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INFLUENCE OF IRRIGATION RATE ON PRODUCTION, QUALITY AND STORAGE ABILITY OF CUCUMBER GROWN UNDER TRANSPARENT POLYETHYLENE LOW TUNNELS

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ABSTRACT

A field experiment was conducted under clear polyethylene low tunnels which furnished with drip irrigation during the two winter seasons of 2003 and 2004. The study was carried out at Borollous area which represents the circumstance and conditions of coastal zone of north Nile Delta. The objective of the investigation was to find out the effect of watering with 0.6, 0.8 and 1.0 ETo on Cucumber (*Cucumis sativus* L.) productivity, yield components and post–harvest parameters.

Data revealed that irrigation with 0.6 ETo was the most suitable watering for cucumber in such area due to various advantages such as highest yield, least applied water, highest productivity per each unit of applied water. In addition, this level was the best regarding the vegetative growth of cucumber crop.

Irrigation with (T_1) 0.6 gave the lowest values in both weight loss and decay percent and exhibited the highest fruit quality including
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and firmness. Besides, T_1 had significantly higher dry matter, total soluble solids and total chlorophyll content than the other treatments.

Weight loss % and decay percent increased as the storage period was prolonged. Additionally Visual quality and chemical constituents (dry matter, total soluble solids and total chlorophyll) decreased in cucumber fruit during the storage period.

INTRODUCTION

Under the present situation of winter shortage of water that facing Egypt which resultes in continuous reduction of per capita share of water for different purposes. The value is less than water poverty edge of 1000m3 and it is expected to be about 500m3 in the forthcoming few decades.

In the meantime, cucumber is considered as one of the most important vegetable crops due to its various usages. The cultivated area of cucumber was increased from 58249 fed. in 1999 (1 fed. = 0.42ha) to 63050 fed. in 2002.

Borollous area, is a part of the Nile Delta coastal zone that adjacent and nearby to the Mediterranean sea with specific features such as high relative humidity, shallow water table about 50cm, fairly high rainfall (about 200mm. Per year), clear differences between day and night temperature.

So, by introducing the technique of clear polyethylene low tunnels along with drip irrigation system, shifting of sowing date of cucumber could be occurred. Thus, off-season production could be obtained.

The impact effect of irrigation level on yield and quality of cucumber has been widely studied either abroad or in Egypt. For instance, Judah and Rushdi (1985) found that cucumber yield was increased when soil moisture tension decreased. EL-Shinawy (1997) found that leaves of cucumber plants which received large amount of irrigation water (100% class A Pan) had lower chlorophyll contents compared with those of plants irrigated with less irrigation rate (75% class A Pan). Lombardo and Patti (1979) cited that the best production of muskmelon was obtained with 70% of class A Pan evaporation. Bogle and Hartz (1986) found that with application of 20, 40 and 60% of available soil water depletion, the muskmelon yield was increased with increased the water application regime. Eliades (1988) found that the highest yield cucumber was obtained with 1.0 of Etp treatment while water application 0.6 of Etp reduced yield significantly. Goyel and Allison (1983) found that the moist treatment gave significant increases in crop yield compared with the wet and dry treatments. On the other hand, Ferreyra *et al.* (1985) found that chlorophyll content was decreased with excessive water application. Bucks *et al.* (1981) noticed that weekly irrigation of melon gave higher yield than daily application.

The availability of soil water is one of the environmental factors that frequently limits plant growth and yield. AL-Jaloud- A.A. *et al.* (2000) noticed that lowering irrigation sustained production and increased water use efficiency without significant decrease in growth and yield components of cucumber. AL-Kayssi *et al.* (1990) showed that growth rate and yield of pepper plants were increased due to modification of plant climate at higher moisture content.

The impact effect of irrigation level on the fruit quality of vegetables has been reported by several investigations. Omar *et al.* (1976) found that irrigating tomato plant with the lowest amount added, resulted in an increase in fruit firmness, total soluble solids, and a decrease in decay percentage and loss in weight.

Soil moisture was negatively correlated with soluble solids content, dry matter and sucrose content in fruit of the two cultivars of muskmelon (Wells and Nugen. 1980).

Srinivas *et al* (1989) indicated that frequent irrigations with 100% evaporation replenishment resulted in highest watermelon fruit yield, dry matter, total soluble solids, and total sugars as compared to other irrigation treatments. The higher values of total soluble solids Cyu *et al.*, 1995; whoom *et al.*, 1997 and Hosny *et al.*, 2001) and fruit firmness were obtained from watermelon plants which supplied with low amounts of irrigation water.

T.S.S. of snap bean pods was lowest when plants were exposed to 20% depletion of soil moisture compared with the other treatments (40, 60%) (Adam 2001).

Cucumber at retail market frequently shriveled and being soft. This shrivelling results from dehydration that may be occurred during marketing (Ryall and Lipton, 1979; Wills *et al.* 1982; Hardenburg *et al* 1986). Water loss from cucumber fruits is a major reason of its deterioration.

