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Effect of Water and Salt Stresses on Productivity of Cantaloupe in Ismailia Soil

A. Abdel-Aziz and A. Sadik
Soil Chemistry and Physics Department , Desert Research Center , Cairo , Egypt

SALINITY is a major problem that negatively impacts agricultural activities in many regions in the world, and especially the Near East and North Africa region. Generally, salinity problems increase with increasing salt concentration in irrigation water. Water scarcity is a limiting factor for crop production in arid and semi-arid regions. Drip irrigation has the greatest advantages over other irrigation methods when saline water is used. In irrigated lands, the production of total and marketable yield depends largely on the quantity and salinity of the irrigation water. Field experiments were carried out in El Kasasin El Gedeida area, El- Ismailia Governorate, Egypt during the summer season of 2015. The main objective was to investigate the effectiveness of applied irrigation water stress ($IR_{100\%}$, $IR_{90\%}$, $IR_{80\%}$ and $IR_{70\%}$) at different salt stress levels of irrigation water SL (FW= 0.80, S1= 1.56, S2= 3.14 and S3= 6.25 dS m^{-1}) on the total production of marketable yield (Ya), fruit quality parameters, water use efficacy (WUE), irrigation water use efficiency (IWUE) and yield response factor (Ky) of cantaloupe (*Cucumis melo* L. var. cantalupensis). The results revealed that the total production and fruit quality parameters of cantaloupe except diameter (D), protein (P) and (pH) were recorded significantly increased with the increase of SL for all IR treatments. Also, fruit quality of cantaloupe except (D), (P) and total soluble solid (TSS) were recorded significantly increased with the decrease of IR for all SL treatments. The values of ET_{cadj} and Ks decreased with increasing SL for all IR treatments while, decreased with decreasing IR for all SL treatments. In addition; the maximum value of Ya for cantaloupe was 7.65 Mg fed^{-1} under FW and $IR_{100\%}$ (control treatment). While, the minimum value of Ya was 1.71 Mg fed^{-1} under S3 and $IR_{70\%}$ treatment. Also, the results reported that the FW and $IR_{80\%}$ treatment recorded the maximum increases reached 33 and 18 % for WUE and IWUE of cantaloupe respectively, compared to that under control treatment. The minimum value of Ky for cantaloupe was 0.17 under FW and $IR_{80\%}$ treatment. Finally, to save approximately 20% of applied irrigation water, $IR_{80\%}$ could be used under salinity levels of irrigation water (FW, S1 and S2). While, to save approximately 10% of applied irrigation water, $IR_{90\%}$ could be used under SL (S3).

Abbreviations: Ks: water and salt stresses; ETcadj: adjust crop evapotranspiration; IR: applied irrigation water; SL: salt stress levels of irrigation water; Ya: marketable yield; ETc: crop evapotranspiration; WUE: water use efficiency; IWUE: irrigation water use efficiency; Ky: yield response factor.

INTRODUCTION

Approximately 20% of the world's cultivated land and nearly half of all irrigated land are affected by salinity (Zhu 2001). Therefore, salinization has been a major factor limiting agricultural crop production (Parida and Das 2005). Hence, the salt tolerance of crops is necessary to sustain the increasing demand in food production in many regions in the world. The future of irrigated agriculture poses the need to develop irrigation strategies using saline and deficit irrigation water to fulfill the food and fiber production gap, in order to ensure long term sustainability in irrigated agriculture. Cantaloupe is considered one of the most important

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vegetables in Egypt, which the majority of its production is exported to Europe. However, due to its sensitivity to water, irrigation scheduling should be linked with its ability to consume water, therefore, water requirement, must be estimate appropriately in accordance with plant wetted root zone (Badr, 2007 and Badr & Abou Hussein, 2008).The soil water stress coefficient (Ks) changes from 0 to 1, and it depends on the soil water depletion linked to water supply (rainfall or irrigation). The diminution of Ks may be attributed to the increase in water depletion at the root zone through a removal of water by transpiration and percolation losses that induced stress condition and diminution of soil moisture at the root zone (Er-Raki et al., 2007). The crop evapotranspiration under nonstandard conditions (ET_{cadj}) is the evapotranspiration from crops grown under management and environmental conditions that differ from the standard conditions. When cultivating crops in fields, the real crop evapotranspiration may deviate from ETc due to non-optimal conditions such as the presence of pests and diseases, soil salinity, low soil fertility, water shortage or water logging. This may result in scanty plant growth, low plant density and may reduce the evapotranspiration rate below ETc. The ETc under nonstandard conditions is calculated by using a water stress coefficient (Ks) and/or by adjusting Kc for all kinds of other stresses and environmental constraints on crop evapotranspiration (Allen et al., 1998). The yield and quality of vegetable crops are adversely affected by environmental factors such as drought and high salinity in the root zone (Goyal et al., 2003). Irrigation treatments were irrigation after I_{65}, I_{80} and I_{95} percent of cumulative evaporation from Class A pan, respectively, EC of irrigation water was 5.25 dS m^{-1}; irrigation water depth for the whole growing period was $I_{65=}$ 300, I80= 342 and I95= 384 mm. The results showed that I_{65} and I_{80} irrigation treatments significantly reduced fresh yield, number of fruit, and fruit weight per plant and water use efficiency. Fresh-fruit yield was 31.73, 38.48 and 54.34 ton ha-1, and water use efficiency was 10.58, 11.25 and 14.16 kg m^{-3} in T_{65}, T_{80} and T_{95} irrigation treatments, respectively. Salinity can negatively impact plants through osmotic, nutritious, and toxic stresses. Growth and yield of most cultivated crops tend to decline when exposed to salinity (Mousavi et al., 2009). However, safe and efficient use of saline water for irrigation requires proper management (such as trickle irrigation in deep sandy soils) to prevent development of excessive soil salinization for crop production (Wang et al., 2007).The marketable yield of melon significantly decreased by reduction in irrigation. Also, the yield response factor Ky, which indicates the level of tolerance of a crop to water stress, was 1.01 for marketable yield, indicating that the reduction in crop productivity is proportionally equal to the relative ET deficit (Kuşcu et al., 2015).

