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Saving Irrigation Water and its Effect on Thompson Seedless Grape Productivity and Fruit Shelf Life Quality

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ABSTRACT

In Egypt, less than 50% of the cultivated area is situated in old lands under the non-controlled flood irrigation system where the average irrigation system efficiency is only about 50%, and grape productivity is only 7.51ton/feddan is significantly low compared to other grape-growing conditions. A trial was conducted in a controlled flood irrigation system during two successive seasons (2005 and 2006) for Thompson seedless grapevines grown in the Experimental Farm of Mansoura Research Station, Dakahlia, Egypt. Five irrigation treatments (T) were carried out. T1 (control) represents irrigation as commonly practiced by the farmer. In contrast, T2, T3, T4 and T5 represent irrigation at 120%, 100%, 80% and 60% from pan evaporation, (E_{pan}), respectively obtained from the nearest climatic station to the vineyard site (Aga Weather Station). Effects of irrigation levels on Thompson seedless grape productivity and fruit shelf life quality were mustered. Berry firmness and adherence strength for all irrigation treatments gradually decreased with an advanced shelf life period (25-30°C and relative humidity 50%) during both seasons of this study. Loss in weight, decay, shatters and shrinks percentages increased by increasing irrigation water and increased also by increasing the shelf-life period.

Keywords:
Thompson seedless; Water-saving; Shelf-life; Shatter; Lose in weight; Total loss.

1. INTRODUCTION

Grapes are cultivated on all the continents of the world except Antarctica and are the most widely distributed fruit crop. This widespread distribution of vines is thanks to the large genetic diversity of available vine species and cultivars.

Water shortage is the most significant limiting factor of crop production worldwide **(Costa *et al.*, 2007; Cominelli *et al.*, 2009)**. Where **Metochis (2006)**, recorded that differential irrigation, ranging from 60 to 120% of the irrigation requirement (125 to 250 mm), did not affect the earliness of grape production. The effect of irrigation scheduling on table grapes under drip irrigation were studied by **Gurovich (2002)**, who mentioned that for 75% ETc treatment, cluster weight was larger than that produced on the 50% ETc treatment; and it have a positive effect on cluster and rachis weight and berry weight and diameter. Similar results were found by **Messaoudi and El-Fellah (2004)**, they found all treatments lower than 80% ETc was affecting negatively on bunch weight, berry number per bunch, berry diameter and affecting negatively on acidity decrease while soluble solids content (S.S.C) increased when 80% ETc constituted the optimal water consumption. **Reynolds *et al*. (2005)**, in Gewurztraminer grapevines, indicated that cluster and berry weight was reduced linearly with the duration of water deficit. **Selles *et al*. (2004)**, in a field trial on table grapes (*Vitis vinifera,* L. cv. Thompson seedless), illustrated that the use of drip irrigation with longer duration and less frequent application on fine-textured soils favored water distribution in the soil resulting in an increase in soluble solids content (S.S.C) at harvest. **Storchi *et al*. (2005)**, reported that high soil water availability from veraison to harvest induced more vegetative growth and reduced sugar. However, vineyards with low soil water availability during hot, dry summers had a low sugar content and acidity. As for changes in fruit weight loss and decay (total loss), **Tourky *et al*. (1995)**, on grapes, **El-Shobaky and Mohamed (2000)**, on Washington Navel orange, and **Tourky *et al.* (2006)**, on the banana. They found that loss in fruit weight, decay, and total loss significantly increased with the storage period advanced. **Mohamed and Ibrahim (2003)**, and **Mohamed and Hassan (2003)**, studied grape bunch freshness at storage they found that grape bunch freshness significantly deteriorated with prolonging the storage period.

2. MATERIALS AND METHODS

The trail was conducted during years 2005 and 2006 in the Experimental Farm of Mansoura Research Station on Thompson seedless grapevines. Vines were 8 years old growing in a clay soil with a field capacity 41.5% and welting point 22.5% under controlled flood irrigation system. Vines were spaced 2x3 m, and trained according to the cane system (pruned six canes, each bearing 12 eyes) under double T trellis system. Five irrigation treatments were carried out as shown in Table 1.

Table 1: Irrigation treatments

Irrigation treatments	
T_1^*	*Control
T_2	120% from pan evaporation
T_3	100% from pan evaporation
T_4	80% from pan evaporation
T_5	60% from pan evaporation

*Irrigated as practiced by farmer (it was found 126% from pan evaporation)

These treatments were arranged in a complete randomized block design with 3 replicates of 3 vines. The area of each plot in this study was 70 m^2. Vines had chosen similar in vigor and free from diseases.

2.1.Pan evaporation (E_{pan})

Daily pan evaporation (E_{pan}) was obtained from Aga Weather Station, for 2005 and 2006 seasons. Aga Weather Station is the nearest climatic station to the vineyard site. The data presented in Table 2. The irrigation frequencies and dates for both seasons indicated in Table 3. Monthly and total amount of irrigation water (mm/season) and (m^3/fed/season) during both seasons illustrated in Table 4.

