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EFFECT OF DIFFERENT IRRIGATION REGIMES ON YIELD AND FRUIT QUALITY OF TWO MANGO CULTIVARS

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ABSTRACT

The present work was carried out during the two seasons 2016 and 2017 to study the effect of three irrigation regimes i.e. 100 , % 80 % and 60 % of E_t on yield , some physical and biochemical fruit characteristics at harvest of two mango cultivars namely Ewais and Tommy Atkins. Mango trees were growing in newly reclaimed area (sandy soil)-Behera governorate, Egypt. The results showed that the irrigation regime 80 % of E_t increased the number of retained fruits per tree, yield / tree (kg), water use efficiency, fruit weight (g) and volume (cm^3), percentages of pulp weight, fruit moisture, TSS %, TSS /acid ratio of mature fruits on harvest stage. Oppositely, the irrigation regime 80 % of E_t caused a substantial decrease in percentages of peel weight, seed weight and pulp firmness (lb/inch^2), percentages of fruit dry matter content and total acidity of fruit juice on harvest day in the two studied cvs. and in the two seasons compared with irrigation regimes 100 or 60 % of E_{tc} . On the other hand, irrigation regime 60 % of E_t caused a decrease in total yield per a tree (kg) due to suffering the mango trees from water deficit stress. However, the decrease in given amount of irrigation to be 60 % of E_t had improved the fruit quality in both mango cultivars and in the two studied seasons.

Key words: Irrigation, mango trees, physical and chemical of fruits, Yield.

INTRODUCTION

Mango (*Mangifera indica* L.) family Anacardiaceae occupies the third place in Egypt after citrus and grapes regarding the cultivated acreage (281153 fed.) and yearly yield production (880875 tons) in year 2015 (**Ministry of Agric., Egypt 2016**). *Mango is widely grown in tropical regions, while in the subtropical regions it is grown in the irrigated semiarid region.* Most of the fruit development phase during fruit season occurred in dry season and farmers have to irrigate mango trees to ensure high yields and good quality of fruit. Out of several biotic and abiotic factors, optimum water management is one of the most important factors that significantly influence productivity and fruit quality (**Adak et al. 2012 & Bhriguvanshi et al. 2012**). **Bithell et al. (2010)** reported that mango trees are tolerant to drought, while a water deficit during the critical period of reproductive phase (flowering, fruit formation and maturation) would decrease fruit production. Irrigation application up to 100% of E_t could crop productivity, while application under the evapotranspiration requirements of the plant is called deficit irrigation or limited irrigation, (**Spreer et al. 2009**). Deficit irrigation is a strategy to stabilize yields and maximize water productivity while maintaining or increasing farmers' profits, (**Fereres and Soriano 2007**). In the limited water conditions, deficit irrigation can improve water use efficiency because water is allocated properly. Deficit irrigation is very interesting when it comes to an efficient allocation of scarce resources like water. This technique can maximize water productivity with good harvest quality, (**Spreer et al. 2007**). It is particularly suitable for crops in which flowering and fruit development (like in mango) take place in the dry season. Due to the application of relatively small amounts of water, the harvest can be stabilized over time thus it can improve economic planning for farmers, which is increasingly interesting under climate change conditions where water resources are becoming scarce and rain is erratic.

The principle of deficit irrigation is enhances water use efficiency by reducing irrigation from the full requirement of one or more of crop growth phases with smallest impact on crop growth and yield, (**Kirda 1999**). Understanding on the different stages of crop growth is required to arrange irrigation schedule according to crop water requirement. Deficit irrigation techniques could save

considerable amounts of water without affecting the yield to a large extent, possibly increasing the average fruit weight apparently without negative long-term effects, (**Speer *et al.* 2009**). Therefore, the objective goal of the present work is to study the effect of different irrigation regimes on yield, some physical and biochemical fruit characteristics at harvest stage and water use efficiency in Tommy Atkins and Ewais Mango cultivars, cultivated in the newly reclaimed desert areas.

MATERIALS AND METHODS

The present study was carried out during the two successive seasons 2016 and 2017 on mango trees *Mangifera indica* L., cvs., Ewais and Tommy Atkins. The trees of the two studied cultivars are grafted on seeded rootstocks. The trees are 15 years old and grown in sandy soil (newly reclaimed), at Behera governorate. The trees of Tommy Atkins cultivar are planted 5×3 meters apart, while those of Ewais cultivar are planted 6×4 meters apart. All trees are irrigated using drip irrigation system. The chosen trees for the experimentation were in each cultivar similar in vigor and subjected to the same cultural practices. The experimentation was done on nine trees (3 replicates each has 3 trees for each cultivar).