Therefore, the aim of this work was to study the effect of water and salt stresses on marketable yield, fruits quality of cantaloupe, adjust crop evapotranspiration, water use efficiency, irrigation water use efficiency and yield response factor under sandy soil conditions.

Materials and Methods

Experiments

Field experiments were carried out in El Kasasin El Gedeida area, El- Ismailia Governorate, Egypt (30° 36` N: 32° 15` E. 13 m a.s.l) during the summer season of 2015. In split plot design with three replicates, the experimental are was divided into 10 m2 plots; each bounded by 1.5 m wide barren to avoid horizontal infiltration. Fig. (1) shows the cantaloupe (*Cucumis melo* L. var. cantalupensis) was cultivated by surface drip irrigation using four applied irrigation water ($IR_{100\%,}$ $IR_{90\%,}$ $IR_{80\%}$ and $IR_{70\%}$ of crop evapotranspiration) were tested under four salinity levels of irrigation water (SL) (FW= 0.80, S1= 1.56, S2= 3.14 and S3= 6.25 dS m^{-1}).The saline water was prepared by mixing fresh water (FW= 0.80 dS m^{-1}) from Ismailia canal with well water (S3= 6.25 dS m^{-1}) calculated by using the equation:

(ECw (dS m-1) X ratio used 1) + (ECw (dS m^{-1}) X ratio used 2) = Resulting ECw (dS m^{-1}) of mix (Ayers and Westcot 1985)

S1 = (0.80 * 0.86) + (6.25*0.14) = 1.56 dS m-1

S2 = (0.80 * 0.57) + (6.25*0.43) = 3.14 dS m-1

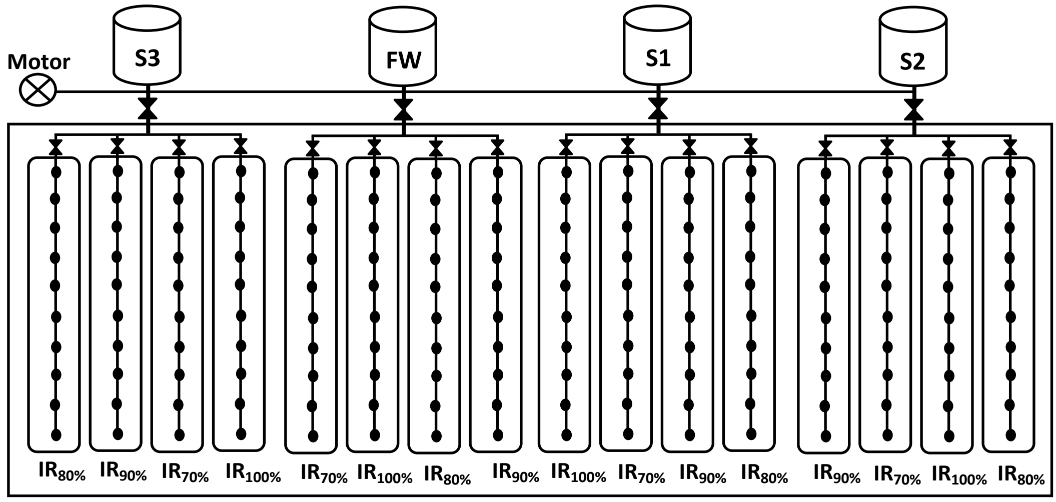

Fig. 1.Field experiment layout

Soil management practices were applied using doses of fertilizer as recommended by the ministry of agriculture.

The fruit diameter D (cm), protein (%), total soluble solid TSS (%), pH of juice, acidity of juice (citric %), total sugar (mg/g FW), actual yield (marketable fruit weight) Ya (Mg fed-1), salinity and water stress coefficient Ks, adjust crop evapotranspiration ETcadj (mm), water use efficiency WUE (Mg m-3), irrigation water use efficiency IWUE (Mg m-3) and yield response factor Ky were calculated for different of salinity levels of irrigation water salinity SL under applied irrigation water (IR) plots.

Soil characteristics

Soil samples were collected for some physical and chemical soil characteristics the methodological procedures were according to methods described by Klute (1986) and Page et al. (1982) respectively (Tables 1&2).

Irrigation water characteristics

Chemical analyses of the irrigation water were measured according to methods described by Bartels (1996) (Table 3).

Reference evapotranspiration ETo

The reference evapotranspiration ETo) shown in Table 4 was calculated using the Cropwate (8) software based on Penman-Monteith equation FAO 56 method (Allen et al., 1998).

Crop evapotranspiration ETc (without stress)

The crop evapotranspiration ETc (without stress) shown in Table 5 was calculated using the equation:

• $ETc = K_{cFAO} . ETo$ (mm day-1) (Allen et al., 1998)

where: K_{cFAO} : crop coefficient from FAO No.(56).
ETo : reference crop evapotranspiration, mm day^{-1}.

Leaching requirement LR

The leaching requirement LR shown in Table 6 was calculated using the equation:

•$LR = EC_w / (5(EC_e) - EC_w) \times 100$ (%) (Allen et al., 1998)

where: EC_w : electrical conductivity of the irrigation water, dS m^{-1}.
ECe : average electrical conductivity of the soil solution extract, dS m^{-1}.

Applied irrigation water IR

The amounts of applied irrigation water IR shown in Table 7 was calculated using the equation:

• IR100, 90, 80, 70%= (ETc - pe)Kr / Ea) + LR (mm period-1) (Keller and Karmeli (1974)

where: Kr: correction factor for limited wetting at cantaloupe percent round coverage by canopy 80%, Kr = 0.90. (Smith 1992).

Ea: irrigation efficiency for surface drip (85%) (Allen et al., 1998).

Pe: effective rainfall, mm. Pe = 0.8 P where P > 75 mm/month; Pe = 0.6 P where P < 75 mm/month.

LR: leaching requirements, under salinity levels of irrigation water (0.10, 0.18, 0.21 and 0.24 x ETc), mm. 8.

