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SQUASH PRODUCTION USING CONTINUOUS AND SURGE DRIP IRRIGATION

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ABSTRACT

The effect of irrigation techniques (surge and continuous drip) and two irrigation water levels of crop water requirements (100% and 80% of CWR) on squash production in new lands were investigated.

The results indicated that wetted areas increased by increasing the irrigation water level. The highest value of yield (5893 kg/fed.) was obtained from T_4 (surge irrigation with 100% of crop water requirements with 45 min irrigation cut-off). Maximum water use efficiency value (7.38 kg/m^3) was recorded with T_9 and T_{10} (surge irrigation, 80% of crop water requirements with 45 min and 60 min irrigation cut-off resp.)

INTRODUCTION

Squash is one of the most popular vegetative crops in Egypt. The cultivated area of squash reached about 95471.0 fed during 2007, which produced yield of about 724579 Mg according to Agric. Statistics (2008).

Hamada and Abd Allah (1997) studied surface irrigation via the other- row and surge irrigation techniques, and reported that total volume of applied water, under the other row and surge irrigation were considerably less than those for the controls. Also data proved that field water use efficiency was improved under the tested irrigation methods.

Abdallah and Sallam (2002) studied consumptive use and yield affected by water regime for squash under sprinkler irrigation system. They reported that calculated irrigation water were 1117.0, 1025.0 and 727.0 m^3 / fed. (3 levels) water use efficiency (WUE) increased in the higher level of irrigation water compared with the others.

Zin EL-Abedin and Ismail (1998) reported that moisture content VS. Soil depth indicated that when the off-time is higher that the on-time the moisture had better distribution then that of continuous application. Also the reduction in the infiltration rate was related to the increase in the soil bulk density.

Izuno *et al*, (1985) and walker and Humpherys (1983) concluded that portions of the furrow first wetted after cut-off of the previous surge have a transition infiltration rate whose magnitude lies between the high time dependent rate and the surge lowered rate.

Testezlaf *et al* (1987) pointed out that surge flow caused a one-thirds in the quasi-steady infiltration rates. The infiltration rate increased at the beginning of each new surge cycle, but then quickly declined.

Walker *et al* (1982) reported that the surge flow irrigation can reduce the infiltration rate in second and third irrigation.

The main objectives of this work were to study the effect of irrigation method, amount of irrigation water and irrigation cut-off on soil wetted areas, soil salinity and yield.

MATERIALS AND METHODS

2.1 Experimental Site:

Field experiments were conducted at the college new established farm in Kalabsho Zyan area – Dakahleya governorate. The field study was started during winter season of 2008/2009. The experimental site has been planted by squash (Eskandarany variety) with 0.75 m row's spacing and about 0.50 m spacing in the row.

Soil texture is sandy in the top layer (90 cm). Soil physical properties and the soil classification (according to Soil and Water Analysis Lab. Fac. of Agric. Mansoura Univ.) are shown in Table (1).

Table (1): Soil physical properties and classification.

Depth cm	Mechanical analysis %			Soil classification	PH 1/2.5	Field Capasity %	Willting point %
	Clay	Silt	Sand				
0- 30	2.30	8.10	89.60	Sandy	8.45	9.20	4.40
30- 60	2.20	8.05	89.75	Sandy	8.46	9.20	4.50
60-90	2.20	8.00	89.80	Sandy	8.50	9.25	4.40