Table 2: Average of daily pan evaporation (E_{pan}) during 2005 and 2006 seasons

Months	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Seasons	E_{pan} (mm)							
2005	3.5	4.6	5.3	5.7	6.2	6.0	5.5	4.8
2006	3.7	4.8	5.5	6.0	6.3	6.1	5.6	5.0

Table 3: Irrigation frequencies and dates for 2005 and 2006 seasons

Months	Mar.	Apr.	May		Jun.		Jul.		Aug.	Sep.	Oct.	Total irrigation frequencies
	Irrigation frequencies and dates / Frequencies											
Seasons	1	1	2		2		2		1	1	1	11
2005	20/3	23/4	8/5	23/5	5/6	20/6	5/7	24/7	21/8	18/9	15/10	
2006	22/3	20/4	6/5	22/5	7/6	24/6	7/7	27/7	23/8	20/9	20/10	

Table 4: Monthly and total amount of irrigation water (mm/season) and (m^3/fed/season) during 2005 and 2006 seasons

Months Treatments	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Total (mm/ season)	Total (m^3/fed/ season)
Season 2005										
T_1	87.0	146.8	158.2	174.0	192.9	183.2	161.5	141.5	1245.1	5229.4
T_2	86.0	129.5	150.5	168.1	187.5	176.6	156.3	130.4	1184.9	4976.6
T_3	79.3	120.3	141.6	153.6	175.9	163.8	140.6	120.4	1095.5	4601.1
T_4	75.7	94.2	122.5	138.3	164.6	140.1	124.3	95.9	955.6	4013.5
T_5	72.4	77.8	83.3	113.1	134.3	120.2	92.8	74.7	768.6	3228.1
Season 2006										
T_1	92.4	147.7	160.6	187.0	197.6	184.1	162.3	142.1	1273.8	5349.9
T_2	91.8	135.9	155.8	177.4	191.5	180.6	157.5	135.7	1226.2	5150.0
T_3	91.5	127.8	148.5	160.8	177.9	168.0	146.3	127.6	1148.4	4823.3
T_4	89.5	96.7	123.1	144.9	167.2	148.4	126.8	98.0	994.6	4177.3
T_5	76.8	80.8	86.3	116.4	138.3	123.2	95.8	78.7	796.3	3344.5

2.2.Methods of various plant observations:

Bud behavior measurements:

Budburst percentage

The percentage of budburst was estimated by counting the number of bursts and expressed as a percentage from the total number of buds left on the vine according to the following equation:

Budburst % = (No. of burst buds/vine) ÷ (No. of buds/vine) x 100 [1]

2.3.Fertile bud percentage

The percentage of fertile buds was estimated by counting the number of fertile buds (buds which given clusters) and expressed as a percentage from the total number of buds left on the vine according to the following equation:

Fertile buds % = (No. of fertile buds/vine) ÷ (No. of buds/vine) x 100 [2]

2.4. Bud fruitfulness percentage

It was calculated by recording the number of clusters then expressed as a percentage from the total number of buds left on the vine according to the following equation:

Bud fruitfulness % = (No. of clusters/vine) ÷ (No. of fertile buds/vine) x 100 [3]

2.4.Yield and fruit quality

At harvest, date clusters per vine for each irrigation treatment was counted to weight and average yield/vine in kilograms was estimated. Representative random samples of 16 clusters/each treatment (4 clusters from each replicate) were taken to the laboratory to determine the clusters and berries' quality.

2.5.Effect of irrigation treatments on fruit behavior of Thompson seedless grapes during shelf life period:

Fruits from treatments were picked at harvest date and immediately taken to laboratory to sort and packed in carton boxes (3 kg grapes each) three replicates of nine samples from every treatment were taken to be held at room temperature (25-30 °C and R.H 45%). Samples were examined at 3 days interval to be objected the following determinations:

- Berry adherence strength (g/cm^3) by using Shatilon's instrument.
- Berry firmness (lb/in^2) by using Shatilon's instrument.
- Soluble solid content percentage (S.S.C%) using hand refractometer.
- The total acidity in juice berries expressed as g tartaric acid/100 ml juice according to the official methods of analysis **(A.O.A.C, 1970)**
- Soluble solid content/acid ratio (S.S.C/Acid).
- Loss in weight percentage.
- Berry decay percentage.
- Berry shatters percentage.
- Berry shrink percentage.
- Total loss percentage: it was collected by adding the percentages of loss in weight, decayed, shatter and shrinks fruits.

Bunch freshness

Stem color, dryness and berry appearance were estimated as shown in Table 5.

