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Effect of Salicylic acid Concentration and Application Times on Vegetative Growth, Seed Yield and Guaran Production of Guar (*Cyamposis tetragonoloba* L.) Plant

Abeer M. Shehata[1] and Asmaa A. Fahmy[2]

[1]*Medicinal and Aromatic Res. Dept., Institute Hort. Res., Agric. Res. Centre, Egypt.*
[2]*Hort. Dept., Fac. Agric., Zagazig Univ., Egypt.*

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ABSTRACT

This study was achieved during the two successive summer seasons of 2017 and 2018. The experiment was conducted at private farm located at Sanor village, Beni Suif Governorate (120 km southern Cairo city), Egypt .The main target of this study was examining the effect of spraying salicylic acid (SA) at 100, 200,300 and 400 ppm every concentration was applied once, twice and three times plus the control treatment on growth, seed yield guaran contents and nutritional status of guar plant grown in sandy soil under Beni Sueif Governorate conditions. Increasing SA concentration resulted in a gradual and significant promotion in all vegetative growth characteristics and seeds yield/plant and seeds yield/feddan. In addition, the guaran production remarkably and significantly increased in response of SA treatment. However, no significant differences were observed between the two highest concentrations (300 and 400 ppm of SA) as well as between the two or three frequencies. Guaran yield per plant as well as per feddan remarkably enhanced as a result of spraying SA, this increment was parallel with increasing the concentrations and number of application. Spraying SA at 100 to 400 ppm once, twice and thrice times considerably improved leaf chlorophylls content and carotenoids contents as well as leaf N, P, K and Mg % of guar plants over the control treatment. Generally, the positive effect of SA was in proportional to the increase the frequencies of application from one to three times.

***Keywords*:** Guar plant, Salicylic acid, Vegetative growth, Seed yield, Guaran content.

Introduction

Guar or cluster bean plant *(Cyamopsis tetragonoloba*, L.) an annual summer adapted well to arid and semi-arid climatic zones (Thakure, 1975). It is also known as saline and drought resistant plant. It belongs to Family leguminosae (Vinizky and Ray, 1988). The major world suppliers are Pakistan, India and United States, with smaller acreages in Australia and Africa (Jackson and Doughton, 1982 and Undersander *et al.*, 1991). The plant is used as a vegetable and cattle feed as well as a green manure. Guar is known and grown in Egypt as a forage crop. Primarily, its green manure and seed production have considered as animal nutritive substances as its protein content 16 %. Recently, the interest of guar plant has extended to be using as a source of galactomannan (guaran) gum.

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, seed yield and the response to environmental stresses (Raskin 1992; Klessing and Malamy, 1994; Yazdanpanah *et al.,* 2011; 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 (Youssef *et al.,*2005; Hayat and Ahmed, 2007; Hayat *et al.,* 2010 and Joseph *et al.,*2010)

The overall aim of this research is to improve understanding of the influence of concentrations and spraying frequencies of SA on guar plant vegetative growth, seed yield and guaran production as well as nutritional status under sandy soil at Beni Suief Governorate conditions.

Material and Methods:

These field trails were carried out during the two successive seasons of 2017 and 2018 at a private farm located at Senor Village, Beni Souif Distract, Beni Souif Governorate, Egypt, to study the effect

Corresponding Author: Abeer M. Shehata, Medicinal and Aromatic Res. Dept., Institute Hort. Res., Agric. Res. Centre, Egypt.

of SA treatments as a foliar application on the vegetative growth, yield and yield components, guaran production and chemical constituents of guar (*Cyamopsis tetragonoloba*, Taub) plants grown at sandy soil.

Experimental work:

Guar seeds of guar plant were sown on March 15th in the first and second seasons. The experimental unit (plot) was 2.00 × 2.40 meters and included 5 rows, 50 cm apart and seeds were sown in hills, 30 cm apart on one side of the row, therefore, each plot contained 21 hills and plants were thinned to one plant/hill after one month from sowing date.

In order to justify the effect and the suitable concentration of SA on guar plant, five concentrations, namely 0.0, 100, 200, 300 and 400 ppm were tested of the present experiment. Frequencies of spraying (once, twice and thrice times) needed for each season were also examined. This study included the following thirteen treatments from the SA concentration and application times:

1- Control, 0.0 ppm of SA (plants sprayed with tap water).
2- Spraying SA at 100 ppm one time.
3- Spraying SA at 100 ppm two times.
4- Spraying SA at 100 ppm three times.
5- Spraying SA at 200 ppm one time.
6- Spraying SA at 200 ppm two times.
7- Spraying SA at 200 ppm three times.
8- Spraying SA at 300 ppm one time.
9- Spraying SA at 300 ppm two times.
10- Spraying SA at 300 ppm three times.
11- Spraying SA at 400 ppm one time.
12- Spraying SA at 400 ppm two times.
13- Spraying SA at 400 ppm three times.

Each treatment was replicated three times, one basin surface 2.00 × 2.40 meters each replicate. Triton B, at 0.05%, as a wetting agent was added to all SA solutions.

Experimental design: These experiments were performed using a randomized complete Block design (RCBD).

Experimental field soils: Table (A) shows some of the physical and chemical analysis of the experimental used soil according to (Buurman *et al.,* 1996 and Walsh and Beaton, 1986).

Table (A): Physical and chemical analysis of experiment soil

Physical analysis			
Sand %	78.40	**Silt %**	14.82
Clay %	7.49	**Texture**	Sandy
Chemical analysis			
EC (1 : 2.5 extract) mmhos / cm / 25 C	0.95	**Organic matter %**	2.62
pH (1 : 2.5 extract)	7.8	**Total $CaCO_3$ %**	1.79
N %	0.09	**Available P (Olsen, ppm)**	6.10
Exch. K^+ (mg/100g)	422.10	**Exch. Ca^{++} (mg/100g)**	20.8

The plants were harvested on the fourth week of September in both experimental seasons.

Different measurements:

The following vegetative growth, yield components and guaran production and plant pigments as well as leaf mineral content, were determined during the two experimental seasons.

Vegetative growth characteristics:

Plant height (cm), number of branches/plant, leaf area (cm^2), shoot fresh weight/plant (g) and shoot dry weight/plant (g) were estimated.

Yield and yield components:

At harvest stage number of pods/plant, number of seeds/5 pods, seed yield/plant (g) and seed yield/feddan (kg) were determined.

Guaran production:

Guaran percentage was determined in cluster bean seeds according to the method described by Anderson (1949). Total guaran yield/plant (g) was calculated by multiplying guaran percentage by yield of seeds/plant. Yield of guaran /fad. (kg) was calculated by multiplying the guaran yield per plant by number of plants/feddan for each treatment.

Leaf pigments:

Samples weight of 0.5 g fresh leaves from the middle of branches (after three weeks the last treatment in both seasons) were taken to determine the contents of photosynthetic pigments namely; chlorophyll a, b and carotenoids as mg/100g fresh weight, by using the spectrophotometer (AOAC, 1984).

Determination of N, P, K and Mg in leaves:

Eight mature leaves located at middle part of main branches for each plant were taken at the middle of June during the two seasons. However, N, P, K and Mg percentages were analyses according to AOAC (1984).

Statistical analyses:

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 according to Snedecor and Cochran (1990).

Results and Discussions

Vegetative growth characteristics

Data obtained during the two experimental seasons as shown in Table (2) displayed that, regardless the concentration used or frequencies of spraying, all spray treatments with SA resulted an remarkable increase over control for the plant height (cm) number of branches per plant and leaf area (cm^2). It is clear from the obtained data that treating guar plants once, twice, and thrice with SA at 100 ppm to 400 ppm significantly was followed by stimulating the abovementioned parameters of plants compared to control, in most cases.

Table 2: Effect of salicylic acid concentration and frequencies on plant height (cm), number of branches/plant and leaf area (cm^2) of guar plants during 2017 and 2018 seasons

Treatments	Plant height (cm)		Number of branches/plant		Leaf area (cm^2)	
	2017	2018	2017	2018	2017	2018
Control	105.5	107.3	7.3	7.1	25.3	26.1
SA at 100 ppm once	109.2	111.5	8.1	8.9	25.4	25.4
SA at 100 ppm twice	114.7	116.9	9.2	9.7	26.8	27.1
SA at 100 ppm thrice	119.2	120.2	10.1	10.7	27.2	27.8
SA at 200 ppm once	109.6	112.5	9.4	10.3	26.9	27.3
SA at 200 ppm twice	119.3	120.2	12.2	14.1	27.9	28.2
SA at 200 ppm thrice	121.7	122.5	13.1	14.9	28.3	28.8
SA at 300 ppm once	136.3	137.5	14.9	15.7	29.1	29.7
SA at 300 ppm twice	141.7	144.8	16.8	16.9	31.5	31.5
SA at 300 ppm thrice	143.1	146.1	16.7	17.3	32.1	32.6
SA at 400 ppm once	137.2	138.9	15.1	15.6	31.5	31.9
SA at 400 ppm twice	142.3	144.1	16.2	16.4	32.0	32.5
SA at 400 ppm thrice	144.9	145.2	16.7	17.2	33.9	33.1
New LSD at 5%	**4.21**	**5.77**	**2.11**	**1.99**	**1.01**	**0.99**

However, increasing salicylic acid concentration from 300 to 400 ppm and its frequencies from two to three had significant effects on the plant height during the two experimental seasons. The maximum values of average plant height (144.9 and 145.2 cm), in the two experimental season respectively, were produced by the plants that received three sprays of salicylic acid at 400 ppm during both seasons.

Regarding the frequencies of spraying, the integrated treatment showed that, the plants spraying two times with salicylic acid at 300 ppm recorded the highest average number of branches/plant in the first season with 16.8 branch/plant (Table 2). While, in the second one those sprayed three times with SA at the same concentration present the highest average leaves number with17.3 branch/plant. Furthermore, the integrated treatment showed that, the plants received three sprays with SA at 400 ppm produced the highest leaf area in the first season with 33.9 and 33.1 cm^2 during the two experimental seasons respectively. In general, non-significant differences were observed between the two highest concentrations.

Data concerning the effect of different concentrations and frequencies of application of salicylic acid on fresh and dry weights of shoots/plant during 2017 and 2018 seasons are presented in Table (3). It is clear that treating guar plants once, twice or thrice with SA at 200 to 400 ppm significantly was accompanied with improving fresh and dry weight of shoots relative to the control treatment.

Table 3: Effect of salicylic acid concentration and frequencies on vegetative growth characteristics of guar plants during 2017 and 2018 seasons

Treatments	Shoot fresh weight/plant (g)		Shoot dry weight/plant (g)	
	2017	2018	2017	2018
Control	251.5	254.4	113.2	114.4
SA at 100 ppm once	252.2	257.6	114.6	115.9
SA at 100 ppm twice	259.1	269.1	116.6	121.1
SA at 100 ppm thrice	266.2	271.8	119.8	122.3
SA at 200 ppm once	261.3	277.4	121.1	127.6
SA at 200 ppm twice	269.4	289.3	123.9	132.9
SA at 200 ppm thrice	272.5	291.1	125.4	133.9
SA at 300 ppm once	331.1	337.7	155.6	158.7
SA at 300 ppm twice	345.1	351.9	162.2	165.4
SA at 300 ppm thrice	349.2	355.4	164.1	167.1
SA at 400 ppm once	335.1	341.3	157.5	160.4
SA at 400 ppm twice	348.3	355.2	163.7	166.9
SA at 400 ppm thrice	351.1	359.1	165.1	168.8
New LSD at 5%	**3.99**	**4.67**	**5.11**	**4.16**

The maximum values of fresh weight and dry weigh (g) of shoot/plant (351.1 and 359.1 g) and (165.1 and 168.8 g) were produced by the plants treated with SA at 400 ppm in both experimental seasons respectively. Contrary, the untreated plants produced the lowest values (251.5 and 254.4 for fresh weight as well as 113.2 and 114.4 g for dry weight) respectively. Similar trend was noticed during both seasons. It is worth to mention that, neither increasing SA concentration from 300 ppm to 400 ppm nor the frequencies of application from two to three times cause a significant increment in fresh or dry weight of shoot/plant.

The beneficial effect of SA on stimulation vegetative growth of Guar plant 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 (Khan *et al*., 2014) which promote cell division and cell enlargement (Fariduddiun *et al*., 2003; Hayat and Ahmed, 2007 and Shehata 2009 and 2013), 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; Ding *et al.,* 2001 and Mohamed, 2017).

The obtained results in vegetative growth are in coincidence with those noted by Hayat *et al*., 2005 and Hayat *et al.,* 2010 they found that foliar application of SA increased the plant height (cm), number

of branches/plant and leaf area (cm^2) ofplants. Similar results were reported by Afshari *et al.,* (2013); Ali and Mahmoud (2013) and Ibrahim (2019) on different plants species.

Yield and yield components:

Data concerning the effect of different concentrations and frequencies of application of SA on seed yield components (number of pods/plant, number of seeds/5 pods, weight of 100 seeds and seed yield/feddan) during 2017 and 2018 seasons are presented in Table (4). Moreover, treating guar plants once, twice or thrice times with a SA at 100 to 400 ppm significantly was accompanied with improving seeds yield (kg/feddan) as well as yield components, rather than control treatment. However, no significant effect on these parameter was observed between the higher two frequencies of application (twice or thrice) as well as the higher concentrations of SA (300 and 400 ppm).

Therefore, from economical point of view, it is suggested to use salicylic acid twice at 300 ppm concentration. Under such promised treatment yield expressed in kg/feddan reached 378.66 and 413.61(kg) during both seasons respectively. Untreated plants produced the lowest yield 106.70 and107 kg during both seasons, respectively. However, weight of 100 seeds reached 3.38 g and 3.39 g in the same previous treatment during 2017 and 2018 seasons. On the other hand, control plants recorded the minimum values of the weight of number of pods/plant, number of seeds/5 pods, weight of 100 seeds as well as yield/feddan expressed in kg (Table 4).

A significant increase in the activity of nitrate reductase (NR) was observed both in roots and leaves of the plants spraying with 5 - 10 M concentration of salicylic acid (Hayat *et al.*, 2005). Such a lower concentration of SA when sprayed to the foliage of mustard plants enhanced their NR activity (Fariduddin *et al*. 2003)

Table 4: Effect of salicylic acid concentration and frequencies on number of pods/plant, number of seeds/ 5 pods, weight of 100 seeds and seed yield/feddan of guar plants during 2017 and 2018 seasons

Treatments	Number of pods/plant		Number of seeds/5pods		Weight of 100 seeds (g)		Seeds yield/fed. (kg)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	51.5	53.9	19.5	19.3	2.81	2.79	106.70	107.9
SA at 100 ppm once	65.6	71.1	19.9	19.8	2.82	2.86	137.29	147.68
SA at 100 ppm twice	73.3	77.1	20.1	21.2	2.94	2.99	159.20	179.60
SA at 100 ppm thrice	75.7	79.2	20.3	21.3	2.97	3.01	169.96	186.62
SA at 200 ppm once	99.3	102.0	20.7	20.8	2.89	2.93	218.31	228.44
SA at 200 ppm twice	109.7	115.3	22.9	22.8	3.02	3.11	278.79	300.47
SA at 200 ppm thrice	110.4	115.4	23.2	23.1	3.09	3.17	290.88	310.52
SA at 300 ppm once	98.8	99.1	21.7	22.5	3.11	3.15	245.04	258.09
SA at 300 ppm twice	118.8	119.2	22.4	23.9	3.38	3.39	347.54	369.94
SA at 300 ppm thrice	120.8	126.4	24.1	24.5	3.41	3.44	363.64	391.72
SA at 400 ppm once	106.5	109.1	23.9	23.6	3.29	3.21	307.77	303.71
SA at 400 ppm twice	120.4	126.9	24.1	24.8	3.42	3.44	364.67	397.84
SA at 400 ppm thrice	125.1	130.7	24.3	24.9	3.48	3.50	378.66	413.61
New LSD at 5%	**5.31**	**4.81**	**0.99**	**1.01**	**0.041**	**0.043**	**36.21**	**37.31**

Increasing the number of pods/plant as well as number of seeds/pod might be due to better photosynthetic leading to proper supply of carbohydrates to the flowers and pods (Hayat and Ahmed 2007 and Hayat *et al.,* 2005). The previous discussion may be explained the enhancement of yield and its parameters of guar plants as a result of increasing the concentration of salicylic acid and its frequencies of application.

Guaran production:

Data concerning the effect of different concentrations and frequencies of application of SA on the yield of guaran [guaran percentage in dry seeds, guaran yield/plant (g) and guaran yield/feddan (kg)] of guar plants grown under sandy soil during 2017 and 2018 seasons are illustrated in Table (5). It is noticed from the obtained data that guaran yield/feddan (kg) and its components were improved significantly as a result of application SA at different concentrations. Treating the plants once, twice

and thrice times with a 100, 200, 300 and 400 ppm was significantly favorable in improving guaran yield in both experimental seasons, in most cases. It could be seen that, the higher SA concentrations (300 and 400 ppm) and the high frequencies of application (twice or thrice) were remarkable effective than those of lowers SA concentrations (100 and 200 ppm) and lower frequencies of application (one time).

Unfavorable effects on guaran yield and its components were recorded on untreated plants. However, the best results with regarding guaran% in dry seeds, guaran yield/plant and guaran yield/feddan were obtained due to spraying SA three times at 400 ppm, also, non-significant were observed between the two highest concentrations (300 & 400 ppm) and frequencies (two and three times).

On the line with our results, concerning the effect of SA on guaran yield and its components were the findings of Shehata (2013); Afshari *et al.,* (2013); Ali and Mahmoud (2013) and Ibrahim (2019) on varying plants.

Table 5: Effect of salicylic acid concentration and frequencies on guaran percentage and yield/plant (g) and /feddan (kg) of guar plants during 2017 and 2018 seasons

Treatments	Guaran percentage		Guaran yield/plant (g)		Guaran yield/fed. (kg)	
	2017	2018	2017	2018	2017	2018
Control	10.22	10.60	0.89	0.91	16.33	16.72
SA at 100 ppm once	10.45	11.82	1.09	1.11	20.03	20.40
SA at 100 ppm twice	12.01	13.11	1.38	1.35	25.36	24.81
SA at 100 ppm thrice	12.44	13.81	1.45	1.49	26.64	27.38
SA at 200 ppm once	12.69	13.94	1.67	1.75	30.69	32.16
SA at 200 ppm twice	14.81	14.96	1.99	2.13	36.57	39.14
SA at 200 ppm thrice	14.99	15.29	2.06	2.20	37.85	40.43
SA at 300 ppm once	13.77	14.21	2.12	2.28	38.96	41.89
SA at 300 ppm twice	14.91	15.81	2.79	2.78	51.27	51.08
SA at 300 ppm thrice	15.42	16.01	2.77	2.89	50.90	53.10
SA at 400 ppm once	15.01	15.21	2.41	2.41	44.28	44.29
SA at 400 ppm twice	15.78	15.67	3.01	3.05	55.31	56.04
SA at 400 ppm thrice	15.82	15.89	3.08	3.11	56.59	57.15
New LSD at 5%	**0.33**	**0.41**	**0.28**	**0.32**	**2.01**	**2.31**

Leaf pigments:

Change in leaf chlorophyll contents (on fresh weight basis) of guar plants in 2017 and 2018 seasons as a response of SA are shown in Table (6). It's clear from this Table that, treating guar plants with SA at 100 ppm to 400 ppm significantly was very effective in enhancing chlorophylls a, b and total carotenoids content (mg/g as fresh weight) in leaves rather than the check treatment. There was a gradual promotion on chlorophyll and total carotenoids pigments with increasing SA concentration, without significant promotion occurred among the highest concentration of SA namely 300 and 400 ppm. The maximum values of chlorophyll a were recorded on the plants received three sprays of SA at 400 ppm. The results were true for the two experimental seasons. On the other hand, the control plants (untreated) produced the minimum values of chlorophyll a & b and total carotenoids duringthe two experimental seasons.

Chlorophyll a and b and total carotenoids 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 guar plant 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 carotenoids.

This positive effect of SA was attributed to the enhancement of CO_2 assimilation, chlorophyll concentration, photosynthetic rate and increased mineral up take by stressed plants treated with SA (Karlidag *et al*., 2009). Also, Abdelkader and Hamad (2014), on roselle, detected that foliar application of salicylic acid increased total chlorophyll content (a+b) content of leaves.

Table 6: Effect of salicylic acid concentration and frequencies on leaf pigments "chlorophyll a, chlorophyll b and total carotenoids" (mg/g as F.W) of guar plants during 2017 and2018 seasons

Treatments	Chlorophyll a (mg/g F.W)		Chlorophyll b (mg/g F.W)		Total carotenoids (mg/g F.W)	
	2017	2018	2017	2018	2017	2018
Control	2.09	2.08	0.69	0.68	0.719	0.742
SA at 100 ppm once	2.13	2.15	0.72	0.71	0.793	0.811
SA at 100 ppm twice	2.29	2.29	0.79	0.81	0.835	0.856
SA at 100 ppm thrice	2.31	2.32	0.81	0.84	0.882	0.891
SA at 200 ppm once	2.31	2.38	0.79	0.79	0.847	0.838
SA at 200 ppm twice	2.42	2.45	0.88	0.89	0.898	0.896
SA at 200 ppm thrice	2.51	2.50	0.91	0.92	0.902	0.917
SA at 300 ppm once	2.41	2.45	0.83	0.85	0.886	0.874
SA at 300 ppm twice	2.59	2.61	0.96	0.97	0.968	0.972
SA at 300 ppm thrice	2.61	2.65	0.98	0.98	0.969	0.991
SA at 400 ppm once	2.44	2.49	0.85	0.84	0.928	0.937
SA at 400 ppm twice	2.61	2.63	0.97	0.98	0.956	0.963
SA at 400 ppm thrice	2.64	2.69	0.99	0.98	0.974	0.990
New LSD at 5%	**0.099**	**0.089**	**0.061**	**0.057**	**0.019**	**0.012**

Leaf mineral contents:

Table (7) show the effect of different concentrations and frequencies of application of SA on guar leaves content of N, P, K and Mg percentages during 2017 and 2018 seasons. Subjecting guar plants one, twice or three times with a SA at 50 to 200 ppm significantly was responsible for increasing the percentage of N, P, K and Mg relative to the control treatment. There was a gradual promotion on these nutrients with increasing the concentration and frequencies of application of SA from 100 to 400 ppm. While, increasing concentration of SA from 300 to 400 ppm, had non-significant promotion on the four macronutrients.

Table 7: Effect of salicylic acid concentration and frequencies on N, P, K and Mg (%) of guar plants during 2017 and 2018 seasons

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Magnesium (%)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	1.49	1.48	0.22	0.21	1.39	1.41	1.22	1.24
SA at 100 ppm once	1.51	1.50	0.30	0.29	1.39	1.42	1.31	1.32
SA at 100 ppm twice	1.55	1.57	0.35	0.36	1.43	1.44	1.33	1.34
SA at 100 ppm thrice	1.58	1.58	0.38	0.37	1.44	1.44	1.35	1.35
SA at 200 ppm once	1.58	1.57	0.35	0.36	1.44	1.43	1.35	1.36
SA at 200 ppm twice	1.63	1.66	0.38	0.39	1.47	1.46	1.39	1.38
SA at 200 ppm thrice	1.65	1.68	0.39	0.39	1.48	1.48	1.41	1.41
SA at 300 ppm once	1.77	1.78	0.36	0.36	1.45	1.46	1.40	1.42
SA at 300 ppm twice	1.79	1.81	0.42	0.43	1.50	1.50	1.49	1.48
SA at 300 ppm thrice	179	1.86	0.43	0.42	1.51	1.53	1.47	1.47
SA at 400 ppm once	1.79	1.83	0.37	0.38	1.46	1.46	1.41	1.42
SA at 400 ppm twice	1.82	1.84	0.38	0.39	1.51	1.50	1.46	1.47
SA at 400 ppm thrice	1.82	1.87	0.41	0.41	1.52	1.52	1.47	1.47
New LSD at 5%	**0.088**	**0.091**	**0.043**	**0.055**	**0.041**	**0.039**	**0.064**	**0.052**

The maximum values of N (1.82 and 1.87 %), and K (1.52 and 1.1.52 %) were recorded on the plants treated with SA at 400 ppm in both tested seasons, respectively. However, the plants received two

sprays from SA at 300 ppm present the highest phosphorus (0.42 and 0.43%) and magnesium (1.49 and 1.48 %) levels. Contrary, the untreated plants produced the lowest values in the four macro elements. Similar trend was noticed during both seasons.

Many studies confirm the effect of salicylic acid on mineral nutrients uptick and accumulations in leaves by several explained. The exogenous salicylic acid affects the activities of the enzymes of nitrate/nitrogen metabolism as well. A significant increase in the activity of nitrate reductase was observed both in roots and leaves of the plants spraying with 5 - 10 M concentration of salicylic acid (Hayat *et al.*, 2005 and Hayat *et al.,* 2010). Such a lower concentration of SA when sprayed to the foliage of mustard plants enhanced their NR activity (Fariduddin *et al*., 2003). These results also found by Dawood *et al*. (2012) on sunflower, Abdul Qudos (2015) on pepper and El-Beltagi *et al*. (2017) on cotton.

Conclusion

In order to improve vegetative growth aspects, seed yield and guaran content as well as leaf mineral contents of guar plant grown under sandy soil, it recommended to spray the plants with SA at 300 ppm three times/year.

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