Emam 1993; Aly 2001; Ezzat *et al.*, 2003 and Hardenburg *et al.*, 1986 reported that cucumber fruit showed a gradual increase in the percentage of weight loss and decay and gradual decrease in chlorophyll, T.S.S. and dry matter content with the prolongation of the storage period.

Cucumber fruits can be kept for 10-14 days at 10-13^{0}C with high relative humidity (95%). At a temperature of 10^{0}C and above, the green colour change into yellow.

The objective of this study was to find out the role of irrigation under clear polyethylene low tunnels on yield and its attributes of cucumber beside its effect on post harvest quality.

MATERIALS AND METHODS

An Experiment was carried out at Borollous site, Kafr EL-Sheikh Governorate, north Nile Delta region during the two successive winter seasons 2003 and 2004. Borollous area is situated at 31°-33' N Latitude, 31°-06' E longitude and represents the environmental conditions of coastal area of the Nile Delta region. Soil texture is sandy, with shallow water Table (1). Cucumber hybrid Prince seeds were sown on 2nd of January 2003 and 2004.

Table (1) Chemical and physical analyses of the soil at Borollous.

pH	Ec	CaCo3	PPm		Cations meq			Anions meq			Mechanical Analysis			
	DS/m	%	N	P	K^+	Ca^{++}	Mg^{++}	Hc_{03}^-	$C1^-$	$So4^-$	Sand %	Silt %	Clay %	Texture
8.20	1.5	4.50	Traces	0.46	1.52	2.55	1.30	1.87	2.10	1.40	88	5	7	Sandy Soil

Base dressing was added according to the recommendations of Ministry of Agriculture and Land Reclamation (MALR). Drip irrigation was the implemented system of irrigation, which was furnished underneath the transparent (clear) polyethylene low tunnel. Laterals of the system were spaced 1.5 m apart with 0.30 cm between drippers. Each dripper was assigned to irrigate a single plant. The seeds were sown in front of the dripper.

2-1 Experimental layout

The experiment was consisted of three strips and three irrigation treatments. Each strip has labeled for a specific level of applied irrigation water. Each strip was contained three replicates, each replicate consisted of dimensions of 4 rows with 1.5 x 21 m and 70 plants for each row. To establish the low tunnels, clear polyethylene of 60 micron thickness was stretched on metallic hoops soon after sowing.

Ventilation of low tunnels started from seedling emergence till about the middle of March at which flowering started to develop, the outdoor climate became stable and more suitable for growth then polyethylene was removed. Fertigation started from seedling emergence through harvest.

2-2 irrigation treatments:

Three irrigation levels were studied, each level of applied water was adjusted to a specific strip. Irrigation treatments were labeled as low, moderate and high ones, which resulted in the same order of soil moisture status. Irrigation regime was computed based on different levels of reference evapotranspiration (ETo) as follows:

- Treatment A was irrigated with o.6 ETo.
- Treatment B was irrigated with o.8 ETo
- Treatment C was irrigated with 1.0 ETo

2-2.1 Reference evapotranspiration (ETo):

Reference evapotranspiration (ETo) was computed according to Hargreaves method (1985):

$$ETo = 0.0023\ Ra.\ TD^{0.5}\ (Ta + 17.8)$$

Where:

ETo = reference evapotranspiration from grass in same units as Ra

Ra = absolute radiation, values of Ra were computed by Rijtema and Abou-Khaled (1975) at Baltim (Borollous) area.

TD = average daily temperature difference = (T max – T min), ^{0}C.

Ta = mean daily temperature = (T max + T min)/2.

Maximum and minimum temperatures were recorded daily in the site. It should be noticed that the applied irrigation water was recorded by water–meter which installed at the inlet of each strip within drip irrigation system.

2-2.2 Water utilization efficiency (W.Ut.E., kg./m^3).

It was calculated according to Doorenbos et al. (1979):

$$W.Ut.E. \ \frac{Y}{W.\ a.}$$

Y = Yield

W.a. = water applied

2-2.3 Statistical design:

Complete randomized blocks design was adopted. Data of vegetative growth, yield and its attributes were adjusted to L.S.D. statistically analyzed according to Snedecor and Cochran, 1980.

2-3 Data collection:

The obtained data were classified as:

2-3.1 Vegetative growth:

Random samples of 10 plants from each plot were collected after 50 days from sowing, and the following data were recoded:

- Plant length (cm.).
- Number of leaves / plant.
- Number of branches / plant.
- Leaf area (cm^2): the area of the sixth leaf from the meristemic top of the main stem was measured during flowering stage using LI–3000 portable Area Meter (PAM).
- Foliage dry matter percentage: samples of fresh plants were immediately weighted and dried at 70^{0}C until a constant weight and percentage of dry matter was calculated.
- Total chlorophyll content using the method of Brougham (1960).