2.2 Irrigation Network:

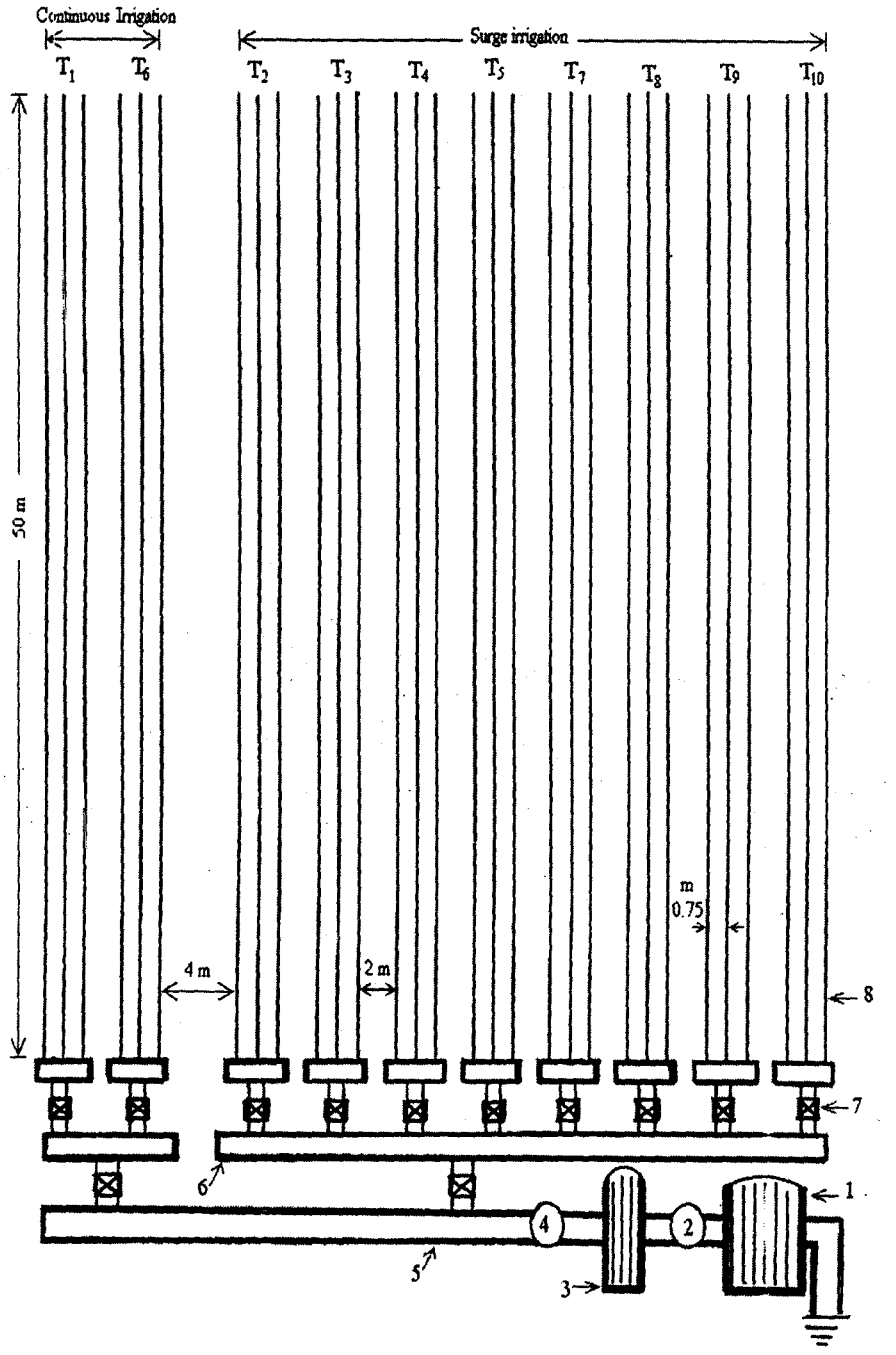
Drip irrigation system was selected in this study as a modern irrigation method.

As shown in fig. (1) drip lines were 16 mm (inside diameter) with 4 L/h irrigation water discharge / dripper at 1.0 bar operating pressure.

Experimental network consists of; pump, main line (□= 50 mm), sub main lines (□ 32 mm), drip laterals (□ = 16 mm), valves (one valve for each treatment and many main valves), filter, flow meter and pressure gauge as shown in fig. (1).

2.3 Crop Water Requirements (CWR):

Crop Water Requirements (CWR) were determined by using pan evaporation method class «A» and climatic data during the different crop stages according to FAO (1977).



1- Pump
2- Flow meter
3- Filter
4- Pressure gauge
5- Main line
6- Submain line
7- Valve
8- Drip line

Fig (1): Irrigation network

2.4 Irrigation Treatments:

* Two irrigation techniques were applied:

- Continuous drip irrigation (cut-off time = zero) which supply yield with calculated irrigation water (non-stop).
- Surge drip irrigation which supply yield with calculated irrigation water with 15, 30, 45 and 60 min irrigation cut-off in the middle of irrigation time.