Table 5: Bunch freshness

Degree Properties	1	2	3	4
Stem color	Green	Little green	Little brown	Brown
Stem dryness	Plump	50% dry	Dry	Very dry
Berry appearance	Excellent	Good	Acceptable	Poor

2.6.*Statistical analysis*

The obtained data throughout the two seasons were subjected to analysis of **SAS Computer Program (1998)** according to Duncan's multiple ranges. This test was used for comparison between means. Different alphabetical letters in the column are significantly at the level of 5% of significance.

3. RESULTS AND DISCUSSION

-Effect of irrigation treatments on bud behavior of Thompson seedless grapevines:

3.1.Budburst percentage

The effect of irrigation treatments on budburst percentage of Thompson seedless grapevines during 2006 season, it can be noticed from Table 6 that the highest recorded percentages were for irrigation treatments 60% E_{pan} (T_5) and 80% E_{pan} (T_4) which had (70.9 and 68.8%), respectively. However, the highest irrigation treatments 100 % E_{pan} (T_3), 120 % E_{pan} (T_2) and control treatment (T_1) gave the lowest percentage of budburst but no significant effect appeared between these three treatments. It can be concluded that the percentage of budburst of Thompson seedless grapes decreased by increasing irrigation water.

3.2. Fruitful bud percentage

The effect of irrigation treatments on the percentage of fruitful buds of Thompson seedless grapevines for the 2006 season is presented in Table 6. In dealing with the differences between the irrigation treatments, it was found that irrigation treatment 120% E_{pan} (T_2) produced the highest fruitful buds percentage (25.7%) followed by irrigation treatments the control (T_1) and 100% E_{pan} (T_3) (25 and 22.3%), respectively, the data show no significant differences between them. It is clear from the same Table that the lowest percentages were for 60% E_{pan} (T_5) and 80 % E_{pan} (T_4) (16 and 20%), respectively.

3.3. Fruitfulness bud percentage

Data presented in Table 6 show the effect of irrigation treatments on fruitfulness buds of Thompson seedless grapevines. The obtained results revealed a positive relationship between irrigation and its effect on fruitfulness buds percentage, i.e. increasing the amount of applied irrigation water from 60% E_{pan} up to 120% E_{pan} progressively increased fruitfulness buds percentage. The data indicated that the irrigation treatment 120% E_{pan} (T_2) and 100% E_{pan} (T_3) showed the significant highest percentage (42.6 and 42.3%), respectively. While the significant least percentage was 31.3% for irrigation treatment 60% E_{pan} (T_5). Comparing the highest effect of the irrigation treatments (T_2) and (T_3) with the control treatment (T_1) no significant effect was detected.

Table 6: Effect of irrigation treatments on bud behavior of Thompson seedless grapevines during 2006 season

Properties Treatments	Budburst (%)	Fruitful buds (%)	Fruitfulness buds (%)
		Season 2006	
T_1	59.8b	25.0a	40.1a
T_2	60.5b	25.7a	42.6a
T_3	62.4b	22.3a	42.3a
T_4	68.8a	20.0ab	36.8b
T_5	70.9a	16.0b	31.3c

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5%.

Generally, and from the above-mentioned results, it is clear that fertile buds, as well as fruitfulness, had a similar pattern of response to different irrigation treatments during the study. In this regard, **Ckamande *et al*. (1996)** As well as **Ndung *et al*. (1996)** reported that in forcing kyoho grapevines water stress was effective in inducing early bud break, cluster formation, and increasing fruitfulness compared to continuously well-watered vines. In this context, **El-Gendy (2002)** indicated that the budburst percentage of Thompson seedless grapes decreased gradually by increasing water discharge of irrigation treatments so a gradual increase in fruitful buds percentage of Thompson seedless grape as applied water amounts increased from 0.75 to 1.5 ET irrigation treatments.

3.4. Effect of irrigation treatments on yield of Thompson seedless grapevines:

The obtained results in Table 7 show that the yield of Thompson seedless grapes increased by increasing the irrigation water. Such increases in general were statistically significant in both growing seasons. The yield expressed by yield/vine increased from (6.0 kg/vine) to (8.3 kg/vine) and from 7.0 kg/vine to 10.0 kg/vine by increasing the irrigation treatments from 60% E_{pan} (T_5) to 120% E_{pan} (T_2) for the two seasons, respectively. The percentage of increase reached about 38.3% and 42.8% for the two seasons, respectively.

Comparing the highest irrigation treatment 120% E_{pan} (T_2) which gave the highest yield with the control (T_1), it was found that the control irrigation treatment (T_1) detected the least yield in comparison with 120% E_{pan} (T_2) but the difference was not significant. These results seemed to be in harmony with the results mentioned by **Srinivas *et al*. (1999)** in "Anab-e-Shahi" grape (*Vitis vinifera*, L.) who found that vines yield increased as the irrigation water rates increased. Moreover, **Ferreyra *et al.* (2006)** disclosed that different irrigation water amounts were applied, between 40 and 100% crop evapotranspiration (ETc). They found that grapevine yield was decreased in comparison with applied water in the range of studied treatments. 60% ETc restriction decreased yield by 22%.

