Effect of Irrigation Amounts and Soil Amendments on The Yield and its Component of Cantaloupe Under Drip Irrigation in Calcareous Soils

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ABSTRACT

A two-year field experiment was carried out in the newly reclaimed calcareous soils at Horticulture Research Station at Nubaria during the 2005 and 2006 summer seasons. The objective of this research was to study the effect of two irrigation regimes (100% ETc and 80% ETc) and the addition of natural and manufactured soil amendments (Organic matter, Tafllah, and polymer) on yield and its components of cantaloupe crop, amounts of applied irrigation water and water utilization efficiency.

The tested variables were:

- Two irrigation amounts (100 and 80% from crop evapotranspiration)
- Control without any soil amendments
- Organic matter (20m^3/feddan)
- Polymer 0.01% on mass basis + organic matter
- Taflah 0.2% on mass basis +organic matter.
- Polymer + Taflah + organic matter.

Results showed that:

1. Average branches length per plant was significantly higher with the irrigation regime 100% ETc. It reache the highest value with the treatment (organic + polymer + taflah) treatment
2. Average total soluble solids (TSS) was higher for the (organic +Taflah) treatment than the other treatments in the two growing seasons and irrigation amount of 80% ETc.
3. Average cantaloupe yield (t/feddan) reached the highest value in the two growing seasons under the 80% ETc irrigation amount and the (organic matter + Taflah + polymer) treatment. These values were 16.36 and 14.77 t/feddan for the 2005 and 2006 seasons, respectively.

INTRODUCTION

Cantaloupe is considered an exporting crop to European countries as early season production. The nutritional value of cantaloupe is high. The cultivated area with cantaloupe is 27263 feddans in Egypt and 5452 feddans are cultivated under low tunnels in order to produce early yield and

the rest are cultivated in open fields. Egypt has occupied the 8th rank in the countries that produce cantaloupe and the Egyptian production reaches 3.24% from the world production (Ministry of Agricultural and Land Reclamation bulletin, (2002).

Egypt has entered this century with a per capita share of water below the poverty level (1000 m^3/person/year). The scarcity of water especially in new reclaimed lands is a limiting factor for expansion in cultivated areas. Optimizing the use of applied irrigation water for all crops and saving water will be used in reclaiming additional areas.

Calcareous soils are characterized with poor in soil fertility, low water holding capacity and non-structure, using natural and manufactured soil amendments is very useful to improve the soil structure, increase water holding capacity and increase the cation exchange capacity to keep nutrients available to plants.

Irrigation and soil physical management are often controlling factors in establishing cantaloupe production and achieving high quality of cantaloupe fruits.

Soil conditioners as organic polymers were first introduced into soil science research by Monsanto, an American chemical company, which produced a product under the trade name of krilum which was a vinyl acetate-maleic anhydride polymer, (Walter Russell. 1973). Metwalli *et al.*, (2004) reported that adding tafla with the rate of 10 m^3 per feddan (1feddan=4200 m^2) to sandy soils improved the water holding capacity of the soil, but the yield of onion was not increased.

The objectives of this study were to test the effect of two irrigation amounts (80% and 100% ETc) and five soil conditioners on cantaloupe yield and quality, yield components, amounts of applied irrigation water and water utilization efficiency under drip irrigation system in the calcareous soils of Nubaria region.

MATERIALS AND METHODS

This study was conducted at Nubaria Horticultural Research Station during the two growing seasons of 2005 and 2006 to investigate the effect of two water amounts on the yield and its quality of cantaloupe (var Ananass-Dokky), amount of applied water, water utilization efficiency. The seeding rate was 1 kg/feddan. The cantaloupe seeds were sown on ridges

with width 2 m and spacing between plants 0.5m. The cantaloupe was sown in 5 and 8 May in the 2005 and 2006 growing seasons, respectively Harvest was on 28 and 30 August for the same respective seasons. The growth parameters were taken at the beginning of flowering

The drip irrigation system consists of main line 4" PVC buried line a: the sub-main line (75 mm outer diameter) PVC buried line, the drip line GR type 4l/h and spacing of 0.5m apart between droppers as shown in experimental layout Figure 1

80%	100%
Tafla + Polymer + OM	Polymer + OM
Organic Matter	Tafla + Polymer + OM
Polymer + OM	Control
Tafla + O.M	Tafla + O.M
Control	Organic Matter
Polymer + OM	Tafla + Polymer + OM
Tafla + Polymer + OM	Organic Matter.
Control	Polymer + OM.
Tafla + O.M.	Tafla + O.M.
Organic Matter.	Control
Polymer + OM.	Tafla + Polymer + OM
Tafla + Polymer + OM	Organic Matter
Control	Polymer + OM.
Tafla + O.M	Tafla + O.M.
Organic Matter.	Control

Figure 1: The layout of the experiments

Soil samples were collected from the experimental site for main physical and chemical characters (Table1).