The applied experimentations were as follows:

Determination of water requirement.

Determination of the potential evapotranspiration (E_t).

Potential evapotranspiration (E_t) was calculated from climatic data of the experimented location depending on the use of the modified Penman-Monteith equation according to **Allen *et al.* (1998)**. The values of potential evapotranspiration (E_t) was recorded in the Central Laboratory for Agriculture Climate (CLAC), Agriculture Research Center, Ministry of Agriculture. A Crop coefficient (k_c) which was between 0.2 to 1.2 was used for the calculation the E_c according to **Okyereh (2009)**.

Water consumption (E_c).

Water consumption is determined according to the following formula reported by **Doorenbos and Pruitt (1977)** using E_c value as follows.

$$E_c = E_t \times K_c \dots\dots\dots (1).$$

Amount of applied irrigation water (IW).

Amount of applied irrigation water (IW) were calculated by using the equation elucidated by **Karmeli and Keller (1975)** as follows.

$$IR = \frac{S_e \times S_i \times Et_o \times K_c \times K_r}{E_a} \times \frac{1}{1 - L_r} \dots\dots\dots (2)$$

Since:

IR= Daily irrigation requirements.

$S_e \times S_i$ = plant area (plant distance on lateral $\times$ between laterals).

Et_o = Reference evapotranspiration (mm /day).

K_c = Crop coefficient.

K_r =Reduction coefficient $G_c/0.85$.

G_c = Ground cover (area of tree canopy).

E_a = Efficiency of irrigation system (80 -90 %).

L_r = leaching requirements= E_{ci} / E_{cd}

E_{ci} = Electrical conductivity of irrigation water.

E_{cd} = Electrical conductivity of drainage water.

The three selected irrigation treatments were designed as follows.

100 % of Et_c .

80 % of Et_c .

60 % of Et_c .

The treatments were periodically given to the soil. The total amount of irrigation water (m^3 /feddan) was calculated in each treatment in the two seasons (**Table 1**).

The biochemical analyses of soil samples were collected from soil layer at depth from 0 – 90 cm were 91.80, 3.7 and 4.50 % of sand, silt and clay respectively. The soil was categorized as sandy soil. The wilting point (PWP), filed capacity (FC) and available water (AW) were 5.39 %, 16.18 % and 10.78 % respectively.

Table (1).Total amounts of given irrigation water (m³/ fed. /year) for the three different treatments of Tommy Atkins and Ewais cvs. of Mango trees in seasons 2016 and 2017.

Treatments	100% Et _c	80% Et _c	60% Et _c	100% Et _c	80% Et _c	60% Et _c
Character	The total amount of water m ³ /feddan.					
Months	Season 2016			Season 2017		
January	47.3	37.9	28.4	52.4	41.9	31.4
February	65.6	52.4	39.3	63.1	50.5	37.9
March	219.1	175.3	131.5	219.7	175.8	131.8
April	365.9	292.7	219.5	376.3	301.0	225.8
May	783.2	626.6	469.9	748.8	599.0	449.3
June	845.6	676.5	507.3	915.7	732.5	549.4
July	931.7	745.3	559.0	948.5	758.8	569.1
August	776.6	621.3	466.0	770.2	616.1	462.1
September	558.1	446.4	334.8	547.9	438.3	328.7
October	232.1	185.7	139.3	217.7	174.1	130.6
November	97.8	78.2	58.7	91.2	73.0	54.7
December	33.0	26.4	19.8	34.2	27.4	20.5
Total	4955.8	3964.7	2973.5	4985.5	3988.4	2991.3
Safe water	---	991.2	1982.3	---	997.1	1994.2

Measurements:

The trees were evaluated regarding the following topics:

The yield.

Fifty-four fruits were collected at maturity stage from 9 trees where 6 fruits per tree, then fruits were divided into three replicates in each studied mango cv. The yield of fruits per tree was estimated according to the following equation: Number of retained fruits per tree x average fruit weight at maturity.

Physical and biochemical fruit characteristics at harvest.

