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EFFECT OF SPRAYING SALICYLIC ACID ON GROWTH AND FRUITING OF SULTANI FIG TREES (*Ficus carica* L.).

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ABSTRACT

This study was achieved during two successive seasons (2017 & 2018). The experiment was conducted on 15 years old uniform in vigor Sultani fig trees *CV* grown in Minia Governorate (250 km southern Cairo city).The main target of this study was examining the effect of spraying Salicylic acid (SA) at 50, 100 and 200 ppm, once, twice and thrice, on growth and fruiting of Sultani fig trees under Minia Governorate conditions.

Spraying SA at 50 to 200 ppm once, twice or thrice considerably improved all vegetative growth aspects, leaf chlorophyll contents, leaf N, P, K (as %) of Sultani fig *CV* over the check treatment. However, no significant differences were observed between the two highest concentrations of SA as well as between the two or three frequencies.

Different concentrations of SA represented varying effects on yield and fruit physical and chemical characteristics of Sultani fig trees. Increasing SA concentration resulted in a gradual and significant promotion in T.S.S.%, reducing sugars %, and decreasing total acidity %. The effect was in proportional to the increase in SA frequencies from one to three times. Increasing the frequencies of application from one to three times also improved both physical and chemical properties of fruits.

The best results with regard to yield and fruit quality of Sultani fig trees grown under Minia region conditions were obtained due to treating the trees two times with SA at 100 ppm.

Key Words: Sultani Fig, Salicylic acid, Vegetative growth, NPK, fruit quality

INTRODUCTION

Fig (*Ficus carica* L.) belongs to Mouraceae family. It is considered as one of the ancient edible fruits known to mankind. *Ficus carica* originated in northern Asia Minor and spread with the Greeks and the Romans throughout the Mediterranean region. Fig fruits are consumed fresh as well as in dried form, also it can be processed into jams and wine. There are about 20 popular varieties of fig that are being grown in different parts of the world. In Egypt the most popular and famous variety is the Sultani fig "also called Poona in India", which is the subject of this study.

Fig being a deciduous sub-tropical tree prefers areas having arid or semiarid environment. The tree can survive temperature as high of 45 ^{0}C, the fruit quality deteriorates beyond 39 ^{0}C. Though the mature tree can withstand low temperature up to 4 ^{0}C, it makes good growth when the temperature is above 15 – 21 ^{0}C. The size, shape, colour of the skin and pulp quality are markedly affected by climate. Fig is one of the most salt and drought tolerant crops. Fig is a moderately important fruit crop with an annual estimated global production of one million tons of fruit of which about 30% is produced by Turkey. The other major producers are Egypt, Morocco, Greece, California, Italy, Algeria, Syria and Tunisia. In 2016, world production of raw figs was 1.05 million tonnes, led by Turkey, Egypt, and Algeria, as the three largest producers, collectively accounting for 58% of the world total.

Salicylic acid (SA) from Latin salix willow trees is widely used in organic synthesis and function as a plant hormone. It is a naturally existing phenolic compound photosynthesis and is found in plants with role in plant growth development, photosynthesis, transpiration as well as uptake and transport of nutrients photosynthetic rate, flowering, fruit yield and the response to environmental stresses (Raskin 1992; Klessing and Malamy, 1994; Hayat *et al.*, 2013; Ying *et al*., 2013 and Abd-El-Rhman and Attia 2016). SA also induces specific changes in leaf anatomy and chloroplast structure. It is involved in endogenous signaling mediating in plant defense against pathogens. It is biosynthesized from the amino acids phenylalanine (Hayat and Ahmed, 2007 and Joseph *et al.*, 2010; Youssef *et al.*, 2017 and Farag, 2019)

The overall aim of this research is to improve understanding of the influence of spraying and frequencies of spraying of SA on Sultani fig *CV* growth and fruiting under Minia governorate condition. This includes an understanding of: Effect of spraying SA and frequencies of spraying on sultani fig *CV* growth characters, leaves chemical composition, yield component and fruit quality under Minia governorate conditions.

MATERIAL AND METHODS:

The present study was conducted during two successive seasons 2017 and 2018 on thirty uniforms in vigor Sultani fig trees, grown in a private orchard located at Makossa Village,

Minia Distract Minia Governorate, 250 km southern Cairo city, where the soil texture is clay and well drained water since water table depth is not less than two meters. The chosen fig trees are 15 years and planted at 4 X 4 meters apart. Surface irrigation system using Nile water was adopted. Winter pruning was followed at the first week of January.

The chosen trees are subjected to regular horticulture practices that were commonly applied in the orchard including fertilization, (namely 60 g/tree nitrogen applied in the form of ammonium nitrate (33% N), 150 kg/fed. calcium superphosphate (15.5% P_2O_5) and 100 kg/fed potassium sulphate, as well as irrigation, hoeing and pest management.

Soil properties:

The soil where the present experiment carried out was clay soil (table 1) at Makossa village Minia Governorate. A composite sample was collected and subjected to Physical and chemical analysis according to the procedures outlined by **Walsh and Beaton (1986)**, the data are shown in Table (1).

Table (1): Physical and chemical analysis of experimental farm soil.

Constituents	Values
Sand %	7.40
Silt %	12.82
Clay %	78.49
Texture	Clay
EC (1 : 2.5 extract) mmhos / cm / 25 C	0.99
Organic matter %	2.52
pH (1: 2.5 extract)	7.6
Total CaCO3 %	1.69
N %	0.09
Available P (Olsen, ppm)	5.90
Exch. K^+ (mg/100g)	432.10
Exch. Ca^{++} (mg/100g)	22.8

Experimental work:

In order to justify the effect and the suitable dose of SA on Sultani fig trees, four doses, namely 0.0 ppm, 50 ppm, 100 ppm and 200 ppm were tested of the present experiment. Frequencies of spraying needed for each season were also examined. This study included the following ten treatments from the SA concentration and frequencies. As follow the ten treatments were arranged:

1- Control, 0.0% SA (trees sprayed with water).
2- Spraying SA at 50 ppm one time.
3- Spraying SA at 50 ppm two times.
4- Spraying SA at 50 ppm three times.
5- Spraying SA at 100 ppm one time.
6- Spraying SA at 100 ppm two times.

7- Spraying SA at 100 ppm three times.
8- Spraying SA at 200 ppm one time.
9- Spraying SA at 200 ppm two times.
10- Spraying SA at 200 ppm three times.

Each treatment was replicated three times, one tree per each. Triton B, at 0.05%, as a wetting agent was added to all SA solutions.

Experimental design:

Experiments were performed using a randomized complete Block design (RCBD), statistical analyses were performed with SPSS program (SPSS Inc., Chicago, USA). The data were analyzed by one-way ANOVA. Means of the treatments were compared using New LSD test, differences at $P<0.05$ were considered as significant.

Different measurements:

The following vegetative growth, leaf chlorophyll contents, leaf mineral contents, yield as well as physical and chemical characters of fruit were measured during the two experimental seasons.

Vegetative growth aspects:

At the first week of May during both seasons, twenty mature leaves from the medal part on the non-productive shoots were picked from each replicate (according to Ibrahim, 2010), Leaf area (cm^2) was estimated in mature fig leaves (full expended leaves). Leaf area was measured by using an area meter (Area Meter Cl, 202).

The average main shoot length (cm) was recorded as a result of measuring the length of eight shoots/tree from the four cardinal points of the tree, two shoots for each direction. The average shoot length was recorded in the end of July.

The average main shoot number/tree was recorded as a result of counting the new shoots/tree, and the average shoot number/tree was recorded in July.

Measurements of leaf chlorophyll contents:

Samples of 8 mature and fresh leaves from those located at the middle part on each shoot were taken at the middle of June during the two experimental seasons and the blades cut into small pieces and 0.5 g weight from each sample was taken, homogenized and extracted by 25% acetone in the presence of little amounts of Na_2CO_3 then filtered. The residue was washed several times with acetone until the filtrate became colorless. The extract was completed to a known volume (20 ml) with acetone 85%. A portion of this extract was taken for the determination of chlorophylls A & B and total chlorophyll calorimetrically (as mg/ 100 g F.W) and acetone (85 % V/V) was used as a blank. The optical density of the filtrate was determined at the wave length of 662 and 664 nm to determine chlorophylls A and B, respectively. Concentration of each pigment was calculated by using the following equations according to Ward and Johnston (1962).

$$\text{Chlorophyll a} = (9.784\ X\ E\ 662) - (0.99\ X\ E\ 644) = \text{mg/100g FW}$$

$$\text{Chlorophyll b} = (21.426\ X\ E\ 644) - (4.65\ X\ E\ 622) = \text{mg/100 g FW}$$

Where E= Optical density at a given wavelength.

Total chlorophyll was estimated by summation of chlorophyll a plus chlorophyll b (mg/ 100 g. F.W)

Determination of Nitrogen, Phosphorus and Potassium contents in leaves:

16 leaves picked from the medal part of 8 main shoots as described by Martin-Préval *et al.,* (1984) for each tree were taken at the middle of June during the two seasons. The blades were separated and discarded and the petioles only were saved for determining different nutrients. The petioles washed with distillated water and dried at air and oven dried and grounded, then 0.5 g weight was digested using H_2SO_4 and H_2O_2 until clear solution was obtained (Martin-Préval *et al.,* 1984). The digested solution was quantitatively transferred to 100 ml volumetric flask and completed to 100 ml by distilled water. Thereafter, contents of N, P, K for each sample were determined as follows:

Nitrogen was determined by the modified micro-kejldahl method as described by (Martin-Préval *et al.,* 1984). Phosphorus was determined by using colorimetric method, described by Walsh and Beaton (1986), by measuring the optical density of phosphor-molibdo-vanadate complex by Spectro-photometrically at wave length 430 nm. Potassium was flam-photometrically determined by using the method outlined by Walsh and Beaton (1986).

Measurement of yield as well as physical and chemical properties of fruit:

The fruits were harvested when fruits become fully colored and the T.S.S/Acid ratio in the juice of the check treatment reached 60 in the two experimental seasons (According to Ying *et al.,* 2013). The yield per tree was recorded in terms of weight (kg) and number of fruits per tree and fruit yield (kg) per tree was calculated.

From each tree, twenty fruits were randomly picked for each tree at maturation date.

The following physical and fruit characteristics were studied:

- Average fruit weight (g), by using sensitivity balance with 0.01g accuracy.
- Average fruit length without neck (cm), by using vernier caliper with 0.01cm accuracy.
- Average fruit diameter (cm), by using vernier caliper with 0.01cm accuracy.

Chemical characteristics of juice:

- Ten fruits from each replicate were randomly chosen from homogenized sample, pressed by Electric Extractor for extracting the juice after dilution at 1:1 with distilled water, the following chemical characteristics were determined:
- Percentage of total soluble solids (T.S.S %) was determined in juice obtained from each

replicate with a refractometer at 20 C, and expressed as a percentage (Brix), according to Rangana (1977).

- Percentage of total titratable acidity (TA), expressed as grams citric acid per 100 grams of juice, was determined by titration against with 0.1 N NaOH, using 1 ml diluted juice in 10 ml distilled H_2O, and the results expressed as gram citric acid/100 grams of fresh juice (%) (According to Rangana (1977).
- Percentages of total and reducing sugars in the juice were determined by using Lane and Eynone volumetric method, according to Rangana (1977).

Statistical analysis of data:

All the obtained data were tabulated and subjected for the proper statistical analysis; by analysis of variance (ANOVA) using the statistical package MSTATC Program. Comparisons between means were made by the F-test and least significant differences (New L.S.D) at p = 0.05.

RESULTS AND DISCUSSIONS:

1- Effect of salicylic acid (SA) concentration and frequencies on some vegetative growth characteristics:

Data in Table (2) show the effect of different concentration and frequencies of spraying of SA on average shoot lengths, numbers of leaves/shoot and leaf area during 2016/2017 and 2017/2018 seasons.

1-1: Effect on main shoot lengths:

Data obtained during the two experimental seasons as shown in Table (2) and fig (1) displayed that, regardless the concentration used or spraying numbers, all spray treatments with salicylic acid resulted in an increase over control for the shoot length.

The concentration and frequencies significantly influenced the shoot lengths. It is clear from the obtained data that treating Sultani fig trees once, twice, and thrice with salicylic acid at 50 ppm to 200 ppm significantly was followed by stimulating the shoot length. This stimulation was related to the increase in concentrations from 50 t0 200 ppm, and frequencies of application from once to thrice. However, increasing salicylic acid concentration from 100 to 200 ppm and its frequencies from two to thrice had no significant effects on the shoot length in the two experimental seasons. The maximum values of main shoot lengths (56.9 and 64.5 cm), in the two experimental seasons respectively, were recorded on the trees that received three sprays of salicylic acid at 200 during 2017 and 2018 seasons. Similar trend was noticed during both seasons.

1-2: Effect on leaves number/shoot:

It is clear from the data in Table (2) that increasing the SA concentration from 50 ppm to 200 ppm and frequency from one to three times have an announced and significant effect on the number of leaves/shoot.

Regarding the frequencies of spraying, the integrated treatment showed that, the trees spraying two

times with salicylic acid at 200 ppm present highest average leaves number/shoot in the second season with 17 leaf/shoot, But in the first season those sprayed three times with SA at 200 ppm present the highest average leaves number with 16 leaf/shoot. However, non-significant differences were observed neither between the two highest concentrations nor between the highest frequencies.

1-3: Effect on leaf area:

Leaf area differed significantly among SA spraying (Table 2). Increased leaf area from SA treatments were observed in all concentration used. It's clear from the data in Table (2) that increasing SA concentration had a significant effect on the leaf area. There was a gradual and significant increase of leaf area. However, non-significant differences were observed between the two highest concentrations (100 ppm and 200 ppm).

Regarding the frequencies of spraying, the integrated treatment showed that, the trees spraying three times with SA at present highest leaf area in the first season with 192.0 cm^2. However, in the second season those sprayed three times with salicylic acid at 100 ppm present the highest leaf area with 174.1 cm^2. However, non-significant differences were observed between the two highest concentrations.

The role of SA on stimulating leaf area was reported by Khalil **(**2014); Ahmed et al., (2014); Habasy (2018); Abdel-Salam (2016); Ali *et al.,* (2014 and Youssef *et al.,* (2017). The obtained results are in harmony with those obtained by: Raskin (1992); Dat *et al.,* (1998); Ahmed *et al.,* (2015); Abid Rashid *et al.,* 2017; Mohamed (2017) Youssef *et al.,* (2017) and Farage (2019).

The beneficial effect of SA on stimulation vegetative growth of Sultani fig might be attributed to its role on enhancing the photosynthesis and uptake and transport of nutrients, upon the endogenous phyto hormones specially the growth promoters, i.e. auxins, gibberellins and cytokinins (Mady, 2014) which promote cell division and cell enlargement (Hayat *et al.,* 2013 and Hayat & Ahmed, 2007), as well as enhancing tolerance of plants to biotic and abiotic stresses as well as lowering the level of oxidative stress in plants which acted as a hardening process and improving the anti-oxidative capacity of the plant and helping to induce the synthesis of productive compounds such polyamines (Raskin *et al.,* 1989; Raskin, 1992; 2001 and Mohamed 2017).

The obtained results in vegetative growth are in coincidence with those noted by Abd El-Rhman and Attia (2016), who found that foliar application of SA increased the shoot length (cm), number of leaves/shoot and leaf area (cm^2) of

Mango trees. Similar results were reported on pomegranate (Mohamed, 2017), on grapevines (Abada and Abd El-Hameed, 2010 and Ahmed *et al.*, (2010), on Orange (Kang *et al.*, 2004), on Balady mandarin (Farag 2019).

2- Effect of salicylic acid concentration and frequencies on chlorophylls content:

Change in leaf chlorophyll contents (on fresh weight basis) of Sultani fig trees in 2017 and 2018 seasons as a response of SA are shown in Tables (3). It's clear from this Table that, treating Sultani fig with SA at 50 ppm to 200 ppm significantly was very effective in enhancing chlorophylls a, b and total chlorophyll in leaves over the check treatments.

There was a gradual promotion on chlorophyll pigments with increasing SA concentration, without significant promotion occurred among the highest concentration namely 100 and 200 ppm. The maximum values of chlorophyll a and b were recorded on the trees received SA at 200 ppm. The results were true for the two experimental seasons. However, the control trees (untreated) produced the minimum values in the mature leaves. The same trained was observed in total chlorophyll contents during the two experimental seasons.

Chlorophylls a, b and total chlorophyll were varied significantly as a response to increase the frequencies of applications SA from one to three times, without significant promotion occurred among the last two frequencies (two and three times) which appeared over the control treatment. These results were true in both experimental seasons.

Chlorophyll a, b and total chlorophyll increase accompanied with increased SA concentration may be due to enhanced hormones (gibberellins and cytokinins). This is important, but it is also important that SA increase the ability of fig trees absorption of macro and micro nutrients, these elements are present in a form acceptable to plants. This leads to increase the rate of synthesis of plant pigments, as well as chlorophyll a, b and total chlorophyll.

The obtained results are in harmony with those obtained by Booth **(**1969); Chapman & Chapman (1980); Radley (1989); Whapham *et al.,* (1993); Rombola *et al.,* (2001); Durand & Metin (2004); Norrie & Keathley (2006); Abada and Abd El-Hameed (2010); Abdel-Mawgoud (2010); Benjama & Masniyom (2012); Arun *et al.,* (2014); Ali & Mohamed (2016) and Farag (2019).

Table (2): Effect of salicylic acid concentration and frequencies on vegetative growth characteristics of sultani fig *Cv.* during 2017 and 2018 seasons.

Treatments	Shoot length (cm)		Number of leaves/shoot		Leaf area(cm^2)	
	2017	2018	2017	2018	2017	2018
Control	40.0	42.2	5	6	124.6	140.9
SA at 50 ppm once	44.2	46.3	6	8	138.0	153.1
SA at 50 ppm twice	46.9	48.8	9	10	153.7	157.0
SA at 50 ppm thrice	47.1	49.6	8	10	153.5	157.4
SA at 100 ppm once	49.9	53.8	10	11	171.6	164.1
SA at 100 ppm twice	53.3	59.8	13	13	192.0	173.9
SA at 100 ppm thrice	53.9	61.2	13	13	191.4	174.1
SA at 200 ppm once	53.1	57.9	12	13	171.5	164.0
SA at 200 ppm twice	56.7	63.8	15	17	191.4	170. 7
SA at 200 ppm thrice	56.9	64.5	16	16	192.0	171.0
New LSD at 5%	3.21	1.82	1.00	0.93	19.61	2.74

Table (3): Effect of salicylic acid concentration and frequencies on leaf chlorophyll a and b content (mg/100g F.W) of sultani fig *Cv.* during 2017 and 2018 seasons.

Treatments	Chlorophyll a (mg/100g FW)		Chlorophyll b (mg/100g FW)		Total Chlorophyll (mg/100g FW)	
	2017	2018	2017	2018	2017	2018
Control	4.10	3.97	1.40	1.03	5.50	4.00
SA at 50 ppm once	5.44	5.50	1.70	1.80	6.15	6.13
SA at 50 ppm twice	5.69	5.90	2.10	2.20	6.79	6.10
SA at 50 ppm thrice	5.71	6.00	2.20	2.30	7.91	8.30
SA at 100 ppm once	6.90	6.70	2.60	2.90	9.50	9.60
SA at 100 ppm twice	7.82	7.00	2.80	3.50	10.62	10.50
SA at 100 ppm thrice	7.88	7.10	2.10	3.40	9.98	10.50
SA at 200 ppm once	7.90	7.13	2.70	3.00	10.60	10.13
SA at 200 ppm twice	8.02	7.10	3.00	3.50	11.02	10.60
SA at 200 ppm thrice	8.10	7.20	3.70	3.90	11.80	10.10
New LSD at 5%	0.199	0.384	0.195	0.199	0.451	0.474

3- Effect of different concentration and frequencies of application of salicylic acid on the percentage of N, P and K:

Table (4) show the effect of different concentrations and frequencies of application of SA on leaves content of N, P, K and Mg of Sultani fig during 2015/2016 and 2016/2017 seasons.

Subjecting Sultani one, twice or three times with a SA at 50 to 200 ppm significantly was responsible for increasing the percentage of N, P and K relative to the control treatment.

There was a gradual promotion on these nutrients with increasing the concentration and frequencies of application of SA. However, increasing concentration of SA from 100 to 200 ppm, had non-significant promotion on N, P and K nutrients.

The maximum values of N (1.97 and 2.09 %), P (0.55 and 0.57%) and K (1.78 and 1.82%) were recorded on the trees that treated with SA at 100 ppm in both experimental seasons respectively. The untreated trees produced the lowest values. Similar trend was noticed during both seasons.

It's clear from the same Table that, the spraying Sultani fig trees with SA was more effective in leaves N.P.K contents in the second season than those of the first season.

Similar results were obtained by Ngullie *et al.,* (2014) on Mango, Ahmed *et al.,* (2010) on grapevines; Siboza (2013) on lemon; Ahmed *et al.,* (2014) on pomegranates.

4- Effect of different concentrations and frequencies of application Salacylic acid on yield:

Data concerning the effect of different concentrations and frequencies of application of Salicylic acid on yield expressed in weight and number of fruit/tree as well as fruit dimension during 2017 and 2018 seasons are presented in Table (5).

It is clear from the data in Table (5) that treating the Sultani fig trees once, twice or thrice with a SA at 50 to 200 ppm significantly was accompanied with improving yield of number of fruit/tree as well as fruit dimension relative to the control treatment.

The promotion on the yield and fruit dimension was in proportional to the increase in frequencies of applications of Salicylic acid from once to thrice as well as the concentrations of SA from 50 to 200 ppm.

No significant effect on these parameter was observed among the higher two frequencies of application (twice or thrice) as well as the higher concentrations of SA 100 to 200 ppm. Therefore, from economical point of view, it is suggested to use salicylic acid twice at 100 ppm concentration.

Under such promised treatment yield expressed in kg/tree reached 48.2 and 31.6 kg during both seasons respectively. Untreated trees produced 17.5 & 17.4 kg during both seasons, respectively. The percentage of increment on the yield due to application of the recommended treating over the control treatment reached 175.4% & 80.6% during both seasons, respectively. Weight of fruit reached 73 g and 67 g in the same previous treatment during 2017 and 2018 seasons.

Table (4): Effect of salicylic acid concentration and frequencies on leaf N,P,K percentage of Sultani fig *Cv.* during 2017 and 2018 seasons.

Treatments	N (%)		P (%)		K (%)	
	2017	2018	2017	2018	2017	2018
Control	1.52	1.51	0.21	0.22	1.34	1.41
SA at 50 ppm once	1.64	1.62	0.32	0.35	1.43	1.46
SA at 50 ppm twice	1.67	1.73	0.35	0.35	1.56	1.57
SA at 50 ppm thrice	1.71	1.78	0.43	0.47	1.61	1.63
SA at 100 ppm once	1.82	1.79	0.45	0.49	1.65	1.67
SA at 100 ppm twice	1.90	1.93	0.52	0.52	1.69	1.71
SA at 100 ppm thrice	1.97	2.09	0.55	0.57	1.78	1.82
SA at 200 ppm once	1.81	1.82	0.47	0.53	1.59	1.65
SA at 200 ppm twice	188	1.92	0.52	0.55	1.64	1.69
SA at 200 ppm thrice	1.94	1.98	0.54	0.56	1.74	1.79
New LSD at 5%	0.042	0.051	0.002	0.004	0.065	0.057

Table (5): Effect of salicylic acid concentration and frequencies on numbers of fruit/tree, fruit weight and Yield/tree of sultani fig *Cv.* during 2017 and 2018 seasons.

Treatments	Fruit numbers/tree		Fruit Weight (g)		Yield (kg/tree)	
	2017	2018	2017	2018	2017	2018
Control	350.3	350	50	50	17.5	17.5
SA at 50 ppm once	400.3	400	57	57	22.8	22.8
SA at 50 ppm twice	450	440	63	59	28.4	25.7
SA at 50 ppm thrice	455	441	64	60	29.1	26.5
SA at 100 ppm once	550	456	68	63	37.4	28.7
SA at 100 ppm twice	650	466	72	66	46.8	30.8
SA at 100 ppm thrice	650	467	72	67	47.2	31.3
SA at 200 ppm once	555	457	69	65	38.3	29.7
SA at 200 ppm twice	659	467	73	66	47.1	30.8
SA at 200 ppm thrice	660	471.3	73	67	48.2	31.6
New LSD at 5%	11.432	25.235	1.635	2.232	0.947	1.573

Control trees recorded the minimum values of yield as well as fruit height and diameter (Table 6). It is worth to mention that the present treatments had no significant effect on the number of fruit/tree in the first seasons. This effect is logic, since fruiting buds were internally formed in the preceding year. Similar trend was noticed during the two experimental seasons.

5- Effect of different concentrations and frequencies of application of SA on physical characteristics of fruits:

Data concerning the effect of different concentrations and frequencies of application of SA on fruit weight and dimensions (longitudinal and equatorial) of Sultani fig during 2017 and 2018 seasons are illustrated in Table (6). It is noticed from the obtained data that all physical characteristics of the fruit were improved significantly to application and concentrations of SA. Treating the trees once, twice and thrice with a 50, 100 and 200 ppm was significantly favorable in improving fruit physical characteristics.

In relation to SA concentration and frequencies of application resulted in significant increase, in both seasons, in fruit weight and fruit dimensions over untreated trees as clearly shown in Table (6). It could be seen that, the high SA concentrations (100 and 200 ppm) and the high frequencies of application (twice or three times) were remarkable effective than those of lower SA (50 ppm) and lower frequencies (one or two times). On the line with our results, concerning the effect of SA on fruit physical properties were the findings of Raskin (1992); Kang *et al.,* (2004); Hayat and Ahmed (2007); Shakirova (2007) Ahmed *et al.*, (2010) Ahmed *et al.,* (2014); Rahmani et al., (2018) and Farag (2019).

Unfavorable effects on fruit physical characteristic were recorded on untreated vines. However, the best results with regarding berry physical properties namely fruit weight, fruit longitudinal and fruit equatorial were obtained due to spraying SA three times at 200 ppm, however non-significant were observed between the two highest concentrations and frequencies.

Improving effect of SA on physical properties of Sultani fig might be explain by its role as endogenous plant growth regulator, furthermore, SA was shown to cause changes in hormonal system associated with transitory parallel accumulation of IAA and ABA with no change in cytokinins led to enhancing fruit growth (Hayat and Ahmed, 2007; Ahmed *et al.,* 2010; Mohamed, 2012; Hayat *et al.,* 2013; Al-Barzinji *et al.,* 2016; Shakirova, 2017; Rahmani *et al.,* 2018 and Farag 2019).

6- Effect of different concentrations and frequencies of application of SA on chemical characteristics of the fruits:

Data concerning the effect of different concentrations and frequencies of application of on total soluble solids, reducing sugars and

total acidity of Sultani fig *CV* during 2017 and 2018 seasons are illustrated in Table (7).

Table (7) shows that both SA concentration and frequencies of application were capable of causing significant promotion in T.S.S and reducing sugars% in Sultani fig fruits over the control trees during the two experimental seasons. One the other hand, gradual and significant decreased in the total acidity%, in the two seasons, was observed compared with untreated trees (Table 7). The promotion on T.S.S% and reducing sugars of the berries was associated with increasing frequencies of application and concentration of SA. However, no-significant promotion was attributed to increasing frequencies of application from two to three times as well as concentrations of SA from 100 to 200 ppm. Therefore, the recommend treated in this respect was the application of SA at 100 ppm. However, unfavorable effects on berries quality were recorded on untreated trees. These results were true during both seasons. The promotion effect of spraying SA on Total soluble solids was reported by: Kang *et al.*, (2004); Abada and Abd El-Hameed (2010); Ahmed *et al.*, (2010); Hayat *et al* (2013); Ying et al., (2013); Ahmed *et al.*, (2014); Al-Barzinji *et al.*, (2016); Hayat and Ahmed (2017); Rahmani et al., (2018) and Farag (2019) on different fruits trees.

Subjecting Sultani fig trees to SA at 50 ppm to 200 ppm significantly was very effective in enhancing reducing sugar % over the check treatment. The promotion on reducing sugar was associated with increasing the concentration and frequencies of SA. However, non-significant differences were recorded neither between the two highest concentrations (100 ppm and 200 ppm) nor between the two highest frequencies (two and three times).

Total acidity was gradually decreased in the two experimental seasons parallel to the gradual increase in SA concentration or frequencies of application. It was clear that such acidity reduction was generally slight at 50 ppm SA (9.04% in the first season and 10.4% in the second season) but sharp at 200 ppm (25.7% in the first season and 32.0 % in the second season) SA concentration. However, non-significant results were observed with increasing the SA concentrations from 100 ppm to 200 ppm.

The role of spraying SA in increase the T.S.S% and Reducing sugar % and decreased the total acidity of Sultani fig fruits was illustrated by: Raskin (1992); Klessing, and Malamy (1994); Kang *et al.*, (2004); Abada and Abd El-Hameed (2010); Ahmed *et al.*, (2010); Siboza (2013); Ngullie *et al.*, (2014); Abd-El-Rahman and Attia (2016); Al-Barzinji et al., (2016); Al-Hameedawi (2016); El-Kenawy (2017); Habasy (2018) and Farag (2019) on different fruit trees specious. This improving effect of SA on chemical properties of Sultani fig might be explain by its high effect on metabolism activity, as well as enhancing hormones such as cytokinins.

Table (6): Effect of salicylic acid concentration and frequencies on fruit dimensions (height and diameter) and T.S.S % of sultani fig *Cv.* during 2017 and 2018 seasons.

Treatments	Fruit height (cm)		Fruit diameter (cm)		T.S.S. %	
	2017	2018	2017	2018	2017	2018
Control	3.61	3.66	3.52	3.49	24	23.9
SA at 50 ppm once	3.81	3.81	3.73	3.71	25	25.1
SA at 50 ppm twice	4	3.86	3.92	3.77	26	25.3
SA at 50 ppm thrice	4	3.87	3.93	3.79	26	25.4
SA at 100 ppm once	4.31	4.02	4.23	3.92	27	26
SA at 100 ppm twice	4.51	4.10	4.43	3.97	28	26.4
SA at 100 ppm thrice	4.81	4.11	4.73	4.00	27	26.5
SA at 200 ppm once	4.34	4.01	4.26	3.93	27	26.2
SA at 200 ppm twice	4.54	4.11	4.46	3.98	28	26.4
SA at 200 ppm thrice	4.81	4.12	4.39	4.01	28.3	26.2
New LSD at 5%	0.1855	0.0223	0.3499	0.00199	0.0223	0.0084

Table (7): Effect of salicylic acid concentration and frequencies on total acidity %, reducing sugars % and total sugars % of sultani fig *Cv.* during 2017 and 2018 seasons.

Treatments	Total acidity (%)		Reducing sugars (%)		Total sugars (%)	
	2017	2018	2017	2018	2017	2018
Control	0.365	0.371	18.1	18.3	21.1	21.2
SA at 50 ppm once	0.332	0.332	19.4	19.0	22.2	22.0
SA at 50 ppm twice	0.315	0.311	21.6	19.5	23.4	22.4
SA at 50 ppm thrice	0.321	0.310	22.7	19.6	23.3	22.5
SA at 100 ppm once	0.300	0.295	23.5	22.0	24.2	23
SA at 100 ppm twice	0.275	0.260	24.5	22.5	25.4	23.4
SA at 100 ppm thrice	0.277	0.258	24.9	22.6	25.7	23.5
SA at 200 ppm once	0.300	0.294	23.2	22.6	24.2	23.5
SA at 200 ppm twice	0.275	0.259	24.7	22.1	24.9	23.0
SA at 200 ppm thrice	0.271	0.252	24.8	22.7	25.1	23.5
New LSD at 5%	0.0225	0.0083	1.657	0.426	0.626	0.414

CONCLUSION:

In order to improve vegetative growth aspects, leaf mineral contents as well as yield and fruit quality of Sultani fig trees, it recommended to spray the trees with SA at 100 ppm three times/year.

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تأثير رش حامض السيلسليك على النمو والأثمار فى أشجار التين السلطانى

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أجريت هذه الدراسة خلال موسمي 2017 و2018, على أشجار التين صنف السلطانى عمرها 15 عام متماثلة فى الشكل والنمو قدر الأمكان مزروعة فى أرض طينية بمحافظة المنيا (250 كم جنوب القاهرة). وكان الهدف الرئيسي للتجربة هو أختبار تاثير الرش بحامض السلسيلك بتركيز صفر, 50, 100 و200 جزء في المليون، سواء مرة واحدة، مرتين أو ثلاث مرات، على النمو والأثمار فى أشجار التين صنف السلطانى تحت ظروف محافظة المنيا.

أدت معاملة أشجار التين السلطانى ثلاث مرات بحامض السلسليك بتركيز 200 جزء فى المليون إلى حدوث تحسن واضح في أطوال النموات الرئيسية، عدد الأوراق/الفرع، مساحة سطح الورقة وكذلك محتوى الأوراق من صبغات الكلوروفيل أ, ب والكلوروفيل الكلى. كما حدث تحسن فى محتوى الأوراق من العناصر الغذائية الرئيسية (النيتروجين، الفوسفور والبوتاسيوم) وذلك مقارنة بالأشجار الغير معاملة. وأظهرت الاوراق المعاملة بالسلسليك ثلاث مرات محتوى أعلى ومعنوى من حيث تركيبها الكيميائى عن تلك التى تم رشها مرة واحدة. فى حين لم تكن تلك الفروق معنوية بين بالأشجار التى تم رشها مرتين أو ثلاثة ولا بين تلك التى تم رشها بالتركيزين المرتفعين.

وقد أمكن الحصول على أفضل النتائج بخصوص كمية المحصول وخصائص الجودة للثمار فى أشجار التين السلطانى النامية تحت ظروف منطقة المنيا وذلك برش الأشجار بحامض السلسليك ثلاث مرات سنوياً بتركيز 100 جزء فى المليون.