2-3.2 Yield and its components:

- Average of fruit weight, g.
- Fruit length, cm.
- Fruit diameter, cm.

- Yield per plant, kg
- Total yield ton/feddan.

2.3.3. Physical and chemical fruit characteristics.

- Fruit dry weight percentage.
- T.S.S. %
- Fruit firmeness
- Fruit total carbohydrates content.

Fruit total carbohydrates was determined calorimetrically according to the method described by Michel *et al.* (1956).

2-3.4 Post harvest parameters:

Cucumber fruits were picked and transferred to postharvest & Handling laboratory of vegetable crops department, Horticultural Research Institute. Factorial experiment (3 irrigation levels x 4 storage period) in R.C.B. D. with 3 replication was used. Twelve healthy fruits from every replicate were chosen and placed in a carton box as one replicate of each treatment. The fruits were stored under cold storage at 12^{0}C, 95% R.H. Samples were taken at random from three replicates for each treatment and examined every four days interval.

The following data were recorded:

General appearance score rating 9 = Excellent 7 = good, 5 = fair, 3 = poor, 1 unuseable.

Weight loss %.

Decay was evaluated on a scale of 1= none, 2 = slight, 3 = moderate, 4 = moderately severe and 5 = severe.

Flesh firmness by using magness at ballouf pressure tester equipment in newtons.

Total soluble solids % (TSS) by using refractometer.

Dry matter percentage.

Total chlorophyll mg./100g. fresh weight.

Data were statistically analyzed according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1- Vegetative parameters:

1- A. Plant length (cm.)

Data in Table (2) show that there is significant effect for the irrigation amount on this trait. The low and the low and medium levels of irrigation were similar in their effect on plant length whereas the` highest level gave significantly the shortest plant length. This finding might be attributed to the possibility of these levels of watering are more convenient to irrigate cucumber in such area of study of north coastal of Nile Delta Zone with high watertable. This was true for the two seasons of study.

1- B. Number of branches.

Significant effect was recorded on the impact of water regime on number of branches. Lowest and medium watering resulted in significant increases over high watering treatment in number of cucumber branches.

There was no significant differences between low and medium irrigation treatments in this concern. Similar trend was obtained in both seasons of study (Table 2).

1- C. Number of leaves.

Greater number of leaves was recorded for the lowest watering level, being significant in the second year compared with the other two treatments (Table 2).

In the meantime medium watering level gave significantly higher number of leaves than the high irrigation regime.

1- D. Leaf area (L..A., cm^2).

Significant effect was clearly observed between levels of irrigation water on leaf area (Table 2).Both seasons gave similar trend. The increase in irrigation water level resulted in significant reduction in leaf area. It seems that the lowest watering level was the most suitable level for leaf area production.

1- E. Total chlorophyll content (mg/100g. F.W.)

Irrigation water treatments had similar effect on total chlorophyll content as leaf area, i.e., increasing watering level induced significant reduction in chlorophyll content. Chlorophyll content and leaf area are essential for photosynthesis process.

1-F. Dry matter of plant foliage.

The dry matter of plant foliage was decreased significantly with increasing level of irrigation during the two studied seasons. Therefore increasing watering had negative effect on dry mater content. The lowest irrigation regime resulted in greater dry matter content. More work is required to find out whether reduction in watering than the lowest regime may give positive results.

So, it could be stated that an adverse effect of irrigation level on the studied vegetative attributes of cucumber under this study for coastal Nile Delta area, due to the following:

- High water table with its possibility for contribution partially for the crop-water requirements.
- The area is one of the most highest areas in rainfall in Egypt. Therefore, excessive watering could be resulted in negative effect on the vegetative attributes of cucumber crop. Therefore, caution should be taken into consideration in irrigation of cucumber in that area.

For vegetative growth parameters the data agree with that of EL-Shinauy (1997) on cucumber, Ferreyra *et al* (1985) on pepper and AL-Jaloud A. A. et al. (2000) on cucumber. On the other hand Bogle and Hartz (1986) on muskmelon and AL-Kayssi et al. (1990) noticed that growth rate was increased with increasing the water application.

2. Physical and chemical Fruit characteristics:

2.A. Fruit dry matter, %.

Irrigation level significantly affected dry matter content of cucumber fruit and produced their highest values with plants irrigated with the low irrigation level (Table 4). On the contrary, the lowest value was associated with plants irrigated with 1.0 ETo.

Table (2): Effect of irrigation levels on vegetative growth, total chlorophyll and dry matter content of cucumber plant grown under transparent polyethylene low tunnels during years 2003 and 2004.

