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PHYSIOLOGICAL RESPONSE OF COTTON PLANT TO FOLIAR APPLICATION WITH CITRINE AND CITRIC ACID

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Abstract

Two field experiments were carried out at Gemmiza Research Station Gharbia Governorate during 1996 and 1997 seasons to study the effect of citrine (containing 15% citric acid and 18% micro elements Ferrous, Manganese and Zinc) compound and citric acid on cotton plants cv. Giza 75. Citrine treatments were at two rates, i.e. one and two L/ fed. and citric acid treatments were at three rates, 200, 300 and 400 ppm Cotton plants were sprayed once at start of flowering or twice, at start of flowering and after 15 days from the first spray. The results showed that one spray of citrine or citric acid increased significantly plant height and number of fruiting branches per plant in one season only. one or two sprays did not affect boll weight. In general all, treatments significantly increased seed index in one season while, lint percentage was not significantly affected in both seasons. Earliness of yield and seed cotton yield were significantly affected. Various concentrations of citrine or citric acid had a significant effect on fiber properties in both seasons.

In cotton leaves, all chlorophyll forms i.e., chlorophyll a, b and total chlorophyll increased significantly by spraying these compounds either once or twice. The hgihest levels of reducing sugars and total soluble sugars were observed when 300 ppm citric acid was used once or twice. Two sprays of these compounds seemed to increase slightly the phenolic compounds such as polyphenols and total phenols. Seed oil percentage was significantly affected by treatments in both seasons.

INTRODUCTION

Two newly available organic chemicals to the cotton researchers are citrine [15% citric acid + 18 % microelements (Ferrous, Manganese and Zinc) + 64% organic materials] and citric acid.

Citric acid is one of the organic acids presented in tricarboxilic acid cycle or malic acid conversion to citric acid (Miernyk and Trelease, 1981). Growth of cotton, corn, bean, pea, and sunflower increased by organic acids external treatment especically succinic, citric and malic acids (Malikd Singh, 1982 and Nofal *et al.*, 1990). Ahmed *et al.*, (1998), reported that the application of 1% ascobine and 0.6% citrine to apple trees increased yield , fruit weight, total soluble solids and total sugars while, reduced the total acidity.

On the other hand, the presence of high-energy compounds in the cell such as phosphoenal pyruvate (PEP), ATP, 6-phosphogluconic acid and citric acid means that the cell is rich in energy. In other words, when the concentration of these compounds is high, the oxidation of carbohydrates via glycolysis is switched off where glycolysis becomes the key metabolic component of the respiratory process which generates energy in the form of ATP in the cells where photosynthesis is not taking place (Goodwin and Mercer, 1985).

Further studies are needed to elucidate the effect of these compounds on cotton plants as they may enhance cotton productivity while at the same time they are safe to environment and human. Thus, this study aimed at studying the response of cotton plants Giza 75 cultivar to citrine and citric acid application during flowering period.

MATERIALS AND METHODS

This investigation was carried out at Gemmiza Research Station, Gharbia Governorate during two successive seasons (1996 and 1997). Seeds of Giza 75 cv. were sown on April 1st and 27th March for 1996 and 1997 seasons respectively.

Citrine compound [15% citric acid+18% microelements (6% Fe. + 6% Mn + 6% Zn) + 64 % organic materials] - a product of the General Organization of Balance Agriculture Fund, at two rates of 1 and 2 L/F and citric acid (authentic) at three rates of 200, 300 and 400 ppm /F, sprayed either once at start of flowering or twice; at start of flowering and after 15 days from the first spray. Control treatments were sprayed by tap water. Each plot consisted of five rows, four meters long. 60 cm. apart and the distance between hills was 20 cm. All cultural practices for cotton plants were carried out as recommended for Giza 75. A complete randomized blocks design in a factorial arrangement, with four replications was used, with a plot area of 12 m^2. The characters studied were:

Plant growth and fruiting characters:

Five plants were collected randomly, from each plot after 30 days from the first spray to study the vegetative and fruiting characters i.e., plant height, number of fruiting branches/plant (symbodial branches) and number of total bolls/plant.

Yield and yield components:

At the end of the season, average of boll weight, seed index, lint percentage, earliness for yield percentage and seed cotton yield in kentar/feddan were determined.