Table 1: presented the soil physical and chemical analysis of the studied soil.

Seasons	2005		2006	
Characteristics	**0-20 cm**	**20-40 cm**	**0-20 cm**	**20-40 cm**
EC, dSm^{-1}	1.52	1.85	1.75	2.05
pH (1:2.5 soil: water)	5.25	8.19	8.15	8.10
OM, %	0.55	0.39	0.45	0.35
$CaCO_3$, %	26.50	28.05	28.20	29.35
N ($mgkg^{-1}$)	39.80	48.50	30.28	33.51
$NaHCO_3$, P, $mgkg^{-1}$	13.30	10.65	12.12	11.52
Available K $mgkg^{-1}$	385.50	320.50	325.50	298.50
Soil Texture class	SCL	SCL	SCL	SCL

SCL = Sandy clay loam.

A split plot experimental design with three replicates was used to conduct the field experiment.

The tested variables were:

(A) Irrigation amounts (2 levels) representing the main plots:

1. 100% of ETc
2. 80% of ETc

The amount of applied irrigation water was measured by flow meter and was calculated according to the following equation (Vermeiren and Gopling, 1984):

$$AIW = \frac{ETp\ X\ Kc\ X\ Kr\ X\ Interval}{Ea} + LR$$

Where:

AIW = applied irrigation water depth (mm/day),

ETp = Potential evapotranspiration (mm/day) values obtained by class A pan method (FAO, 1979) and calculated as follows:

$$ETP = Epan\ X\ Kpan$$

Where:

E_{pan} = measured pan evaporation daily values (mm/day),

K_{pan} = Pan coefficient for class A pan values depend on the relative humidity, wind speed and the site conditions (bare or cultivated). A

k_{pan} = value of 0.75 was used for the experimental site.

K_c = crop coefficient for cantaloupe (FAO, 1979).
K_r = reduction factor that depends on ground cover. A K_r value of 0.6 was used since lateral spacing is 2 meters apart (FAO, 1979)

Ea = Irrigation efficiency= K_1 X K_2= 0.85

Where:
K_1 = Emitter uniformity coefficient = 0.90 for the drip system at the site,
K_2 = Drip irrigation system efficiency = 0.94 for the drip system at the site.
interval = irrigation intervals (days) = 1 day for the experimental site.
LR = Leaching requirements (No additional water for leaching was added during the growing seasons due to the low EC values of irrigation water and soil profile).

(B) Soil amendments (5 levels), representing the sub-main plots.

Polymer vinyl acetate was used with concentration of 0.1% on weight basis of the surface soil layer (0-20) cm. where, Tafla was added with concentration of 0.2 % on weight basis on the surface layer (0-20cm). Soil amendments used were:

1. Control,
2. Organic matter (20 m3/fed),
3. Taflla + Organic matter,
4. Polymer + organic matter and
5. Tafla + organic matter + Polymer.

The crop measurements:

1. Number of branches
2. Branch length
3. Number of fruits per plant.
4. average fruit weight/plant
5. Total yield/feddan.
6. TSS (Total soluble solids)

Water utilization efficiency:

Water utilization efficiency (WUtE) values were calculated from the following equation (Jensen 1983) as follows:

$$WUtE = \frac{\text{Total fresh fruits of cantaloupe (kg/fed.)}}{\text{applied irrigation water (m3/fed).}}$$

The obtained data were statistically analyzed using CoHort software (2004), and the Duncan's multiple range tests was used to compare the differences among treatments means as illustrated by Steel and Torries (1984).

