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IRRIGATION CUT-OFF AS EFFICIENT SCHEME FOR MAXIMIZING CANTALOUPE PRODUCTIVITY AND QUALITY UNDER DIFFERENT IRON APPLICATION TECHNIQUES

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ABSTRACT

Two field experiments were conducted to quantify the response of cantaloupe crop (*Cucumis melo, Hybrid French F_1*) to variable irrigation regimes and Fe-fertilizer application techniques on some irrigation parameters, fruit yield, yield components, water consumption and some crop -water relations. Four cut-off irrigation regimes were assessed e.g. stop irrigation as the water front reached 100 (control), 90, 80 and 70% of the entire furrow length(FL). Four iron application techniques e.g. in soil (Fe_1), foliar spraying(Fe_2), in soil plus foliar spraying (Fe_3) and without Fe application (Fe_4) during 2012 and 2013 growing seasons. The trials were executed at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. The important findings could be summarized as follows:

1-After irrigation stopping, under 90% FL regime, water front advanced to irrigate the non- irrigated distance (7m), whereas under 70 and 80% FL regimes, the distances irrigated due to water front advancement, represented ~50 and ~75% of non-irrigated distance, respectively. Ponding times under 90, 80 and 70% FL regimes were lower by 15.91, 27.27 and 38.64%, respectively, comparable with 100% FL regime, so, the opportunity time has an adverse trend with furrow length to stop irrigation. The trend of seasonal consumptive use values were in parallel with those of applied irrigation water. The highest values of WUtE, WUE and Ecu% were recorded with cut- off irrigation as water front reached to 90%FL.

2-All of the evaluated vegetative growth traits exhibited higher figures under 100% FL cut off irrigation regime. Cut off irrigation regime of 90% FL was superior to produce fruit yield potential (17.79 and 18.01 ton fed^{-1}, in 1st and 2nd seasons, respectively), however, the difference was insignificant comparing with 100%FL regime. Fe_3 proved to be more efficient to produce higher vegetative growth than the other tested Fe application techniques.

3-The highest values of fruit weight and length traits were attained under 100%FL regime without significant difference comparing with those under 90%FL regime. In addition, the highest figures of fruit yield attributes were recorded with (Fe_3).

4-Total sugar% and acidity% exhibited higher values with70%FL cut off irrigation, and the value tended to reduce, gradually, with increasing the irrigation run. Nevertheless, Vitamin C content, TSS %, fruit firmness and fruit flesh thickness exhibited an opposite trend where higher values were reported with longer irrigation run. Furthermore, higher values of all the above mentioned fruit quality attributes were attained due to (Fe_3).

5-Higher values of N, P, K and chlorophyll contents in cantaloupe leaves were recorded under 100% FL irrigation regime. In addition, similar trends were observed due to (Fe_3). Interaction of 100% cut off irrigation regime and (Fe_3), in general, exhibited higher values of the above mentioned contents.

6-On conclusion, it is advisable to irrigate cantaloupe crop under 90%FL irrigation regime combined with applying Fe in the soil & foliar application technique in order to obtain higher and reasonable fruit yield and quality and water productivity as well under the experimental conditions.

Keywords*:* Cantaloupe yield and quality, Cut-off irrigation, Crop-water efficiencies,Fe application techniques

INTRODUCTION

Water is fast becoming an economically scarce resource in many areas of the world, especially in arid and semi-arid regions such as the Mediterranean basin. In Egypt, agricultural production is mainly irrigated agriculture and the River Nile is the main source of water supply with fixed allocation from its water. At present capita share per annum for different purposes is less water poverty edge of 1000 m^3. Moreover, it is decreasing rapidly due to increasing in population and expected to be less than the water scarcity edge of 500 m^3 per annum in the coming two decades. So, it is difficult to accomplish reasonable economical development. Agriculture is the main sector in water consumption with more than 85% from total national water supply. Geerts and Raes (2009) considered the concept of water productivity to be an important issue and warned that due to the current development policy adopted in the world, the pressure on water resources for food production will increase, and water consumption will reach 5.600 km^3 $year^{-1}$ in 2050, represents three times the amount of water currently used for irrigation worldwide.

Surface irrigation is the wide spread irrigation method in Egypt as well as worldwide. In Egypt, furrow irrigation is the common method for cantaloupe production especially in the clayey soils. The local farmers allowing the wetting front to reach the end of the strip resulting in water losses due to deep percolation, particularly, in the upper part of the irrigation strip. On saving applied water issue, cut-off irrigation scheme is preferable implemented on clay soils due to low infiltration rate where horizontal lateral water movement is higher than vertical downward movement. Under cut-off irrigation, water front should be stopped before the end of cultivated border and advancement movement of the accumulated water is used in watering the remaining un-irrigated area. This technique is practicable as a direct simple effective way in water saving. In addition, less water will percolate down word to the drainage system. In this regard, Raine and Bakker (1996) reported that under commercial conditions, a significant components of the irrigation water applied may be lost as excessive tailwater and deep drainage and 20% of the applied water could be saved if irrigation was stopped as soon as the soil water deficit was fully recharged. In connection, Horst *et al.* (2005) reported a large water saving resulted from reducing the irrigation cut-off times in every-furrow irrigation, corresponding 150–200 mm through the irrigation season. Moreover, Ibrahim and Emara (2009) reported that with sugar beet, cut-off irrigation technique resulting in reducing amounts of supplied water where the advancement movement of the accumulated water after stopping irrigation was used in watering the remaining un-irrigated area. Kassab *et al.* (2012) found that irrigating berseem crop in North Nile Delta till 90 % of strip length, comparing with irrigating till the strip end, similar yields were obtained, about 8% irrigation water saving besides exhibiting higher both WUtE and WUE values.

Sensoy *et al.* (2007) stated that excessive application of water leading to reduction of the melon fruit yield, lower fruit quality characteristics and plant disease as well. Nevertheless, Gil *et al.* (2000) and Lei *et al.* (2003) found that application of limited amounts of water may improve fruit quality and sometimes improve the yield compared with full irrigation. Moreover, Ribas *et al.* (2001) stated that melon yield could significantly decrease by using less amount of water than recommended.

Iron deficiency (Fe chlorosis) is one of the most serious problems for horticultural crops, including cantaloupe, and fruit trees cultivated in alkaline and calcareous soils (Lucena *et al.* 2007). In general, plant Fe efficiency has been related to the plant's capacity to develop specific physiological and morphological responses at the root level under Fe-deficient conditions (Briat, 2008). Fe is an essential nutrient element for plant growth and development and is involved in chlorophyll synthesis, thylakoid synthesis, and chloroplast development (Buchanan *et al.* 2000). Iron is essential for plants due to its involvement in major metabolic processes such as reduction of rib nucleotides and molecular nitrogen, and the energy-yielding electron transfer reactions of respiration and photosynthesis (Guerinot and Yi 1994).

The optimum fertility level needed for vegetative production can be achieved from the quantities of nutrient removed by the crop. The removal may vary according to the soil nutrient content and their availability as affected by soil moisture and temperature (Ifitihar *et al.* 2004). Kannan (2010) noticed that foliar sprays cannot substitute soil fertilization, but that they can be used as supplement of soil applications in sustainable crop production. Iron deficiency in plant causes chlorosis, deceases in vegetative growth, reduce net photosynthetic rate and chlorophyll content in plants (Goss and Johanson, 2000).

The herein research trial objectives are to determine the potency of irrigation cut off techniques for improving furrow irrigation performance and optimizing water productivity under different Fe application techniques. Cantaloupe yield and quality as well as some crop-water relationships were considered.

MATERIALS AND METHODS

The current study was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate during 2012 and 2013 seasons to study the effect of different irrigation regimes under cut off scheme and iron application techniques on cantaloupe crop production and some crop - water relations. Soil particle size distribution and bulk density were determined as described by Klute (1986). Field capacity, permanent wilting point and available water characters were determined according to James (1988). Chemical characteristics of soil were determined as described by Jackson (1973) and all data are illustrated in Table 1.

All of the usual agronomic practices for cantaloupe production in the area were executed. The experimental design is a split plot with four replicates. The main plots were randomly assigned to 4 irrigation regimes while the sub main plots were assigned to 4 iron application techniques as follows:

A. Main treatments (cut-off irrigation regime)

1: Traditional furrow irrigation, where entire furrow length was irrigated (100%FL, control).