* Two irrigation water levels were investigated

- Irrigation with 100% of CWR.
- Irrigation with 80% of CWR.

The different treatments may be classified as follows:

T_1: Continuous drip irrigation by 100% of CWR.
T_2: Surge drip irrigation by 100% of CWR with 15 min cut-off in the middle of irrigation time.
T_3: Surge drip irrigation by 100% of CWR with 30 min cut-off in the middle of irrigation time.
T_4: Surge drip irrigation by 100% of CWR with 45 min cut-off in the middle of irrigation time.
T_5: Surge drip irrigation by 100% of CWR with 60 min cut-off in the middle of irrigation time.
T_6: Continuous drip irrigation by 80% of CWR.
T_7: Surge drip irrigation by 80% of CWR with 15 min cut-off in the middle of irrigation time.
T_8: Surge drip irrigation by 80% of CWR with 30 min cut-off in the middle of irrigation time.
T_9: Surge drip irrigation by 80% of CWR with 45 min cut-off in the middle of irrigation time.
T_{10}: Surge drip irrigation by 80% of CWR with 60 min cut-off in the middle of irrigation time.

Every treatment has 105 m^2 (2.1 m width x 50 m length).

2.5 Measurements:

Measurements recording in this study may be summarized as follows:

2.5.1 Soil moisture distribution and wetted area.

It was determined (at the end of season) 5-6 hours after irrigation. Soil samples were taken around and under drippers for all treatments using gravimetric method **(Michael 1978).**

2.5.2 Soil salinity distribution

Soil salinity was measured by using electrical conductivity meter in 1: 5 soil water extract samples as described by Black (1965).

2.5.3 Yield

- Total obtained yield from different treatments was recorded during harvesting time (Mg/fed.).
- Effect of irrigation level and irrigation technique on yield.

2.5.4 Irrigation water applied (m^3/fed.)

Irrigation water applied = total amount of irrigation water during season (m^3/fed).

2.5.5 Water use efficiency «WUE» (kg/m^3)

It was determined according to Awady *et al.* (1976) and using the following equation:

$$\text{Water use efficiency} = \frac{\text{Total yield kg/fed}}{\text{Total applied water m}^3\text{/fed}} \quad \text{kg/m}^3$$

2-5-6 Statistical analysis

- Statistical analysis was calculated using two factors completely randomize design.

RESULTS AND DISCUSSION

3.1 Soil moisture distribution and wetted area:

Data in figs (2) and (3) show the soil moisture distribution and wetted areas for 100% and 80% irrigation level resp. Wetted areas in figs (2 and 3) which have moisture content between F.C. and W.P.

- Irrigation level 100% of CWR:

Data in fig (2) indicated that wetted areas which were obtained with continuous irrigation (T_1) more depth and extended to about 40 cm depth while depth of wetted areas for the surge irrigation (T_2, T_3, T_4 and T_5) varied between 35 to 38 cm. But the width of wetted areas were about 20 cm (in the upper layers) for continuous irrigation (T_1) and reached to about 35-37 cm under surge irrigation (T_2, T_3, T_4 and T_5) as shown in fig(2).

- Irrigation level 80% of CWR:

Data in fig (3) indicated that wetted areas which were obtained under continuous irrigation (T_6) more depth from the others under surge irrigation and reached to about 35 cm. Treatments under surge irrigation (T_7, T_8, T_9 and T_{10}) had wetted depth between 30 to 34 cm. On anther hand there difference in width of wetted areas under the different treatments; it was 20 cm with continuous irrigation (T_6) and reached to about 32 cm under surge irrigation.

On anther hand, figs (2 and 3) indicated that wetted areas which have moisture content between F.C. and W.P. (available water) increased by increasing level of irrigation water. Also areas of available water increased under surge irrigation than the same treatments under continuous irrigation.