RESULTS AND DISCUSSIONS

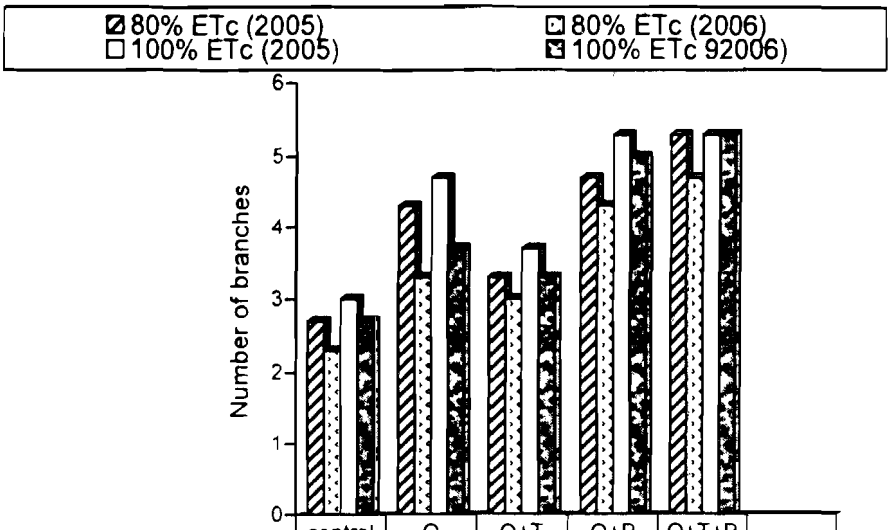
1. Vegetative Growth:

The following graphs show the effect of tested variables on vegetative growth of cantaloupe plants. Results obtained revealed that, there are a significant differences between Soil conditioners treatments (organic matter, Tafla and Polymers) and branch length in two studied seasons 2005 and 2006, but it was not significant between number of branches and soil conditioners treatments in the two growing seasons. These results are in agreement with that obtained by (El-Waraky, 1988 and WalterRussell, 1973.).

The mixture of (Polymer + Tafla + organic matter) treatment resulted in the highly values for number of branches and branch length as compared with all other treatments.

Number of branches

Effect of tested variableson number of branches of cantaloup.



	control	O	O+T	O+P	O+T+P	
80% ETc (2005)	2.7	4.3	3.3	4.7	5.3	
80% ETc (2006)	2.3	3.3	3	4.3	4.7	
100% ETc (2005)	3	4.7	3.7	5.3	5.3	
100% ETc 92006)	2.7	3.7	3.3	5	5.3	

No. of branches

$LSD_{0.05}$(2005) = 0.72922

$LSD_{0.05}$(2006) = 0.84203

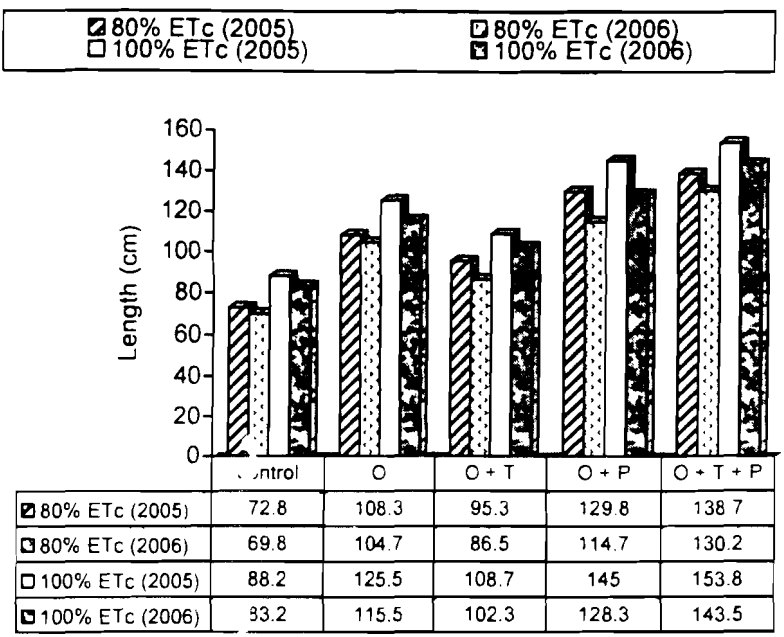
Irrigation

$LSD_{0.05}$ (2005) = 0.4697

$LSD_{0.05}$ (2006) = 0.55579

Branch length and number of fruits per plant:
1) Branch length (cm).

