%, 38.2% and 53.6% for furrow, sprinkler and drip irrigated cucumber, respectively.

The main objectives of the present research are to study the following:

- ❶ Effect of fertilization methods under two levels of irrigation water on crop growth, yield, nitrogen use efficiency and water use efficiency.
- ❷ Proper irrigation methods which can save water with proper method for fertilizer application.

MATERIALS AND METHODS

Field experiments were conducted at El-Bustan Research Station, Nobaria sector during summer 1999 and 2000 seasons. Summer squash (*cucurbita pepo* L.) was chosen in this study as an important crop in sandy soils. Two irrigation systems, tow irrigation levels and two types of fertilizer applicators represented in this study. Experimental layout is illustrated in Fig. (1).

Table (1) shows some physical and chemical properties of experimental soil (according data of El- Bustan Research Station)

Table (1) Some soil physical and chemical properties of experimental soil.

Depth (cm)	Particle size distribution %				F.C %	W.P. %	B.D g/cm^3	PH 1/2.5	EC Ds/m	Texture
	Sand	F. Sand	silt	Clay						
0 – 30	52.8	41.4	4.1	1.7	9.4	4.3	1.68	8.2	1.27	Sandy
30 – 60	50.0	43.5	5.0	1.5	8.4	4.4	1.57	8.3	1.22	Sandy
60 - 120	52.0	42.0	4.3	1.7	9.2	4.4	1.55	8.3	1.30	Sandy

1- Treatments

This study has 8 treatments (in 4 replicates) as follows:

1- **$I_1L_1F_1$:** irrigation using surface drip at 60% of ETcrop with traditional fertilization.

2- **$I_1L_1F_2$:** irrigation using surface drip at 60% of ETcrop with fertigation.

3- **$I_1L_2F_1$:** irrigation using surface drip at 80% of ETcrop with traditional fertilization.

4- **$I_1L_2F_2$:** irrigation using surface drip at 80% of ETcrop with fertigation.

5- **$I_2L_1F_1$:** irrigation using subsurface drip at 60% of ETcrop with traditional fertilization.

6- **$I_2L_1F_1$:** irrigation using subsurface drip at 60% of ETcrop with fertigation.

7- **$I_2L_2F_1$:** irrigation using subsurface drip at 80% of ETcrop with traditional fertilization.

8- **$I_2L_2F_2$:** irrigation using subsurface drip at 80% of ETcrop with fertigation.

All treatments were irrigated every day

2- Fertilization program:

1-Ten cubic meters of manure per fed, and two hundred kg of super phosphate (15.5 % P_2O_5) were applied during land preparation

2- Nitrogen fertilizer was added at the rate of 250 kg/fed. In the form of ammonium nitrate (33.5 % N.).Nitrogen fertilizer was added in 5 equal doses for the traditional treatment .It was added in 10 equal doses for the fertigation treatments

3- Potassium sulfate (48 % K_2O) was added at the rate of 150 kg /fed. Potassium fertilizer was added in the same manner as nitrogen fertilizer.