TABLE 1. Some physical characteristics of experimental soil .

Soil depth (cm)	Particle size distribution %					Textural class	OM %	ρ_b g/cm³	Ks cm/h	FC %	WP %	AW %
	C. sand	M. sand	F. sand	Silt	Clay							
0-15	5.20	67.39	13.67	8.73	5.01	Sandy	0.52	1.54	11.36	12.48	3.56	8.92
15-30	6.73	65.96	14.29	8.57	4.45	Sandy	0.48	1.57	11.92	11.75	3.49	8.26
30-45	7.39	63.61	16.45	8.32	4.23	Sandy	0.45	1.59	12.54	10.93	3.24	7.69

TABLE 2. Some chemical characteristics of experimental soil

Soil depth (cm)	EC (dS m^{-1})	pH	$CaCO_3$ %	CEC meq /100 g soil	Soluble ions (meq/l) in the saturated soil paste								Exchangeable cations meq/100g soil			
					Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	HCO_3^-	$CO_3^{=}$	$SO_4^{=}$	Ca^{++}	Mg^{++}	K^+	Na^+
0-15	2.15	7.62	2.63	6.79	9.94	1.23	5.91	4.42	10.31	2.90	-	8.28	1.37	1.70	0.15	1.99
15-30	2.38	7.50	2.76	6.20	9.41	2.90	6.63	4.88	11.49	2.80	-	9.54	1.36	1.68	0.31	1.69
30-45	2.91	7.47	2.89	6.10	9.29	4.09	8.61	7.07	14.21	2.59	-	12.27	1.46	2.00	0.36	1.37

TABLE 3. Some chemical analysis for irrigation water

Sample	pH	EC dS m^{-1}	SAR	Soluble cations, meq/l				Soluble anions, meq/l			
				Ca^{++}	Mg^{++}	Na^+	K^+	$CO_3^{=}$	HCO_3^-	$SO_4^{=}$	CL^-
FW	7.11	0.80	1.83	2.56	2.24	2.83	0.37	8.00	3.36	1.12	3.52
S1	7.44	1.56	6.15	2.99	2.24	9.95	0.43	15.60	2.93	2.89	9.78
S2	7.44	3.14	7.85	3.89	7.21	18.50	1.71	31.30	3.13	7.78	20.39
S3	7.46	6.25	10.28	11.36	12.50	35.51	3.13	62.50	5.68	14.91	41.90

TABLE 4. Calculation reference evapotranspiration (mm day^{-1}) through cantaloupe growth period for season 2015

Month	August	September	October	November	December
ETo, mm day^{-1}	7.04	5.82	4.46	2.82	2.31

TABLE 5. Calculation crop evapotranspiration (mm day^{-1}) through cantaloupe growth period for season 2015

Stages	Initial	Develop	Mid	Late	Total
Period length (day)	10	60	25	25	120
Kc_{FAO} (-)	0.50	0.68	0.85	0.60	--------
ETo (mm)	66.74	301.04	70.5	59.28	497.56
$ETc_{100\%}$ (mm)	33.37	204.71	59.93	35.57	333.58

TABLE 6. Calculation of leaching requirement (%) under different salinity levels of irrigation water for season 2015

Salinity Levels	ECw (dS m^{-1})	ECe (dS m^{-1})	LR (%)
FW	0.80	1.75	10
S1	1.56	2.13	18
S2	3.14	3.51	21
S3	6.25	6.57	24

TABLE 7. Calculation applied irrigation water (IR), mm of cantaloupe for season 2015

IR (%)	SL (dS m^{-1})	Applied Irrigation water (mm)				
			Growth Stages			
		Initial	Development	Mid	Late	Seasonal
100	FW	38.69	237.35	69.48	41.24	386.76
	S1	41.23	252.94	74.04	43.95	412.17
	S2	42.49	260.67	76.31	45.29	424.75
	S3	43.25	265.32	77.67	46.10	432.34
90	FW	34.82	213.62	62.53	37.12	348.08
	S1	37.11	227.65	66.64	39.56	370.95
	S2	38.24	234.60	68.68	40.76	382.28
	S3	38.93	238.79	69.90	41.49	389.11
80	FW	30.95	189.88	55.58	32.99	309.41
	S1	32.98	202.35	59.23	35.16	329.74
	S2	33.99	208.54	61.05	36.23	339.80
	S3	34.60	212.26	62.14	36.88	345.87
70	FW	27.08	166.15	48.64	28.87	270.73
	S1	28.86	177.06	51.83	30.77	288.52
	S2	29.74	182.47	53.42	31.70	297.33
	S3	30.28	185.72	54.37	32.27	302.64

FW =0.80 dS m-1 S1= 1.56 dS m-1 S2= 3.14 dS m-1 S3= 6.25 dS m-1
Convert mm to m3 = water per mm depth * Area (3.57 not 4.2 for drip irrigation)

Adjust (actual) crop evapotranspiration ETcadj (with stress)

The adjust crop evapotranspiration ETcadj was calculated using the equation:

• $ET_{cadj} = Ks.\ Kc_{FAO}\ .\ ETo$ (mm day$^{-1)}$) (Allen et al., 1998)

where: Ks: water and salt stresses coefficient.

KcFAO: crop coefficient from FAO No.(56).

ETo: reference crop evapotranspiration, mm day-1.

• Water and salt stresses coefficient

$$Ks = \left[1 - \frac{b}{Ky\ 100}\left(ECe - ECe_{threshold}\right)\right]\left[\frac{TAW - Dr}{TAW - RAW}\right] \quad (-)$$

Where: b : reduction in yield per increase in ECe [%/(dS m^{-1})].

ECe : mean electrical conductivity of the saturation extract for the root zone, dS m^{-1}.

$ECe_{threshold}$: electrical conductivity of the saturation extract at the threshold of ECe when crop yield first reduces below Ym, dS m^{-1}.

Dr : rooting depth, m.

- **Total available** **$TAW = 1000 (\theta_{FC} - \theta_{PWP}) . Z_r$** **(1998) Allen *et al.*,**

Where: θ_{FC} : water content at field capacity, (%).