Fiber properties:

Micronaire reading and Pressley index (fiber strength) were tested and estimated at cotton Technology Research Division, Giza, according to the method of testing A.S.T.M., (1967).

Chemical analysis:

Fresh leaves from the main stem on the fourth node from the apex were taken at random after 30 days from the first spray to determine the following chemical constituents in 1997 season. Chlorophyll a, b and total Chlorophyll (Arnon, 1949), Carotenoids (Rolbelen, 1957), total soluble sugars (Smith *et al.*, 1956), reducing sugars (A.O.A.C. 1965), total phenols (Simons and Ross, 1971) Polyphenols (A.O.A.C. 1965), and Seed oil percentage (A.O.A.C. 1966)

The data were subjected to statistical analysis as shown by Snedecor and Chochran (1967). Comparisons between means were further tested using the L.S.D. at 5% probability level.

RESULTS AND DISCUSSIONS

Plant growth and fruiting characters:

1. Plant height:

The data in Table 1 showed that height was significantly affected by number of sprays, chemical concentration and their interaction only in 1996 season, while in 1997 season, the effect of chemical concentration only exerted a significant influence. The data in 1996 season, revealed that plants which were sprayed one time with such chemicals were taller than those twice. The tallest plants (187.3 cm) were obtained when citrine was applied at the rate of one litre/feddan, while citric acid produced shorter plants as compared to the control. For the interaction, the data showed that the tallest plants were obtained from plants given one spray with citrine at a rate of one litre/fed. On the other hand, the data in 1997 season revealed that plants treated with citrine at the rate fo two litre/fed. produced taller plants as compared to the other treatments.

Table A. Soil analysis of Gemmiza Research Station in 1996 and 1997 seasons. (according to Richard, 1969).

Soil unit	Scason 1996	Scason 1997	Critical levels
Texture	Clay	Clay	
pH	7.5	7.65	
EC (mmhos Cm 25°C)	3.3	1.60	
N (ppm)	20.7	21.7	25
P (ppm)	18.6	3.6	9
K (ppm)	585	414	300
Fe (ppm)	9.5	10.7	20
Mn (ppm)	12.4	4.8	18
Zn (ppm)	1.55	1.25	0.8
Cu (ppm)	0.75	0.69	0.5

2. Number of fruiting branches/plant:

In 1996 season, the number of fruiting branches was higher in plants received one spray as compared to those which received two sprays, while the application of citrine at a rate of one L/fed. was more effective in increasing this trait . For the interaction, the data showed that the highest value (25.7) was obtained for plants sprayed one time with citrine at a rate of two L/fed. The data in 1997 season revealed also that the application of citrine at the rate of two L/fed. produced the highest value (21.7) as compared to citric acid Nehra *et al.*, (1987) and Nishikimi (1975), obtained similar results.

3. Number of total bolls/plant:

The data revealed that the application of citrine and /or citric acid concentrations and their interactions with number of sprays was significant only in 1996 season. The results showed that the highest value of total bolls/plant (34.2) was obtained when plants were sprayed with citric acid at the concentration of 300 ppm. For the interaction the data indicated that plants sprayed one time with citric acid at the con-

Table 1. Effect of citrine and citric acid on the development and growth characters of cotton plant after 30 days from the first spray in 1996 and 1997 seasons.

Treatments		Plant height (cm)		No. fruiting branches/plant		No. total bolls/plant	
		1996	1997	1996	1997	1996	1997
Control		176.7	156.7	22.2	18.3	29.9	28.0
One spray							
Citrine	1L/fed	192.1	161.7	25.6	20.0	30.4	29.3
	2L/fed	190.4	168.6	25.7	21.6	31.3	30.2
Citric acid	200 ppm	155.4	168.3	20.1	21.0	33.9	30.5
	300 ppm	162.5	161.7	20.8	20.8	34.3	31.8
	400 ppm	157.9	158.9	20.3	21.2	32.7	31.4
Mean		172.5	162.7	22.5	20.48	32.08	30.20
Two sprays:							
Citrine	1L/fed	182.5	163.3	24.8	20.0	32.0	29.2
	2L/fed	165.8	166.9	22.0	21.8	31.5	29.8
Citric acid	200 ppm	156.7	161.7	20.3	20.7	31.8	30.7
	300 ppm	164.1	160.0	21.0	20.8	34.0	31.4
	400 ppm	156.7	161.5	20.5	20.6	33.3	30.8
Mean		167.1	161.7	21.8	20.37	32.08	29.98
Average							
Citrine	1L/fed	187.3	162.5	25.2	20.0	31.2	29.3
	2L/fed	178.1	167.8	23.9	21.7	31.4	30.0
Citric acid	200 ppm	156.1	165.0	20.2	20.9	32.9	30.6
	300 ppm	163.3	160.8	20.9	20.8	34.2	31.6
	400 ppm	157.3	160.2	20.4	20.9	33.0	31.1
L.S.D. (0.05)							
Sprays		3.95	N.S.	0.44	N.S	N.S.	N.S.
Treatments		6.84	4.04	0.77	0.99	1.6	N.S.
Interactions		9.67	N.S.	1.08	N.S.	2.3	N.S.