Samples of 18 fruits replicated (three times) were collected from each tree (3 × 6 × 3 replicated) in each irrigation treatment. The maturity stage was determined at fruit age 109 and 123 day in Tommy Atkins and Ewais cvs. respectively according to **Khalefa (2006)**.

Physical fruit characteristics.

Fruit weight (g), peel, pulp and seed weight (%), fruit volume (cm³) and flesh firmness (lb / inch² using a pressure tester (Digital

force - Gouge Model IGV-O.SA to FGV-100A. Shimpo instruments) were determined.

Biochemical fruit characteristics.

1-The fruit pulp moisture % and dry matter %. :

The fruit moisture content was determined by drying 10 g of the fruit pulp at 70 °C to constant weight. The following equation was applied.

2- Fruit moisture % = Fresh weight – dry weight x 100/ Fresh weight.

3- Fruit dry matter % = Dry weight x 100/ Fresh weight.

4- Total soluble solids (T.S.S. %) was determined by using Zeiss hand refractometer.

5- Total acidity (%) was determined in fruit juice as percentage of anhydrous citric acid according to **(A.O.A.C 2005)**.

6- Total soluble solids/acid ratio was calculated from the values of total soluble solids divided by values of total acids.

7- Fruit total sugar content was determined colorimetrically in fruit dry weight (g / 100 g dr. wt.) according to the method of **Smith et al. (1956)**.

Water Use Efficiency (WUE) (Kg/m³):

The WUE was calculated per tree as the harvested yield (kg) per volume of irrigation water (m³) according to FAO recommendations **(Doorenbos and Kassam 1979)**.

Statistical analysis:

The results were statistically analyzed using F-value test, and the means were compared by the L.S.D at the level of 5% probability according to **Snedecor and Cochran (1980)**. **(COSTAT, V4)** was the computer program that used to calculate the obtained results.

RESULTS AND DISCUSSION

The yield.

Results in **Table (2)** indicated that irrigation at 80 % of Et_c, gave the highest number of fruits in both Ewais and Tommy Atkins cvs., whereas it gained 116, 104 and 87.7, 84.7 fruit / tree in both cultivars and seasons 2016 and 2017 respectively, followed in descending order

by those irrigated with 100 % of irrigation regime and then those treated with 60 % of Et_c which gained the least significant number of retained fruits per tree, in the two cultivars and seasons 2016 and 2017 respectively.

Regarding fruit weight the irrigation regime at 100 % Et_c gave the highest fruit weight (455.83, 436.57g. and 275.77, 258.70 g.) in both Tommy Atkins and Ewais cvs., in the both seasons respectively followed in descending order by 80 %, and then 60 % Et_c which had the least significant fruit weight. The results demonstrated also that fruit number was low in Tommy Atkins cultivar as result of high fruit weight and vice versa in the Ewais cultivar.

The results also indicated that irrigation the trees with 80 % Et_c caused the highest estimated yield of fruits (36.79, 32.41 and 28.26, 24.61 kg / tree) in Tommy Atkins and Ewais cvs., in seasons 2016 and 2017 respectively, followed in descending order by 100 %, and 60 % Et_c , which had the least significant value of estimated yield fruits per tree (kg) in the two seasons respectively.

Although Tommy Atkins cv. had the lower total number of fruits than Ewais cv. but it had the higher yield per tree than Ewais cv. because of it showed higher fruit weight in comparison with Ewais cv.

The significant increase in the estimated yield per a tree under the effect of 80 % of Et_c irrigation treatment compared with those under 100 % of Et_c or 60 % of Et_c could be attributed to the significant increase in both number of retained fruits as well as fruit weight. It seems that irrigation regime 80 % of Et_c is more suitable for fruit production of both cultivars Ewais and Tommy Atkins than that of 100 % Et_c or 60 % Et_c .

The results are in agreement with those of **Ibrahim (2005)** who found that yield of mango Zebda cv., was the highest at treatments 80 and 100 % of Et_o . On the other hand the treatments 60 and 120 % of Et_o gave the lowest yield. According to **Azevedo et al. (2003)** and **Silva, et al. (2009)**, the yield of mango Tommy Atkins cv. was higher (11%) at treatment (90 % Et_o) than control treatment (100 % Et_o). **Heryani et al. (2016)** reported that the number of fruits / tree and the yield of mango Arumanis cv, recorded the highest values at irrigation treatment of 50 % of Et_c compared with 120, 100, 75% and 0 water requirement treatments. **Subbaiah et al. (2017)** found that the irrigation of mango Banganpalli tree with 100 % of Et_c recorded significantly superior performance in terms of yield / tree followed by

75%. Stronger trees were obtained with a record of a high fruit number / plant compared with the other treatments.