Characters	First season (2003)						Second season (2004)					
	Plant	No. of	No. of	Leaf	To.	Foliage	Plant	No. of	No. of	Leaf	To.	Foliage
Treatments	Length cm	branches	Leaves	area cm^2	Chlorophyll mg/100g F.W.	D. W. %	Length cm	Branches	Leaves	area cm^2	Chlorophyll mg/100g F.W.	D. W. %
T_1	164.0	5.4	56.2	278.4	275..3	14.8	180.3	5.5	49.6	275.1	281.6	15.6
T_2	157.0	4.8	47.3	237.9	255.7	12.9	170.3	4.8	36.8	252.0	245.8	14.4
T_{32}	112.3	.3.4	37.8	203.2	230.2	11.5	154.3	4.3	21.5	213.4	217.7	9.9
L.S.D. 5 % level	20.6	1.1	9.4	18.8	2.4	1.2	13.71	0.6	11.7	17.8	3.7	١,١

T_1 Irrigation with 0.6 ETo T_2 Irrigation with 0.8 ETo
T_3 Irrigation with 1.0 ETo ETo = values of reference evapotranspiration

Table (3) : Effect of irrigation levels on yield and its components of cucumber plants grown under clear polyethylene low tunnels, 2003 and 2004.

Characters	First season (2003)					Second season (2004)				
Treatments	Aver. fruit weight gm	Fruit Length cm	Fruit diameter cm	Yield / plant Kg.	Total yield ton/fed.	Aver. fruit weight gm	Fruit Length cm	Fruit diameter cm	Yield / plant Kg.	Total yield ton/fed.
T_1	110.7	13.4	3.3	1.9	17.83	122.3	13.7	3.4	1.9	17.70
T_1	107.7	12.9	3.2	1.4	13.07	112.7	13.9	3.3	1.3	12.13
T_1	99.3	12.7	3.2	1.3	12.13	101.4	12.8	3.1	1.2	11.20
L.S.D. 5%	8.16	0.2	N.S	0.3	1.92	9.7	0.4	N.S	0.1	0.79

T_1 Irrigation with 0.6 ETo T_2 Irrigation with 0.8 ETo
T_3 Irrigation with 1.0 ETo ETo = values of reference evapotranspiration

2.B. Total soluble solids (T.S.S.%)

Percentage of T.S.S. was not significantly affected with the level of applied irrigation water. The mean value of this parameter under all irrigation treatments as computed from Table (3) is 4.71% theoretically, T.S.S. increased under the low soil moisture content. But due to the hydrological specification of the area which include high rainfall, shallow water table and high relative humidity, all these factors are compensate the effect of low soil moisture content.

2.C. Fruit firmness:

Concerning fruit firmness, data in Table (4) show that significant differences in fruit firmness were detected among the irrigation levels. (T_1) irrigation with 0.6 Eto showed the highest fruit firmness (63.88 N), the lower value was obtained from plant irrigated with 1.0Eto (60.25N) in the first season. These results hold true in the second season.

2.D.Total Carbohydrates.

The total carbohydrates of cucumber fruits are presented in Table (3). It is clear that the lowest irrigation levels showed significantly the highest carbohydrate content. The results indicated also that increasing irrigation level decreased significantly total carbohydrates of the cucumber fruits. This could be due to the greater photosynthates produced by greater leaf area and leaf number.

For physical and chemical fruit characteristics the data agree with that of Omar *et al* (1976) on tomato, Wells and Nugent (1980) on muskmelon, Cyu *et al* (1995); Whoom *et al.* (1997) and Hosny *et al.* (2001) on watermelon and Adam (2001) on snap bean. On the other hand, The negative result was recorded by Sriniva *et al.* (1989) on watermelon.

3- Yield and its components.

3.A. Average fruit weight gm.

There was no significant difference in average fruit weight between low and medium irrigation regimes (Table 3). Whereas both mentioned irrigation water levels gave significantly greater average fruit weight compared with the high irrigation level. This was true in the two seasons of study. This could be due to the greater photosynthesis occurred as a result of greater number of leaves and leaf area. These parameters were lower due to higher irrigation level.

3.B. Fruit length cm.

The impact of watering level on fruit length of cucumber was significant (Table 3). However low or medium irrigation regimes had significantly longer fruits than the high one in both seasons of study (Table 3), through However the difference between low and medium irrigation regimes was significant being the fruits of the low regime were longer than those of the medium irrigation level in the first year. In the second year no significant differences were observed between them.

3.C. Fruit diameter cm.

The average fruit diameter of cucumber during the two seasons under the watering treatments showed no significant effect of watering regime on such trait fruit diameter (Table 3). This must be a desirable result as thick cucumber fruits are not popular.

3.D. Total yield, ton/fed.

Total yield was significantly affected by applied irrigation amount. (Table 3). The highest yield was resulted under the lowest moisture status with significant differences. This high yield could be due to the high average fruit weight which resulted from an increase in fruit length rather than fruit diameter. Thus high crop yield per each unit of applied water could be achieved. Meaningfully, maximization of water utilization efficiency could be implemented.