2: Irrigation cut off as water front reached 90 % of furrow length, (90%FL).

3: Irrigation cut off as water front reached 80 % of furrow length, (80%FL) and

4: Irrigation cut off as water front reached 70 % of furrow length, (70%FL).

The cultivated furrows were 70m in length and 1.2m in width and irrigation was stopped as water front reached 70, 63, 56 and 49 m for 100%FL (control), 90, 80 and 70%FL irrigation regimes, respectively.

B. Sub main treatments (Fe application techniques)

Fe_1: Soil application — Fe_2: Foliar application

Fe_3: Soil plus foliar application and Fe_4: Without iron application

With Fe soil application technique, magnetite iron (MI) was distributed and incorporated into the soil surface before transplanting at 150 kg MI/fed rate. Whereas with the foliar spraying technique, Fe was applied as Fe-EDTA chelating form, in three equal doses (600 gm/fed. each) at 15, 30 and 45 days after transplanting.

Table 1 Particle size distribution, bulk density, some both soil-water characters and chemical soil properties of the experimental site (mean of 2012 and 2013 seasons)

Soil layer depth (cm)	Particle size distribution†			Textural class	Bulk density (Kgm^{-3})	Soil- water constant		
	Sand%	Silt%	Clay%			F.C* (%,wt/wt)	P.W.P** (%,wt/wt)	A.W*** (%,wt/wt)
00-15	15.50	25.30	59.20	Clayey	1.18	44.82	24.36	20.46
15-30	18.90	29.80	51.30	Clayey	1.21	42.12	22.89	19.23
30-45	21.42	29.08	49.50	Clayey	1.25	41.01	22.29	18.72
45-60	21.11	31.51	47.38	Clayey	1.29	38.28	20.80	17.48
Mean	19.25	28.92	51.85	Clayey	1.23	41.56	22.59	18.97

Chemical Soil characteristics

	pH	EC dSm^{-1}	Soluble cations, $meqL^{-1}$				Soluble anions, $meqL^{-1}$			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
00-15	8.10	2.62	5.0	5.0	15.6	0.65	-	9.50	3.70	13.05
15-30	8.10	2.83	3.6	6.4	18.0	0.28	-	9.20	10.00	9.08
30-45	7.90	3.70	5.2	6.8	24.8	0.28	-	13.50	14.80	8.78
45-60	7.70	3.70	7.0	14.0	15.6	0.37	-	10.50	16.50	9.97
Mean	7.95	3.21	5.2	8.05	18.5	0.40	-	10.68	11.25	10.22

FC* = Field capacity, PWP = Permanent wilting point and AW*** = Available soil water**

Cantaloupe (*Cucumis melo, Hybrid French F_1)* seedlings, 22 days age, were transplanted on one side of the ridge in hills spaced 0.40 m apart giving a plant density of about two plants m^{-2}. Transplanting dates were on

May 28, 2012 and May 24, 2013. The experimental plot area equals 672 m^2 (0.16 feddan) and including 8 ridges.

1. Irrigation water control

Irrigation water was controlled and measured by submerged rectangular weir upstream and water was distributed and maintained by spills inserted beneath the bank of each irrigated furrows set. Applied irrigation water quantity was determined according to Michael, (1978) as follows:

$$Q = CA\sqrt{2gh}$$

Where:

Q = Water discharge, $cm^3 sec^{-1}$
C = coefficient of discharge ranged from 0.6 up to 0.8 or more
A = weir cross - sectional area, cm^2
g = acceleration due to of gravity, 981cm sec^{-2} and
h = pressure head causing water discharge, cm

2. Advance and recession times:

Along each furrow, stations in 10 m apart system were established till the furrow end. Time of advanced water front at each station and at the end of the proposed furrow length was recorded from watering beginning and expressed as the advance time. The corresponding elapsed time for the water disappearing at each station was recorded and expressed as recession time. At each station, the difference between advance and recession times is expressed as the opportunity time of irrigation water.

3. Water consumptive use:

Soil moisture percentage was determined (on weight basis) just before and 48 hrs after each irrigation as well as at harvest to compute the actual consumed water as stated by Hansen *et al.* (1979) as follows:

$$CU = S.M.D. = \sum_{i=1}^{i=4} \frac{\phi_2 - \phi_1}{100} \times D_{bi} \times D_i$$

Where:

CU =Water consumptive use (cm) in the effective root zone of 60 cm soil depth
S.M.D. = Soil Mmoisture Depletion, cm.
i= Number of soil layer (1-4)
D_i = Soil layer thickness (15 cm)
D_{bi} = Bulk density (Kg gm^{-3}) of the concerned soil layer
ϕ_1 = Soil moisture percentage (wt/wt) before irrigation and
ϕ_2 = Soil moisture percentage (wt/wt), 48 hours after irrigation.

4. Crop-Water efficiencies:

Crop water efficiencies were calculated according to Doornbos and Pruitt (1975) as follows:

$$\text{Water Utilization Efficiency (WUtE, kgm}^{-3}) = \frac{Y}{Wa}$$

$$\text{Water Use Efficiency (WUE, kgm}^{-3}) = \frac{Y}{CU}$$

Where:

WUtE = Water utilization efficiency (kgm^{-3}).
WUE = Water use efficiency (kgm^{-3}).
Y = Fruitl yield ($kgfed^{-1}$).
Wa = Seasonal applied water (m^3fed^{-1}) and
CU = Seasonal crop-water consumed (m^3fed^{-1}).

5. Consumptive use efficiency (Ecu):

The consumptive use efficiency (Ecu) was calculated as described by Doornbos and Pruitt (1975) as follows:

$$Ecu = \frac{ETc}{Wa} \times 100$$

Where:

Ecu = Consumptive use efficiency%
Etc = Total evapotranspiration $\simeq$ consumptive use (m^3fed^{-1}).
Wa = Water applied to the field (m^3fed^{-1}).

6. Crop yield:

Measurements and calculations:

*** Vegetative and growth Measurements**

- Shoots fresh & dry weights(g)
- Plant height (cm)
- Number of leaves per plant
- Leaf area per plant (dm^2)
- Chlorophyll content ($mgdm^{-2}$): determined spectrocolorimeterically at 60 days after transplanting as described by Moran and Porath (1982).

*** Fruit yield, yield components and quality**

- Early fruit yield (yield of first picking) and total fruit yield ($tonfed^{-1}$) -
- Mean fruit weight (g) - Fruit Length (cm) - Fruit Diameter (cm)
- Vitamin C (mg / 100 g fresh wt) - Acidity content (%)
- Total Soluble Solids (TSS %) - Sugar content (%).
- Firmness ($kgcm^{-2}$) and - Flesh Thickness (cm)

*** Mineral content**

Nitrogen (%) was determined in the digestion product using the micro-kjeldahl method (AOAC, 1980). Phosphorus (%) was determined colorimetrically at 725 µm (King, 1951). Potassium (%) was determined using a flame photometer (Jackson, 1973).

Data were statistically analyzed according to the technique of analysis of variance (ANOVA) as published by Gomez and Gomez (1984). Means of the treatments were compared using Least Significant Difference (LSD) at 5% level of significance as developed by Waller and Duncan (1969).

RESULTS AND DISCUSSION

A. Advance, recession and opportunity times:

Data in Table 2 revealed that the shortest time to stop irrigation (8-10 min) was attained under 90% FL irrigation cut off regime, while under both 80 and 70% FL regimes the time was extended to be 18-20 min. In addition, the distances still non- irrigated, just after irrigation stopping, were longer by 100 and 200% with 80 and 70%FL regimes, respectively, than that under 90% FL regime. Furthermore, after irrigation stopping, under 90% FL regime, water front advancement proved to be sufficient to irrigate the non- irrigated distance (7m), whereas under 70 and 80% FL regimes, the distances irrigated due to water front advancement, represented ≃50 and ≃75% out of non –irrigated distance, respectively.

In order to choose the most proper irrigation cut-off regime, two items should be taken into consideration and must be evaluated the first is amount of water saving and the second is the crop yield potentiality along with productivity of applied water unit. On such basis, irrigating with 90% FL regime, the corresponding time is less than that recorded with 100% FL regime and this means less water could be drained underneath the root zone.