centration of 300 ppm had the highest value. In general all chemicals applied tended to increase number of total bolls as compared to the control. Similar results were demonstrated by Nehra et al., (1987) and Nishikimi (1975).

Yield and yield components:

1. Boll weight:

The data in Table 2 show that boll weight was significantly affected by chemical treatments and their interaction with number of sprays in both seasons. It is clear from these data that the application of citric acid at a rate of 200 ppm had the highest value of boll weight in both seasons. For the interaction, the results showed that the highest value of boll weight (3.42 gm) in 1996 season was obtained from the application of citric acid at the concentrations of 200 and 400 ppm sprayed once and twice respectively, while in 1997 season, the heaviest bolls (3.43 gm) were obtained from the application of citric acid sprayed once at a concentration of 200 ppm.

2. Seed index:

Seed index as shown in Table 2 was significantly affected by chemical treatments and their interaction with number of sprays only in 1996 season. In general, the highest value of seed index (11.40 gm) was obtained when citric acid was applied at a rate of 200 ppm. For the interaction, the data of 1996 season revealed that the highest value was obtained when citric acid was applied at a concentration of 200 ppm one or two times.

3. Lint percentage:

Lint percentage was not significantly affected by any of the tested treatments.

4. Earliness for yield:

Earliness percentage was sigificantly affected by all factors in 1996 season, while in 1997 season, it was affected by chemical treatments only. The data of 1996 season showed that, the application of these materials two times as a foliar spray increased earliness value as compared to one spray. Also, the highest value was obtained from the application of citric acid when applied at a concentration of 400 ppm in both seasons.

The interaction between number of sprays and chemical treatments reveal that the application of citric acid at a concentration of 400 ppm produced the highest value

when applied two times, this is true for both seasons.

5. Seed cotton yield:

The results in Table 2 revealed that, seed cotton yield was significantly affected by all treatments under study in both seasons. It is clear from these data that the application of such chemicals two times was more effective in increasing yield as compared to one spray, this was true in both seasons. In general, the application of either citrine or citric acid to cotton plants as foliar spray increased seed cotton yield as compared to the control. It is clear from the data that the application of citric acid to plants was more effective in increasing yield as compared to the application of citrine. Also, the data showed that the maximum yield of seed cotton (11.01 k/fed.) obtained when citric acid was applied at a concentration of 300 ppm in both season. Concerning the interaction between number of sprays and chemical treatments, the data showed that the highest yield (11.28 k/fed.) was obtained from the application of citric acid at one spray with a concentration of 300 ppm in 1996 season only. Such results may be attributed to the stimulation effect of citric acid on number and weight af open bolls/ plant. In this respect Brar *et al.* (1983), Nehra *et al.* (1987) and Ahmed *et al.* (1998) found similar results.

Fiber properties:

Results in Table 2 showed that number of sprays did not affect fiber properties i.e., micronaire reading and Pressley index in both seasons except Pressley index in 1996 season. However, both characters were affected significantly by foliar spraying of citrine or and citric acid. On the other hand, various concentrations of citrine or citric acid and interaction between number of sprays and chemical treatments affected significantly fiber properties, the highest value for micronarire reading and Pressley index were obtained when using citric acid at a rate of 200 ppm in both seasons .