This useful finding is confirmed with the traditional farming of the local farmers in the area, that is so called digging earth tunnels which depending upon the water Table and rainfall as the source of crop – water needs. This process is clear in cucumber production. So-many disadvantages of digging such earth tunnels such as changes in soil topography and its fertility, high cost of digging and low yield. So, by implement the technique of low tunnel cultivation, which furnished with drip irrigation, effective management of irrigation water and high yield could be achieved, especially under the low level of irrigation water. This implementation of watering regime is strongly coincide with the local environment of coastal area of Nile delta, with its features of shallow water table and high rainfall.

This results was obtained by Bucks et al (1981) on melon, Judah and Rushdi (1985) on cucumber and AL-Jaloud. A.A. *et al.* (2000) on cucumber Negative results were noticed by (Lombardo and Patti 1979) and (Bogle and Harts 1986) on muskmelon, Eliades (1988) on cucumber, (Groyel and Allison 1983 and Srimivas *et al.*, 1989) on watermelon.

Crop water functions:

a- Water applied

Seasonal water applied (W.a.) consists of irrigation water (i.w.) plus effective rainfall (Rf.) which equals 0.8 from the total (Rf.) data in Table (5) show that the irrigation water applied for the different treatments were 796.2, 1061.6 and 1327.0m^3/fed in the first season and 753.8, 1003.6 and 1253.2 m^3/fed,in the second season treatments T_1, T_2 and T_3, respectively. The stated treatments were irrigation with 0.6, 0.8 and 1.0 Eto, respectively. The mean seasonal Rf. was equal 426.0 in the first season and 436.8m^3/fed in the second season. So, the total water applied under the studied irrigation regimes is 1222.2, 1487.6 and 1753.0m^3/fed in the first season and 1190.6, 1439.8 and 1690.0 in the second season, respectively.

b- Water utilization efficiency (W.Ut. E., Kg./ m3).

Water utilization efficiency (W.Ut. E.) is defined as the crop water productivity and reflects the capability of applied water in crop production. The magnitude of (W. ut. E.) is a function of the crop yield as a nominator and applied water as a dominator.

So, mean values of (W. ut. E) at the two seasons as presented in Table (5) were 10.1, 10.0 kg/m^3. Therefor it could be stated that by increasing the applied water, values (W ut. E). should be decreased. This finding could be explained as, plied is the dominator of such crop-water function.

Table (4) :Effect of levels of irrigation water on physical and chemical fruits characteristics of cucumber plant grown under clear polyethylene low tunnels, 2003 and 2004.

Characters / Treatments	First season (2003) D.W. Fruit %	T.S.S. %	Firmness (Newton)	Total carbohydrates (mg/100g F.W.)	Second season (2004) D.W. Fruit %	T.S.S. %	Firmness (Newton)	Total carbohydrates (mg/100g F.W.)
T_1	5.66	4.71	63.88	2581	5.56	5.37	65.56	2752
T_2	5.52	4.52	61.96	1860	5.02	5.2	63.14	2533
T_3	5.32	4.41	60.25	1640	4.59	5.02	61.06	1867
L.S.D. 5%	0.13	N.S	1.34	18.2	0.36	N.S	1.29	23.1

1 Irrigation with 0.6 ETo T_2 Irrigation with 0.8 ETo
T_3 Irrigation with 1.0 ETo ETo = values of reference evapotranspiration

Table (5): Water utilization efficiency (W.Ut. E., kg/m3) and water applied per plant under different irrigation treatments in the two seasons of 2003 -2004.

Parameters / Treatments	Yield Kg/fed.	Seasonal water applied: Irrigation Water m^3/fed.	Seasonal water applied: Rainfall M^3/Fed.	Total water applied m^3/Fed.	W.Ut. E. Kg/ m^3	Water applied leter/plant	Water needed for one / kg. per leter
First season (2003)							
T_1=0.6 ETo	17825	796.2	426.0	1222.2	14.6	131	068
T_1=0.8 ETo	13066	1061.6	426.0	1487.6	8.8	159	114
T_1=1.0 ETo	12133	1327.0	426.0	1753.0	6.9	188	144
Second season (2004							
T_1=0.6 ETo	17700	753.8	436.8	1190.6	14.9	128	067
T_1=0.8 ETo	12133	1003.0	436.8	1439.8	8.4	154	199
T_1=1.0 ETo	11200	1253.2	436.8	1690.0	6.6	181	151

No. of plants per feddan = 9333
ETo = values of reference evapotranspiration.

In the same direction, to produce one kg of cucumber fruits an amount of 68, 114 and 144 litre were required under treatments T_1, T_2 and T_3 respectively, for the first season, in the second season the amount were 67, 199 and 151 liter for the same treatments, respectively.

c- Water applied per plant.