Table 2 Average of times to stop irrigation, none irrigated distance and water front advancement under the adopted irrigation cut-off regimes

Cut-off irrigation regime	Time to stop water front (min)	Non irrigated distance (m)	Water front advancement after stopping irrigation (m)
100% FL(control)	None	None	None
90% FL	8-10	7.0	= 7
80% FL	18-22	14.0	≃10.5
70% FL	18-22	21.0	≃ 10.5

The direction of curves of water advance and recession times which were almost parallel under the adopted irrigation regimes, figure. 1 Time of ponding, in take opportunity time, which equals the consumed time needed to infiltrate2 the accumulated water at each station from the soil surface to inside soil, is affected by the adopted irrigation cut-off regimes. Ponding times under 90, 80 and 70%FL regimes were lower by 15.91, 27.27 and 38.64%, respectively, comparable with 100%FL regime. The opportunity time has the adverse trend with furrow length to stop irrigation. On other words, by increasing the length of irrigation run (traditional, without cut-off) the highest opportunity time is resulted and vice versa.

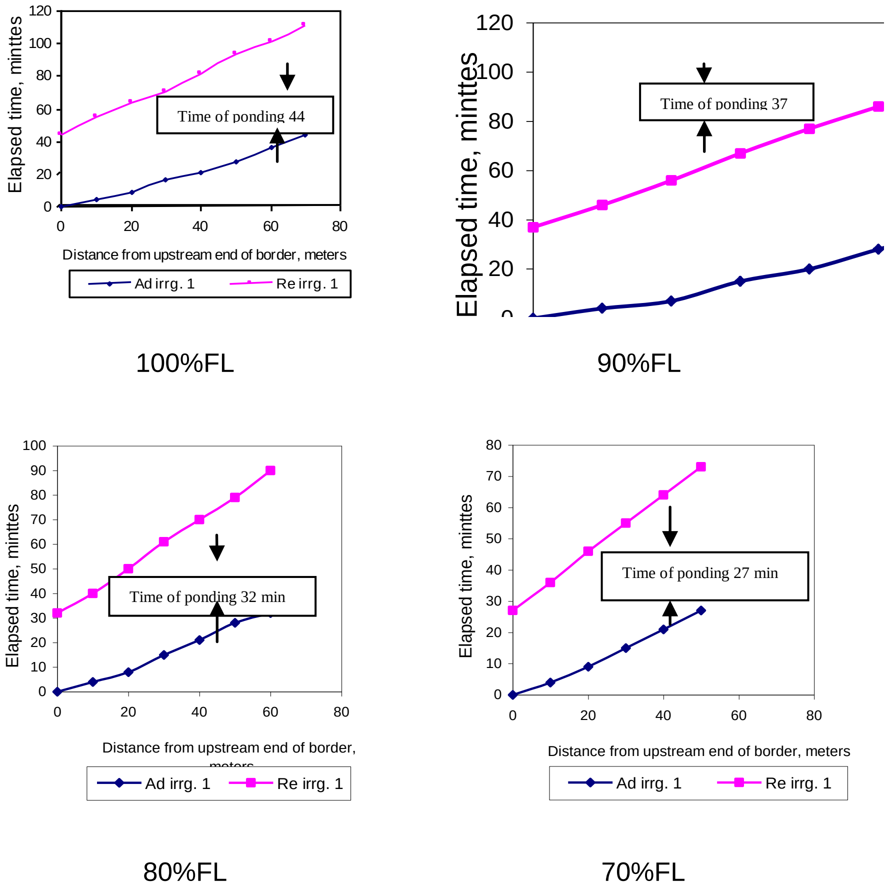

Fig.(1) Irrigated length and elapsed time for 100, 90, 80 and 70% of furrow length regime.

B- Applied irrigation water, crop consumptive use and efficiencies.

1- Irrigation water applied:

Data in Table 2 revealed that the mean values of applied irrigation water, for cantaloupe crop, water tended to decrease as irrigation length decrease, and vice versa. The reduction values in applied water amounted to 8.26, 13.84 and 17.31% under 90, 80 and 70% FL, respectively, less than that with 100% FL(control).Such findings are logic and expected since longer irrigation length resulted in more applied irrigation. In connection, Raine and Bakker (1996) stated that under alluvial soil condition, more than 20% of the applied water could be saved by more accurate timing of irrigation cut off. Moreover, Ibrahim and Emara (2009) found that seasonal water applied for sugar beet in north Nile delta is ranged to 71cm with traditional furrow irrigation and 61cm with 80% irrigation cut-off. Şimşek *et al.* (2004) stated that higher value of irrigation water applied was recorded with irrigating watermelon according to 1.25, total irrigation water applied (IW)/cumulative pan evaporation (CPE), comparing with 1.00, 0.75 and 0.50 ones. Moreover, Badr and Abou Hussein (2008) found that greater volume of water applied, to drip – irrigated cantaloupe crop, resulted from irrigating at 1.4ETc level comparing with 1.0 and 1.2Etc ones.

2- Crop water consumptive use (CU):

Crop water consumptive use (CU) or crop evapotranspiration (ETc) was computed on the basis of water depletion from the effective root zone of the upper 60 cm soil depth. The general trend of seasonal consumptive use values is in parallel with that of applied irrigation water, (Table 2). The CU values were lower by 7.99, 15.65 and 19.74% under 90, 80 and 70% FL, comparable with100% FL (control), respectively. These are still expected, where increasing irrigation length resulted in higher both soil water intake and moisture content which subjected to higher absorption rate by the root system and consequent higher transpiration from the crop canopy besides higher evaporation from the soil surface. In this sense, Levitt *et al.* (1995) stated that more frequent irrigation events provide high evaporation opportunity from the relatively wet rather than dry soil surface. Şimşek *et al.* (2004) found that seasonal watermelon crop evapotranspiration (ET_c) values were proportioned with IW/CPE ratio. In the present trial, it is worthy to notice that, under the adopted irrigation cut off regimes, daily consumptives use for cantaloupe crop exhibited a similar trend of both applied irrigation water and seasonal consumptive use.

3- Crop-water efficiencies:

Crop-water efficiency is a parameter indicates productivity of the irrigation water unit. This function could be evaluated in the two terms e.g. water utilization efficiency (WUtE) which related yield to the water applied and water use efficiency (WUE) which relates yield to water consumed. Data in Table 2 illustrated that the highest WUtE value was recorded due to applying cut- off irrigation technique as water front reached to 90% of the full irrigation length (90%FL). The increases in cantaloupe fruit yield resulted from the unit of applied water, under 90% FL regime, amounted to 11.10, 15.10 and 28.76% more than those attained under 100, 80 and 70%FL regimes, respectively. Such increases could be attributed to higher cantaloupe fruit yield produced due to applying 90%FL regime. Zeng *et al.* (2009) with muskmelon crop, found that irrigation water use efficiency (IWUE) values showed that the lower the amount of irrigation water applied, the higher the irrigation water use efficiency obtained. Ibrahim and Emara (2009) reported that irrigation till 90 % furrow length resulted in higher water utilization efficiency (WUtE) values for both root and sugar beet yield.

As for Water Use Efficiency (WUE), the highest figure still recorded under 90% FL irrigation regime with increase percentages reached to 10.78, 12.40 and 24.17, respectively, higher than those obtained under 100, 80 and 70% FL irrigation regimes,Table 2. Higher WUE values could be attributed to higher fruit yield under 90% FL irrigation regime. In connection, Cabello *et al.* (2009) recorded higher WUE values for melon crop under the moderate water stress (75% of Etc). In addition, the present findings are in accordance with those of Ibrahim and Emara (2009) who reported that irrigation till 90 %

furrow length resulted in higher water use efficiency (WUE) for both root and sugar beet yields.