We can come to the conclusion that, the irrigation treatment at 80 % of E_t gave the highest number of fruits and yield /tree (kg), while irrigation treatment at 60 % of E_t gave the lowest number of fruits and yield /tree (kg). Tommy Atkins cv. had the lower total number of fruits than Ewais cv. but it had higher yield per tree than Ewais cv. because of its high fruit weight compared with Ewais cv.

Table 2. Effect of different irrigation regimes on fruit number, fruit weight and yield per tree (Kg) of Tommy Atkins and Ewais Mango cultivars at harvest in 2016 and 2017 seasons.

Characteristics Cultivars		Number of fruits / tree	Average fruit weight (g).	Estimated yield / tree (kg).	Number of fruits / tree	Average fruit weight (g).	Estimated yield / tree (kg).
	Treatments	Seasons 2016			Seasons 2017		
Tommy Atkins	100 % of E_t (control)	74.00	455.83	33.74	68.33	436.57	29.83
	80 % of E_t .	87.67	419.60	36.79	84.67	382.80	32.41
	60 % of E_t .	52.67	370.27	19.50	50.33	349.47	17.59
	L.S.D (5%)	4.26	11.64	2.44	1.15	17.75	1.06
Ewais	100 % of E_t (control)	85.00	275.77	23.44	75.00	258.70	19.40
	80 % of E_t .	116.00	243.67	28.26	104.00	236.67	24.61
	60 % of E_t .	61.33	221.17	13.56	52.67	214.33	11.29
	L.S.D (5%)	4.52	5.65	0.74	9.11	4.28	2.03

Physical and biochemical characteristics of fruits at harvest.

Physical characteristics of fruits.

Data in **Tables (3 and 4)** showed that the decrease of given irrigation regime led to a significant decrease in fruit weight at maturity (harvest day), in both studied cvs, and in the two studied seasons. Thus, the maximum fruit weight and volume was obtained under the effect of irrigation treatment 100 % of E_t , followed in descending order by those of 80 % of E_t , while the least fruit weight values were recorded for at irrigation treatment 60 % of E_t . The major percentage of the pulp weight and the least Peel % and seed % of fruit weight were obtained by irrigation treatment 80 % of E_t .

compared with other treatments in both cvs., and the two studied seasons.

The reduction in irrigation water regime to be 60 % of Et_c increased the pulp firmness of mango fruits compared with those irrigated with 100 % Et_c . Therefore, we can assume that reduction of irrigation treatment up to 60 % of Et_c should delay the ripening processes through inhibition of some enzymes.

The present results are in agreement with those of **Ibrahim (2005)** who found that the higher weight of fruit, peel, pulp, seed and volume of mango Zebda cv. fruits was obtained by irrigation regimes at 100 % and 80 % Et_0 . On the other hand, irrigation with 120 % (control) or 60 % of Et_0 gave the lowest weight of fruits, peel, pulp, seed % and volume in both seasons. Oppositely, pulp firmness of fruits was relatively higher at treatment 80 % Et_0 than at 120 %, 100 %, or 60 % of Et_0 . **Duran et al. (2011)** found that the differences in the weight percentage of skin, pulp and seed of mango Osteen cv., fruits were not affected by the irrigation treatment, since these parameters are normally more related to the variety of mango itself than to any other factors. **Abdel-Razik (2012)** found that the reduction in irrigation water regime to be 70 % of Et_c increased the pulp firmness of mango fruits compared with those irrigated with 100 % Et_c .

Table 3. Effect of different irrigation regimes on some physical characteristics of Mango fruit (Tommy Atkins cv.) at harvest in 2016 and 2017 seasons.