Table 7: Effect of irrigation treatments on yield of Thompson seedless grapevines during 2005 and 2006 seasons

Properties	Yield/vine (kg)		Yield/fed (kg)	
Treatments	Seasons			
	2005	2006	2005	2006
T_1	7.6a	9.2a	5320a	6440a
T_2	8.3a	10.0a	5810a	7000a
T_3	7.9a	9.9a	5530a	6720a
T_4	7.2ab	8.6ab	5040ab	6020ab
T_5	6.0b	7.0b	4200b	4900b

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5%.

3.5. Effect of irrigation treatments on fruit behavior of Thompson seedless grapes during shelf life:

3.5.1 Berry firmness

Table 8 shows the effect of irrigation treatments on berry firmness during the shelf-life period. As for the effect of irrigation treatments, it is clear that significant differences were obtained, where the highest irrigation treatment gave the significant lowest berry firmness. This is true for the two seasons of the study. As the effect of shelf life period on berry firmness, it was observed that berry firmness decreased as shelf life progressed. Berry firmness had a rapid decrease after 3 days of shelf life period followed by a gradual and continual decrease achieved by the progress of shelf-life period. This is true for the two seasons of the study. From the same Table, it is also clear that the lowest value of berry firmness was detected under the highest irrigation levels at the end of the shelf-life period. This is not strange since, the rate of degradation of insoluble protopectins to simple soluble pectin, was increased with the progress of shelf-life time finding agreed with those reported by **Hussein *et al.* (1998)** on guava, **Tarabia (2006)** on peach, and **Tourky *et al.* (2006)** on the banana. They mentioned that fruit firmness decreased with the progress of the shelf-life period.

3.5.2 Soluble solids content (S.S.C,%)

Data in Table 9 show the effect of irrigation treatments on S.S.C% of Thompson seedless grape during shelf life conditions. Results appeared that the lowest irrigation treatments 60% E_{pan} (T_5) and 80% E_{pan} (T_4) gave the significant highest values of S.S.C% while the significant lowest values were for 120% E_{pan} (T_2) and the control (T_1) treatments in 1st season. The same trend was detected in the second season. There was a gradual increase in S.S.C% towards the end of the shelf-life period under all irrigation treatments in both seasons. These increases were significant; the gradual increase in the percentage of S.S.C. which appeared during the shelf life period could be due to the degradation of complex insoluble compounds like starch to simple soluble compounds like sugars, which are the major component of S.S.C. in the fruits. In addition, other complex components degrade to soluble forms such as pectin and so on or this increase is due to water loss by transpiration through the shelf-life period. These results are in agreement with the findings of **Ram and Kartar (1996)**, who found that T.S.S. and total reducing sugar of Perlette grapes increased with increasing storage period.

3.5.3 Total acidity percentage

Data of the two studied seasons presented in Table 10 proved that increasing irrigation treatments increased the berry total acidity at harvest in two seasons of study. The accumulation of tartaric acid in berry juice was associated with increasing irrigation water. The decrease of acid percentage, during the shelf life period at room temperature (25-30^{o}C and 50% RH), could be due to the construction of organic acids through oxidation and consumption of these acids, as an organic substrate in the respiration processes of the fruit tissues. Also, the high temperatures and the progress of shelf-life raised the respiration rate of fresh fruits **(Ball, 1997 and Al-Shoffe, 2005)**. This, also, could explain the lower acidity in the fruits storage at high temperatures (20^{o}C). The lowest values of the total acidity were found at the end of the shelf-life period. This is true for the two seasons. These results seemed to be in harmony with that mentioned by **Tourky *et al.* (1995) and (1996)** who found that the total acidity values of Thomson seedless grapes were gradually decreased as the storage period progressed.

Table 8: Effect of irrigation treatments on berry firmness of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

	Berry firmness (Ib/in^2)									
Seasons	2005					2006				
	period in days									
Treatments	H*	3	6	9	Means	H*	3	6	9	Means
T_1	0.87b	0.83c	0.78c	0.70c	0.79d	0.93b	0.88c	0.83c	0.77c	0.85d
T_2	0.98b	0.93b	0.89b	0.78b	0.89c	1.00b	0.96b	0.90b	0.85b	0.93c
T_3	1.03ab	0.95b	0.90b	0.82b	0.92c	1.06ab	1.00b	0.96b	0.90b	0.98b
T_4	1.10a	0.97a	0.93b	0.87b	0.98b	1.20a	1.15a	1.10a	1.03a	1.12a
T_5	1.20a	1.10a	1.03a	0.97a	1.06a	1.25a	1.20a	1.15a	1.10a	1.17a
Means	1.04a	0.96b	0.91c	0.83d		1.09a	1.04b	0.99b	0.93c	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5% and H* = at harvest.