θ_{PWP} : water content at permanent wilting point, (%).

Zr : rooting depth, m.

- Readily available RAW = TAW. P (Allen et al., 1998)

where: TAW : total available soil water in the root zone, mm.
p : average fraction of total available soil water (TAW) that can be depleted from the root zone before moisture stress (reduction in ET) occurs (Cantaloupe P = 0.45).

- Water use efficiency $WUE = Ya / ETc_{adj}$ ($Mg\ m^{-3}$) (Howell, 2001)

where: Ya : actual yield of the crop, ($Mg\ fed^{-1}$). ($Mg\ m^{-3}$) (Michael, 1978)

- Irrigation water use efficiency IWUE = Ya / IR

where: IR : seasonal amounts of applied irrigation water, (m^3) (Table7).

- **Yield response factor (Ky) 1998) (Allen *et al.*,**

$$\left[1 - \frac{Y_a}{Y_m}\right] = K_y \left[1 - \frac{ETc_{adj}}{ETc}\right] \quad (-)$$

where: ETcadj : adjust evapotranspiration, mm day-1.
ETc : crop evapotranspiration (without stress), mm day^{-1}.
Ym : maximum yield at IR100 %, Mg Fed^{-1}.

Statistical analysis

Co-state software program was used to analyze the data (Snedecor and Cochran 1989).

Results and Discussion

Effect of IR and SL on cantaloupe fruit diameter (D) and protein (P)

Data in Table 8 presented that the values of cantaloupe fruit diameter (D) and protein (P) decreased with increasing salinity levels of irrigation water (SL) it represents nearly a descending order of FW > S1 > S2 > S3 for all applied irrigation water quantities. Also, data showed that the values of cantaloupe D and P decreased with decreasing IR, it represents nearly a descending order of IR100% > IR90% > IR80% > IR70% for all SL treatments. The maximum values of cantaloupe D and P were (9.76 cm and 7.71 %) respectively, under the control treatment (FW and IR100%). While, the minimum values of cantaloupe D and P were (5.45 cm and 4.29 %), respectively under highly water and salt stresses (S3 and IR70%). Meanwhile, The values of cantaloupe D and P under (S3 and IR70%) treatment were recorded decreased significantly by about 79 and 80% respectively, compared to that under control treatment (FW and IR100%).The decrease may be attributed to that the soil salinity in general badly affects some crops production and growth by the influence on several facets of plant metabolism like osmotic adjustment, ions uptake, protein, synthesis of nucleic acids, enzyme activities and hormonal balance. These results are in agreement with (Munns and Tester 2008).

Effect of IR and SL on cantaloupe total soluble solid (TSS)

Data in Table 8 showed that the values of cantaloupe total soluble solid (TSS) increased with increasing SL it represents nearly a descending order of FW > S1 > S2 > S3 for all IR treatments. Also, data showed that the values of cantaloupe TSS decreased with decreasing IR it represents nearly a descending order of IR100% > IR90% > IR80% > IR70% for all SL treatments. The maximum value of cantaloupe TSS was (11.69 %) under (S3 and IR100%) treatment. While, the minimum value of cantaloupe D was (8.11 %) under (FW and IR70%) treatment. these results are in agreement with (Trajkova et al. 2006).

TABLE 8. Effect of IR and SL on some fruit quality parameters of cantaloupe .

IR (%)	SL (dS m-1)	D (Cm)	P (%)	TSS (%)	pH	AC (Citric %)	TS (mg/g FW)
100	FW	9.76	7.71	9.85	6.13	0.12	55.51
	S1	9.52	7.67	10.01	6.07	0.12	57.37
	S2	9.15	7.34	10.23	5.95	0.13	59.65
	S3	8.28	6.52	11.69	5.31	0.15	67.70
90	FW	9.51	7.67	9.52	6.29	0.12	56.34
	S1	9.35	7.54	9.86	6.14	0.13	58.69
	S2	8.76	7.09	10.04	6.05	0.14	61.73
	S3	7.93	6.35	11.47	5.37	0.15	69.86
80	FW	9.08	7.19	8.49	6.68	0.13	58.49
	S1	8.53	6.90	8.71	6.32	0.14	62.27
	S2	7.71	6.15	9.07	6.09	0.15	65.94
	S3	6.87	5.32	10.43	5.54	0.17	74.21
70	FW	8.23	6.37	8.11	7.41	0.14	62.63
	S1	7.39	5.83	8.59	6.78	0.16	69.91
	S2	6.42	5.05	8.96	6.56	0.17	75.78
	S3	5.45	4.29	10.24	5.69	0.18	84.46
LSD (0.05)	IR	0.19	0.12	0.17	0.12	0.00	0.57
	SL	0.22	0.17	0.12	0.17	0.01	0.68
	IR X SL	0.39	0.25	0.34	0.24	0.01	1.13

FW =0.80 dS m^{-1} S1= 1.56 dS m^{-1} S2= 3.14 dS m^{-1} S3= 6.25 dS m^{-1}

Cantaloupe acidity (AC), total sugar (TS), total soluble solid (TSS), cantaloupe fruit diameter (D) and protein (P)

TABLE 9. Effect of IR and SL on electrical conductivity and depletion in the active root zone for all growth stages of cantaloupe