Characteristics Treatments	Fruit weight (g)	Fruit volume (cm ³)	Peel weight (%)	Seed weight (%)	Pulp weight (%)	Pulp firmness (lb/inch ²)
2016 Seasons						
100%Et_c of (control)	449.17	440.00	14.18	9.43	76.39	31.48
80 % of Et_c	412.93	411.00	13.33	8.99	77.69	32.68
60 % of Et_c	363.60	363.33	15.08	10.83	74.08	34.00
L.S.D (5%)	15.1	25.31	0.44	0.12	0.92	0.44
2017 Seasons						
100%Et_c of (control)	429.90	421.67	14.13	9.38	76.50	30.50
80 % of Et_c	376.13	373.33	13.26	8.76	77.98	32.12
60 % of Et_c	342.80	344.33	14.97	10.74	74.29	33.38
L.S.D (5%)	22.85	21.67	0.65	0.42	0.63	1.24

Table 4. Effect of different irrigation regimes on some physical characteristics of Mango fruit (Ewais cv.) at harvest in 2016 and 2017 seasons.

Characteristics Treatments	Fruit weight (g)	Fruit volume (cm ³)	Peel weight (%)	Seed weight (%)	Pulp weight (%)	Pulp firmness (lb/inch ²)
2016 Seasons.						
100%Et _c of (control)	269.10	261.67	16.62	11.06	72.31	22.95
80 % of Et _c	237.00	235.00	16.09	10.30	73.61	24.17
60 % of Et _c	214.50	214.33	17.57	12.14	70.29	25.47
L.S.D (5%)	14.5	13.87	0.23	0.45	0.74	0.27
2017 Seasons.						
100%Et _c of (control)	252.03	246.67	16.16	10.65	73.19	22.50
80 % of Et _c	230.00	228.33	15.47	9.64	74.89	23.75
60 % of Et _c	207.67	208.33	16.92	11.35	71.73	24.90
L.S.D (5%)	9.50	12.90	0.15	0.27	0.71	0.30

Biochemical characteristics:

Moisture percentage.

Data in **Tables (5 and 6)** showed that fruit pulp moisture % was gradually and proportionally decreased with decreasing the irrigation water % of Et_c from 100 % to 60 %. The reduction in moisture content may be due to the fruit skin transpiration and to some extent to fruit respiration as reported by **Rathore *et al.* (2007)**. The present results are also similar with the finding of **Proietti and Antognozzi (1996)**, who reported that with increasing irrigation regime, pulp water content of olive was increased. **Othman and Mbogo (2009)** found that the mango Dodo cv. had higher moisture content than mango Viringe cv. Early season fruits had the lowest moisture content while late season fruit had the highest moisture. **Abdel-Razik (2012)** found that fruit pulp moisture % of Mango was gradually and proportionally decreased with decreasing the irrigation water. Similar results were found with **Wei *et al.* (2017)** in mango Guifei cv.

Dry matter.

Data presented in **Tables (5 and 6)** showed that dry matter was significantly affected by different water regimes treatments in both seasons. Maximum percentage of dry matter was obtained by irrigation treatment 60 % of Et_c followed in descending order by 80 %

of Et_c . The least values of dry matter percentage were shown by irrigation treatment 100 % Et_c in the two seasons.

The results were in agreement with those found by **Bhuyan (1994)** who reported that irrigation which was applied at fortnightly intervals from bloom or no irrigation of tree caused a reduction in dry matter in ripe fruits of mango Corabo cv.

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

Data in **Tables (5 and 6)** indicated that TSS % in the fruit juice of the two mango cultivars increased with decreasing of the irrigation water % of Et_c from 100 % to 60 % of Et_c in both seasons.

These results are in agreement with those found by **Ibrahim (2005)** who reported that TSS % of mango pulp fruits were slightly higher at treatments 80% or 60 % Et_0 than other treatments 100 and 120 % Et_0 . **Abdel-Razik (2012)** showed that fruit TSS % was increased with the reduction of irrigation water that given to the orchard and the maximum increase was recorded at 70 % of Et_c . while the lowest at 100 % of Et_c . Similar results found with **Wei et al. (2017)** in mango Guifei cv,. **Rathore et al. (2007)** found that the increase and decrease in TSS % is directly correlated with hydrolytic changes in starch and conversion of starch to sugar being an important index of ripening process in mango. The reduction in TSS % is due to dilution of sugars with excessive fruit moisture contents according to **Nasir and Haq-Mian (1993)**.

Total fruit acidity percentage.

Results in **Tables (5 and 6)** showed that the total acidity percentages of two mango cvs. was significantly decreased with increasing the irrigation regimes from 60 % to 100 % of Et_c in the two studied mango cvs., in both studied seasons. The highest value of total acidity percentage was found at 60% of Et_c at harvest while the lowest at 100% of Et_c .