Table 9: Effect of irrigation treatments on S.S.C. percentage of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

	S.S.C (%)									
Seasons	2005					2006				
	Period in days									
Treatments	H*	3	6	9	Means	H*	3	6	9	Means
T_1	16.5a	16.8a	17.0a	17.5b	17.0c	16.6a	17.0b	17.3b	17.9b	17.3b
T_2	16.6a	16.9a	17.7a	18.3ab	17.4c	16.7a	17.3a	18.0a	18.7a	18.0ab
T_3	17.0a	17.6a	18.2a	18.7ab	17.8b	17.3a	17.7a	18.3a	19.0a	18.5a
T_4	17.2a	17.7a	18.4a	19.0a	18.2a	17.5a	18.0a	18.5a	19.3a	18.9a
T_5	17.4a	17.8a	18.4a	19.1a	18.5a	17.8a	18.3a	19.0a	19.6a	19.1a
Means	16.9c	17.4c	17.9b	18.8a		17.2c	17.9b	18.6b	19.7a	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5% and H* = at harvest.

Table 10: Effect of irrigation treatments on acidity percentage of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

Acidity (%)

Seasons	2005					2006				
	Period in days									
Treatments	H*	3	6	9	Means	H*	3	6	9	Means
T_1	0.73a	0.72a	0.70a	0.67a	0.71a	0.75a	0.73ab	0.70ab	0.68a	0.71a
T_2	0.70a	0.69a	0.66a	0.64a	0.67ab	0.73a	0.70a	0.68a	0.64a	0.69a
T_3	0.65b	0.63a	0.61ab	0.58ab	0.61bc	0.70b	0.69a	0.64a	0.60a	0.66a
T_4	0.62b	0.60ab	0.58ab	0.57b	0.59cd	0.64b	0.60ab	0.58ab	0.56b	0.60b
T_5	0.59c	0.57ab	0.56b	0.53b	0.56d	0.61c	0.58ab	0.57b	0.55b	0.58c
Means	0.65a	0.64b	0.62c	0.60d		0.69a	0.66b	0.63 c	0.60d	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5% and H* = at harvest.

3.5.4.Soluble solids content/acid ratio

Response of S.S.C/acid ratio to the different irrigation treatments as presented in Table 11 showed a similar trend to that found with the effect of irrigation treatments on S.S.C%. It means that increasing irrigation water leads to the reduction of the S.S.C/acid ratio in two seasons of study. However, the longer period of shelf life increased S.S.C/acid ratio in the two seasons also. These were an interaction between the two factors (irrigation treatments and storage period).

3.5.5 Loss in weight percentage

Data obtained from Table 12 show loss in weight percentage for Thompson seedless grapes as affected by the effect of irrigation treatments. It is clear that the least percentage of loss in weight was obtained from the lowest irrigation treatment 60% Epan(T5) and 80% Epan(T4) while the biggest loss in weight was for the control (T1) irrigation treatment and 120% Epan(T2) in two seasons of study. It was noticeable that the loss in weight was the smallest for the second season compared with the first one. From the same Table, it is noticeable that loss in weight increased as the shelf life period increased. There was an interaction between irrigation treatments and shelf life period where the loss in weight percentage increased by increasing both irrigation water and the shelf life period. The loss in weight was a result of water loss from the tissues of the fruit and partially from the respiration process. The high temperature of the fruits during shelf life caused an increase in respiration rate, moisture loss, and also loss in weight. This is not strange, since the water loss by this natural phenomenon as well as, table grapes is very sensitive to high temperature during shelf life **(Halachmy and Mannheim, 1991).** The results agreed with those reported by **Tourky et al. (1995) and (2006)** on grapes fruits and on banana fruits, respectively.

3.5.6 Berry decay percentage

Data in Table 13 indicate that decay percentage in Thompson seedless grapes increased by increasing irrigation water where the highest value was for treatment 120% Epan (T2) in 1st season but in 2nd season the control (T1) and 120% Epan (T2) gave the highest decay percentage. However, the lowest percentage was for 60% Epan (T5) in both seasons. Decay percentage increased as the advancing of shelf life period in the two seasons of study. Grapevines treated with low water levels had lessened the percent of decay caused by decaying organisms during shelf life periods compared with grapevines treated with the high water levels, since, the percent of decay in 60% Epan (T5) and 80% Epan (T4) reached about (5.2 and 4.3%) and (6.5 and 4.9%) during the two seasons, respectively after 9 days of shelf life. Contrary to that, grapevines treated with high water level the control (T1) and 120% Epan (T2) had percent of decay ranged about (10.3 and 11.4%) and (10.2 and 10.7%)

during the two seasons respectively after 9 days of shelf life.

From the above results, we can conclude that irrigating Thompson seedless grapevines with high water levels induced fruit decay which caused the shortest shelf life periods. While irrigation with low water levels reduced fruit decay with caused the longest shelf life period. These results are in agreement with the findings of Adel et al. (2000), who found that the decay percentage in Ruby seedless grapes increased with the advancing of the shelf-life period.