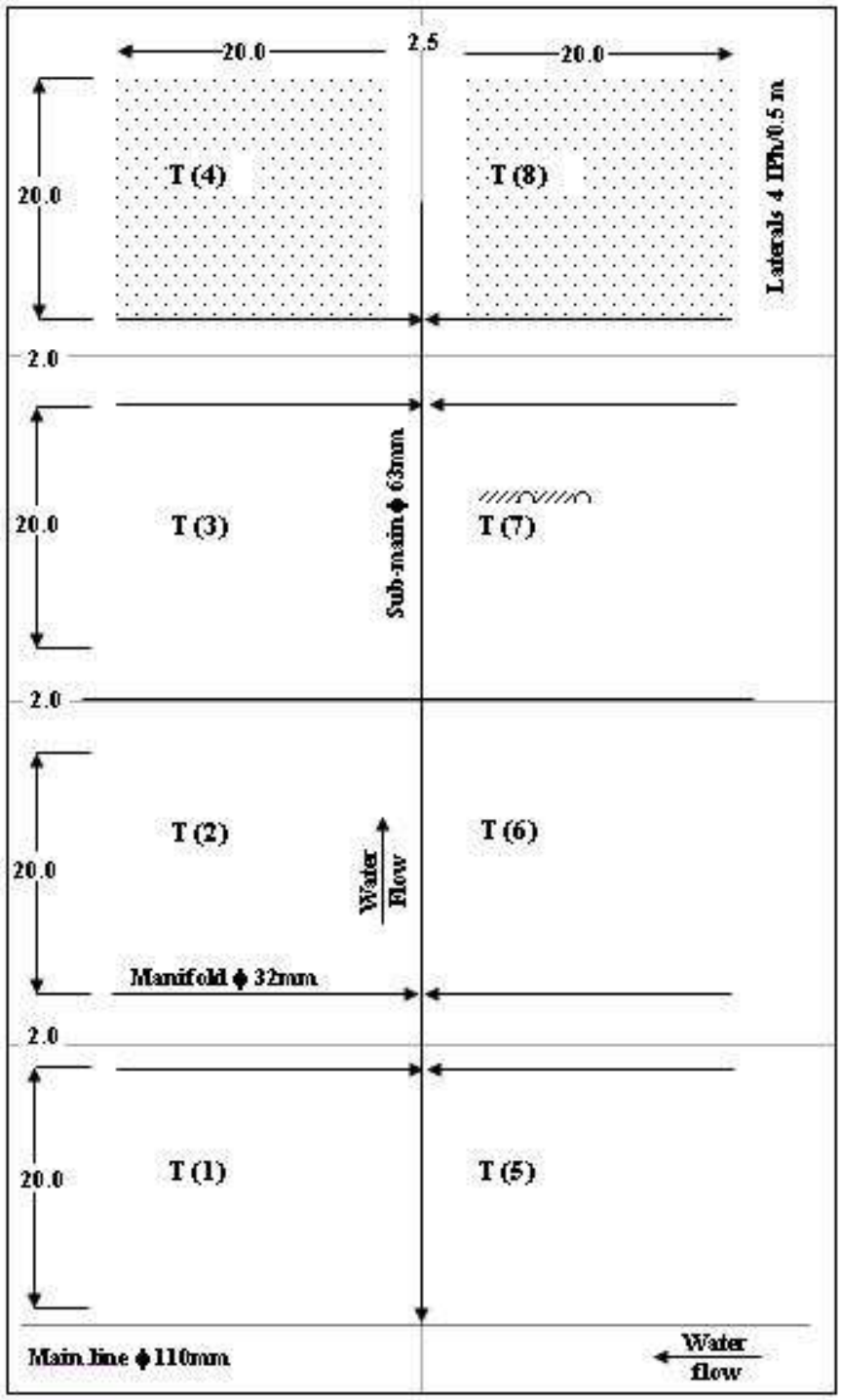

Fig. (1) Experimental layout.

4- Phosphorous was also added as phosphoric acid at the rate of 25 kg./fed.(about 15 kg. P_2O_5) for all treatments

3- Crop evapotranspiration (ETcrop)

It was calculated according to FAO (1984) using pan evaporation method by the following equation:

$$\mathbf{ETcrop = ET_0 \ X \ K_c = E_{pan} \ X \ K_p \ X \ K_c}$$

Where

ETcrop: Crop evapotranspiration (mm / day).

ET_0 : Reference evapotranspiration (mm / day).

E_{pan} : Pan evaporation (mm / day).

K_c : Crop coefficient, (dimension less).

K_p : Pan coefficient (equal to 0.7).