Effect of tested variables On branch length



	Control	O	O + T	O + P	O + T + P
80% ETc (2005)	72.8	108.3	95.3	129.8	138.7
80% ETc (2006)	69.8	104.7	86.5	114.7	130.2
100% ETc (2005)	88.2	125.5	108.7	145	153.8
100% ETc (2006)	83.2	115.5	102.3	128.3	143.5

Tested variables

Branch length
$LSD_{0.05}$ (2005) = 7.8919
$LSD_{0.05}$ (2006) = 10.1284

Irrigation
$LSD_{0.05}$ (2005) = 7.5796
$LSD_{0.05}$ (2006) = 4.8053

2. Total yield and quality:

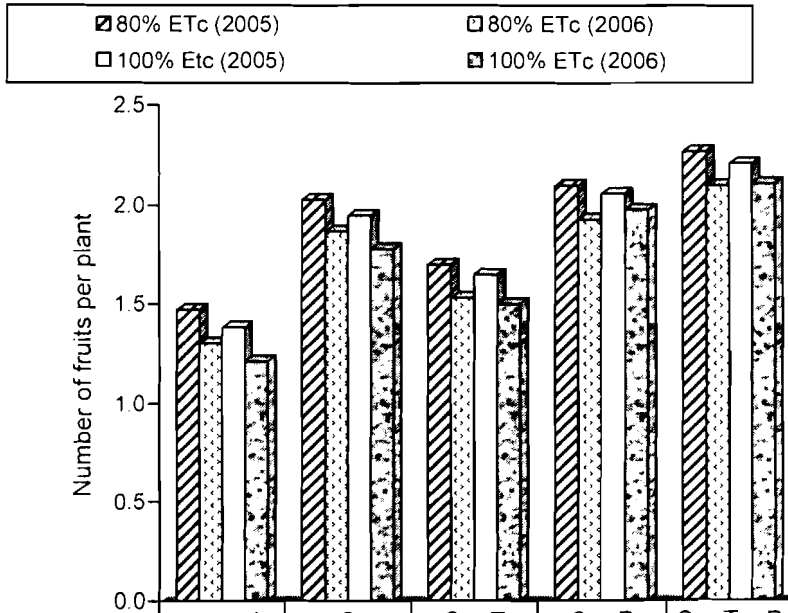
Results showed that there are significant differences in number of fruits per plant between soil conditioner, treatments in the two growing seasons. The (organic + Tafla + Polymer) treatment had the highest significant increase of 2.21 and 2.11 for the 2005 and 2006 seasons. respectively. The (Organic + Tafla) treatment had the lowest significant value of 2006 and 1.98 for the 2005 and 2006 seasons, respectively. These results are in agreement with (El-Waraky, (1988) and Walter Russell, (1973).

Also, the figures show that the average fruit weight per plant increased significantly with the tested soil conditioners as compared to the

control treatment. The highest value was for the (Organic + Tafla + Polymer) treatment, while the lowest was for the (Organic + Tafla) treatment. These results are similar to those obtained by Hamail, *et al.*, (1994) and Walter Russell, (1973).

Average number of fruits per plant

Effect of tested variables on number of fruits per plant



	control	O	O + T	O + P	O + T + P
80% ETc (2005)	1.47	2.03	1.7	2.1	2.27
80% ETc (2006)	1.3	1.87	1.53	1.93	2.1
100% Etc (2005)	1.38	1.95	1.65	2.06	2.21
100% ETc (2006)	1.21	1.78	1.5	1.98	2.11

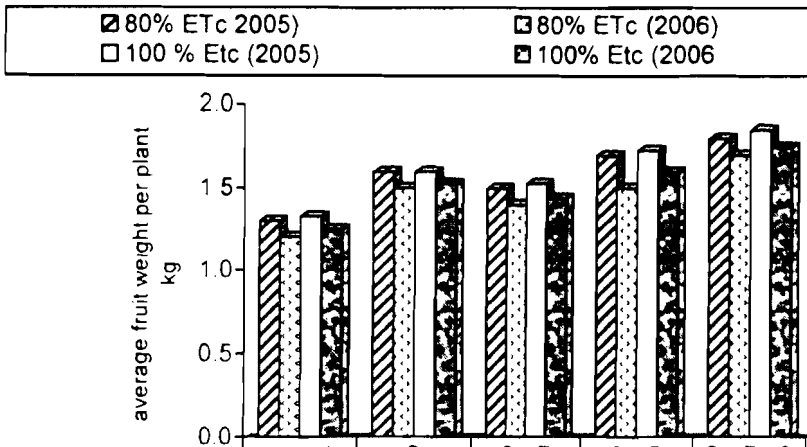
Tested variables

Number of fruits
$LSD_{0.05}$ (2005) = 0.19896
$LSD_{0.05}$ (2006) = 0.0884

Irrigation
$LSD_{0.05}$ (2005) = 0.10183
$LSD_{0.05}$ (2006) = 0.1894

Average fruit weight per plant

Effect of tested variables on average fruit weight per plant



	c ntrol	O	O + T	O + P	O + T + P
80% ETc 2005)	1.3	1.6	1.5	1.7	1.8
80% ETc (2006)	1.2	1.5	1 4	1 5	1 7
100 % Etc (2005)	1.33	1.6	1 53	1 73	1.85
100% Etc (2006	1 25	1.53	1 44	1 6	1 75

