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Influence of Salicylic Acid on Cucumber Plants under Different Irrigation Levels

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ABSTRACT

In order to evaluate the effect of foliar application by salicylic acid (SA) on vegetative growth and yield responses in cucumber plants under different irrigation levels. Two field experiments were performed at a private farm in Dekernes, Dakahlia governorate, Egypt, in summer seasons of 2017 and 2018, to investigate the impact of four foliar application rates of salicylic acid (0.0, 0.15, 0.30 and 0.45 g/l) and three irrigation levels (1200, 900 and 600 m^3/fed.) on growth and yield of cucumber cv. Gabbar. Water shortage stress significantly reduced vegetative growth (main stem length, branches number, foliage fresh weight, leaves number and leaves area per plant and yield components; fruits weight and numbers per plant, Vit. C, TSS and total yield (ton/fed.). On contrary, foliar application of SA significantly improved these parameters under water shortage stress conditions. However, the lowest used water irrigation quantity increased leaf and fruits dry matter percentage, sex ratio and water use efficiency. On the other hand, water shortage stress significantly reduced leaf pigments (chlorophyll a, b and carotenoid) as compared to the highest rate (1200 m^3) and these were further increased by using SA. Salicylic acid at a concentration of 0.30 g/l gave the highest fruits yield and its components. As well as, 1200 m^3/fed and 0.3 g/l salicylic acid treatments were recorded the highest values for most effective mentioned criteria.

Keywords: Cucumber, salicylic acid, irrigation levels, water use efficiency, electrolyte leakage, sex ratio and fruits yield.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important vegetable crops of the Cucurbitaceae family grown in summer season. Cucumbers are commonly harvested when the fruits are physiologically immature. It is eaten as raw and generally used for salad. The fresh cucumber fruits are still a source of vitamin A, vitamin C, vitamin K, vitamin B_6, thiamin, and potassium (Sahin *et al*., 2015).

The growth of cucumber has been seriously influenced by several biotic and non-biotic stresses. Water deficit is one of the most common non-biotic stresses that effects on growth and development of plants (Siamak *et al*., 2014). Early investigations reported that water deficit led to decreasing leaves area, main stem length, fruits number and fruits yield (El-Gindy *et al*., 2009 on squash, Sahin *et al*., 2015 on cucumber), Also, leaves fresh weight (Ibrahim and Selim, 2010 on squash). In addition, drought led to reduction of chlorophyll content on cantaloupes (Ali *et al*., 2014). On the other hand, water shortage resulted in increasing of sex ratio of cucumber plant (Kamal *et al*., 2009), water use efficiency of cantaloupes (Ali *et al*., 2014) and free proline of melon (Kavas *et al*., 2013).

Salicylic acid (SA) a ubiquitous plant phenolic compound may play a key role in regulate many of processes in plants (Hayat *et al*., 2008). Also, it is enhanced plant growth attributes under water shortage on mungbean (Tahereh *et al*., 2014). SA resulted in increasing of the antioxidant enzymes and contributing to the increase of plants resistance to drought effects by reducing generation of reactive oxygen species (ROS), activate the translocation of soluble carbohydrates to young cell which led to enhancement plant growth (Metwally *et al*., 2003). In addition, Salicylic acid have a role as cofactors for dismutases, peroxidases and catalases, those catalyzed mitigated of the toxic free radicals (H_2O_2), (OH), (O^{2-}). Furthermore, SA was affected on growth development and ion uptake (Simaei *et al*., 2012).

Several studies were revealed that SA can reduce the worst impacts of water deficit stress in different species (Arfan *et al*., 2007). In this concern, Nasrabadi *et al*. (2015) showed that melon plants sprayed with 100 ppm of SA produced larger amounts of leaves area, chlorophyll content, fruit ripening duration and TSS than untreated plants. Siamak *et al*. (2014) reported that SA increased plant height protein content of the chickpea. In addition, Salicylic acid resulted in increasing of leaves area of broccoli (Zohair, 2014), leaf relative water content of mungbean, total soluble solid (TSS), vitamin C and lycopene of tomato (Hafeznia *et al*., 2014) and the tubers yield and its component (Metwaly and El-Shatoury, 2017) on potato.