4- Soil moisture distribution

Soil moisture distribution in root zone was studied for each treatment. Soil samples were collected from the different depths (15, 30, 45 and 60 cm). Also in 4 points across plants rows at 0 cm (dripper), 5, 15 and 25 cm distance (on the two sides of plant). Soil samples were collected directly before irrigation during mid – season stage. Moisture content was measured using gravimetric method, Michael (1978)

5- Data recorded

1- soil moisture distribution

2- seasonal applied irrigation water (m^3/fed)

3- Yield and its attributes

At harvest , random samples of 20 plants were taken from each treatment to estimate the following:

- Fruit diameter (cm)
- Fruit number / plant
- Fruit Length (cm)
- Plant height (cm)
- Leaves area (cm^2 / plant)
- Fresh yield (t / fed)

4- Water use efficiency (WUE):

It was determined according to Bos (1980) using the following equation:

$$WUE = \frac{\text{Average yield (kg/fed)}}{\text{Amount of applied water (m}^3\text{/fed)}} \quad \text{kg/m}^3$$

5- Fertilizer use efficiency (FUE):

It was determined using the following equation :

$$FUE = \frac{\text{Average yield (kg/fed)}}{\text{Amount of applied fertilizer (kg/fed)}} \quad \text{kg yield/kg fertilizer}$$

RESULTS AND DISCUSSION

1- Soil moisture distribution:

Fig. (2) shows the soil moisture distribution for the different treatments. Soil moisture content were classified to four ranges as follows:

Less than 60% of F.C., 60%-75% of F.C., 75%-90% of F.C. and more than 90% of F.C.

Data in Fig (2) indicated that, the highest wetted area which has moisture content more than 90% of F.C. presented only with the treatments 7 and 8 which were irrigated by using subsurface irrigation at 80% of ETcrop. The wetted area (between 75% and 90% of F.C) were larger under using subsurface drip irrigation method and 80% of ETcrop irrigation level than the others. Also the wetted areas which have 60%-75% of F.C. take the same trend.

On the other hand the lowest wetted areas which represented less than 60% of F.C. were more larger under surface irrigation with 60% of ETcrop irrigation level than the other treatments (subsurface irrigation and 80% of ETcrop).

It can be concluded that the irrigation water level and irrigation method have strong effect in the soil moisture distribution. But fertilization method have no effect.

2- Seasonal applied irrigation water:

Seasonal applied irrigation water was estimated according to ETcrop during different growth stages and illustrated in Fig. (3).