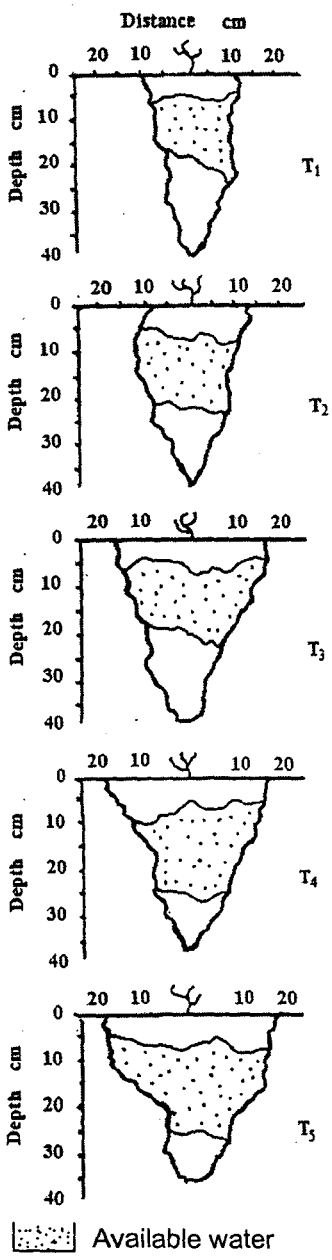


Fig (2): Soil moisture distribution with 80% of CWR

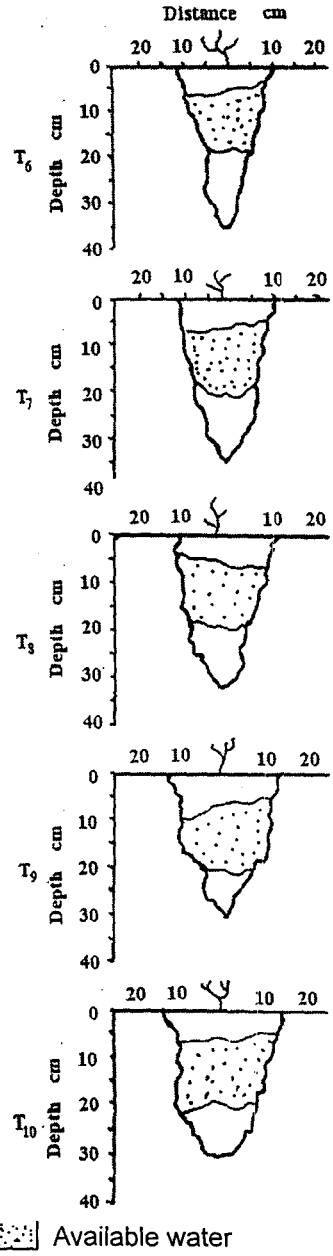


Fig (3): Soil moisture distribution with 100% of CWR

Generally, it can be concluded that:
- Wetted areas increased by increasing level of irrigation water.
- Surge irrigation method is more suitable for squash which has small roots which need wetted zoon in the upper soil layers.

3.2 Soil salinity

Data in table (2) shows E.C. values under the different treatments

Table (2): Soil salinity values (ds/m) for the different depth under all treatments.

Treatments	Depth cm					
	Zero (soil surface)	15	30	45	60	Means
T_1	4.10	4.10	4.20	4.35	4.45	4.24
T_2	4.15	4.15	4.40	4.40	4.50	4.32
T_3	4.10	4.19	4.15	4.30	4.35	4.22
T_4	4.22	4.25	4.25	4.40	4.46	4.32
T_5	4.12	4.20	4.30	4.35	4.42	4.28
T_6	4.20	4.25	4.35	4.35	4.50	4.33
T_7	4.20	4.25	4.30	4.40	4.45	4.32
T_8	4.30	4.17	4.30	4.35	4.48	4.32
T_9	4.10	4.20	4.19	4.30	4.42	4.24
T_{10}	4.40	4.30	4.40	4.43	4.48	4.40

Data indicated that E.C. values varied between 4.22 to 4.40 ds/m. It can be seen that the highest values of E.C. were found at the deeper layers (60 cm under soil surface). It because the farm near Mediterranean Sea (about 8-10 km distance) therefore underground water in the farm has high salt accumulation.

3.3 Yield

- Average yield.

Table (3) shows the effect of different irrigation treatments on yield.

Table (3): Average yield for the different treatments.