The present study aimed to investigate the influence of SA applications on growth and yield parameters of cucumber plants under different irrigation levels**.**

MATERIALS AND METHODS

Two field experiments were performed at a private farm in Dekernes district, Dakahlia governorate, Egypt, in the two summer seasons of 2017 and 2018, to study the influence of three irrigation levels and four salicylic acid concentrations as foliar application and their interactions on growth and yield components of cucumber cv. Gabbar grown under drip irrigation system. Physical and chemical analyses of soil are shown in (Table 1).

Table 1. Physical and chemical parameters of soil during the two seasons of 2017 and 2018.

Seasons	Silt %	Clay %	Sand %	Texture soil	Field Capacity %	Welting point%	Available water %	PH	E.C (dSm-1)	Organic matter %	$CaCO_3$ %	N ppm	P ppm	K ppm
2017	40.2	36.5	23.3	Clay loamy	35.5	18.2	17.3	8.1	1.49	1.9	3.38	54	6.1	299
2018	40.6	36.4	23.0	Clay loamy	35.2	18.3	16.9	7.9	1.68	1.8	3.41	52	6.5	289

These experiments were included 12 treatments which were combination between three levels of irrigation (1200, 900 and 600 m^3/fed.) and four concentrations of salicylic acid (0.0, 0.15, 0.3 and 0.45 g/l). These treatments were distributed in a split-plot factorial experiment based on randomized complete block design with three replicate. The levels of irrigation were randomly distributed in the main plots while salicylic acid concentrations were randomly distributed in the sub plots, the area of the experimental unit was 24 m^2. It consists of three dripper lines (16/50) each of them 5m length and 1.6m width. One line was used for yield determination and the other two lines were used to measure vegetative growth parameters. In addition, one row was left between each two experimental units as a guard to avoid the overlapping of spraying solution. Four cucumber seeds were planted manually per hill at two sides of dripper on 1st and 3rd of August in the first and second summer seasons, respectively. Plants were thinned at 2 plants per hill after one week from beginning of germination. Three Irrigation water levels were done during two seasons as follows; all experimental units received equal amounts of water during germination for all treatment equally. Irrigation water quantities remainder (m^3/fed.) was determined by water counter at 2.0 bar, also, drippers flow rate were (4 liter/h). The irrigation treatments were done daily began at 5th and 7thAugust (4 days after planting) and ended 11 and 13 October. Treatments of salicylic acid were added every ten days as foliar application after planting to the end of experiment. All mineral fertilizers were added at recommended dose of N, P, K + Mg, Ca and Trace element, which applied during the two seasons according to fertigation program in the farm. The other normal agricultural practices for cucumber plants, except irrigation treatment were practiced.

Data recorded:

A random samples of four plants from each plot were taken at 35 days after planting to measure all parameters except sex expression, yield and its components were determined during entire growth seasons and the following data were recorded;

1- Vegetative growth characters:

Main stem length (cm), branches number, foliage fresh weight (g), leaves number per plant, leaves area (cm^2) per plant and leaves dry matter percentage.

2- Sex expression:

Four plants from each plot were chosen and labeled for the present study. Sex ratio = (male/ female) were determined as number of male and female flowers for each plot every two days intervals up to the end of the season.

3- Water relations parameters

Water use efficiency was estimated according to (Ali *et al*., 2014), Electrolyte Leakage and Leaf relative water content were determined according to (Akram *et al*., 2016).

4- Fruits yield and its components:

Forty plants (one dripper line) from each plot were chosen and labeled for the present study to measured fruits weight and numbers per plant, fruits DM % and total yield (ton fed).

5- Chemical composition:

N.P.K. percent, chlorophyll a, b and carotenoids content in leaves, Vit. C and TSS in fruits were determined according to A.O.A.C (1990).

Statistical analysis:

Data for all characters were analyzed using the analysis of variance according to Snedecor and Cochran (1980).The means were compared using computer program of Costate version 6.303 (Analytical software). Means were compared by LSD test at 5 percent probability level for each trait.