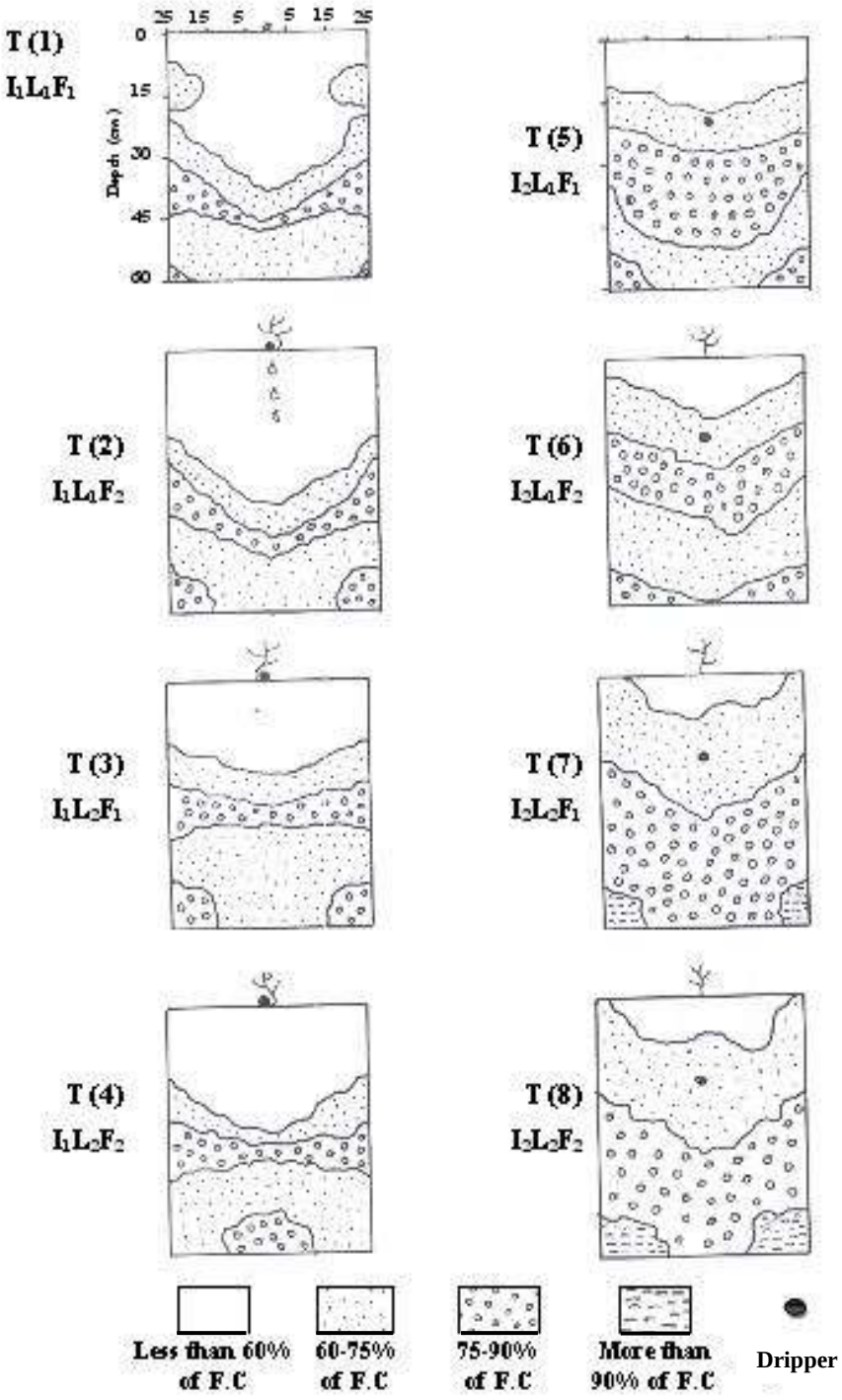

Fig. (2) Soil moisture distribution for the different treatments.

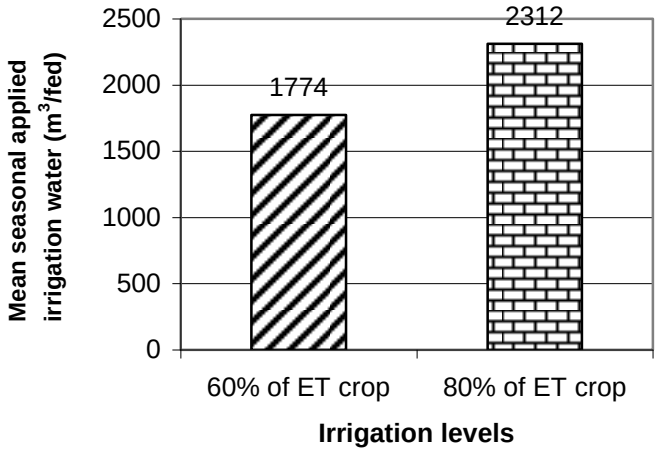

Fig. (3) Mean seasonal applied irrigation water

3- Yield and its attributes:

Fruit diameter (cm), fruit number/plant, fruit length (cm), plant height (cm), leaves area (cm^2/plant) and fresh yield (Mg/fed) are tested for different treatments. Data in Table (2) shows the effect of different treatments on plant growth characters.

Average fruit diameter (cm):

The average fruit diameter varied between 2.4 and 3.2 cm as obtained with treatments No (1) and No (8) respectively.