IR (%)	SL (dS m-1)	ECe (dS m-1) and Dr (mm)							
		Growth Stages							
		$ECe_{Ini.}$	$ECe_{Dev.}$	$ECe_{Mid.}$	ECe_{Late}	$Dr_{ini.}$	$Dr_{Dev.}$	$Dr_{Mid.}$	Dr_{Late}
100	FW	1.78	2.17	2.32	1.95	17.74	17.92	17.49	17.61
	S1	2.15	2.69	2.80	2.32	17.01	16.69	16.54	17.36
	S2	3.57	4.39	4.65	3.78	14.05	15.06	14.89	13.98
	S3	5.10	6.81	6.97	5.34	12.08	12.74	12.36	11.80
90	FW	2.15	2.43	2.89	2.36	17.13	17.37	16.91	17.10
	S1	2.73	2.91	3.37	2.69	16.40	16.05	15.93	16.89
	S2	4.01	4.42	4.78	4.17	13.61	13.70	13.47	13.53
	S3	5.23	6.87	7.15	5.54	11.54	12.29	11.85	11.27
80	FW	2.81	3.59	4.03	3.06	16.36	16.62	16.19	16.34
	S1	3.27	4.15	4.49	3.24	15.69	15.25	15.11	16.17
	S2	4.19	5.07	5.31	4.40	12.82	12.49	12.65	12.70
	S3	5.70	7.21	7.57	5.89	10.74	11.56	11.13	10.49
70	FW	3.76	4.58	5.05	4.00	15.51	15.94	15.58	15.76
	S1	4.03	5.21	5.60	4.19	15.04	14.67	14.45	15.52
	S2	4.91	6.43	6.64	5.12	12.17	11.91	12.02	12.09
	S3	6.18	7.80	8.09	6.46	10.12	11.09	10.54	9.91
LSD (0.05)	IR	0.19	0.22	0.24	0.20	0.27	0.33	0.31	0.25
	SL	0.23	0.26	0.28	0.24	0.41	0.46	0.43	0.38
	IR XSL	0.31	0.34	0.36	0.32	0.54	0.61	0.59	0.53

FW =0.80 dS m^{-1} S1= 1.56 dS m^{-1} S2= 3.14 dS m^{-1} S3= 6.25 dS m^{-1}

Effect of IR and SL on cantaloupe pH of juice (pH)

Data in Table 8 concluded that the values of cantaloupe pH of juice (pH) decreased with increasing SL, it represents nearly a descending order of FW > S1 > S2 > S3 for all IR treatments. Also, data showed that the values of cantaloupe pH increased with decreasing IR, it represents nearly a descending order of IR100% > IR90% > IR80% > IR70% for all SL treatments. The maximum value of cantaloupe pH was (7.41 %) under (FW and IR70%) treatment. While, the minimum value of cantaloupe pH was (5.31 %) under (S3 and IR70%) treatment. these results are in agreement with (Devic et al. 2010).

Effect of IR and SL on cantaloupe acidity (AC) and total sugar (TS)

Data in Table 8 reported that the values of cantaloupe fruit acidity (AC) and total sugar (TS) increased with increasing SL; it represents nearly a descending order of FW > S1 > S2 > S3 for all IR treatments. Also, data showed that the values of cantaloupe AC and TS increased with decreasing IR it represents nearly a descending order of IR100% > IR90% > IR80% > IR70% for all SL treatments. The maximum values of cantaloupe AC and TS were (0.18 % and 84.46 mg/g FW) respectively, under highly water and salt stresses (S3 and IR70%) treatment. While, the minimum values of cantaloupe AC and TS were (0.12 % and 55.51 mg/g FW) under the control treatment (FW and IR100%). Meanwhile, The values of cantaloupe AC and TS under (S3 and IR70%) treatment were recorded increased significantly by about 50 and 52% respectively, compared to that under control treatment (FW and IR100%). The reduction in AC and TS were detected in all osmo-dried cantaloupes compared to fresh cantaloupe. This might be due to the membrane responsible for osmotic transport is not perfectly selective, other natural solutes present in the cells such as sugars, organic acids, minerals, salts, etc. can also be leached into the osmotic solution. These results are in agreement with Botia et al. (2005) and Naknean (2012).

Effect of IR and SL on cantaloupe water and salt stress coefficient (Ks)

The effects of water and salt stresses on ETc are described by reducing the value for the crop coefficient (Kc). This is accomplished by multiplying the crop coefficient by the water and salt stresses coefficient (Ks). Data in Table (9) illustrated that the values of soil electrical conductivity (ECe) and depletion (Dr) in the active root zone (0-45); it was used to calculate water and salt stresses coefficient (Ks).

Data in Table 10 showed that the values of cantaloupe water and salt stresses coefficient (Ks) for all growth stages decreased with increasing salinity levels of irrigation water (SL) it represents nearly a descending order of FW > S1 > S2 > S3 for all applied irrigation water quantities. Also, data showed that the values of Ks decreased with decreasing IR it represents nearly a descending order of IR100% > IR90% > IR80% > IR70% for all SL treatments. The maximum values of Ks were (1.00, 0.99, 0.99 and 1.00) for all growth stages (Initial, Development, Mid and Late) respectively, under the control treatment (FW and IR100%). While, the minimum values of Ks were (0.69, 0.40, 0.36 and 0.65) for all growth stages (Initial, Development, Mid and Late) respectively, under highly water and salt stresses (S3 and IR70%) treatment. However, during the development stage the peak values of soil salinity (ECe) in the root zone were obtained. The accumulation of solutes may allow plants to maintain a positive pressure potential, which is required to keep stomata open and to sustain gas exchange and growth. The Ks values clearly differ from stage to other because the water and salt stresses causes both osmotic stresses, due to a decrease in the soil water potential, and ionic stress, toxicity caused by high concentrations of certain ions within the plant, these results are in accordance with Salama et al. (2011).

Effect of IR and SL on Adjust crop evapotranspiration (ETc_{adj})

Data in Table 11 illustrated that the values of adjust crop evapotranspiration (ETc_{adj}) of cantaloupe decreased with increasing SL it represents nearly a descending order of FW > S1 > S2 > S3 for all IR treatments. Also, data reported that the values of ETcadj decreased with decreasing IR it represents nearly a descending order of IR100% > IR90% > IR80% > IR70% for all SL treatments. The maximum value of seasonal adjusted crop evapotranspiration ETcadj for cantaloupe was 330.93 mm under the control treatment (FW and IR100%). While, the minimum value of seasonal ETcadj for cantaloupe was 104.73 mm under highly water and salt stresses (S3 and IR70%) treatment. Meanwhile, data showed that the maximum values of ETcadj for cantaloupe at development growth stage for all treatments. The minimum values of ETcadj for cantaloupe at initial growth stage for all treatments. The decreased may be attributed to that the adjust crop evapotranspiration ETcadj may deviate from ETc due non-optimal conditions i.e pests and diseases, soil salinity, low soil fertility and water shortage or water logging. This may result in scanty plant growth, low plant density and may reduce the evapotranspiration

TABLE 10. Effect of IR and SL on water and salt stresses coefficient (Ks) for all growth stages of cantaloupe

IR (%)	SL ($dS\ m^{-1}$)	Water and saline stress coefficient (Ks) Growth Stages: Initial	Development	Mid	Late	Seasonal
100	FW	1.00	0.99	0.99	1.00	1.00
	S1	1.00	0.98	0.98	1.00	0.99
	S2	0.98	0.82	0.79	0.95	0.89
	S3	0.82	0.53	0.51	0.79	0.66
90	FW	1.00	0.98	0.95	1.00	0.98
	S1	0.99	0.98	0.93	0.97	0.97
	S2	0.93	0.87	0.82	0.91	0.88
	S3	0.81	0.53	0.49	0.77	0.65
80	FW	0.98	0.87	0.83	0.95	0.91
	S1	0.95	0.85	0.80	0.93	0.88
	S2	0.93	0.81	0.76	0.90	0.85
	S3	0.76	0.49	0.44	0.73	0.61
70	FW	0.89	0.76	0.71	0.85	0.80
	S1	0.87	0.72	0.67	0.83	0.77
	S2	0.84	0.61	0.57	0.81	0.71
	S3	0.69	0.40	0.36	0.65	0.53
LSD (0.05)	IR	0.04	0.01	0.02	0.03	0.01
	SL	0.05	0.01	0.01	0.04	0.01
	IR X SL	0.08	0.01	0.04	0.07	0.02

FW =0.80 $dS\ m^{-1}$ S1= 1.56 $dS\ m^{-1}$ S2= 3.14 $dS\ m^{-1}$ S3= 6.25 $dS\ m^{-1}$

TABLE 11. Effect of IR and SL on adjust crop evapotranspiration (ETc_{adj}) for growth stages of cantaloupe.

IR (%)	SL ($dS\ m^{-1}$)	Adjust crop evapotranspiration (ETc_{adj}) Growth Stages: Initial	Development	Mid	Late	Seasonal
100	FW	33.37	202.66	59.33	35.57	330.93
	S1	33.37	200.62	58.73	35.57	328.29
	S2	32.70	167.86	47.34	33.79	281.69
	S3	27.36	108.50	30.56	28.10	194.52
90	FW	30.03	180.56	51.23	32.01	293.83
	S1	29.73	180.56	50.15	31.05	291.49
	S2	27.93	160.29	44.22	29.13	261.57
	S3	24.32	97.65	26.43	24.65	173.05
80	FW	26.17	142.48	39.79	27.03	235.47
	S1	25.37	139.20	38.35	26.46	229.38
	S2	24.83	132.65	36.43	25.61	219.52
	S3	20.29	80.25	21.09	20.77	142.40
70	FW	20.79	108.91	29.78	21.17	180.65
	S1	20.32	103.18	28.11	20.67	172.28
	S2	19.62	87.41	23.91	20.17	151.11
	S3	16.12	57.32	15.10	16.19	104.73
LSD (0.05)	IR	1.07	1.16	1.15	1.02	1.91
	SL	1.43	1.79	0.67	1.21	1.65
	IR X SL	2.13	2.32	2.30	2.04	3.82

FW =0.80 $dS\ m^{-1}$ S1= 1.56 $dS\ m^{-1}$ S2= 3.14 $dS\ m^{-1}$ S3= 6.25 $dS\ m^{-1}$

Convert mm to m^3 = water per mm depth * Area (3.57 not 4.2 for drip irrigation)

TABLE 12. Effect of water and salt stresses on Ya, WUE, IWUE and Ky of cantaloupe.

IR (%)	SL ($dS\ m^{-1}$)	Ya ($Mg\ fed^{-1}$)	WUE ($Mg\ m^{-3}$)	IWUE ($Mg\ m^{-3}$)	$1-(Ya/Y_{max})$	$1-(ETc/ETc_{adj})$	Ky
100	FW	7.65	6.48	5.54	0.00	0.01	0.00
	S1	7.54	6.43	5.12	0.01	0.02	0.50
	S2	6.41	6.37	4.23	0.16	0.16	1.00
	S3	4.25	6.12	2.75	0.44	0.42	1.05
90	FW	7.39	7.04	5.95	0.03	0.12	0.25
	S1	7.14	6.86	5.39	0.07	0.13	0.54
	S2	6.21	6.65	4.55	0.19	0.22	0.86
	S3	3.90	6.31	2.81	0.49	0.48	1.02
80	FW	7.27	8.65	6.58	0.05	0.29	0.17
	S1	6.89	8.41	5.85	0.10	0.31	0.32
	S2	4.94	6.30	4.07	0.35	0.34	1.03
	S3	2.91	5.72	2.36	0.62	0.57	1.09
70	FW	4.13	6.40	4.27	0.46	0.46	1.00
	S1	3.87	6.29	3.76	0.49	0.48	1.02
	S2	3.15	5.84	2.97	0.59	0.55	1.07
	S3	1.71	4.57	1.58	0.78	0.69	1.13
LSD (0.05)	IR	0.13	0.17	0.10	-	-	-
	SL	0.24	0.28	0.19	-	-	-
	IR X SL	0.27	0.35	0.21	-	-	-

FW =0.80 $dS\ m^{-1}$ S1= 1.56 $dS\ m^{-1}$ S2= 3.14 $dS\ m^{-1}$ S3= 6.25 $dS\ m^{-1}$
Ymax = Ya at IR =100% and FW

ETc (Allen et al., 1998). The same table shows that the large influence of decreasing ETc happened in development stage due to the maximum value of salinity (ECe) and depletion (Dr) of soil at affective root zone occurring in this stage. These results are in accordance with (Dudley et al., 2008) they reported that the used saline water in irrigation causes a reduction in transpiration, which subsequently results in reduced ETc.

Effect of IR and SL on the marketable fruit yield (Ya) of cantaloupe

Data in Table 12 showed that the values of marketable fruit yield (Ya) for cantaloupe decreased with increasing SL it represents nearly a descending order of FW > S1 > S2 > S3 for all IR treatments. Also, data showed that the values of cantaloupe Ya decreased with decreasing IR it represents nearly a descending order of IR100% > IR90% > IR80% > IR70% for all SL treatments. The maximum value of cantaloupe Ya was 7.65 Mg fed-1 under control treatment (FW and IR100%). While, the minimum value of cantaloupe Ya was 1.71 Mg fed-1 under highly water and salt stresses (S3 and IR70%) treatment. Meanwhile, the value of cantaloupe Ya under (S3 and IR70%) treatment was recorded decreased significantly by about 78% compared to that under control treatment (FW and IR100%). These results may be attributed to the IR and SL can inhibit plant growth by a range of mechanisms, including low external water potential, ion toxicity and interference with the uptake nutrients. Also, the soil salinity, saline irrigation water and deficit irrigation can severely restrict plant growth, causing foliage damage and even death of plants.These results agree with Taffouo et al. (2009 &2010).

Effect of IR and SL on water use efficiency (WUE)

Data in Table 12 concluded that the maximum value of water use efficiency (WUE) for cantaloupe was 8.65 Mg m-3 under (FW and IR80%) treatment. While, the minimum value of WUE for cantaloupe was 4.57 Mg m-3 under highly water and salt stresses (S3 and IR70%) treatment. Meanwhile, the value of WUE under (FW and IR80%) treatment was recorded increased significantly by about 33 % compared to that under control treatment (FW and IR100%). These may be attributed to the decreases in total crop yield with increasing SL for all IR treatments which increases the energy that plant must expend to acquire water from the soil and make the biochemical adjustment necessary to survive. Also, reduction in photosynthesis and plant dry mass with increased salinity could be attributed to the difference in the efficiency of root system in limiting the transport of ions to shoots. These results agree with Al-Omran et al. (2012) and to induced water deficit (Wahb-Allah et al., 2011).

Effect of IR and SL on irrigation water use efficiency (IWUE)

Data in Table 12 showed that the maximum value of irrigation water use efficiency (IWUE) for cantaloupe was 6.58 Mg m-3 under (FW and IR80%) treatment. While, the minimum value of IWUE for cantaloupe was 1.58 Mg m-3 under highly water and salt stresses (S3 and IR70%) treatment. Meanwhile, the value of IWUE under (FW and IR80%) treatment was recorded increased significantly by about 19 % compared to that under control treatment (FW and IR100%). These results agree with Taffouo et al. (2010).

Effect of IR and SL on crop yield response factor (Ky)

The crop yield response factor (Ky) was determined for the applied irrigation water at different salinity level of irrigation water treatments. The Ky usually indicates a linear relationship of the relative reduction in water that was consumed with a relative reduction in yield (Lovelli et al. 2007). When crops have Ky values that are lower than one, they are considered to be tolerant of water deficiency. On the contrary, crops with Ky values greater than one are considered to not be tolerant to deficit irrigation, as noted by (Ayas and Domirtas, 2009). Data in Table (12) showed that the Ky of cantaloupe increased with increasing SL it represents nearly a descending order of FW > S1 > S2 > S3 for all IR treatments. Also, data concluded that the values of Ky increased with decreasing IR it represents nearly a descending order of IR100% > IR90% > IR80% > IR70% for all SL treatments. The maximum value of cantaloupe Ky was 1.13 under highly water and salt stresses (S3 and IR70%) treatment. While, the minimum value of Ky was 0.17 under (FW and IR80%) treatment. These results were similar to those reported by Patane and Cosentino (2010).

Conclusion

This study evaluated the effectiveness of applied irrigation water stress at different salt stress levels of irrigation water on the marketable yield, fruit quality parameters, water use efficacy, irrigation water use efficiency and yield response factor under Egyptian sandy. This study concluded that:

1- The values of cantaloupe fruit quality like AC and TS increased with increasing SL for all IR treatments. Also, the values of cantaloupe AC and TS increased with decreasing IR for all SL treatments.
2- The values of cantaloupe Ya decreased with increasing SL for all IR treatments. Also, the values of Ya decreased with decreasing IR for all SL treatments.
3- The maximum value of cantaloupe Ya was 7.65 Mg fed-1 under control treatment (FW and IR100%).
4- The values of ETcadj and Ks decreased with increasing SL for all IR treatments. Also, the values of ETcadj decreased with decreasing IR it represents for all SL treatments.
5- The maximum values of WUE and IWUE for cantaloupe were (8.65 and 6.58 Mg m-3) respectively, under (FW and IR80%) treatment. While, the values of WUE and IWUE under (FW and IR80%) treatment was recorded increased significantly by about (33 and 19%) respectively, compared to that under control treatment (FW and IR100%).
6- Finally, the minimum value of Ky was 0.17 under (FW and IR80%) treatment compared to that 0.00 under control treatment.

So, it could be recommended that use the applied irrigation water IR80% under salinity levels of irrigation water (FW= 0.80, S1= 1.56 and S2= 3.14 dS m-1) this treatments could be saved about 20% of irrigation water. While, use IR90% under SL (6.25 dS m-1) treatment could be saved about 10% of irrigation water. Meanwhile, use these treatments maximizing fruit quality parameters of cantaloupe, such as total sugars and citric acid.

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تأثير الأجهاد المائى والملحى على أنتاجية الكنتالوب فى أرض الأسماعيلية

على أحمد على وعمروصادق محمد
مركز بحوث الصحراء - القاهرة - مصر

مما لا شك فيه أن الأجهاد المائى والملحى من أهم العوامل المؤثرة على مواصفات الجودة وأنتاجية المحاصيل لذا أجريت هذه التجربة الحقلية لدراسة تأثير كميات مياه الرى المضافة تحت مستويات ملوحة مختلفة على جودة وأنتاجية محصول الكنتالوب وكذلك معامل الأجهاد المائى والملحى وكفاءة الأستهلاك المائى والأروائى ومعامل أستجابة المحصول للنقص وبالتالى أمكن تحديد أنسب كمية مياه رى مضافة لكل مستوى من مستويات الملوحة المختلفة. أجريت هذه التجربة فى منطقة القصاصين الجديدة بمحافظة الأسماعيلية – جمهورية مصر العربية خلال الموسم الصيفى ٢٠١٥ تم أستخدام التصميم الأحصائى القطع المنشقة مرة واحدة بثلات مكررات لكل معاملة وتم زراعة محصول الكنتالوب تحت نظام الرى بالتنقيط السطحى بأستخدام أربع نسب من كميات مياه الرى المضافة (١٠٠ , ٩٠ ، ٨٠ , ٧٠٪) وأربع مستويات من ملوحة مياه الرى المضافة (٠,٨٠ , ١,٥٦ , ٣,١٤ , ٦,٢٥ ديسي سيمنز/ متر) وقد أوضحت النتائج المتحصل عليها الأتى :

١- أنخفاض قيم كلا من قطرثمرة الكانتالوب ونسبة البروتين بها بزيادة مستويات الملوحة المختلفة لجميع النسب المضافة من كميات مياه الرى مقارنة بالمعاملة التقليدية (المروية بمياه عذبة ٠,٨٠ ديسي سيمنز/ متروكمية مياه رى مضافة ١٠٠٪). كما لوحظ أيضا أنخفاض كلا من قطر الثمرة ونسبة البروتين بنقص كميات مياه الرى المضافة لجميع مستويات الملوحة المختلفة.

٢- زيادة قيم المواد الصلبة الذائبة لثمرة الكانتالوب بزيادة مستويات الملوحة المختلفة لجميع النسب المضافة من كميات مياه الرى مقارنة بالمعاملة التقليدية. كما لوحظ أيضا أنخفاض قيم المواد الصلبة الذائبة بنقص كميات مياه الرى المضافة لجميع مستويات الملوحة المختلفة.

٣- أنخفاض قيم حموضة عصيرثمرة الكانتالوب بزيادة مستويات الملوحة المختلفة لجميع النسب المضافة من كميات مياه الرى مقارنة بالمعاملة التقليدية. كما لوحظ أيضا زيادة قيم الحموضة بنقص كميات مياه الرى المضافة لجميع مستويات الملوحة المختلفة.

٤- زيادة قيم كلا من حامض الستريك والسكريات الكلية لثمرة الكانتالوب بزيادة مستويات الملوحة المختلفة لجميع النسب المضافة من كميات مياه الرى مقارنة بالمعاملة التقليدية. كما لوحظ أيضا زيادة قيم كلا من حامض الستريك والسكريات الكلية بنقص كميات مياه الرى المضافة لجميع مستويات الملوحة المختلفة.

٥- أنخفاض قيم كلا من معامل الأجهاد المائى والملحى Ks وكذلك البخر نتح الفعلى ETcadj لمحصول الكنتالوب تدريجا بزيادة مستويات الملوحة المختلفة لجميع النسب المضافة من كميات مياه الرى مقارنة بالمعاملة التقليدية. كما لوحظ أيضا أنخفاض قيم كلا من Ks و ETcadjبنقص كميات مياه الرى المضافة لجميع مستويات الملوحة المختلفة.

٦- أنخفاض قيم الأنتاجية الكلية لثمارالكانتالوب بزيادة مستويات الملوحة المختلفة لجميع النسب المضافة من كميات مياه الرى مقارنة بالمعاملة التقليدية. كما لوحظ أيضا أنخفاض قيم الأنتاجية الكلية بنقص كميات مياه الرى المضافة لجميع مستويات الملوحة المختلفة. سجلت المعاملة (المروية بمياه ملوحتها ٦,٢٥ ديسي سيمنز/ متروكمية مياه رى مضافة ٧٠٪) أقل أنتاجية لمحصول الكنتالوب (١,٧طن/ فدان) مقارنة بالمعاملة التقليدية التى سجلت أعلى أنتاجية للكنتالوب (٧,٦٥ طن/ فدان) لتصل نسبة الفقد فى المحصول لحوالى ٧٨٪.

٧- سجلت المعاملة المروية بمياه ملوحتها ٠,٨ ديسي سيمنز/ متروكمية مياه رى مضافة ٨٠٪ أعلى قيم لكفاءة الأستهلاك المائى والأروائى لمحصول الكنتالوب (٨,٦٥ و ٦,٥٨ كجم/م٣) على الترتيب مقارنة بالمعاملة التقليدية (٦,٤٨ و ٥,٥٤ كجم/م٣) على الترتيب لتصل نسبة الزيادة لحولى (٣٣ و١٩٪) على الترتيب.

٨- زيادة قيم معامل أستجابة محصول الكانتالوب بزيادة مستويات الملوحة المختلفة لجميع النسب المضافة من كميات مياه الرى مقارنة بالمعاملة التقليدية. كما لوحظ أيضا زيادة قيم معامل أستجابة محصول الكانتالوب بنقص كميات مياه الرى المضافة لجميع مستويات الملوحة المختلفة.

لذا يمكن التوصية بأستخدام كمية مياه الرى المضافة ٨٠٪ عند مستويات الملوحة (٠,٨٠ , ١,٥٦ , ٣,١٤ ديسي سيمنز/ متر) توفير حوالى ٢٠٪ من مياه الرى بينما يمكن أستخدام كمية مياه الرى المضافة ٩٠٪ عند مستوى الملوحة (٦,٢٥ ديسي سيمنز/ متر) وتوفيرحوالى ١٠٪ من مياه الرى المضافة. كما أن أستخدام هذه المعاملات المسموح بها من الأجهاد المائى والملحى يحسن بعض مواصفات الجودة لمحصول الكنتالوب كنسبة السكريات الكلية وحمض الستريك.