RESULTS AND DISCUSSION

1- Vegetative growth characters:

Data presented in Table 2 illustrate that decrease irrigation levels caused significant decreasing in main stem length (cm), branches number, foliage fresh weight (g), leaves number and leaves area (cm^2) per plant. On contrast, leaves dry matter % was increased by decreasing irrigation levels in the 1st and 2ed seasons. This decrease can be due to that available less water reducing nutrient availability; Also, water shortage resulted in more production of ROS which led to breakdown of vital material in cells such as DNA, RNA, protein and phospholipids which reflexed to decline of cells division, elongation and development in different plant tissues (Siamak *et al*.,2014; Sahin *et al*.,2015)

As well as results tabulated in the same table show that there were significant differences in both seasons. Increasing salicylic acid levels increased significantly mentioned characters in both seasons compared to the control. The biggest values of these criteria were registered by using salicylic acid at 0.30 g/l in the both seasons, followed by 0.45 g/l. This could be attributed to the water shortage led to the oxidative damage inevitably, producing reactive oxygen species (ROS) which resulted oxygen reduction (Cruz de Carvalho, 2008). Salicylic acid prevent the high activity of ROS, improving cell division and elongation of plants tissues, activate translocation of soluble carbohydrates, ion uptake and membrane permeability which reflected in on more growth and development (Simaei *et al*., 2012).

The interaction between irrigation levels and foliar spraying of salicylic acid had significant effect on main stem length (cm), branches number, foliage fresh weight (g), leaves number and leaves area (cm^2) per plant and leaves dry matter %. Data presented in Table 2 showed that the interaction between 1200 m^3/fed. and 0.30 g/l salicylic acid recorded the optimum values of mentioned parameters, on the other hand the lowest values were observed with 600 m^3/fed. of irrigation water without salicylic acid foliar application.

On the contrary, the highest leaves dry matter % was achieved by using 600 m^3/fed. with foliar application of salicylic acid at 0.30 g/l, on the other hand; the lowest values were noticed with 1200 m^3/fed. without salicylic acid foliar treatment. These results in accordance with those obtained by El-Gindy *et al*. (2009) on squash; Kavas *et al*. (2013) on melon and Nasrabadi *et al*. (2015) on melons.

Table 2. Influence of irrigation levels, salicylic acid and their interaction on vegetative growth characters of cucumber during two seasons of 2017 and 2018.

Treatments		Main stem length (cm)		Branches No/plant		Foliage FW g / plant		Leaves No / plant		Leaves area (cm^2) / plant		Leaves DM %	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Irrigation levels m^3/fed.													
1200		136.0	132.6	8.65	8.43	516	503	82.1	80.1	5379	5237	2.39	2.33
900		111.3	108.6	7.08	6.91	423	412	67.2	65.6	4403	4295	2.79	2.72
600		94.6	92.3	6.01	5.87	359	350	57.1	55.7	3743	3649	3.49	3.40
LSD 5%		13.2	13.9	0.84	0.85	50	46	8.0	7.9	525	518	0.35	0.34
Salicylic acid g/l													
0.0		101.0	99.3	6.42	6.32	383	377	61.0	60.0	3997	3929	2.62	2.58
0.15		109.2	106.9	6.94	6.80	414	406	65.9	64.6	4318	4218	2.78	2.72
0.30		126.2	123.7	8.02	7.86	479	469	76.2	74.7	4992	4890	3.16	3.10
0.45		119.5	114.7	7.60	7.30	454	435	72.2	69.3	4727	4537	3.00	2.88
LSD 5%		9.2	8.7	0.58	0.55	35	33	5.5	5.3	365	348	0.23	0.22
Interaction													
1200	0.0	116.6	114.6	7.42	7.29	443	435	70.4	69.2	4611	4533	2.13	2.09
	0.15	129.4	126.7	8.23	8.06	491	481	78.1	76.5	5117	4977	2.36	2.32
	0.30	153.1	150.1	9.74	9.54	581	570	92.5	90.6	6056	5935	2.62	2.57
	0.45	144.9	139.1	9.22	8.85	550	528	87.5	84.0	5731	5502	2.47	2.37
900	0.0	103.0	101.2	6.55	6.44	391	384	62.2	61.1	4072	4003	2.67	2.63
	0.15	105.3	103.3	6.70	6.57	400	392	63.6	62.3	4166	4082	2.68	2.63
	0.30	120.5	118.1	7.66	7.51	457	448	72.8	71.3	4766	4670	2.97	2.91
	0.45	116.6	111.9	7.41	7.12	442	425	70.4	67.6	4610	4426	2.85	2.73
600	0.0	83.6	82.2	5.31	5.23	317	312	50.5	49.6	3307	3250	3.07	3.01
	0.15	92.8	90.9	5.90	5.78	352	345	56.1	54.9	3673	3595	3.29	3.22
	0.30	105.0	102.8	6.68	6.54	399	390	63.4	62.1	4153	4066	3.90	3.82
	0.45	97.0	93.2	6.17	5.93	368	353	58.6	56.2	3839	3685	3.69	3.54
LSD 5%		16.0	15.1	1.01	0.96	60	58	9.6	9.1	633	603	0.41	0.38