Average fruits number/ plant:

Maximum number of fruits/plant was 6.5 obtained with treatment No (8). Meanwhile, minimum number was 3.5 was obtained with treatment No (1).

Average fruit length (cm):

The greatest fruit length (16.3) was obtained with treatment No (2), but the least length (14.5) was obtained with treatment No (1).

Average plant height (cm):

The highest value (49.3) was recorded with treatment No 6, but the lowest (41.5) was recorded with treatment No (3).

Average leaves area/plant (cm^2):

The largest leaves area/plant (319) was recorded with treatment No (8), while the smallest (235) was recorded with treatment No (1).

Average fresh yield (Mg/fed):

Maximum fresh yield (8.9 Mg/fed) was obtained with treatment No (8) but minimum value (6.31 Mg/fed) was obtained with treatment No (1).

Table (2) Effect of the different treatments on yield and its attributes.

Characters / Treatments		Fruit diameter (cm)	Fruits number /plant	Fruit length (cm)	Plant height (cm)	Leaves area (cm^2/plant)	Fresh yield (Mg/fed)
1	$I_1L_1F_1$	2.4	3.5	14.5	41.6	235	6.31
2	$I_1L_1F_2$	2.7	4.9	16.3	46.4	271	7.40
3	$I_1L_2F_1$	2.7	4.3	14.7	41.5	254	7.01
4	$I_1L_2F_2$	3.1	5.7	15.4	45.3	286	8.30
5	$I_2L_1F_1$	2.6	4.5	15.0	44.3	240	6.74
6	$I_2L_1F_2$	2.9	5.5	15.8	49.3	296	8.00
7	$I_2L_2F_1$	2.9	5.4	15.6	44.7	253	7.31
8	$I_2L_2F_2$	3.2	6.5	15.9	48.8	319	8.90

The almost data in Table (2) indicated that, the highest values of yield and its attributes were obtained with treatments which used subsurface drip irrigation, irrigation level 80% of ETcrop and fertigation. But the lowest values were obtained under using surface drip irrigation with irrigation level 60% of ETcrop and traditional fertilization method.

4- Water use efficiency (WUE):

Table (3) shows the values of fresh yield, seasonal applied irrigation water and water use efficiency.

Data in Table (3) indicated that, the maximum value of water use efficiency (4.51 kg/m^3) was obtained with treatment (6) which using subsurface drip irrigation and 60% of ETcrop irrigation level with fertigation. But the minimum value (3.03 kg/m^3) was obtained with treatment (3) which irrigated by surface drip irrigation and 80% of ETcrop irrigation level with traditional fertilization.

5- Fertilizer use efficiency (FUE):

Table (4) shows the values of fertilizer use efficiency (FUE) with the different treatments.

The highest value of FUE (35.60 kg yield/kg nitrogen) was obtained with treatment $I_2L_2F_2$ (subsurface drip irrigation with 80% of ETcrop irrigation level using fertigation method). While the lowest value (25.24 kg yield/kg nitrogen) was obtained with the first treatment, $I_1L_1F_1$ (surface drip irrigation with 60% of ETcrop irrigation level using traditional fertilization).

Table (3) Water use efficiency under the different treatments.

Characters / Treatments		Fresh yield		Seasonal applied irrigation water m^3/fed	WUE kg/m^3
		Mg/fed	kg/fed		
1	$I_1L_1F_1$	6.31	6310	1774	3.55
2	$I_1L_1F_2$	7.40	7400	1774	4.17
3	$I_1L_2F_1$	7.01	7010	2312	3.03
4	$I_1L_2F_2$	8.30	8300	2312	3.59
5	$I_2L_1F_1$	6.74	6740	1774	3.80
6	$I_2L_1F_2$	8.00	8000	1774	4.51
7	$I_2L_2F_1$	7.31	7310	2312	3.16
8	$I_2L_2F_2$	8.90	8900	2312	3.85

Table (4) Effect of the different treatments on fertilizer use efficiency (FUE).