Level of irrigation					
Treatments	100% of CWR		Treatments	80% of CWR	
	Yield			Yield	
	kg/treat.	Mg/fed		kg/treat.	Mg/fed
T_1	139.5	5.583	T_6	124.0	4.972
T_2	143.0	5.723	T_7	140.0	5.602
T_3	142.0	5.686	T_8	137.0	5.503
T_4	147.0	5.893	T_9	140.0	5.630
T_5	146.0	5.846	T_{10}	140.0	5.631

Data indicated that the maximum yield was 5.893 Mg/fed obtained with treatment (4), while minimum yield was 4.972 Mg/fed obtained with treatment (6). This means that the highest yield recorded by using the higher CWR (100%) under surge irrigation with 45 min cut-off in the middle of irrigation time. So one may say that surge drip irrigation has strong effect on yield with 45 min cut-off using 100% of CWR.

- Effect of irrigation level and irrigation technique on yield:

Table (4): Effect of irrigation level on yield.

100% of CWR		80% of CWR		Increasing value Mg/fed.	Increasing Ratio %
Treatment	Yield Mg/fed.	Treatment	Yield Mg/fed.		
T_1	5.583	T_6	4.972	0.61	10.9
T_2	5.723	T_7	5.602	0.12	2.1
T_3	5.686	T_8	5.503	0.10	3.2
T_4	5.893	T_9	5.630	0.26	4.5
T_5	5.846	T_{10}	5.631	0.22	3.7

Tables (4 and 5) show effect of irrigation level and irrigation technique on yield.

Data in table (4) indicated that yield increased by increasing irrigation water level. Increasing ratio varied between 10.9% and 2.1%. The highest increasing ratio obtained under continuous irrigation.

Table (5): Effect of irrigation technique on yield:

Irrigation level	Surge irrigation	Yield Mg/fed.	Continuous irrigation	Yield Mg/fed.	Increasing Value Mg/fed.	Increasing Ratio %
100 % of CWR	T_2	5.723	T_1	5.583	0.14	2.4
	T_3	5.686			0.10	1.8
	T_4	5.893			0.31	5.3
	T_5	5.846			0.26	4.5
80% of CWR	T_7	5.602	T_6	4.972	0.63	11.2
	T_8	5.503			0.53	9.6
	T_9	5.630			0.66	11.7
	T_{10}	5.631			0.66	11.7

Data in table (5) indicated that yield values increased under surge irrigation more than the same treatments under continuous irrigation. Increasing ratio varied between 1.8% and 11.7%.

Generally, it can be concluded that,

- the highest yield obtained under using surge irrigation and the values of yield increasing ratio increased by increasing cut-off time of irrigation.

3.4 Applied irrigation water:

Amount of water applied/season for the two irrigation water levels (100% and 80% of CWR), where (954.0 and 763.0 m^3/fed).

3.5 Water use efficiency (WUE):

Table (6) shows the water use efficiency (WUE) for the different treatments. Data indicated that, the maximum water use efficiency was 7.38 kg/m^3 recorded with treatments T_9 and T_{10}.

Table (6): Water use efficiency (kg/m^3) for different treatments:

Level of irrigation water							
Treatments	100% of CWR			Treatments	80% of CWR		
	Yield kg/fed	Applied irrigation water m^3/fed	WUE kg/m^3		Yield kg/fed	Applied irrigation water m^3/fed	WUE kg/m^3
T_1	5583	954.0	5.85	T_6	4972	763.0	6.52
T_2	5723		6.00	T_7	5602		7.34
T_3	5686		5.96	T_8	5503		7.21
T_4	5893		6.17	T_9	5630		7.38
T_5	5840		6.13	T_{10}	5631		7.38

3-6 Statistical Analysis

Statistical analysis was calculated using two factors completely randomize design.

Table (7) shows ANOVA (analysis of variance) for the effect of irrigation levels (A), cut-off time (B) and interaction (A x B) on squash yield. Data indicated that the effect of irrigation level (A) on yield was significant; also the effect of cut-off time (B) on yield was significant. But the interaction (A x B) was not significant.

Table (7): ANOVA for the effect of irrigation levels (A), cut-off time (B) and interaction (AXB) on yield.