These results were in agreement with those found by many workers on mango. They reported that the highest value of total acidity was found at 60 % of Et_c while the lowest was found at 100 % of Et_c (**Abdel-Razik 2012; Ibrahim 2005; Naglea et al. 2010; Pavel et al. 2003 and Wei et al. 2017**).

TSS/Acid ratio.

TSS/Acid ratio is a parameter that indicates the fruit quality. The increase of the TSS/Acid ratio is coincided with increasing the sweetness of the fruit and vice versa. Therefore, the producer hopes that TSS / Acid ratio attained a value, at which fruit sugar and total fruit acidity will be in balance, neither very sweet nor acid. Thus the very sweet fruit in absence of acids is not desirable.

The results in **Table (5 and 6)** clearly showed that the differences between ratio of TSS / Acid under the two irrigation treatments 100 % and 80 % of E_t were insignificant. Oppositely, the results showed a significant difference between TSS / Acid ratio under the effect of 60 % of E_t irrigation treatment and the fruit TSS / Acid ratio under the effect of both 100 % and 80 % of E_t irrigation treatments in both studied cvs. and in the two seasons. TSS / Acid ratio under 60 % E_t showed a significant decrease in the ratio where it attained the minimal value compared with those under 100 % or 80 % of E_t irrigation treatments.

These results are in agreement with those found by **Ibrahim (2005)** who reported that the TSS / acid ratio of mango fruits Zebda cv. was higher at irrigation treatment 80 % E_t than 120, 100 and 60 % of E_t . **Spreer et al. (2007)** found that the TSS / acid ratio of mango fruits was increased in all treatments, which regulated deficit irrigation and control (100 % E_t). **Nasir and Haq-Mian (1993)** reported that, excessive moisture has a depressing effect on TSS/acid ratio.

Total sugars percentage (g / 100 g dr. wt.).

Results in **Tables (5 and 6)** showed that the total sugars content of the two mango cvs. was significantly increased by decreasing the irrigation regimes of E_t from 100% to 60 % in both 2015 and 2016. The maximum increase in total sugar was recorded at 60 % of E_t , while the lowest one was at 100 % of E_t .

These results are in agreement with those found by **Pavel et al. (2003)** who reported that the total sugars of fruits mango were the lowest at treatments deficit irrigation 79 and 69 % from field capacity) than control (95 % field capacity) at harvest. **Khattab et al. (2011)** found that the total sugar % of fruits pomegranate was decreased by increasing irrigation levels. Similar results found by **Subbaiah et al. (2017)** and **Wei et al. (2017)** on mango tree.

Table 5. Effect of different irrigation regimes on some biochemical characteristics of Mango fruit (Tommy Atkins cv.) at harvest in 2015 and 2016 seasons.

Characteristics Treatments	Moisture %	Dry matter content %	TSS %	Total acidity %	TSS/acid ratio	Total sugars %
2016 Seasons.						
100 % of Et _c (control)	80.67	19.33	8.55	1.09	7.83	6.84
80 % of Et _c	79.00	21.00	9.08	1.13	8.03	7.87
60 % of Et _c	78.00	22.00	9.48	1.30	7.32	8.54
L.S.D (5%)	1.35	1.35	0.29	0.027	0.094	0.25
2017 Seasons.						
100 % of Et _c (control)	79.67	20.33	8.63	1.03	8.41	6.91
80 % of Et _c	78.67	21.33	9.57	1.07	8.97	8.39
60 % of Et _c	77.83	22.17	10.20	1.24	8.23	9.09
L.S.D (5%)	1.29	1.29	0.18	0.01	0.13	0.20

Table 6. Effect of different irrigation regimes on some biochemical characteristics of Mango fruit (Ewais cv.) at harvest in 2015 and 2016 seasons.