2- Leaves chemical composition parameters:

Results presented in Table 3 indicate that N, P, K, chlorophyll a, chlorophyll b and carotenoids in cucumber leaves tissue were increased gradually by increasing irrigation levels. The highest irrigation levels (1200 m^3/fed) registered the maximum values in this respect.

Table 3. Influence of irrigation levels, salicylic acid and their interaction on N, P, K percentage and pigments in leaves of cucumber during two seasons of 2017 and 2018.

Treatments		N %		P %		K %		Chl. a mg/100g FW		Chl.b mg/100g FW		Carotenoids mg/100g FW	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Irrigation levels m^3/fed.													
1200		3.13	3.06	0.380	0.370	3.92	3.82	80.2	78.2	40.8	39.7	22.5	21.9
900		2.56	3.50	0.311	0.303	3.21	3.15	65.7	64.1	33.4	32.5	18.4	17.9
600		2.18	2.12	0.264	0.257	2.73	2.66	55.8	54.4	28.4	27.6	15.6	15.2
LSD 5%		0.30	0.29	0.037	0.035	0.38	0.37	7.8	7.9	3.9	4.1	2.1	2.0
Salicylic acid g/l													
0.0		2.33	2.29	0.282	0.277	2.91	2.86	59.6	58.6	30.3	29.8	16.7	16.4
0.15		2.51	2.46	0.305	0.298	3.15	3.08	64.4	63.1	32.7	32.0	18.0	17.7
0.30		2.91	2.85	0.352	0.345	3.64	3.57	74.4	72.9	37.8	37.1	20.9	20.4
0.45		2.75	2.64	0.334	0.320	3.45	3.31	70.5	67.7	35.8	34.4	19.7	19.0
LSD 5%		0.21	0.20	0.025	0.025	0.26	0.25	5.4	5.1	2.7	2.5	1.5	1.1
Interaction													
1200	0.0	2.69	2.64	0.325	0.320	3.36	3.30	68.8	67.6	34.9	34.3	19.3	18.9
	0.15	2.98	2.92	0.361	0.354	3.73	3.65	76.3	74.7	38.8	38.0	21.4	20.9
	0.30	3.53	3.46	0.428	0.419	4.42	4.33	90.3	88.5	45.9	45.0	25.3	24.8
	0.45	3.34	3.21	0.405	0.389	4.18	4.01	85.5	82.1	43.4	41.7	24.0	23.0
900	0.0	2.37	2.33	0.287	0.283	2.97	2.92	60.7	59.7	30.9	30.3	17.0	16.7
	0.15	2.43	2.38	0.294	0.288	3.04	2.97	62.1	60.9	31.6	30.9	17.4	17.1
	0.30	2.78	2.72	0.336	0.330	3.48	3.41	71.1	69.7	36.1	35.4	19.9	19.5
	0.45	2.69	2.58	0.326	0.312	3.36	3.23	68.8	66.0	34.9	33.5	19.3	18.5
600	0.0	1.92	1.89	0.233	0.229	2.41	2.37	49.3	48.5	25.0	24.6	13.8	13.6
	0.15	2.14	2.10	0.259	0.254	2.68	2.62	54.8	53.6	27.8	27.2	15.3	15.0
	0.30	2.42	2.37	0.293	0.287	3.03	2.96	61.9	60.6	31.5	30.8	17.3	17.0
	0.45	2.24	2.15	0.271	0.260	2.80	2.69	57.2	54.9	29.1	27.9	16.0	15.4
LSD 5%		0.43	0.42	0.053	0.051	0.54	0.53	9.4	8.9	4.8	4.3	2.6	1.8