As shown in Table (5) the applied water for an individual cucumber plant during its growing season was 131.0, 159 and 188 litre under watering with 0.6, 0.8 and 1. ETo of treatments T_1, T_2 and T_3, respectively in the first season, while it was 128, 154 and 181 liters for mentioned treatment, respectively in the second seasons.

Conclusion:

Under the conditions of this experiment, Watering with 0.6 ETo was proven as the most convenient level of irrigation due to the following advantages:

-Introduce the highest average yield of 17.8 ton/fed.
- The least in water applied of 1222.2 and 1190 m^3/fed., for the first and second seasons, respectively.
- The highest in crop production per each unit of applied water, about 14.8kg cucumber could be produced from one m^3 water applied.
- So, one kilogram of cucumber needs an amount of 68 litres of water.
- An individual plant of cucumber needs 130 litres of water to complete its growing season.

Effect of irrigation levels on some properties of cucumber fruits during storage.

Visual quality

Data in Table (6) show that irrigation levels had no significant effect on the visual quality of cucumber fruits in both seasons of situdy. All treatments of this study showed that visual fruit quality was good (Scores between 7and 8).

Table (6) :Effect of irrigation levels on some physical and chemical properties of cucumber fruits during storage in 2003 and 2004 seasons.

Treatments	Visual quality	Weight loss %	Decay %	Firmness (Newton)	Dry matter %	Total soluble solids T.S.S. (%)	Total chlorophyll (mg/100. F. W.)
2003 season							
Treatments 1	8.05	3.51	1.33	63.88	5.66	4.71	42.50
" 2	8.05	4.11	1.37	61.96	5.52	4.52	39.74
" 3	7.17	4.96	1.63	60.25	5.32	4.41	30.29
L.S.D. at 0.05 (A)	N.S	0.42	N.S	1.34	0.13	N.S	2.56
2004 season							
(A) Treatments 1	7.50	4.12	1.22	65.56	5.56	5.37	49.92
" 2	7.39	4.16	1.32	63.14	5.02	5.20	47.81
" 3	7.00	5.38	1.66	61.06	4.59	5.02	44.54
L.S.D. at 0.05	N.S	0.03	N.S	1.29	0.36	N.S	1.36

T_1 = Irrigation with 0.6 ETo T_2 = Irrigation with 0.8 ETo T_3 = Irrigation with 1.0 ETo.
Visual quality score rating 9 = Excellent, 7 = good, 5 = Fair, 3 = Poor, 1 = Unusable.
Decay score rating: 1 = none, 2 = slight, 3 = Moderate, 4 = Moderately severe, 5 = severe.

Weight loss

The lowest irrigation water amount (T_1) gave significantly the lowest weight loss percentage in the two seasons of study (Table 6). Weight loss was increased significantly with increasing irrigation water level.

Decay

No significant differences were noticed on fruit decay related to irrigation levels in seasons 2003 or 2004.

Fruit firmness

Data in Table (6) indicated that fruit firmness was significantly greater with the low amount of irrigation. In other words, (T_1) had significantly the highest fruit firmness compared to the other treatments in the first season. The similar trend was noticed in the second season.

Dry Matter content:

Table (6) shows that dry matter content was significantly affected by irrigation level treatments, (T_1) resulted in the highest fruit dry matter content followed by (T_2) and then (T_3) in the first season. Similar results were obtained in the second season. Wells and Nugent (1980) reported that soil moisture can affect dry matter content of muskmelon positively.

Total soluble solids (T.S.S.%)

With respect to total soluble solids (T.S.S.), data in Table (6) show that (TSS%) was not affected by irrigation level treatment in the both seasons. On the other Hand, Wells and Nugent (1980) found that TSS of muskmelon was declined as the soil moisture increased.

Total chlorophyll

Concerning total chlorophyll, data in Table (6) indicate clearly that total chlorophyll was significantly influenced by the irrigation level. The highest value of total chlorophyll was recorded for fruits obtained from plant irrigated with (0.6 ETo), Whereas, the lowest value of this content was noticed in fruits from plants irrigated with (1.0 ETo). These results were true in both seasons.

Fruit quality during storage:

Visual quality

It is clear from the data in Table (7) that there were no significant differences between the storage periods for visual quality scores in both seasons.

Weight loss %

Extending the period of storage increased significantly the percentage of weight loss in both seasons (Table 7). These results agreed with those obtained by Emam (1993) and Ezzat (2003) on cucumber. These results might be attributed to the increase in evaporation and respiration (Wills et al 1982).

Decay

Regarding decay score, it was noticed that this character followed the same trend as weight loss percent however the difference was not significant (Table 7). In other words decay score was increased with the prolongation of the period of storage and reached 2.11 and 1.88 after 12 days of storage in the first and second seasons respectively.

These results were matched well with those obtained by Aly (2002) and Ezzat (2003) on cucumber fruits. The increase in decay percentage at the later period of storage might be attributed to that the biological activity in fruit became low and this in turn facilitate infection of fruits by microorganisms, as stated by Ryall and Liptpn (1979) and Wills *et al* (1982).