Tested variables

Average fruit weight
$LSD_{0.05}$ (2005) = 0.6807
$LSD_{0.05}$ (2006) = 0.09276

Irrigation
$LSD_{0.05}$ 2005 = 0.1851
$LSD_{0.05}$ 2006 = 0.18591

3. Fresh fruit yield and quality;

Results in Table 2 show clearly that, there are no significant differences between irrigation treatments (80% and 100% from ETc) and total fresh yield of cantaloupe in the two growing seasons, which means that it is better to irrigate with less water (80%) and the yield will not significantly affected. So, we can save water and get more yields too. Also, there is significant increase, in fresh fruit yield with soil conditioners treatments comparing with the control treatment and at the same time there are different in values between the soil conditioners treatments in the two growing seasons. The treatment (Organic + Tafla + Polymer) was the highest and (Organic + Tafla) was the lowest in the two growing seasons These results are in agreement with Brantly. (1959); Brantly and Warren. (1961) and Walter Russell. (1973)

Concerning the total soluble solids (TSS) as a crop quality results in Table 3 show that there are significant increase in TSS with decreasing the amount of applied irrigation water from 100 to 80% ETc. That means irrigating with 80% gives higher quality than 100%. These results are similar to those obtained by Brantly and warren, (1960); Metwalli *et al.*, (2004).

Table 2: The effect of studied variables on total fruit yield of cantaloupe (t/ feddan).

Treatments	2005		2006		2005	2006
	80%	100%	80%	100%	Mean	
Control	7.65	7.17	6.25	5.79	7.41 d	6.02 e
Organic	12.93	11.91	10.93	10.84	12.42 b	10.88 c
Organic + Tafla	10.56	10.28	8 76	8 41	10.82 c	8.586 d
Organic + Polymer	14.03	13.68	12.89	12.45	13.85 b	12.673 b
Organic+Tafla+Polymer	16.27	16.45	14.87	14.67	16.36 a	14.766 a
Mean	12.2866 a	11.8986 a	10.74 a	10.43 a		
$LSD_{0.05}$	0.9381		0.72024		1.653	1.047

Total soluble solids (TSS):

Table 3: The Total soluble solids (TSS) in cantaloupe fruits as affected by tested variables.

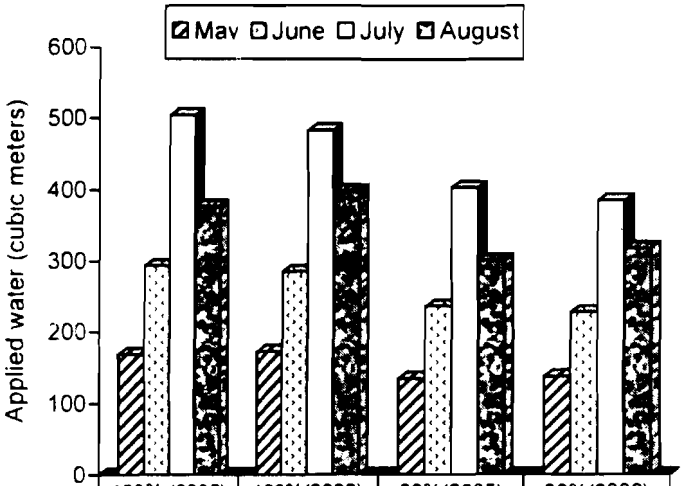
Treatments	2005		2006		2005	2006
	80%	100%	80%	100%	Mean	
Control	11.00	9.50	11.00	9.83	10.25 b	10.41 b
Organic	10.00	9 16	10.30	9.33	9.58 c	9.91 c
Organic + Tafla	11.33	9.83	11.33	10.16	10.58 a	10.73 a
Organic + Polymer	10.50	9.66	10.33	9.50	10.08 b	10.00 c
Organic+Tafla+Polymer	10.66	9.50	10.66	9.33	10.08 b	10.00 c
Mean	10.76 a	9.50 b	10.76	9.66		
$LSD_{0.05}$	0.4266		0.21007		0.2850	0.2578

4. Irrigation treatments and water utilization efficiency (WUtE):

Applied irrigation water (AIW):