SV	DF	SS	MS	F	Significant
Replications	-	-	-	-	-
Irrigation levels(A)	1	0.765	0.765	6.42	0.01 (*)
Cut-off time (B)	4	1.656	0.044	3.48	0.03 (*)
Interaction (A x B)	4	0.864	0.215	1.80	0.016 (NS)
Error	-	-	-	-	-
Total	-	-	-	-	-

NS: not significant *= significant at 5% level

Table (8) shows the means of the significant yield values. Data indicated that irrigation water level has effect on yield.

Form the statistical analysis, regression equation for calculate the amount of yield:

Yield =

6.66 – 0.014 x level of irrigation +0.00679 x cut-off time Mg/fed

R^2 = 80.3%

Table (8) The means for the significant values.

Factors	Means	LSD	
		5%	1%
Irrigation level (A)	5.74, 5.42	0.25	--------
Cut-off time (B)	5.38 , 5.56 , 5.43 , 5.50 ,6.03	0.39	--------
Interaction (AB)	5.43 , 5.33 , 5.80 , 5.31 ,5.57 5.29 , 5.93 , 5.07 , 5.97 ,5.10	0.55	--------

CONCLUSION

The following conclusion may be drawn:

- **Soil moisture distribution**
  - Wetted area increased by increasing the irrigation water level .
  - Width of wetted areas increased by increasing cut-off time of irrigation.
- **Soil salinity**
  - Soil salinity values (E.C.) varied between 4.10 to 4.50 (ds/m).
  - The highest values of E.C. were found in the deeper layers (60 cm under soil surface)

- **Yield**
  - The highest yield (5893 Kg/fed.) was obtained with T_4 (surge irrigation with 100% of crop water requirements and 45 min cut-off).
  - The maximum water use efficiency value (7.38 Kg/m^3) was recorded with treatments 9 and 10.
  - Generally highest values of WUE were obtained under surge irrigation with low irrigation level (80% of crop water requirements).

Recommendation

It can recommended that surge drip irrigation in sandy is more suitable for vegetables production which have small roots.

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إنتاج الكوسة بإستخدام الري بالتنقيط المستمر والمتقطع

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أجريت هذه الدراسة على محصول الكوسة الإسكندراني في أرض رملية بمزرعة كلية زراعة المنصورة بمنطقة قلابشو وزيان (١٠كم تقريبا من البحر المتوسط) خلال الموسم الشتوي ٢٠٠٨/٢٠٠٩.

وتهدف الدراسة إلى إستخدام نظام الري بالتنقيط (المستمر والمتقطع) ومعرفة تأثير ذلك على التربة والمحصول. وقد كانت معاملات الدراسة إستخدام أسلوبين للري بالتنقيط (مستمر ومتقطع) ومستويين لكميات مياة الري ١٠٠%، ٨٠% من الإحتياجات المائية للمحصول. وقد كان هناك أربع أزمنة لإيقاف عملية الري (في الري المتقطع) هي ١٥، ٣٠، ٤٥، ٦٠ق وذلك في منتصف الزمن الخاص بعملية الري في كل رية.

- وقد تم دراسة تأثير المعاملات على:
- توزيع الرطوبة في التربة.
- تأثير عملية الري في ملوحة التربة.
- كمية المحصول الناتج.
- كفاءة إستخدام مياة الري.

وقد كانت أهم النتائج ما يلي:

- إزدادت المساحة المبتلة في التربة بزيادة مستوى الري.
- إزداد إتساع المساحة المبتلة بالتربة في الري المتقطع عنه في الري المستمر بينما زاد عمق المساحة المبتلة في الري المستمر عنه في الري المتقطع.
- المساحة التي تحتوي على نسبة الماء اليسر للنبات كانت أكبر في نظام الري المتقطع عنه في الري المستمر.
- أعلى كمية محصول (٥٨٩٣ كجم/ف) وقد تم الحصول عليها بإستخدام الري المتقطع مع ٤٥ دقيقة إيقاف لعملية الري مع مستوى ري ١٠٠% من الإحتياجات المائية للمحصول.
- على كفاءة لإستخدام مياة الري (٧,٣٨ كجم/م^3) وقد تم الحصول عليها تحت نظام الري المتقطع مع فترات إيقاف لعملية الري ٤٥، ٦٠ دقيقة ومستوى ري يعادل ٨٠% من الإحتياجات المائية للمحصول.