Table (7) :Effect of storage period on some physical and chemical Characters of cucumber fruit during storage in 2003 and 2004 seasons.

Storage periods in days (B)	Visual quality	Weight loss %	Decay %	Firmness (Newton)	Dry matter %	Total soluble solids T.S.S. (%)	Total chlorophyll (mg/100. F. W.)
Season 2003							
at harvest	9.00	-	-	64.36	5.93	4.37	43.70
After 4 days	9.00	1.92	1.00	62.30	5.73	4.81	40.59
After 8 days	7.59	4.90	1.22	61.39	5.43	4.67	39.26
After 12 days	7.59	5.74	2.11	60.08	4.91	4.34	31.44
L.S.D. at 0.05	N.S.	1.23	-	0.94	0.43	0.28	3.51
Season 2004							
at harvest	9.00	-	-	66.03	5.71	5.23	52.07
After 4 days	9.00	2.66	1.00	63..99	5.37	5.52	49.49
After 8 days	6.18	4.43	1.22	62.62	4.89	5.33	46.87
After 12 days	5.00	6.56	1.88	60.39	4.25	4.80	41.27
L.S.D. at 0.05	N.S	0.83	-	1.16	0.56	0.17	2.26

Firmness

The storage period affected significantly fruit firmness (Table 7), there was a progressive and constant decrease in fruit firmness with the prolongation of the storage period in both seasons.

Results had a similar trend to that reported by Emam (1993) Aly (2002) and Ezzat (2003) on cucumber. The decrease in fruit firmness may be attributed to the gradual breakdown of protopectin to soluble pectins by increasing activity of enzyme pectin methyl esterase, which leads to fruit softening. (Ryall and Lipton 1979).

Dry matter %

The storage period significantly affected dry matter content in the two seasons (Table 7). Obtained results showed that, a slight decrease occurred, as the time elapsed, significant losses in dry matter were observed after 8 days of storage in the first and second season.

Total soluble solids (T.S.S.%)

Concerning T.S.S of cucumber fruits, data in Table (7) show the values of this character during storage, which increased until 4 days then decreased till the end of storage period.

These results agreed with those obtained by Emam (1993), Aly (2002) and Ezzat (2003) on cucumber. On this discussing the previous results, it may be noticed that the changes in T.S.S. at the various storage period are a results of 3 aspects, i.e. respiration, inversion of insoluble compounds to simpler forms and moisture loss by evaporation. So, the tendency of TSS to increase at the first period may be attributed to the quick conversion of insoluble solids to soluble ones beside the high rate of moisture loss. The opposite may be true regarding the decrease in these contents, which occurred at the end of the storage period Emam (1993).

Total chlorophyll

With respect to total chlorophyll, data in Table (7) revealed that a significant decrease in such quality criteria with the advancement of the storage period. Similar results were obtained by Emam (1993), Aly (2002) and Ezzat (2003) on cucumber. However, the decrease in the chlorophyll content during the storage period was expected due to the effect of chlorophyllase activity (Emam 1993).

Effect of the interaction (irrigation level x storage period) on some characters of cucumber fruits during storage.

Visual quality

As for the interaction (irrigation level x storage period) data on Table (8) revealed that (T_1) and (T_2) retained cucumber fruits in better quality for 8 days of cold storage when compared with (T_3) in both seasons (Table 8).

Weight loss

Significant interaction (irrigation level x storage period) was found in the two seasons (Table 8). It was noticed that (T_3) gave the highest percentage of weight loss after 12 days of storage in the first season (7.32%). The same results were also noticed in the second season.

Decay

(T_3) had higher decay score after 12 days of storage than the other treatments (T_1 and T_2) in the two seasons (Table 8).

Dry matter

Significant losses in dry matter content were observed at the end of 12 days of cold storage at 10^0C in all treatments in the both seasons (Table 8). (T_3) after 12 days of cold storage showed the lowest dry matter content (4.74%) than the other treatments, whereas (T_1) at harvest time demonstrated relatively higher dry matter content (5.99%) in the first season. Same results were noticed in the second season.

Total soluble solids (TSS%)

Data in Table (8) indicate that the interaction (irrigation level Vs storage period) effect on total soluble solids was significant during the two seasons. The results show that (T_1) had higher total soluble solids after 4 days of cold storage than the other treatments. On the other hand, (T_3) showed the lowest value after 12 days of cold storage.

Table (8) :Effect of the interaction between irrigation levels and the storage period on some physical and chemical characters of cucumber fruits during storage in 2003 and 2004 season.