Table 11: Effect of irrigation treatments on S.S.C/Acid ratio of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

S.S.C/Acid ratio										
Seasons	2005					2006				
	Period in days									
Treatments	H*	3	6	9	Means	H*	3	6	9	Means
T_1	22.6c	23.3c	24.3b	26.1c	24.1cd	22.1c	23.3c	24.7bc	26.3b	24.1cd
T_2	23.7bc	24.5c	26.8c	28.6c	25.9cd	22.9c	24.7c	26.5c	29.2b	25.8cd
T_3	26.1b	27.9b	29.8b	32.2b	29.4c	24.7bc	25.6b	28.5b	31.7b	28.2c
T_4	27.7ab	29.5ab	31.7a	33.3ab	30.5b	27.3ab	30.0ab	31.9a	34.5ab	30.9b
T_5	29.5a	31.2a	32.8a	36.0 a	32.5a	29.2a	31.5a	33.3a	35.6a	32.4a
Means	26.0d	27.3c	29.4b	31.2a		25.7d	27.0c	29.0b	31.5a	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5% and H* = at harvest.

Table 12: Effect of irrigation treatments on loss in weight percentage of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

Loss in weight (%)								
Seasons	2005				2006			
	Period in days							
Treatments	3	6	9	Means	3	6	9	Means
T_1	5.8a	17.6a	22.1a	15.2a	6.5a	15.5a	20.5a	14.2a
T_2	5.6a	16.8a	21.7a	14.7a	6.2a	14.0ab	20.9a	13.7a
T_3	5.3a	15.0ab	20.1ab	13.5ab	5.8ab	12.8b	18.0ab	12.2ab
T_4	4.2b	14.2ab	19.8ab	12.7ab	4.7b	11.5b	17.0b	11.1ab
T_5	4.0b	13.7b	18.8b	12.2b	4.0b	10.5c	16.0c	10.2b
Means	4.98c	15.5b	20.5a		5.44c	12.86b	18.5a	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5%.

Table 13: Effect of irrigation treatments on decay percentage of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

Decay (%)								
Seasons	2005				2006			
	Period in days							
Treatments	3	6	9	Means	3	6	9	Means
T_1	4.0a	5.7ab	10.3a	6.67ab	4.5a	6.2a	11.4a	7.37a
T_2	3.6a	7.8a	10.2a	7.20a	4.0a	5.9a	10.7a	6.87a
T_3	3.3ab	4.9ab	7.4ab	5.20b	2.9b	4.7ab	5.5b	4.36b
T_4	3.0ab	4.3b	6.5b	4.60b	2.8b	3.8ab	4.9b	3.83bc
T_5	2.8b	3.2b	5.2b	3.73c	1.6b	3.5b	4.3b	3.07c
Means	3.34c	5.18b	7.92a		3.16c	4.82b	7.32a	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5%.

3.5.7. Berry shatter percentage

From Table 14 it is obvious that, the data concerning the percent of shattered berries took almost the trend of those dealing with the loss in weight. This is not strange since both berries shattering and loss in cluster weight were mainly due to loss in moisture content. In addition, shatter occurs mainly due to rough handling and high temperature, since, shatter can be reduced by gentle handling and maintaining recommended temperature and relative humidity. **Berry and Aked (1996)** reported that after storage Thompson seedless grape for 6 days at room temperature loss dehydration and berry shatter were the main causes of quality loss at this stage.

3.5.8. Berry shrink percentage

According to Table 15, it is clear that grapevines irrigated with low water levels (T_5 and T_4) reduced fruit shrink percentage to be the least as compared with grapevines irrigated with the high water levels in the two seasons of the study. Shrink percentage during shelf life in both seasons of investigation showed a gradual and continuous increase with increasing shelf life period. There was an interaction between irrigation treatments and shelf life period where shrink percentage increased by increasing both irrigation and the shelf life period.

3.5.9. Total loss percentage

Data presented in Table 16 show that, the total loss percentage in clusters held under room temperature (25 - 30 ^{o}C and R.H 50%). The total loss includes loss in cluster weight mainly due to desiccation, loss caused by decaying organisms, loss imputed to fruit shatter and shrink. The total loss was gradually increased as the shelf-life period was prolonged with all practices. It is obvious from the previously mentioned data that the loss in cluster weight was the main factor causing the highest loss percentage in fruits of different irrigation treatments. The loss caused by this factor amounted to 56% of total loss at the end of shelf-life period (9 days). While the loss attributed to the decaying organisms, shattering, and shrinking comprised only about 24, 22 and 4%, respectively. About the effect of various irrigation treatments on a total loss, data disclosed that irrigation treatments with low water levels (60 and 80% E_{pan}) had lessened the total loss. Therefore, the total loss caused as a result of 60 and 80% E_{pan} reached only (30.46 and 28.00%) and (35.2 and 32.5%) after 9 days at shelf life in both seasons, respectively. Contrary to irrigation treatments with low water levels, the effect of treatments with high water levels and control ($T_{1,}$ $T_{2,}$ and T_3) had markedly increased the total loss compared with other irrigation treatments (T_4 and T_5). Therefore, the total percentage ranged (42.1 and 45.0%) and (44.0 and 47.1%) for 120% E_{pan} and control after 9 days of shelf life in both seasons, respectively.