On the other hand, the minimum values were observed by using 600 m^3/fed. of irrigation water, these findings may be due to that shortage of water led to reduction cell division and roots formation and nutrients uptake which reflected in reducing of N and Mg nutrient absorption which are necessary for chlorophyll pigments synthesis (Yavas and Unay, 2016).

Results presented in Table 3 revealed that N, P, K, chlorophyll b and carotenoids attributes in leaves of cucumber plants were significantly increased in the 1st and 2ed seasons by using salicylic acid up to 0.30 g/l then decline at 0.45 g/l This increasing may be due to (ROS) has devastating effect for chlorophyll pigments under shortage of water. On contrast, SA useful for mitigation the worst damage of (ROS) on chlorophyll by ameliorate antioxidants systems, increase cell division and elongation, increasing of soluble carbohydrates translocation, (Fasaei, 2013). In addition, Nazar*et al*. (2015) reported that SA prevents chlorophyll oxidase enzymes.

Data in Table 3 indicate that the combination between irrigation levels and foliar spraying of salicylic acid had significant effect on N, P, K, chlorophyll a, b and carotenoids content, the optimum values were recorded by using combination consist of 1200 m^3 and 0.30 g/l. On other hand, the lowest values were observed using 600 m^3/fed. of irrigation water without salicylic acid foliar treatment (0.0 g/l). Our results are in the same line with those obtained by Zohair (2014) on broccoli; Nasrabadi *et al*. (2015) on melon; Abdul Qados (2015) on pepper; Vaisnad and Talebi (2015) on chickpea

3- Sex expression and water relations parameters:

Male and female flowers No., sex ratio, leaf relative water content (LRWC), electrolyte leakage and water use efficiency were affected significantly by irrigation levels (Table 4). Male flowers No., sex ratio, electrolyte leakage and water use efficiency were significantly higher under the lowest irrigation level (600 m^3/fed.). On other hand, female flowers No. and leaf relative water content were higher under highest irrigation levels 1200 m^3/fed. These findings could be due to water shortage led to decreasing elements uptake, gibberellins and cytokines level which results in poor roots formation. Water shortage results in the membrane injury and lipid peroxidation, which resulted in increasing of electrolyte leakage % (Scandadalius, 1993).

Table 4. Influence of irrigation levels, salicylic acid and their interaction on Sex expression and water relations of cucumber during two seasons of 2017 and 2018.