Table 3 Some water parameters under cantaloupe crop as affected by different cut-off irrigation regimes in 2012 and 2013 growing seasons

Irrigation Parameter*	Cut – off irrigation regime											
	100 % FL, control			90 % FL			80 % FL			70 % FL		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
IW (m^3fed^{-1})	1465	1440	1452.5	1340	1325	1332.5	1245	1258	1251.5	1200.0	1202	1201
CU (cm)	32.32	31.20	31.76	29.66	28.78	29.22	26.59	26.94	26.76	25.28	25.68	25.49
CU_d(cmday^{-1})	0.359	0.346	0.352	0.329	0.318	0.324	0.295	0.299	0.297	0.281	0.285	0.283
WUtE, kg/m^{-3}	11.76	12.41	12.09	13.27	13.59	13.43	11.65	11.69	11.67	10.35	10.51	10.43
WUE, kg/m^{-3}	12.69	13.64	13.17	14.28	14.90	14.59	12.98	12.99	12.98	11.70	11.80	11.75
Ecu (%)	92.65	91.00	91.83	92.96	91.23	92.10	89.73	91.17	90.29	88.49	89.73	89.14

***Irrigation water applied(IW), seasonal Water Consumption (CU), Daily Water Consumption (CU_d), Water Utilization Efficiency(WUtE), Water Use Efficiency (WUE) and Consumptive use efficiency (Ecu,%)**

4- Consumptive use efficiency (Ecu):

Consumptive use efficiency (Ecu) is a parameter referrers to the capability of plants to utilize the soil moisture stored in the effective roots zone in proportion to total applied water. On this basis, higher Ecu value (92.10%) was obtained due to executed cut- off irrigation technique as water front reached to 90% of the full irrigation length(90% FL), comparing with 91.83, 90.29 and 89.14% under 100, 80 and 70% FL treatments, respectively. In connection, Raine and Bakker (1996) with cane crop grown on alluvial soil, reported higher application efficiency reached to 26% higher with optimum cut off irrigation timing than with traditional irrigation. The present results are in parallel with those of Ibrahim and Emara (2009) who stated that Ecu values were 74.4, 76.0 and 77.2 % under traditional furrow irrigation, 90 and 80 % irrigation cut-off regimes, respectively.

Vegetative growth

1- Shoots fresh, dry weights and plant height

- Shoots fresh and dry weight

Data in Table 4 showed that the adopted irrigation regimes exerted highly significant effects to influence cantaloupe shoots fresh and dry weights. The highest shoot fresh weight resulted in irrigating with 100% FL regime and amounted to 772.5 and 779.8 g plant^{-}1 in 1st and 2nd seasons, respectively. With applying irrigation cut off regimes, shoot fresh weight tended to reduce, where the values were (4.93 and 2.33%), (16.92 and 13.40%) and (24.27 and 21.17%) in 1st and 2nd seasons under 90, 80 and 70%FL irrigation regimes lower than that recorded with 100% FL regime, respectively. Shoot dry weight exhibited similar trend since values of shoot dry weight reduction under 90, 80 and 70%FL irrigation regimes, in 1st and 2nd seasons, reached to (5.36 and 1.09%), (16.18 and 7.48%) and (23.87 and 15.61%) lower than those under 100%FL irrigation regime, respectively.

Regarding effects of Fe application techniques on cantaloupe shoots fresh and dry weights, data in Table 4 indicated that the adopted Fe application techniques exerted significant effect to alter both traits. Higher shoots fresh and dry weights values were recorded with Fe soil plus foliar application technique and reached to (3.11 and 3.02%), (6.71 and 8.14%) and (9.63 and 8.28%) higher than those under soil, foliar and without Fe application techniques in 1st and 2nd seasons, respectively. Shoot dry weight exhibited similar trend since the value under soil plus foliar Fe application was higher by (5.75and 8.29%), (8.11 and 14.28%) and (5.81 and 17.24%), in 1st and 2nd seasons, than those under soil, foliar and Zero Fe application techniques, respectively.

The highest figures of shoots fresh and dry weights traits were recorded due to irrigating with 100%FL regime as interacted with soil & foliar Fe application technique and such results were true in 1st and 2nd seasons.

- Plant height

Data in Table 4 revealed that plant height attribute significantly affected due to the adopted irrigation regimes in 1st and 2nd seasons. The highest figure of plant height was recorded with 100%FL regime (control) and amounted to 199.6 and 198.2cm, respectively, in 1st and 2nd seasons. Plant height exhibited reduced values under 90, 80 and 70%FL irrigation regimes, in 1st and 2nd seasons, comparing with the control. The reduction values, in 1st and 2nd seasons, were (1.70 and 1.51%), (16.58 and 16.45%) and (20.64 and 19.88%) with 90, 80 and 70%FL irrigation regimes less than that recorded with 100%FL regime, respectively.

Plant height trait was significantly influenced due to the adopted Fe application techniques, Table 4. Soil plus foliar Fe application technique still superior than the other tested techniques, where plant height was higher by (0.55 and 0.28%), (1.96 and 0.89%) and (3.71 and 2.66%) than those under soil, foliar and Zero Fe application techniques, in 1st and 2nd seasons, respectively.

Interaction of the adopted treatments did not affect plant height of cantaloupe crop, however, the highest values were recorded due to irrigating with 100%FL regime as interacted soil & foliar Fe application technique, and such results were true in1st and 2nd seasons.

- Leaves number per plant and plant leaf area

Data in Table 4 showed that number of leaves/plant trait was significantly affected due to the adopted irrigation regimes and such result was true in 1st and 2nd seasons. Irrigating with 100%FL regime resulted in the highest figures of number of leaves / plant which reached to 101.6 and 97.8 in 1st and 2nd seasons, respectively. Applying irrigation cut off under 90, 80 and 70% FL irrigation regimes, in 1st and 2nd seasons, exhibited lower number of leaves / plant values amounted to (3.35 and 2.45%), 14.57 and 15.44%) and (17.22 and 19.33%), comparable with those recorded with 100%FL irrigation regime. as affected by irrigation water deficit.

Concerning leaves/plant, higher values were obtained with soil plus foliar Fe application technique where the figures were increased to reach (3.77 and 3.17%), (5.25 and 3.99%) and (4.64 and 4.95%) higher than those under soil, foliar and without Fe application techniques, in 1st and 2nd seasons, respectively.

The highest leaves/plant figures were recorded due to irrigating with 100%FL regime as interacted soil and foliar Fe application technique and such results were found in1st and 2nd seasons.

Table (4) Vegetative and growth parameters of cantaloupe crop as affected by cut - off irrigation regime and Fe application technique in 2012 and 2013 seasons

Treatments		Shoots Fresh Weight(g)		Shoots Dry weight(g)		Plant height (cm)		No of leaves/ plant		Leaf area /plant(cm^2)	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Cut – off irrigation regime											
100 % FL, control		772.5	779.8	201.5	210.7	199.6	198.2	101.6	97.8	74.9	73.4
90%FL		734.4	761.6	190.7	208.4	196.2	195.2	98.2	95.4	71.2	70.4
80%FL		641.8	675.3	168.9	195.0	166.5	165.6	87.0	82.7	64.0	65.1
70%FL		585.0	614.7	153.4	177.8	158.4	158.8	84.1	78.9	58.0	57.8
$LSD_{0.05}$		3.561	5.009	1.582	3.236	2.289	1.327	0.864	0.833	0.874	0.574
Iron application technique (Fe)											
Fe_1		694.7	714.7	179.1	200.3	180.9	180.1	92.8	88.3	67.5	67.7
Fe_2		669.4	700.3	175.2	189.8	178.4	180.0	91.5	87.6	66.3	66.3
Fe_3		716.3	736.3	189.4	216.9	181.9	181.6	96.3	91.1	70.1	69.3
Fe_4		653.4	680.0	170.9	185.0	175.4	176.9	90.3	86.8	64.6	63.6
$LSD_{0.05}$		4.096	4.657	2.037	3.111	2.763	1.297	0.945	0.748	0.587	0.566
The interaction between irrigation and Fe application											
100 % FL	Fe_1	758.0	790.0	203.8	213.8	202.0	199.7	101.3	98.0	75.5	74.3
	Fe_2	757.5	775.0	194.3	199.0	198.0	198.5	100.0	96.3	74.0	72.5
	Fe_3	806.3	798.8	216.3	233.7	205.0	202.5	105.75	101.0	78.0	76.0
	Fe_4	741.3	755.0	191.8	196.3	193.5	192.0	99.5	95.8	72.3	71.0
90% FL	Fe_1	733.8	767.5	191.8	208.8	194.5	194.5	98.0	93.7	70.8	70.8
	Fe_2	728.8	755.0	189.3	197.5	191.8	191.2	96.8	94.3	71.8	70.5
	Fe_3	762.5	785.0	197.0	231.3	195.3	198.5	101.3	96.8	73.8	72.8
	Fe_4	712.5	738.8	184.8	196.3	187.3	188.2	96.8	93.0	68.8	67.8
80% FL	Fe_1	662.5	683.8	167.5	195.0	169.3	168.0	87.0	82.3	63.8	66.5
	Fe_2	616.3	662.5	165.5	188.8	166.5	163.5	86.5	82.2	62.7	65.5
	Fe_3	681.3	718.8	182.0	212.5	169.2	169.2	89.3	84.3	68.0	67.3
	Fe_4	607.5	636.3	160.8	183.8	164.7	163.5	85.5	82.0	61.8	61.3
70% FL	Fe_1	597.5	617.5	153.3	183.8	161.8	160.5	85.3	79.3	59.0	59.3
	Fe_2	575.0	608.8	151.6	173.8	157.5	160.7	82.3	77.5	57.5	56.8
	Fe_3	615.0	642.5	162.5	190.0	160.3	162.0	89.0	82.5	60.5	61.0
	Fe_4	552.5	590.0	146.3	163.8	156.3	156	79.5	76.5	55.8	54.3
F test	I	***	***	***	***	***	**	***	***	***	***
	Fe	***	***	**	***	***	***	***	***	***	***
	I*Fe	***	***	**	**	NS	NS	**	*	NS	**

*** Fe_1, Fe_2, Fe_3 and Fe_4 are referred to Fe application techniques e.g. soil, foliar, soil& foliar and without Fe application, respectively.**

- Plant leaf area

Data revealed that the highest values of this trait (74.9 and 73.4cm^2) were obtained with 100%FL irrigation regime 1st and 2nd seasons, respectively. Irrigating with 90, 80 and 70%FL irrigation regimes exhibited lower leaf area/plant figures comprised (4.94 and 4.08%), 14.55 and 11.31%) and (22.56 and 48.50%), as compared with those under 100%FL irrigation regime.

Leaf area/plant figures were higher by (3.85 and 2.36%), (5.73 and 4.52%) and (8.51 and 8.96%) with soil Fe application technique, comparable with those under soil, foliar and Zero Fe application treatment, in 1st and 2nd seasons, respectively.

The highest leaf area/plant values were recorded due to 100%FL irrigation regime and soil & foliar Fe application technique interaction and such results were similar in1st and 2nd seasons.

Higher values of shoots fresh& dry weights, plant height, number of leaves and leaf area per plant under 100%FL irrigation regime could be attributed to proper availability of soil moisture, under such irrigation regime, which encourage the plants to absorb water and nutrients required for healthy growth. The present findings are in parallel with those of Cabello *et al.* (2009) with melon and Zeng *et al.* (2009) with muskmelon who found that the tested different irrigation water amounts significantly affected crop growth.

Fruit yield and yield attributes and fruit quality

Early and total fruit yields

Early fruit yield

In vegetable, the first three picked are known as early yield. This yield mostly bought with a higher price. Data in Table 5 illustrated that either the tested cut off irrigation regimes or Fe application techniques significantly affected early yield of cantaloupe fruit yield. Higher early fruit yields (4.47 and 4.51 ton fed^{-1}) were recorded with irrigation under 90% FL regime, in1st and 2nd seasons, respectively.

Data revealed that the highest early fruit yields (4.46 and 4.46 ton fed^{-1}) were attained due to soil& foliar Fe application technique, in 1st and 2nd seasons, respectively. Moreover, with soil, foliar and without Fe application techniques the reduction in early fruit yield comprised (6.95 and 0.89%), (15.56 and 10.76%) and (17.04 and 15.92%) in 1st and 2nd seasons, respectively, lower than those under soil& foliar Fe application technique.

Data in Table 5 indicated that the highest early fruit yields were recorded under 90%FL irrigation regime as interacted with soil & foliar Fe application technique.

Total fruit yield

As for total fruit yield, the highest figures (17.79 and 18.01 tonfed^{-1}) still recorded with irrigation at 90% FL regime without significant difference comparing with 100% FL regime . In addition, yield reduction values reached to (3.25 and 0.73%), (22.64 and 22.52%) and (43.12 and 42.60%) due to irrigating with 100, 80 and 70% FL regimes, in1st and 2nd seasons, comparable with90% FL regime, respectively. In this sense, Erdem and Yuksel (2003) found the highest fruit yield was obtained from the plots where irrigation water was adequately applied during the total growing season. In addition, Sensoy *et al.* (2007) found that the highest yield was obtained from the treatment employing the greatest frequency and quantity of irrigation. In connection, Ribas *et al.* (2001) stated that melon yield could significantly decrease by using less amount of water than recommended. Furthermore, Cabello *et al.* (2009) found that moderate water stress (75% of Etc) did not reduce melon yield and with severe deficit irrigation, the yield was reduced by 22% which mainly due to decrease fruit weight.

The techniques of Fe application significantly influenced total cantaloupe fruit yield, and the highest values (17.13 and 17.35 tonfed^{-1}), in 1st and 2nd seasons, respectively, were attained due to soil& foliar Fe application technique. In addition, with applying soil, foliar and without Fe application techniques lower figures of total fruit yield reached to (0.87 and 9.91%), (8.17 and 12.97%) and (15.94 and 17.46%), in 1st and 2nd seasons, respectively, comparable with soil & foliar Fe application technique.

Data in Table 6 illustrated that the highest total fruit yields (19.25 and 20.02 tonfed^{-1}) in 1st and 2nd seasons, resulted from 90%FL irrigation regime and soil & foliar Fe application technique interaction.

Fruit yield attributes

The yields attributes of total fruit yield e.g. fruit weight, fruit length and fruit diameter were significantly affected due to the adopted irrigation regimes. Such findings are harmony with those of Zeng *et al.* (2009) who stated that The highest values of fruit weight and fruit length traits (1.12 kg and 22.31 cm) and (1.17 kg and 23.09 cm) in 1st and 2nd seasons, respectively, were attained under 100%FL regime without significant difference comparing with those under 90%FL regime. Whereas, fruit diameter trait, under100% FL regime, was significantly higher than those recorded under the tested other cut off irrigation regimes. Sensoy *et al.* (2007) stated that most fruit yield traits were significantly affected by differences in irrigation treatment. Cabello *et al.* (2009) found that melon fruit weight was decreased with severe deficit irrigation and resulted in yield reduction down to 22%.

The considered fruit yield attributes were significantly influenced due to Fe application techniques and the highest figures of such attributes, in 1st and 2nd seasons, were recorded with soil & foliar Fe application technique.

In general, 100%FL irrigation regime and soil& foliar Fe application technique interaction exhibited higher values of the tested cantaloupe fruit yield attributes in the two seasons of study.

Table (5) Fruit yield of cantaloupe as affected cut off irrigation regimes and Fe application techniques in 2012 and 2013 seasons

Treat.		Fruit Weight (kg)		Fruit Length (cm)		Fruit Diameter (cm)		Early yield (tonfed^{-1})		Total Yield (tonfed^{-1})	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Irrigation cut off regime											
100% FL		1.12	1.17	22.31	23.09	19.03	19.76	4.23	4.30	17.23	17.88
90% FL		1.12	1.16	21.27	22.89	18.61	19.58	4.47	4.51	17.79	18.01
80% FL		1.01	1.06	18.27	20.44	14.51	15.58	3.91	3.97	14.50	14.70
70% FL		0.92	0.94	17.25	17.73	13.98	14.07	3.60	3.63	12.43	12.63
$LSD_{0.05}$		0.025	0.25	0.342	0.358	0.159	0.379	0.118	0.119	0.496	0.256
Fe application technique											
Fe_1		1.06	1.11	19.81	21.20	16.11	17.55	4.15	4.24	16.98	15.63
Fe_2		1.02	1.07	19.39	20.39	16.05	16.77	3.90	3.98	15.73	15.10
Fe_3		1.11	1.13	20.96	21.90	17.27	18.07	4.46	4.46	17.13	17.35
Fe_4		0.981	1.01	18.96	19.99	15.69	16.64	3.70	3.75	14.40	14.32
$LSD_{0.05}$		0.021	0.024	0.223	0.329	0.231	0.1885	0.053	0.072	0.208	0.222
Interaction											
100% FL	Fe_1	1.10	1.14	22.55	23.52	18.40	19.70	4.43	4.49	17.40	17.00
	Fe_2	1.12	1.17	21.15	22.67	19.03	19.10	4.16	4.27	16.45	16.98
	Fe_3	1.17	1.20	24.12	24.37	20.40	21.50	4.53	4.76	18.95	19.54
	Fe_4	1.11	1.15	21.45	21.80	18.27	18.75	3.99	4.12	16.92	16.32
90% FL	Fe_1	1.17	1.21	21.30	22.88	17.40	19.60	4.39	4.46	17.59	17.69
	Fe_2	1.13	1.18	21.15	21.60	17.17	19.05	4.26	4.33	16.95	17.32
	Fe_3	1.15	1.20	23.43	23.95	18.77	21.00	4.86	4.92	19.25	20.02
	Fe_4	1.05	1.08	20.23	21.03	17.10	18.67	4.36	4.33	17.37	16.97
80% FL	Fe_1	1.06	1.11	18.17	20.30	14.32	18.67	4.08	4.22	15.08	15.08
	Fe_2	0.99	1.05	18.32	20.02	14.20	14.25	3.75	3.80	13.90	14.07
	Fe_3	1.07	1.11	19.1	21.25	15.77	15.75	4.30	4.26	15.93	16.35
	Fe_4	0.95	0.98	17.47	20.20	13.77	13.65	3.54	3.59	13.10	13.35
70% FL	Fe_1	0.94	0.98	17.20	18.13	14.10	14.40	3.74	3.79	12.87	12.77
	Fe_2	0.87	0.92	16.92	17.27	14.05	14.15	3.40	3.49	11.75	12.07
	Fe_3	1.04	1.02	18.17	18.62	14.13	14.15	4.18	4.1	14.37	14.47
	Fe_4	0.83	0.84	16.70	16.93	13.62	13.67	3.08	3.17	10.70	11.18
F test	I	***	***	***	***	***	**	***	***	***	***
	Fe	***	***	***	***	***	*	**	**	**	**
	I*Fe	**	**	***	*	**	*	***	**	**	**

*** Fe_1, Fe_2, Fe_3 and Fe_4 are referred to Fe application techniques e.g. soil, foliar, soil& foliar and without Fe application, respectively.**

Fruit quality:

Total sugar and fruit acidity, %

Total sugar %

Regarding total sugar% as affected by the assessed Fe application techniques, data indicated that the highest values (8.01 and 8.29%) in 1st and 2nd seasons, were observed with soil & foliar Fe application technique, respectively. Soil, foliar and without Fe application techniques resulted in total sugar% values reached to (10.74 and 9.90%), (14.16 and 15.45%) and

(18.11 and 17.85%) lower than those with soil & foliar Fe application technique, respectively, in 1st and 2nd seasons.

Fruit acidity %

Regarding fruit juice acidity%, data in Table 6 exhibited significant differences due to the adopted cut off irrigation regimes. Fruit acidity values were lower (0.20 and 0.20 %) with 70% FL regime and tended to increase, gradually, as furrow length to cut off irrigation was increased and reached to 0.21 - 0.33 and 0.21 - 0.30 %, in 1st and 2nd seasons, respectively.

The adopted Fe application techniques exerted significant influence to alter cantaloupe fruit acidity in 1st and 2nd seasons. Lower acidity values (0.17 and 0.18%, in 1st and 2nd seasons, respectively) were attained without Fe application and tended to increase under the other Fe application techniques in the range of 0.25 to 0.31%.

Vitamin C and total soluble solids

Vitamin C (VC)

Data in Table 6 revealed that VC contents significantly altered due to the assessed cut off irrigation regimes. The highest VC values (41.55 and 40.01 mg/100 g fresh wt., in 1st and 2nd seasons) were obtained with 100%FL cut off irrigation regime, respectively. Vitamin C values seemed to reduce, gradually, as furrow length to cut off irrigation was reduced and ranged 40.83 – 36.56 and 39.49 – 33.94 mg/100 g fresh wt., in 1st and 2nd seasons, respectively.

The technique of Fe soil & foliar application exhibited higher VC values amounted to 40.99 and 27.55 mg/100 g fresh wt., in 1st and 2nd seasons, respectively. The VC values tended to decrease by (2.94 and 5.73%), (5.84 and 8.62%) and (10.19 and 14.01%) in 1st and 2nd seasons with soil, foliar and without Fe application techniques, respectively, comparable with soil & foliar Fe application.

Data in Table 6 indicated that the assessed fruit quality attributes were significantly influenced due to the adopted irrigation regimes. In this sense, Zeng *et al.* (2009) with drip - irrigated muskmelon found that the fruit quality was significantly affected under different irrigation water amounts. In the present trial, total sugar% exhibited higher values (8.33 and 8.87%) with70%FL cut off irrigation, and the value tended to reduce by (1.22 and 0.45%) and (6.84 and 11.39%) and (8.16 and 14.09%) under 80, 90 and 100FL regimes, in 1st and 2nd seasons, respectively, comparing with 70%FL regime. The present findings are in accordance with Fabeiro *et al.* (2002) and Kirnak *et al.* (2005), who found that fruit sugar content was affected positively by soil water deficit.

Data in Table 6 indicated that TSS% significantly affected due to the assessed cut off irrigation regimes. The highest TSS% (10.49 and 10.71%, in 1st and 2nd seasons) were obtained with 100%FL cut off irrigation regime, respectively. Total soluble solids% tended to decrease, gradually, as furrow length to cut off irrigation was reduced by (3.76 and 4.28%), (8.93 and 10.41%) and (12.43 and 15.04%), in 1st and 2nd seasons, with 90, 80 and 70%FL irrigation regimes, respectively, comparing with 100%FL irrigation regime.

Table 6: Cantaloupe fruit quality as affected by cut off irrigation regimes and Fe application techniques in 2012 and 2013 seasons

Treatments		Sugar content (%)		Acidity content (%)		Vitamin C ($mg 100g^{-1}$ fresh wt)		TSS %		Firmness ($kg cm^{-2}$)		Flesh Thickness, cm	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Irrigation cut off regime													
100% FL		7.65	7.62	0.33	0.30	41.55	40.01	10.49	10.71	5.57	5.76	3.79	3.88
90% FL		7.76	7.86	0.22	0.21	40.85	39.49	10.11	10.27	5.34	5.71	3.60	3.84
80% FL		8.21	8.83	0.21	0.21	38.11	36.19	9.63	9.70	4.93	4.99	3.08	3.52
70% FL		8.33	8.87	0.20	0.20	36.56	33.94	9.33	9.31	4.36	4.58	2.86	2.87
$LSD_{0.05}$		0.116	0.165	0.179	0.002	0.428	0.556	0.732	0.124	0.045	0.071	0.046	0.227
Fe application technique													
Fe_1		8.01	8.29	0.25	0.21	39.82	37.55	9.91	9.91	5.05	5.24	3.35	3.53
Fe_2		7.77	8.03	0.21	0.19	38.73	36.55	9.63	9.64	4.96	5.18	3.25	3.51
Fe_3		8.87	9.11	0.31	0.25	40.99	39.70	10.76	11.03	5.27	5.54	3.50	3.68
Fe_4		7.51	7.73	0.17	0.18	37.20	34.82	9.13	9.43	4.92	5.08	3.24	3.38
$LSD_{0.05}$		0.132	0.148	0.161	0.001	0.450	1.125	0.041	0.145	0.036	0.070	0.064	0.150
Interaction													
100% FL	Fe_1	7.72	7.60	0.21	0.19	41.57	41.05	10.43	10.75	5.55	5.77	3.83	3.89
	Fe_2	7.43	7.35	0.21	0.21	41.32	39.28	10.18	10.30	5.46	5.74	3.69	3.86
	Fe_3	8.30	8.35	0.18	0.18	43.02	42.65	11.05	11.84	5.60	5.80	3.87	3.97
	Fe_4	7.15	7.10	0.27	0.27	40.30	37.08	9.83	9.93	5.58	5.72	3.77	3.82
90% FL	Fe_1	7.75	7.83	0.20	0.19	40.62	39.78	10.02	10.42	5.41	5.71	3.69	3.83
	Fe_2	7.50	7.68	0.21	0.21	40.32	38.08	10.10	10.12	5.29	5.70	3.56	3.81
	Fe_3	8.45	8.75	0.18	0.18	43.00	41.98	11.06	11.45	5.52	4.77	3.79	3.92
	Fe_4	7.32	7.40	0.26	0.25	39.38	37.00	9.59	9.75	5.26	5.67	3.53	3.78
80% FL	Fe_1	8.17	8.82	0.19	0.20	38.75	36.02	9.77	9.55	4.88	4.78	3.06	3.51
	Fe_2	7.85	8.55	0.21	0.21	37.82	35.77	9.43	9.25	4.82	4.73	2.98	3.50
	Fe_3	9.15	9.20	0.17	0.24	39.65	37.75	10.38	10.77	5.22	5.48	3.38	3.82
	Fe_4	7.70	8.20	0.24	0.20	36.23	35.03	8.94	9.25	4.79	4.78	2.92	3.18
70% FL	Fe_1	8.40	8.92	0.19	0.19	38.35	34.35	9.40	9.13	4.48	4.70	2.90	2.89
	Fe_2	8.30	8.57	0.21	0.21	35.77	34.05	9.36	9.05	4.28	4.57	2.85	2.83
	Fe_3	9.57	9.60	0.17	0.18	38.95	36.27	10.1	10.25	4.74	4.98	2.95	3.03
	Fe_4	7.87	8.20	0.23	0.23	33.15	31.10	8.46	8.83	3.93	4.07	2.75	2.75
F test	I	**	***	**	***	**	**	***	***	***	***	***	***
	Fe	**	**	NS	***	**	**	***	***	***	***	***	**
	I*Fe	*	NS	NS	***	**	*	***	*	***	***	*	NS

*** Fe_1, Fe_2, Fe_3 and Fe_4 are referred to Fe application techniques e.g. soil, foliar, soil& foliar and without Fe application, respectively.**

Total soluble solids (TSS%)

Fe soil & foliar application technique exhibited higher TSS values reached to 10.76 and 11.03%, in 1st and 2nd seasons, respectively. The TSS% values tended to decrease by (7.90 and 10.15%), (10.50 and 12.60%) and (15.15 and 14.51%) in 1st and 2nd seasons with soil, foliar and without Fe application techniques, respectively, comparable with soil & foliar Fe application.

Fruit firmness, ($kgcm^{-2}$)

Data in Table 6 indicated that fruit firmness significantly affected due to the tested cut off irrigation regimes. The highest fruit firmness (5.57 and 5.76 $kgcm^{-2}$, in 1st and 2nd seasons) were obtained with 100%FL cut off irrigation regime, respectively.

Fruit firmness tended to decrease, gradually, as furrow length to cut off irrigation by (4.31 and 0.88%), (12.98 and 15.43%) and (27.52 and 25.76%), in 1st and 2nd seasons, with 90, 80 and 70%FL irrigation regimes, respectively, comparable with 100%FL irrigation regime.

Fe soil & foliar application technique exhibited higher values of fruit firmness reached to 5.05 and 5.24 $kgcm^{-2}$, in 1st and 2nd seasons, respectively. The fruit firmness values tended to decrease by (4.17 and 5.42%), (5.88 and 6.50%) and (6.64 and 8.30%) in 1st and 2nd seasons with soil, foliar and without Fe application techniques, respectively, comparable with soil & foliar Fe application.

Fruit flesh thickness, cm

Data in Table 6 indicated that fruit flesh thickness significantly affected due to the tested cut off irrigation regimes. The highest fruit flesh thickness (3.79 and 3.88 cm, in 1st and 2nd seasons) were obtained with 100%FL cut off irrigation regime, respectively. Fruit flesh thickness tended to decrease, gradually, as furrow length to cut off irrigation reduced by (5.28 and 1.04%), (23.05 and 10.23%) and (32.52 and 35.19%), in 1st and 2nd seasons, with 90, 80 and 70%FL irrigation regimes, respectively, comparable with 100%FL irrigation regime.

Fe soil & foliar application technique exhibited higher values of fruit flesh thickness reached to 3.50 and 3.68 cm, in 1st and 2nd seasons, respectively. The value tended to decrease by (4.29 and 4.08%), (7.14 and 4.62%) and (7.43 and 8.15%) in 1st and 2nd seasons with soil, foliar and without Fe application techniques, respectively, comparable with soil & foliar Fe application.

Interaction of the adopted treatments differentially affected cantaloupe fruit quality where higher sugar content% and lower acidity% were obtained with70%FL irrigation regime as interacted with soil & foliar Fe application technique. Meanwhile, interaction of 100%FL irrigation regime and soil & foliar Fe application technique exhibited higher values for vitamin c, TSS %, fruit firmness and flesh thickness, and such findings were true in 1st and 2nd seasons.

N, P, K and Chlorophyll contents in cantaloupe leaves:-

Nitrogen%: -

Data in Table 7 revealed that N% content significantly affected due assessed cut off irrigation regimes. The highest N% content (5.16 and 5.22%, in 1st and 2nd seasons) were recorded with 100%FL cut off irrigation regime, respectively. Leaves N% content seemed to decrease, gradually, as furrow length to cut off irrigation decreased by (3.30 and 1.53%), (10.85 and 3.07%) and (14.53 and 6.70%), in 1st and 2nd seasons, with 90, 80 and 70%FL irrigation regimes, respectively, compared with 100% FL irrigation regime.

Fe soil & foliar application technique exhibited higher N% content values reached to 5.28 and 5.30%, in 1st and 2nd seasons, respectively. The value tended to decrease by (8.71 and 3.58%), (11.93 and 5.28%) and (16.29 and8.30 %) in 1st and 2nd seasons with soil, foliar and without Fe application techniques, respectively, comparable with soil & foliar Fe application.

Phosphorus,%

Data in Table 7 revealed that P% content significantly affected due assessed cut off irrigation regimes. The highest P% content (0.45 and 0.45%, in 1st and 2nd seasons) were recorded with 100%FL cut off irrigation regime, respectively. Leaves P% content seemed to decrease, gradually, with reducing the irrigation length by (6.67 and 4.44%), (17.39 and 11.11%) and (22.22 and 13.33%), in 1st and 2nd seasons, with 90, 80 and 70%FL irrigation regimes, respectively, compared with 100%FL irrigation regime.

Fe soil & foliar application technique still exhibited higher P% content values reached to 0.45 and 0.45%, in 1st and 2nd seasons, respectively. The value tended to decrease by (8.88 and4.44%), (13.33 and11.11%) and (24.44 and 20.0%) in 1st and 2nd seasons with soil, foliar and without Fe application techniques, respectively, compared with soil & foliar Fe application.

Potassium%

Data in Table 7 revealed that K% content significantly affected due assessed cut off irrigation regimes. The highest K% contents which amounted to 0.45 and 0.45%, in 1st and 2nd seasons were noticed with 100%FL cut off irrigation regime, respectively. Leaves K% content seemed to decrease, gradually, with reducing the irrigation length

by (5.29 and 4.87%), (16.07 and 15.47%) and (22.62 and 23.94%), in 1st and 2nd seasons, with 90, 80 and 70%FL irrigation regimes, respectively, comparing with 100%FL irrigation regime.

Fe soil & foliar application technique still exhibited higher K% content values reached to 4.39 and 4.41%, in 1st and 2nd seasons, respectively. The value tended to decrease by (4.78 and4.99%), (5.47 and 6.12%) and (6.38 and 8.39%) in 1st and 2nd seasons with soil, foliar and without Fe application techniques, respectively, comparable with soil & foliar Fe application.

Chlorophyll

Data in Table 7 revealed that chlorophyll content significantly affected due assessed cut off irrigation regimes. The highest figures which amounted to 35.1 and 36.2 $mgdm^{-2}$, in 1st and 2nd seasons, were attained with 100%FL cut off irrigation regime, respectively. Leaves chlorophyll content seemed to decrease, gradually, with reducing the irrigation length by (1.14 and %), (3.14 and %) and (5.98 and %), in 1st and 2nd seasons, with 90, 80 and 70%FL irrigation regimes, respectively, comparing with 100%FL irrigation regime. In this sense, Lessani and Mojtahedi (2002) reported that water deficit can destroy the chlorophyll resulting in a lowered capacity for light harvesting. Moreover, Herbinger *et al.* 2002 stated that degradation of the absorbing pigments is negatively affected the production of reactive oxygen species which are mainly driven by excess energy absorption in the photosynthetic apparatus.

Fe soil & foliar application technique exhibited higher chlorophyll content values reached to 34.4 and 35.7 $mgdm^{-2}$, in 1st and 2nd seasons, respectively. The value tended to decrease by (0.0 and 0.28%), (0.87 and 6.16%) and (1.16 and 7.84%) in 1st and 2nd seasons with soil, foliar and without Fe application techniques, respectively, as compared with soil & foliar Fe application

Table 7: N, P, K and chlorophyll contents in cantaloupe leaves as affected by cut off irrigation regimes and Fe application techniques in 2012 and 2013 seasons

Treatments		N (%)		P (%)		K (%)		Chlorophyll, ($mgdm^{-2}$)	
		2012	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
Irrigation cut off regime									
100% FL		5.16	5.22	0.45	0.45	4.73	4.72	35.1	36.20
90% FL		4.99	5.14	0.42	0.43	4.48	4.49	34.7	34.48
80% FL		4.60	5.06	0.38	0.40	3.97	3.99	34.0	33.50
70% FL		4.41	4.87	0.35	0.39	3.66	3.59	33.0	32.60
$LSD_{0.05}$		0.025	0.029	0.332	0.007	0.039	0.046	0.308	0.346
Fe application technique*									
Fe_1		4.82	5.11	0.41	0.43	4.18	4.19	34.4	34.6
Fe_2		4.65	5.02	0.39	0.40	4.15	4.14	34.1	33.5
Fe_3		5.28	5.30	0.44	0.45	4.39	4.41	34.4	35.7
Fe_4		4.42	4.86	0.34	0.36	4.11	4.04	34.0	32.9
$LSD_{0.05}$		0.027	0.020	0.300	0.004	0.382	0.035	0.144	0.433
Interaction									
100% FL	Fe_1	5.19	5.28	0.46	0.46	4.63	4.63	35.1	36.6
	Fe_2	5.08	5.15	0.45	0.45	4.73	4.71	35.0	35.6
	Fe_3	5.42	5.48	0.48	0.48	5.04	5.03	35.3	37.5
	Fe_4	4.94	4.97	0.39	0.40	4.51	4.51	35.0	34.9
90% FL	Fe_1	5.18	5.17	0.44	0.45	4.51	4.51	34.8	34.9
	Fe_2	4.95	5.08	0.43	0.42	4.40	4.40	34.4	33.9
	Fe_3	5.38	5.42	0.46	0.47	4.77	4.77	35.1	36.1
	Fe_4	4.48	4.93	0.37	0.38	4.25	4.27	34.4	33.0
80% FL	Fe_1	4.63	5.08	0.40	0.42	4.00	4.03	34.4	34.2
	Fe_2	4.35	4.99	0.39	0.39	3.94	3.92	33.8	32.7
	Fe_3	5.25	5.28	0.41	0.43	4.03	4.07	34.0	35.1
	Fe_4	4.19	4.88	0.32	0.36	3.90	3.94	33.9	32.0
70% FL	Fe_1	4.29	4.92	0.35	0.37	3.61	3.61	33.4	32.8
	Fe_2	4.24	4.87	0.33	0.36	3.52	3.55	33.0	31.9
	Fe_3	5.07	5.03	0.39	0.40	3.7	3.77	33.1	34.0
	Fe_4	4.07	4.66	0.31	0.32	3.79	3.46	32.7	31.6
F test	I	***	***	NS	***	***	***	***	***
	Fe	***	***	NS	***	***	***	***	***
	I*Fe	***	**	NS	*	***	***	**	NS

***** Fe_1, Fe_2, Fe_3 and Fe_4 are referred to Fe application techniques e.g. soil, foliar, soil& foliar and without Fe application, respectively.*

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As for N, P, K and chlorophyll contents in cantaloupe leaves, in general, interaction of 100% cut off irrigation regime and Fe soil & foliar application technique exhibited higher values.

On conclusion, under North of Nile Delta conditions, it is advisable to irrigate cantaloupe crop under 90%FL irrigation regime and applying Fe in the soil & foliar application technique in order to obtain higher and reasonable figures of fruit yield and quality and water productivity as well.

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إيقاف جبهة الري كطريقة فعالة لجودة وإنتاج الكنتالوب تحت إضافات مختلفة لصور الحديد

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية (محطة بحوث البساتين) بسخا ـ كفر الشيخ لمنطقة شمال الدلتا خلال موسمى 2012 ، 2013م لمعرفة تأثير طول شريحة الرى الواجب إيقاف الرى عندها فيما يسمي بـ cut-off و طرق إضافة الحديد وأثر ذلك علي العائد المحصولي من وحدة الماء المضاف والعلاقات المائية لمحصول الكنتالوب وكذلك المحصول الكلي والمبكر وصفات جودة الثمار

وكانت المعاملات:-.

المعاملات الرئيسية :- (الري)

أ- الري التقليدي إلي نهاية الخط (100%) ب- إيقاف الري عند 90% من طول الخط

ج- إيقاف الري عند 80% من طول الخط د- إيقاف الري عند 70% من طول الخط

المعاملات التحت رئيسية:- (صور أضافة الحديد)

1- إضافة الحديد في الصورة الارضية.

2 -إضافة الحديد في صورة الرش.

3- إضافة الحديد في الصورة الارضية + اضافتة في صورة الرش.

4- بدون إضافة للحديد.

صممت التجربة في قطاعات منشقة بأربع مكررات و كانت فترات الري ثابتة بالنسبة لجميع المعاملات.

وقد أوضحت النتائج المتحصل عليها ما يلي:-

- المتوسط الموسمي للماء المضاف ما بين 1201,0م^3/فدان إلى 1452,5م^3/فدان ويتراوح المتوسط الموسمي للماء المضاف على الترتيب 1452,5 > 1332,5 > 1251,5 > 1201,0 م3/فدان للمعاملات أ ، ب ، جـ ، د على الترتيب.
- يمكن ترتيب قيم الاستهلاك المائي تنازليا كالآتي: 31,76 > 29,22 > 26,76 > 25,49 سم للمعاملات أ ، ب ، جـ ، د.
- متوسط قيم كفاءة استهلاك المياه فقد تراوحت ما بين 89,14% إلى 92,14% للمعاملات المختلفة أ الي د وسجلت أعلي القيم تحت المعاملة I_2.
- سجلت المعاملة I_1Fe_3 أعلي القيم بالنسبة للوزن الطازج والوزن الجاف للنبات وكانت القيم 806,3 جم و 216,3جم في الموسم الاول و798,8جم و 233,7 جم للموسم الثاني للوزن الطازج والجاف علي التوالي.
- سجلت المعاملة I_1Fe_3 أعلي القيم أيضا بالنسبة لطول النبات وعدد الأوراق والمساحة الورقية.
- بالنسبة لصفات الثمرة من وزن الثمره و طول الثمرة وقطر الثمرة سجلت المعاملتينI_1Fe_3 و I_2Fe_3أعلي القيم ولم تسجل بينهما فروق معنوية أما بالنسبة للمحصول المبكر والكلي سجلت المعاملة I_2Fe_3 أعلي القيم 4,86 و19,25 & 4,92 و 20,02 للموسمين الأول والثاني علي الترتيب.
- بالنسبة لصفات جودة الثمرة من حيث السماكة والصلابة والاملاح الكلية الذائبة وفتامين سي وجد أنها زادت بزيادة طول جبهة الري وأضافة الحديد في الصورة الأرضية والرش معا.
- كذالك بالنسبة لمحتوي الأوراق من عناصر النيتروجين والفسفور والبوتاسيوم أخذت نفس إتجاة صفات جودة الثمرة.

وعليه فتوصي الدراسة بان ري الكنتالوب بـ 90% من طول الشريحة وإضافة الحديد في الصورة الأرضية والرش معا أعطت أعلي النتائج في المنطقة موضع الدراسة كما توصي الدراسة بإجراء مزيد من الدراسات الحقلية في المنطقة لتعظيم إنتاجية الكنتالوب من وحدة المياه بمعني " أعلي محصول لكل قطرة " وكذا أفضل الطرق لإضافة الحديد.