During shelf life periods, data showed that both irrigation treatments 60% E_{pan} and 80% E_{pan} gave fruits in good condition at 3 and 6 days of shelf life. Since, the total loss percentage ranged (8.13 and 7.33%) and (8.53 and 9.55%) after 3 days of shelf life in both seasons, while it reduced to (20.63 and 19.25%) and (23.87 and 21.7%) after 6 days of shelf life in both seasons, respectively. Contrary to the above-mentioned results, irrigation treatments with high water levels (T_1 and T_2) had markedly increased the total loss, since these values ranged (11.3 and 12.8%) and (12.1 and 13.9%), respectively after 3 days of shelf life, while these values ranged about (32.07 and 28.40%) and (29.96 and 29.60%) respectively after 6 days of shelf life in both seasons. Thus, it becomes clear irrigation treatments with low water levels reduced total loss percentage and clusters behaved better in shelf-life period than the irrigation treatments with high water levels. This is not strange, since, vines treated with low water levels gave berries had the highest values of berry firmness and adherence strength, the previous factors are suitable for a long period of shelf life as well as, fruits of table grapes are fast perishable fruits. This is the reason that irrigation treatments with low water levels are recommended for grapevines 3 weeks pre-harvest to improve clusters' quality during handling and shelf life. The results go in according with **Berry and Aked (1996)** reported that after storage for 6 days of grapes at room temperature dehydration andberry shatter were the main causes of quality loss at this stage.

Table 14: Effect of irrigation treatments on shatter percentage of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

	Shatter (%)							
Seasons	2005				2006			
	Period in days							
Treatments	3	6	9	Means	3	6	9	Means
T_1	1.87a	5.50 ab	9.70 a	5.69a	2.20a	6.50a	11.50 a	6.73a
T_2	1.50 a	6.60 a	8.50 a	5.53 a	2.00 a	6.90 a	10.80 a	6.56 a
T_3	1.40ab	5.60ab	8.20ab	5.07ab	1.80 a	6.60 a	10.70a	6.37a
T_4	1.30 b	4.90 b	7.80 b	4.67 b	1.70 b	5.70 b	8.80 b	5.40 b
T_5	1.30 b	3.40 c	5.60 c	3.43 c	1.40 b	4.60 b	6.70 c	4.42 c
Means	1.47 c	5.20 b	7.96 a		1.82 c	6.06 b	9.70 a	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5%.

Table 15: Effect of irrigation treatments on shrink percentage of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

	Shrink (%)							
Seasons	2005				2006			
	Period in days							
Treatments	3	6	9	Means	3	6	9	Means
T_1	0.43a	1.16a	1.90 a	1.16 a	0.70 a	1.40 a	3.70a	1.93 a
T_2	0.43a	0.87ab	1.70 a	1.00 a	0.60 a	1.60 a	2.60 ab	1.60a
T_3	0.17a	0.46b	1.20 b	0.61 b	0.44 a	1.40 a	2.00 b	1.28 b
T_4	0.03a	0.47b	1.10 b	0.53 b	0.35 b	0.70 b	1.80 b	0.95 c
T_5	0.03a	0.33c	0.86 c	0.41 c	0.33 b	0.65 b	1.20 c	0.72 c
Means	0.22c	0.66b	1.35 a		0.80 c	1.15 b	2.26 a	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5%.

Table 16: Effect of irrigation treatments on total loss percentage of Thompson seedless grapes at shelf life period during 2005 and 2006 seasons

	Total loss (%)							
Seasons	2005				2006			
	Period in days							
Treatments	3	6	9	Means	3	6	9	Means
T_1	12.10a	29.96ab	44.00a	28.68a	13.90a	29.60a	47.10a	30.20a
T_2	11.13a	32.07a	42.10a	28.43a	12.80a	28.40a	45.00a	28.73a
T_3	10.17b	25.96ab	36.90b	24.34b	10.94b	25.50b	36.20b	24.21b
T_4	8.53bc	23.87bc	35.20b	22.53bc	9.55c	21.70bc	32.50b	21.25bc
T_5	8.13c	20.63 c	30.46c	19.74c	7.33d	19.25c	28.00c	18.19c
Means	10.01c	26.50 b	37.73a		10.90c	24.69b	33.76a	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5%.