Treatments		Male flowers No/ plant		Female flowers No/ plant		Sex ratio		Leaf relative water content %		Electrolyte leakage %		Water use efficiency kg / m^3water	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Irrigation levels m^3/fed.													
1200		90.0	87.2	13.6	12.5	6.6	7.0	90.3	88.8	70.0	68.7	10.9	10.6
900		96.6	94.3	12.1	10.7	8.0	8.8	79.3	77.3	75.1	73.3	11.9	11.6
600		103.0	100.5	10.3	9.5	10.1	10.5	67.4	65.7	79.9	78.0	15.2	14.8
LSD 5%		1.4	2.0	0.3	0.7	0.2	0.5	8.6	8.4	1.1	1.0	1.7	1.5
Salicylic acid g/l													
0.0		100.1	97.7	11.1	10.1	9.2	9.8	71.9	70.7	77.7	76.2	11.3	11.1
0.15		98.2	95.2	11.6	10.6	8.6	9.1	77.7	76.1	76.3	74.7	12.2	11.9
0.30		93.2	91.0	13.1	11.8	7.2	7.8	84.8	83.2	72.4	70.8	14.0	13.7
0.45		94.7	92.1	12.3	11.2	7.9	8.4	81.5	79.0	73.7	71.6	13.2	12.7
LSD 5%		4.7	4.4	1.2	0.8	1.0	0.8	4.7	4.5	3.5	3.4	1.0	0.7
Interaction													
1200	0.0	94.6	91.3	13.0	11.3	7.3	8.0	83.1	81.6	73.6	71.9	9.3	9.2
	0.15	94.3	89.3	13.3	12.3	7.1	7.2	92.1	90.2	73.3	71.7	10.4	10.2
	0.30	85.3	83.0	14.3	13.6	5.9	6.1	93.7	92.3	66.3	64.9	12.3	11.0
	0.45	86.0	85.3	14.0	13.0	6.2	6.5	92.5	91.0	67.0	66.3	11.6	10.8
900	0.0	98.3	96.6	11.0	10.0	8.9	9.7	73.3	72.0	76.2	74.9	11.0	11.2
	0.15	97.0	95.0	12.0	10.3	8.1	9.2	75.0	73.5	75.3	73.8	11.3	12.0
	0.30	95.0	92.6	13.3	11.6	7.1	7.9	85.8	84.1	73.9	72.0	12.9	12.6
	0.45	96.3	93.0	12.3	11.0	7.8	8.5	83.0	79.7	74.9	72.4	12.5	12.0
600	0.0	107.3	105.3	9.3	9.0	11.5	11.7	59.5	58.5	83.4	81.9	13.4	13.2
	0.15	103.3	101.3	9.6	9.3	10.8	10.8	66.1	64.7	80.3	78.6	14.9	14.6
	0.30	99.3	97.3	11.6	10.3	8.5	9.4	74.8	73.2	77.0	75.4	16.9	16.5
	0.45	102.0	98.0	10.6	9.6	9.6	10.1	69.1	66.3	79.2	76.0	15.6	15.0
LSD 5%		8.1	7.6	2.1	1.5	1.8	1.4	8.2	7.8	6.2	5.9	1.7	1.3

As for salicylic acid effect, the data in the same table illustrated that, the female flowers No., LRWC and water use efficiency characters were increased compared to the control. The maximum values were noticed at 0.30 g/l salicylic acid followed with 0.45 g/l salicylic acid. On the other hand the minimum values were recorded with the control. On contrast, Male flowers No., sex ratio and electrolyte leakage were decreased by using salicylic acid. Untreated plants treatment gave the highest values while the 0.30 g/l salicylic acid recorded the lowest values of Male flowers No., sex ratio and electrolyte leakage. These results attributed to SA caused decreases

in production of 1-aminocyclopropane-1-carboxylic acid (ACC) which precursor to ethylene production in the plant (Li *et al*., 1992). Ethylene will led to the increasing of male flower number (Arfan, 2007).

Data presented in Table 4 indicate that, the interaction combinations were significant in the both seasons, the highest values of male flowers No., sex ratio and electrolyte leakage were recorded with 600 m^3/fed. water irrigation and 0.0 g/l salicylic acid, on contrast, the minimum values were recorded by using 1200 m^3/fed. water combined with foliar application of salicylic acid at 0.3 g/l. SA. On the other hand, the maximum values of water use efficiency were achieved by using 600 m^3 and 0.3 g/l salicylic acid. On contrary, the lowest values were noticed with 1200 m^3/fed. of irrigation water without salicylic acid foliar application. As for female flower and leaf relative water content the application of 1200 m^3/fed. and 0.30 g/l salicylic acid registered the maximum values in both seasons. But the minimum values were observed at 600 m^3/fed. and 0.0 g/l salicylic acid. Similar results were reported by Siamak *et al*. (2014) on chickpea, Akram *et al*. (2016) on mungbean, Metwaly and El-Shatoury (2017) on potato and Yavas and Unay (2016) on wheat.

4- Fruits yield and its components:

Data tabulated in Table 5 revealed that fruits weight and number /plant, Vit. C, TSS and total yield (ton/fed.) of cucumber were gradually decreased by decreasing irrigation levels in the two seasons except fruits DM %. The greatest values were achieved with the highest used irrigation level (1200 m^3/fed.); whoever the lowest value was noticed with the lowest used irrigation level (600 m^3/fed.). In other way, the lowest level (600 m^3/fed.) gave the maximum values of fruits DM%, but the minimum values were recorded using 1200 m^3 of irrigation water. These data could be due to water shortage resulted in increasing (ROS), Ethylene and abscisic acid, on the other hand, photosynthesis, nutritious elements, gibberellins and cytokines will decline in plants (Lahlou *et al*., 2003).

Respecting of salicylic acid, it was observed that, fruits weight and number /plant, Vit. C, TSS and total yield (ton/fed.) of cucumber in Table 5 were significantly increased in the both seasons by using salicylic acid up to 0.30 g/l then decline at 0.45 g/l. The highest values were achieved with foliar application of salicylic acid at 0.3 g/l, but the lowest values were recorded the control in the two season of this work. This enhancement in fruits weight /plant, fruits number /plant, Vit. C, TSS and total yield (ton/fed.) could be due to salicylic acid effect on increasing catalase, dismutase, peroxidase, which resulted in breakdown of ROS radicals. On contrast, SA causes decreasing of ethylene production (Li *et al*., 1992), auxin oxidation (Fariduddin *et al*. 2003), which stimulates plant growth.

Table 5. Influence of irrigation levels, salicylic acid and their interaction on fruits yield and its components of cucumber during the two seasons of 2017 and 2018.

Treatments		Fruits weight (g) / plant		Fruits No./ plant		Fruits dry matter %		Vit. C mg/100g F.W		TSS %		Total yield (ton/ fed.)	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Irrigation levels m^3/fed.													
1200		626	610	9.83	9.56	3.26	3.18	33.3	32.4	3.42	3.34	13.15	12.82
900		512	500	8.01	7.81	3.67	3.58	27.2	26.5	2.80	2.73	10.76	10.50
600		435	424	6.81	6.65	4.01	3.91	23.1	22.6	2.38	2.32	9.15	8.92
LSD 5%		61	56	0.93	0.95	0.43	0.32	3.2	2.7	0.33	0.32	1.28	1.18
Salicylic acid g/l													
0.0		465	457	7.30	7.17	3.35	3.29	24.7	24.3	2.54	2.50	9.77	9.60
0.15		503	492	7.87	7.71	3.51	3.44	26.7	26.1	2.75	2.69	10.55	10.34
0.30		581	569	9.08	8.90	3.96	3.88	30.9	30.2	3.18	3.11	12.20	11.95
0.45		550	528	8.62	8.26	3.77	3.61	29.2	28.0	3.01	2.89	11.55	11.09
LSD 5%		42	36	0.66	0.63	0.27	0.17	2.2	2.0	0.23	0.21	0.89	0.76
Interaction													
1200	0.0	537	527	8.50	8.33	3.11	3.06	28.5	28.0	2.94	2.89	11.27	11.08
	0.15	596	583	9.33	9.13	3.17	3.10	31.6	31.0	3.26	3.19	12.51	12.25
	0.30	705	691	11.03	10.80	3.49	3.42	37.4	36.7	3.86	3.78	14.80	14.51
	0.45	667	640	10.46	10.00	3.27	3.14	35.4	34.0	3.65	3.50	14.01	13.45
900	0.0	474	466	7.40	7.30	3.41	3.35	25.2	24.7	2.59	2.55	9.95	9.78
	0.15	485	475	7.60	7.43	3.58	3.50	25.7	25.2	2.65	2.60	10.18	9.98
	0.30	554	544	8.66	8.46	3.92	3.84	29.5	28.9	3.03	2.97	11.65	11.41
	0.45	536	515	8.40	8.06	3.78	3.63	28.5	27.4	2.93	2.82	11.27	10.82
600	0.0	385	378	6.0	5.90	3.53	3.47	20.4	20.1	2.10	2.07	8.08	7.94
	0.15	427	418	6.70	6.56	3.79	3.71	22.7	22.2	2.34	2.29	8.98	8.79
	0.30	483	473	7.56	7.43	4.49	4.39	25.7	25.2	2.65	2.59	10.15	9.94
	0.45	446	429	7.00	6.73	4.25	4.08	23.7	22.8	2.45	2.35	9.38	9.00
LSD 5%		73	63	1.14	1.09	0.46	0.29	3.9	3.4	0.40	0.38	1.54	1.32

Regarding the combination between irrigation levels and salicylic acid foliar treatments, the previous criteria in Table 5 were significantly affected in 1st and 2ed seasons, the biggest fruits weight and number / plant, Vit. C, TSS and total yield (ton/fed.) values were registered with 1200 m^3/fed water and 0.3 g/l salicylic acid treatment. On contrast, the minimum values were observed at 600 m^3/fed. water without salicylic acid foliar treatment. These results are in accordance with those obtained by Mahdi *et al*. (2012) on tomato; Tahereh *et al*. (2014) on mungbean; Nasrabadi *et al*. (2015) on melon; Vaisnad and Talebi (2015) on chickpea; Sahin *et al*. (2015) on cucumber.

CONCLUSION

The obtained result from the present study suggest that foliar application with salicylic acid at 0.3 g/l was the most efficient treatment, which gave the best results to alleviate the deleterious impact of shortage irrigation levels on the vegetative growth and fruits yield using 1200 m^3/fed. of irrigation water with foliar application of 0.3 g/l of salicylic was the best combination and it is recommended for cucumber under the same conditions in order to get the highest fruits yield and its chemical quality.

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تأثير حمض السالسيليك على نباتات الخيار تحت مستويات ري مختلفة

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أجرى هذا البحث بهدف دراسة تأثير الرش الورقي بحمض السالسيليك على استجابة النمو الخضري والمحصول في الخيار تحت تأثير نقص مياه الرى. وقد أجريت تجربتان حقليتان في مزرعة خاصة في مركز دكرنس، محافظة الدقهلية، مصر، في المواسم الصيفية لعامي ٢٠١٧ و ٢٠١٨، وذلك لدراسة تأثير أربع مستويات لحمض السالسيليك (٠.٠ ، ٠.١٥ ، ٠.٣٠ ، ٠.٤٥ جرام لكل لتر) وثلاثة كميات من مياه الري (١٢٠٠ ، ٩٠٠ ، ٦٠٠ م٣ / فدان) على النمو والمحصول للخيار صنف جبار. أدى نقص مياه الرى الى نقص كبير فى صفات النمو الخضرى للنبات (طول الساق، عدد الفروع، الوزن الطازج للنمو الخضرى، عدد الأوراق والمساحة الورقيه) وكذلك مكونات المحصول (وزن وعدد الثمار للنبات، فيتامين ج، المواد الصلبة الذائبة الكلية والمحصول الكلى طن/فدان). على العكس من ذلك فإن الرش الورقى بحمض السالسيليك أدى إلى تحسن كبير في هذه الصفات تحت ظروف اجهاد نقص المياه. ومع ذلك، أدت كمية الري المنخفضة للمياه إلى زيادة نسبة المادة الجافة للأوراق والثمار، والنسبة الجنسية، وكفاءة استخدام المياه. وقد أدى الإجهاد الناجم عن نقص المياه إلى انخفاض كبير في كلوروفيل أ، ب والكاروتينويد مقارنة بأعلى معدل (١٢٠٠ م^3/ فدان) وزادت هذه القيم باستخدام حمض السالسيليك. ولقد أعطى حمض السالسيليك بتركيز ٠.٣٠ جم فى اللتر أعلى محصول ثماروجودة مكوناته. من ناحية أخرى سجلت معاملة ١٢٠٠ م^3/ فدان مع ٠.٣جرام للتر أكبر القيم لمعظم الصفات السابقة.