Characteristics Treatments	Moisture %	Dry matter content %	TSS %	Total acidity %	TSS/acid ratio	Total sugars %
2016 Seasons.						
100 % of Et _c (control)	79.73	20.27	14.17	1.01	14.08	10.39
80 % of Et _c	78.50	21.50	15.90	1.10	14.50	12.72
60 % of Et _c	77.30	22.70	16.67	1.21	13.78	13.89
L.S.D (5%)	0.59	0.59	0.221	0.034	0.28	0.60
2017 Seasons.						
100 % of Et _c (control)	79.60	20.40	14.60	0.99	14.70	10.71
80 % of Et _c	78.27	21.73	16.10	1.05	15.40	12.88
60 % of Et _c	76.87	23.13	16.83	1.17	14.39	14.03
L.S.D (5%)	0.56	0.56	0.48	0.051	0.75	0.36

Water Use Efficiency

Since water is a limiting factor of production, limited irrigation can enhance water use efficiency (WUE), so that the available water is better allocated. Data in **Table (7)** indicated that WUE of 80 % of Et_c treatment was higher than that of 100 % and 60 % Et_c treatments of both Mango Tommy Atkins and Ewais cvs and both studied seasons.

These results are in agreement with those found by **Heryani *et al.* (2016)** who reported that the WUE of 50 % and 75 % of E_t was higher than that of 100 % E_t of mango Arumanis cv.,. Out of several biotic and abiotic factors, optimum water management is one of the most important factors that significantly influence productivity and quality of the product) **Bhriguvanshi *et al.* 2012).**

Table 7. Yield, total amounts of given irrigation water (m^3 / tree./year) and water use efficiency at different water treatments of Tommy Atkins and Ewais cvs. Mango trees in seasons 2016 and 2017.

Characteristics Cultivars		Yield/ tree (kg).	Irrigation (m^3 /tree)	water use efficiency (kg/m^3)	Yield /tree (kg).	Irrigation (m^3 /tree)	water use efficiency (kg/m^3)
	Treatments	2016 Seasons			2017 Seasons		
Tommy Atkins	100 % of E_t (control)	33.74	22.12	1.53	29.83	22.26	1.34
	80 % of E_t .	36.79	17.70	2.08	32.41	17.81	1.82
	60 % of E_t .	19.50	13.27	1.47	17.59	13.35	1.32
Ewais	100 % of E_t (control)	23.44	35.40	0.66	19.40	35.61	0.54
	80 % of E_t .	28.26	28.32	1.00	24.61	28.49	0.86
	60 % of E_t .	13.56	21.24	0.64	11.29	21.37	0.53

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تأثير أنظمة الري المختلفة على محصول وجودة ثمار صنفين من المانجو.

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أجرى هذا البحث خلال موسمين متتاليين 2016 و 2017 على أشجار مانجو صنفى تومى اتكينز و عويس ، نامية فى تربة رملية (أراضى مستصلحة حديثا) بمحافظة البحيرة – مصر. و كان عمر الأشجار 15 عام و مطعومة على أصول بذرية، و مسافة الزراعة 3×5م للصنف تومى اتكينز و 4 × 6 م للصنف عويس و كانت تروى بالتنقيط . و يهدف البحث لدراسة تأثير مستويات مختلفه من الري و هى 100 % (كنترول)، 80 % و 60 % من الإستهلاك المائى على المحصول و الصفات الطبيعية و الكيماوية للثمار. و قد أظهرت النتائج أن معاملة الري 80 % من الإستهلاك المائى للمحصول أعطت أعلى عدد للثمار المتبقية على الأشجار و كذلك محصول الشجرة (كجم) على عكس المعاملة 60 % التى أعطت أقل عدد للثمار و كذلك محصول / شجرة (كجم) لكلا صنفى و موسمى الدراسة. و كانت أشجار الصنف تومى اتكينز تحمل عدد أقل للثمار المتبقية على الشجرة على عكس أشجار الصنف عويس، و لكن محصول شجرة تومى اتكينز كان عالى و ذلك لأن وزن ثمرة الصنف تومى اتكينز كانت أكبر من وزن ثمرة الصنف عويس . و ايضا وجد أن المعاملة 80 % حسنت من الصفات الطبيعية و الكيماوية للثمار عند الحصاد من خلال زيادة وزن ،حجم و النسبة المئوية لللب الثمار ، المواد الصلبة الذائبة ، المواد الصلبة الذائبة / الحموضة الكلية للحم للثمار و كفاءة الاستهلاك المائى و تزامن هذا مع نقص كل من النسبة المئوية للقشرة و البذرة و صلابة لحم الثمار ، محتوى الثمار من الرطوبة و الحموضة الكلية للثمار فى كلا صنفى و موسمى الدراسة مقارنة مع المعاملات الأخرى لكلا صنفى و موسمى الدراسة.