Chemical constituents of cotton leaf:

1. Leaf pigments:

Results of leaf pigment analysis are shown in Table 3. All chlorophyll forms i.e. chlorophyll a, b and total chlorophyll were significantly affected by spraying these compounds either once or twice. These results may be attributed to that these compounds delayed leaf senescence thus producing more photo pigments. The increase in chlorophyll contents was more pronounced as the rates of citrine and citric acid were in-

creased up to two L/fed. and 300 ppm for citrine and citric acid, respectively. Such results are in accordance with those of Brar *et al.* (1985) and Dhopte and Lall (1987), who found that citrine and citric acid had a good effect on decreasing leaf reddening and increasing photosynthetic and respiration rates.

2. Carbohydrates:

Results in Table 3 showed clearly that citrine and citric acid enhanced and increased significantly carbohydrate contents under one or two sprays as compared with control. The hgihest value of carbohydrate contents (R. sugars and T.S. sugars), was observed when 300 ppm of citric acid sprayed one time. Ahmed *et al.*, (1998), found that application of two organic compounds (Ascobine at 1% and Citrine 0.6%) at growth start and 30 days later increased total soluble solids and total sugars. It could be concluded that, citric acid mainly plays a role as activator or intermediates in the formation of carbohydrate during photosynthesis.

3. Phenolic components:

Data presented in Table 3, showed that citrine and citric acid exerted significant effects on phenolic components as polyphenol and total phenols in cotton leaves. Two sprays of such compounds increased the phenolic components more than one spray, the best results were obtained by foliar spraying of citrine at a rate of two L/fed.

High values for polyphenol / total phenol percentage were recorded when citric acid at a rate of 400 ppm was sprayed one time only. Polyphenols and other derivatives from shikimate metabolism play an important role in decreasing IAA oxidation by 30% in healthy cotton tissues because these compounds contribute to the increase of IAA and decrease IAA decarboxylation Wiese and Vay (1970). Also, Zinc and Muller (1963) and Abdel-Al *et al.* (1998), recorded that polyphenols inhibit the action of IAA oxidase.

4. Seed oil content:

Data in Table 3, revealed that seed oil percentage was significantly affected by number of sprays in one season only, while the chemical treatments and interaction between chemical treatments and number of sprays were significantly affected in both seasons, the best treatment was obtained when citric acid was used at a rate of 200 ppm. Such results may be due to the fact that citric acid exerts its effects on the metabolism and biosynthesis of oil and related compounds

It could be noticed that spraying cotton plants one time at start of flowering was more effective in increasing leaf pigments, carbohydrates contents in cotton leaves than spraying twice. However, two sprays were more effective in increasing phenolic compounds and oil seed percentage than one spray.

Table 2. Effect of citrine and citric acid on yield, yield components and fiber properties of cotton plants in 1996 and 1997 seasons.

Treatments		Boll weight (gm)		Seed index (gm)		Lint (%)		Earliness (%)		Seed Cotton yield (k/fed)		Micronaire reading		Pressley index	
		1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
Control		3.03	3.14	10.23	11.05	37.50	36.97	64.33	60.76	9.38	9.76	4.27	4.25	10.43	10.40
One spray															
Citrine	1L/fed	3.38	3.35	10.83	11.50	36.87	37.33	54.55	57.84	9.36	10.14	4.33	4.30	11.13	11.00
	2L/fed	3.19	3.20	10.93	11.40	37.77	37.60	52.68	56.22	9.06	10.00	4.27	4.28	10.67	10.90
Citric acid	200 ppm	3.42	3.43	11.17	11.80	37.43	36.77	63.07	61.22	10.56	10.53	4.80	4.70	11.10	11.12
	300 ppm	3.24	3.40	10.89	11.30	37.33	37.53	64.88	62.80	11.28	10.83	4.57	4.58	11.00	11.00
	400 ppm	3.29	3.30	10.81	11.25	37.33	37.50	64.90	63.40	10.68	10.60	4.80	4.65	11.33	11.20
Mean		3.26	3.30	10.81	11.38	37.37	37.28	60.74	60.37	10.22	10.31	4.51	4.46	10.94	10.94
Two sprays:															
Citrine	1L/fed	3.10	3.24	10.39	11.06	37.70	37.40	61.33	58.33	10.56	11.05	4.40	4.40	10.23	10.60
	2L/fed	3.16	3.25	10.78	11.28	38.40	37.60	60.08	57.20	10.33	10.80	4.73	4.60	10.80	10.80
Citric acid	200 ppm	3.36	3.31	11.63	11.01	36.97	37.40	66.36	64.65	10.32	10.90	4.80	4.70	11.13	11.10
	300 ppm	3.30	3.28	10.62	11.24	37.90	37.90	66.58	64.60	10.74	11.18	4.53	4.50	11.13	11.15
	400 ppm	3.42	3.40	10.93	11.30	37.33	37.60	66.99	65.00	10.38	10.65	4.60	4.60	10.76	10.80
Mean		3.25	3.27	10.76	11.16	37.63	37.48	64.28	61.75	10.45	10.72	4.56	4.51	10.73	10.81
Average															
Citrine	1L/fed	3.24	3.30	10.61	11.28	37.28	37.37	57.94	58.09	9.96	10.60	4.37	4.35	10.68	10.80
	2L/fed	3.18	3.23	10.86	11.34	38.08	37.60	56.38	56.71	9.70	10.40	4.50	4.44	10.73	10.85
Citric acid	200 ppm	3.39	3.37	11.40	11.41	37.20	37.09	64.72	62.94	10.44	10.72	4.80	4.70	11.12	11.11
	300 ppm	3.27	3.34	10.76	11.27	37.60	37.72	65.73	63.70	11.01	10.01	4.55	4.54	11.07	11.08
	400 ppm	3.36	3.35	10.87	11.34	37.33	37.55	65.95	64.20	10.53	10.63	4.70	4.63	11.00	11.00
L.S.D. (0.05)															
Sprays		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	2.09	N.S.	0.12	0.28	N.S.	N.S.	0.18	N.S.
Treatments		0.07	0.09	0.17	N.S.	N.S.	N.S.	3.61	2.4	0.21	0.43	0.18	0.17	0.32	0.30
Interactions		0.10	0.12	0.24	N.S.	N.S.	N.S.	5.11	N.S.	0.29	N.S.	0.26	0.25	0.45	0.42

Table 3. Effect of citrine and citric acid on the chemical constituents of cotton leaves as mg/g (after 30 days from the first spray) in 1997 season and seed oil perentage in 1996 and 1997 seasons.

Treatments		Chlorophyll mg/gm				Sugars		Phenoles		polyphenols/ Total phenols (%)	Seed oil (%)	
		Chl. a	Chl b	Total Chl.	Carote-noides	Reducing sugars	T.soluble sugars	Poly-phenols	Total phenols		1996	1997
Control		3.23	1.15	4.38	0.48	9.72	24.12	7.11	8.53	83.35	16.83	17.72
One spray												
Citrine	1L/fed	3.25	1.65	4.90	0.52	11.00	26.45	8.52	9.26	92.00	18.57	18.53
	2L/fed	3.85	1.68	5.53	0.57	14.75	29.33	8.80	11.18	78.71	19.20	19.40
Citric acid	200 ppm	3.10	1.58	4.68	0.54	17.88	33.85	9.13	10.64	85.80	21.70	20.80
	300 ppm	3.60	1.65	5.25	0.56	18.65	33.64	9.31	10.70	87.00	18.30	19.40
	400 ppm	3.15	1.45	4.60	0.50	20.07	31.33	8.80	9.06	97.13	17.83	17.80
Mean		3.36	1.53	4.89	0.53	15.34	30.12	8.61	9.90	86.97	18.74	18.99
Two sprays:		3.30	1.60	4.90	0.51	13.14	26.25	11.02	11.20	85.53		
Citrine	1L/fed	3.20	1.25	4.45	0.50	15.12	29.45	9.69	11.78	93.55	19.83	18.65
	2L/fed	3.30	1.65	4.95	0.52	14.37	32.40	10.40	11.00	88.09	16.63	17.60
Citric acid	200 ppm	3.60	1.60	5.20	0.50	15.98	35.32	8.31	11.26	92.36	21.33	20.40
	300 ppm	3.20	1.40	4.60	0.47	13.87	30.17	9.35	10.58	78.54	19.60	18.38
	400 ppm	3.31	1.44	4.75	0.50	13.70	29.62	9.31	10.73	87.14	21.30	20.60
Mean											19.29	18.89
Average												
Citrine	1L/fed	3.28	1.63	4.91	0.52	12.07	26.35	9.05	10.23	88.46	19.20	18.59
	2L/fed	3.53	1.47	5.00	0.54	14.94	29.39	9.91	11.48	86.32	17.92	18.50
Citric acid	200 ppm	3.20	1.62	4.82	0.53	16.13	33.13	9.41	10.82	86.97	21.52	20.60
	300 ppm	3.60	1.63	5.23	0.53	17.32	35.48	9.86	10.98	89.80	18.95	19.04
	400 ppm	3.18	1.43	4.61	0.48	16.97	30.75	8.56	9.82	87.16	19.57	19.20
L.S.D. (0.05)												
Sprays		0.02	0.01	0.2	0.01	0.06	0.31	0.04	0.03		0.21	N.S.
Treatments		0.03	0.01	0.03	0.02	0.10	0.35	0.08	0.05		0.36	0.26
Interactions		0.05	0.02	0.04	0.03	0.14	0.76	0.11	0.08		0.51	0.38

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الإستجابة الفسيولوجية لنباتات القطن باستخدام الرش بالسترين وحمض الستريك

مصطفي حسن حسن غراب

معهد بحوث القطن - مركز البحوث الزراعية - الجيزة.

أجري البحث في تجربتين حقليتين بمحطة بحوث الجميزة - محافظة الغربية - خلال موسمي ١٩٩٦ ، ١٩٩٧ بغرض دراسة تأثير كل من المركب العضوي سترين وحمض الستريك علي نباتات القطن صنف جيزة ٧٥.

وقد تم رش السترين (١٥ ٪ حمض ستريك + ١٨٪ عناصر صغري (حديد ، زنك ، منجنيز) + ٦٤٪ مواد عضويه)، بمعدل ١ ، ٢ لتر / فدان، وحمض الستريك بمعدل ٢٠٠ ، ٣٠٠ ، ٤٠٠ جزء في المليون. وقد تم الرش مرة واحدة في بداية التزهير أو مرتين في بداية التزهير وبعد ١٥ يوم من الرشة الأولي.

وقد أوضحت نتائج الرش مرة واحدة بحمض الستريك أو مركب السترين إلي زيادة معنوية في طول النبات، وكذا عدد الأفرع الثمرية / نبات في موسم ١٩٩٦ فقط. وكانت أفضل النتائج باستخدام مركب السترين بمعدل ٢ لتر/فدان في كلا الموسمين ، كما أدي الرش باستخدام السترين أو حمض الستريك إلي زيادة في عدد اللوز علي النبات نتيجة لنقص معدل تساقط اللوز علي النبات سواء عند رشة واحدة أو رشتين.

وأظهرت نتائج المحصول أن وزن اللوزة لم يتأثر معنوياً بعدد مرات الرش، ولكن أعطت المعاملة بحمض الستريك بتركيز ٢٠٠ جزء في المليون أعلي وزن لوزة بالجرام. كما أدت جميع المعاملات إلي زيادة في معامل البذرة (وزن ١٠٠ بذرة بالجرام)، بينما أدت المعاملات إلي زيادة غير معنوية في تصافي الحليج. كما تأثرت نسبة التبكير للمحصول وأعطت المعاملة بحمض الستريك بتركيز ٤٠٠ جزء في المليون أعلي نسبة تبكير للمحصول في كلا الموسمين. كما أعطي إستخدام حمض الستريك بتركيز ٣٠٠ جزء في المليون أعلي محصول للقطن الزهر/فدان في كلا الموسمين . وكان للتركيزات المختلفة من السترين أو حمض الستريك تأثيرا معنوياً علي صفات الشعر (المتانة ، وقراءة الميكرونير).

وقد أوضحت نتائج التحليل الكيميائي لأوراق القطن عن زيادة معنوية في المكونات الكلية للصبغات النباتية كلورفيل أ ، ب) سواء بعد رش هذه المركبات مرة واحدة أو مرتين . كما أعطي إستخدام حمض الستريك بمعدل ٣٠٠ جزء في المليون أعلي مستوي من السكريات المختزلة والسكريات الذائبة الكلية عند رشة واحدة أو رشتين، كما تأثرت الفينولات برش هذه المركبات خاصة عند معدل رشتين، وأدت إلي زيادة بسيطة للمركبات الفينولية (بولي فينول والفينولات الكلية) ، وكذا تأثرت نسبة الزيت بهذه المركبات.

وأعطت المعاملة بحمض الستريك بتركيز ٢٠٠ جزء في المليون أعلي نسبة زيت في كلا الموسمين مقارنة بباقي المعاملات ومعاملة المقارنة.