Characters / Treatments		Fresh yield (kg/fed)	Nitrogen fertilizer (kg/fed)	FUE kg yield / kg nitrogen
1	$I_1L_1F_1$	6310	250	25.24
2	$I_1L_1F_2$	7400	250	29.60
3	$I_1L_2F_1$	7010	250	28.04
4	$I_1L_2F_2$	8300	250	33.20
5	$I_2L_1F_1$	6740	250	26.96
6	$I_2L_1F_2$	8000	250	32.00
7	$I_2L_2F_1$	7310	250	29.24
8	$I_2L_2F_2$	8900	250	35.60

CONCLUSION

The following conclusions may be summarized:

- The highest fresh yield (8.9 t/fed) was obtained with treatment $I_2L_2F_2$ (subsurface drip irrigation with 80% of ETcrop irrigation level using fertigation method).
- Subsurface drip irrigation has the best irrigation water distribution in the soil which more suitable for roots and yield.
- Irrigate with 80% of ETcrop was obtained the highest yield.
- Maximum value of WUE was 4.51 kg yield/m^3 irrigation water recorded with treatment $I_2L_1F_2$, but the minimum value (3.03) was recorded with treatment $I_1L_2F_1$.

- The highest value of fertilizer use efficiency (35.60 kg yield/kg nitrogen) was obtained with treatment $I_2L_2F_2$ (subsurface drip irrigation with 80% of ETcrop irrigation level and fertigation method). While the lowest value (25.24) was obtained with treatment $I_1L_1F_1$ (surface drip and 60% of ETcrop irrigation level with tradisitonal fertilization method).

The study recommended that:

Subsurface drip irrigation system, 80% of ETcrop (irrigation level) and fertigation method are the best conditions for producing the highest yield.

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الملخص العربى

تأثير التسميد ومستويات الري على محصول الكوسة الصيفي تحت نظام الري بالتنقيط

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أجريت هذه الدراسة على محصول الكوسة الإسكندراني خلال الموسم الصيفي لعامي ١٩٩٩، ٢٠٠٠ بمنطقة البستان بالنوبارية.

وكان الهدف من هذا البحث هو دراسة بعض العوامل المؤثرة في إنتاج محصول الكوسة مثل نظام الري وكميات مياه الري بالإضافة إلى طريقة التسميد ولذلك كانت معاملات الدراسة:

- نظام الري: ري بالتنقيط سطحي وتحت سطحي.
- مستويات الري: ري المحصول يوميا بإضافة ٦٠٪، ٨٠٪ من **ETcrop**.
- طريقة التسميد: إضافة الأسمدة بالطريقة التقليدية، التسميد مع مياه الري.

وقد كانت أهم النتائج:

- أعلى كمية محصول (٨,٩٠ طن/فدان) مع المعاملة $I_2L_2F_2$ (ري تنقيط تحت سطحي – والري بـ ٨٠٪ من **ETcrop** – والتسميد مع الري).
- أكبر كفاءة لاستخدام المياه (٤,٥١ كجم/م^3) وكانت مع المعاملة $I_2L_1F_2$ (ري تنقيط تحت سطحي – ري ٦٠٪ من **ETcrop** – تسميد مع مياه الري).
- معدل الاستفادة من التسميد النيتروجيني وصل للحد الأقصى (٣٥,٦ كجم محصول / كجم نيتروجين) وكان ذلك مع المعاملة $I_2L_2F_2$ (ري تنقيط تحت سطحي – ٨٠٪ من **ETcrop** – تسميد مع مياه الري).

من خلال نتائج البحث توصى الدراسة بإستخدام نظام الرى بالتنقيط التحت سطحى مع مستوى رى ٨٠ % من **ETcrop** والتسميد من خلال مياه الرى لأنها تعطى أعلى إنتاج محصولى.

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