Irrigation level (A), Storage periods (B), (Ax B)	Visual quality	Weight loss %	Decay %	Firmness (Newton)	Dry matter %	Total soluble solids T.S.S. (%)	Total chlorophyll (mg/100. F. W.)
Season 2003							
at harvest	9.00	-	-	66.62	a 5.90	4.50	46.43
after 4 day	9.00	3.95	1.00	64.61	ab 5.85	4.95	46.40
T_1 after 8 day	8.55	5.05	1.11	63.16	b 5.66	4.91	41.98
after 12 day	5.66	5.65	2.00	61.16	c 5.14	4.46	35.11
at harvest	9.00	-	-	63.32	5.91	4.44	44.50
after 4 day	9.00	4.93	1.00	62.27	5.78	4.76	42.12
T_2 after 8 day	8.55	5.49	1.50	61.38	5.54	4.50	39.40
after 12 day	5.66	6.06	2.00	60.87	4.84	4.39	32.92
at harvest	9.00	-	-	61.12	5.88	4.17	40.18
after 4 day	9.00	5.90	1.00	60.02	5.58	4.72	39.30
T_3 after 8 day	5.66	6.69	1.55	59.62	5.09	4.61	36.40
after 12 day	5.00	7.32	2.33	58.20	4.74	4.16	26.29
L.S.D. at 0.05	**0.53**	**1.53**	**-**	**1.31**	**0.26**	**0.36**	**3.17**
Season 2004							
at harvest	9.00	-	-	64.42	6.16	5.33	54.50
after 4 day	9.00	3.42	1.00	66.54	5.75	5.76	51.87
T_1 after 8 day	6.33	4.21	1.00	64.68	5.52	5.47	49.60
after 12 day	5.66	6.09	1.66	62.61	4.82	4.95	43.70
at harvest	9.00	-	-	65.67	5.77	5.20	52.60
after 4 day	9.00	3.00	1.00	64.32	5.47	5.47	49.83
T_2 after 8 day	6.55	3.49	1.00	62.81	4.81	5.33	47.40
after 12 day	5.00	6.49	1.66	59.77	4.04	4.80	41.40
at harvest	9.00	-	-	63.99	5.21	5.17	49.10
after 4 day	9.00	4.28	1.00	61.10	4.89	5.33	46.76
T_3 after 8 day	5.66	5.60	1.66	60.37	4.34	5.20	43.60
after 12 day	4.33	7.12	2.33	58.78	3.90	4.66	38.70
L.S.D. at 0.05	**0.62**	**1.78**	**-**	**1.53**	**0.41**	**0.22**	**2.27**

Firmness

Data presented in Table (8) showed that (T_1) had higher values of fruit firmness as compared with the other treatments used during the storage periods, the same results were noticed in the two seasons.

Total chlorophyll

The data in Table (8) showed that (T_1) resulted in the highest total chlorophyll content, whereas the lowest values of total chlorophyll were obtained with (T_3) after 12 days of cold storage these results hold true in the two seasons.

Finally, it can be concluded that low irrigation rate (T_1) had significantly positive effect on cucumber fruits stored at 10^0C. It is worth to mention here that saving water resulted in higher yield, better fruit quality and prolonged storage period.

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اثر معدل الرى على الإنتاج والجودة والقدرة التخزينية لمحصول الخيار المنزرع تحت الأقبية البلاستيكية

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فى تجربتين حقليتين تحت ظروف الأنفاق البلاستيكية بنظام الرى بالتنقيط فى الموسم الشتوى لعامى ٢٠٠٣- ٢٠٠٤ وذلك فى منطقة البرلس الواقعة تحت ظروف المنطقة الساحلية لشمال الدلتا لدراسة تأثير معدلات الرى بـ ٠,٦ ، ٠,٨ ، ١,٠ (بخر – نتح) على المحصول والجودة والقدرة التخزينية للخيار هجين (برنس).

أوضحت النتائج أن الرى بمعدل ٠,٦ (بخر – نتح) هو المعدل المناسب لرى الخيار تحت ظروف منطقة البرلس حيث أعطى أفضل نتائج من حيث إنتاجية المحصول، كما أنه أعطى أعلى إنتاجية بالنسبة لوحدة المياه المضافة (متر مكعب) كما أنه أعطى أقل إحتياجات مائية بالنسبة لوحدة الخيار المنتجة.

وبالتالى يعتبر هذا المعدل ٠,٦ (بخر – نتح) من أفضل معدلات الرى فى هذه المنطقة لزراعة محصول الخيار.

وقد وجد أن الرى بمعدل ٠,٦ (بخر – نتح) أعطى أقل معدل فى الفقد فى الوزن ونسبة التالف كما أظهرت أعلى مستويات الجودة والصلابة والمواد الصلبة الذائبة والمادة الجافة والمحتوى الكلوروفيلى بالنسبة لباقى المعاملات (٠,٨ ، ١,٠ بخر – نتح).

أما بالنسبة لفترات التخزين فإن الفقد فى الوزن ونسبة التالف زادة بزيادة فترات التخزين بينما قلت كل من الجودة والمواد الصلبة الذائبة والمادة الجاف خلال فترة التخزين.