Results presents the following graph and Table, show the amount of applied water for cantaloupe (100% and 80%) under different soil conditioners and its effect on fresh fruit yield. Results indicated that, the average AIW during 2005 and 2006 seasons were 1295.9 and 1073.5 m^3/fed for 100% and 80%, respectively. These results are in agreement with,(1973). Also, average of yield, average of applied water and average WUtE for cantaloupe as affected by tested variables are presented in Table 4. Average water utilization efficiency (WUtE) values for (2005 & 2006) seasons for the irrigation treatment (100% ETc) were 5, 8.8, 7.2, 10.1 and 10.5 kg cantaloupe /m^3 applied water for the control, organic, organic + tafla, organic + polymer and organic + tafla + polymer, treatments, respectively. These values for the (80% ETc) treatment were 6.4, 11.6, 8.99, 12.5 and 14.5 kg cantaloupe/m^3 applied water for the same representative treatments.

Average applied irrigation water for cantaloup in the two growing seasons.



	100% (2005)	100%(2006)	80%(2005)	80%(2006)
May	168	172.2	134.4	137.76
June	294	285.6	235.2	228.5
July	504	483	403.2	386 4
August	378	399	302 4	319.2

Water Utilization Efficiency (WUtE):

Table 4: Average fruit yield, average applied water and water utilization efficiency.

Treatments soil conditions	Av. Yield t/fed.		Av. Applied water m^3/fed.		Av. WUtE	
	80%	100%	80%	100%	Mean	
Control	6.48	6.95	1295.9	1073.5	5.0	6.4
Organic	11.38	12.42	1295.9	1073.5	8.8	11.6
Organic + Tafla	9.35	9.66	1295.9	1073.5	7.2	8.99
Organic + Polymer	13.07	13.46	1295.9	1073.5	10.1	12.5
Organic+Tafla+Polymer	15.56	15.57	1295.9	1073.5	10.5	14.5

Conclusions:

The tested treatment (80% ETc) with soil conditioners (tafla + organic + polymer) gave the best tested treatment. This combination will save irrigation water at same time higher yield than the other tested treatments.

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الملخص العربى

تأثير كميات الرى ومحسنات التربة على محصول الكنتالوب ومكوناته تحت نظام الرى بالتنقيط فى الأراضى الجيرية

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١ ، ٣ معهد بحوث البساتين ، ٢ معهد بحوث الأراضي والمياه والبيئة

أجريت تجربتان حقليتان بالأراضى الجيرية بمحطة بحوث بساتين النوبارية فى موسمى صيفى ٢٠٠٥ و ٢٠٠٦ . الهدف من هذا البحث هو دراسة تأثير الرى بكميات مياه تعادل ١٠٠% و٨٠% من جهد البخر نتح للمحصول تمثل القطع الرئيسية ومعاملات المحسنات الأرضية للتربة تمثل القطع المنشقة وهى:

- بدون إضافة محسنات للتربة (كنترول).
- إضافة مادة عضوية ٢٠ م٣/فدان.
- إضافة بوليمر ٠,٠١% على أساس الوزن + مادة عضوية ٢٠ م٣/فدان.

- إضافة طفلة ٠,٢ % على أساس الوزن + مادة عضوية ٢٠ م٣/فدان.
- إضافة بوليمر ٠,٠١% على أساس الوزن + مادة عضوية ٢٠ م٣/فدان+ إضافة طفلة ٠,٢ % على أساس الوزن.

وقد أوضحت النتائج ما يلى :

- متوسط طول أفرع الكنتالوب كانت معنوية مع معاملة الرى ١٠٠% من جهد البخر نتح للمحصول (ETC) مع محسنات التربة (بوليمر + طفلة + مادة عصوية).
- متوسط المواد الذائبة الكلية (TSS) كانت معنوية مع معاملة الرى ٨٠% من جهد البخر نتح للمحصول ومع معاملة المحسنات (الطفلة + المادة العضويه خلال موسمى الدراسة).
- متوسط إنتاج محصول الكنتالوب الطازج وصل الى أعلى قيمة خلال موسمى النمو ٢٠٠٥ و٢٠٠٦ مع معاملة رى ٨٠% من جهد البخر نتح للمحصول ومع معاملة المحسنات للتربة (مادة عضوية + بوليكر + طفلة) وكانت القيم الناتجة ١٦,٣٦ و ١٤,٧٧ طن/فدان لموسمى ٢٠٠٥ و ٢٠٠٦ على التوالى.