3.5.10. Bunch freshness

Thompson seedless grapes variety is harvested and picked in the hot season and held at room temperature as shelf life, this can result in stem drying and browning as well as in berry shatter and even wilting and shivering of berries. One of the most important factors affecting fruit quality is water loss from the stem. The stem green color and its freshness are necessary conditions to mention the high quality of bunch for shelf life and marketing. Data illustrated in Table 17 cleared that, bunch freshness (the average of stem color, dryness, and berry appearance). Bunch freshness significantly deteriorated with prolonging the shelf life period. Studies concerning bunch freshness **Mohamed and Ibrahim (2003)** and **Mohamed and Hassan (2003)** found that bunch freshness significantly deteriorated by prolonging the storage period.

Table 17: Effect of irrigation treatments on bunch freshness of Thompson seedless grapes at shelf life during 2005 and 2006 seasons

Bunch freshness										
Seasons	2005					2006				
	Period in days									
Treatments	H*	3	6	9	Means	H*	3	6	9	Means
T_1	1.0a	2.0a	3.0a	4.0a	2.5a	1.0a	2.0a	3.0a	3.0a	2.25a
T_2	1.0a	2.0a	3.0a	4.0a	2.5a	1.0a	2.0a	3.0a	3.0a	2.25a
T_3	1.0a	2.0a	3.0a	4.0a	2.5a	1.0a	2.0a	3.0a	3.0a	2.25a
T_4	1.0a	2.0a	3.0a	4.0a	2.5a	1.0a	2.0a	3.0a	3.0a	2.25a
T_5	1.0a	2.0a	3.0a	4.0a	2.5a	1.0a	2.0a	3.0a	3.0a	2.25a
Means	1.0d	2.0c	3.0b	4.0a		1.0c	2.0b	3.0a	3.0a	

Means followed by the same letters within each column do not significantly differ using Duncan's multiple range test at the level of 5% and H* = at harvest.

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توفير مياه الري وتأثيرها على إنتاجية العنب البناتي صنف طومسون وجودة التخزين في جو الغرفة

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الملخص

أجريت هذه التجربة بهدف تحديد كميات مياه الري في كل ريه لصنف العنب البناتي حيث تم التحكم في كميات المياة المضافة بتشييد نظام ري غير مكلف. اقيمت التجربة في المزرعة التجريبية التابعة لمحطة بحوث البساتين بالمنصوره محافظة الدقهلية لعامي 2005 –2006علي كرمات العنب البناتي عمر 8 سنوات منزرعة في ارض طينية ذات سعة حقلية 41.5% ومعامل الذبول 22.5% النباتات منزرعة علي مسافات 2 x 3 م و مرباة بالطريقة القصبية ومدعمة بطريقة حرف T المزدوج.

معاملات الرى:

اشتمل البحث على خمسة معاملات رى حددت من بيانات معامل وعاء البخر Pan evaporation (E_{pan}) وهى على التوالى الكنترول (T_1) وهو ما تم إضافة المياه بمعرفة المزارع، T_2 = (E_{pan}120%)، T_3 = (100% E_{pan})، T_4 = (80%E_{pan})، T_5 = (60% E_{pan}). تم حساب الاستهلاك المائي الموسمي كما تم دراسة تأثير معاملات الرى على نمو وخصائص جودة المحصول وفيما يلى أهم النتائج:

تاثير معاملات الري علي سلوك البراعم:

وجد ان زيادة الماء ادت الي قلة في تفتح البراعم وعلي العكس من ذلك فان زيادة ماء الري ادت الي زيادة في نسبة البراعم الخصبة وايضا نسبة الخصوبة.

تاثير معاملات الري علي المحصول و بعض صفات جودة الثمار:

عند مقارنة المعاملة الثانية (120% E_{pan}) والتي اعطت اعلي محصول بمعاملة الري الخامسة (60% E_{pan}) وجد ان المعاملة الثانية اعطت زيادة في المحصول عن المعاملة الخامسة بنسبة وصلت الي 38.3% في السنة الاولي و 42.8% في السنة الثانية.

تأثير معاملات الري علي صفات جودة الثمار اثناء تخزينها في جو الغرفة:

التخزين في جو الغرفة علي درجة 25-30 ºC مع رطوبة نسبية 50% ولمدة 9 ايام جعل هناك نقص في عامل الشد خلال موسمي التجربة. زيادة فترة التخزين في جو الغرفة ادي الى زيادة في نسبة المواد الصلبة الكلية وهذه الزيادة كانت واضحة كلما قلت كمية ماء الري.

ظهر بعد فترة التخزين في جو الغرفة نقص كبير في الحموضة لكل معاملات الري واعطت المعاملة الخامسة (60% E_{pan}) اعلي قيمة نقص في نهاية فترة التخزين عن باقي المعاملات خاصة المعاملة الثانية (E_{pan}120%) والكنترول.

النقص في وزن العنقود و كرمشة وفرط الحبات والاعفان (كل الصفات غير المقبولة للعنقود) زادت بزيادة ماء الري وزيادة فترة التخزين في جو الغرفة مما ادى الى زياده كبيرة في نسبة الفاقد الكلي.

مجلة العلوم الزراعية والبيئية المستدامة

الكلمات المفتاحية: