EFFECT OF FOLIAR APPLICATION WITH SOME ORGANIC ACIDS ON SUGAR BEET PLANTS

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Abstract

Two field experiments were conducted during 2002-2003 and 2003 - 2004 seasons in Sakha Agric. Res. Station (ARC) Kafer El-Sheikh Governorate to study the effect of foliar application with some organic acids (O. A.) namely citric, malic, α-ketoglutaric and ascorbic acids at the levels of 0, 1000, 2000 and 3000 mg l^{-1} in two equal doses at 70 and 90 days from sowing on some chemical constituents, quality and yields of sugar beet plants. The obtained results revealed that:

Foliar application with O. A. induced significant increases of root length and diameter in the first season, fresh and dry weights of root and top/plant, photosynthesis pigments, i.e. chl. a, b and carotenoids, sugar fractions (reducing, non reducing and total soluble sugars) in both seasons. Also, O. A. significantly improved N% and some technological parameters, i.e. sugar lost in molasses (SLM) and sugar extractable % (SE %) but these increases were not significant for P %, K % and alkalinity coefficient. It is important to mention that roots and sugar yields were significantly increased as well. On the contrary, purity % was significantly decreased. Foliar spray with citric acid gave the best results than other O. A. used, on the most studied traits.

Regarding, the concentrations of O. A., results indicate that foliar application of O. A. at the level of 2000 mg l^{-1} significantly enhanced root length and diameter and fresh and dry weights of root and top/plant, sugar fractions, mineral composition, some technological parameters (SLM and SE %), roots and sugar yields. Whereas, 1000 mgl^{-1} level gave the highest photosynthesis pigments, i.e. chl. a, b and carotenoids.

The interaction between O. A. and their concentrations (C) significantly affected most studied traits compared with control. Studies offered that foliar spray with citric acid at 2000 mg l^{-1} at 70 and 90 days gave maximum roots and sugar yields.

INTRODUCTION

Sugar beet *(Beta vulgaris* L) is the second source for sugar production in Egypt. Sugar demand in Egypt has increased at a very rapid rate due to the drastic growth of the population as well as the changes of sugar consumption patterns. Therefore, the increase in the gab between production and consumption has been taken place. This problem could be solved by achieving optimization of sucrose storage capacity which reflect positively on fresh weight concentration of sucrose with high storage root dry mass. Recently, organic acids (as growth regulators) were experimented on some crops and remarkable responses were observed on their growth and yield. Glycolysis and tricarboxylic acid cycles as the main sources of respiratory, plant growth and all nutritional processes which reflect on plant growth and nutrients uptake, are dependent on organic acids level in plant tissues (Givan, 1979 and Nofal *et al.,*1990).

Citric (tricarboxylic acid), α-ketoglutaric and malic (dicarboxylic acids) present in creb's cycle intermediate, citric acid synthesized from acetyl -coA then conversion to α -ketoglutaric acid and last conversion to malic acid (Miemyk and Trelease, 1981). Ascorbic acid has been synthesized in higher plants through glucose metabolism (Helsper *et al.,* 1982). In addition, Grun *et al.* (1982) reported that ascorbic acid plays an important role in the electron transport system. It is considered to be a powerful reducing agent.

Moreover, literature have been stated that organic acids have a positive effect on plant growth (Genaidy *et al.,* 1995 and Nofal *et al.,* 1996), the contents of photosynthetic pigments (El-Guibali *et al.,* 2003), contents of elements (Negm *et al.,* 1996 and Nofal *et al.,* 1996), and root quality, yields of roots and sugar(Bassiem and Anton, 1998, Elwan *et al.,* 2002 and Guibali *et al.,* 2003).

The aim of this work is to study the effect of foliar application with some organic acids on sugar beet plants, yield and its quality .

MATERIALS AND METHODS

Two field experiments were carried out in Sakha Agricultural Research Station, ARC, Kafr El-Sheikh Governorate to study the effect of foliar spray of some organic acids namely: citric, malic, α -ketoglutaric and ascorbic acids at the levels of 0, 1000, 2000 and 3000 mg l^{-1}, in two equal doses at 70 and 90 days from sowing on some chemical constituents, quality and yields of sugar beet plants. Some mechanical analysis and chemical characteristics of a represented soil sample for the studied soils are shown in Table 1.

Table 1: Some mechanical and chemical analysis of the studied soils.

Soil properties	2002-2003	2003-2004
I. Mechanical analysis:		
Coarse sand %	3.95	2.86
Fine sand %	16.47	20.10
Silt %	28.24	26.05
Clay %	46.80	46.10
Soil texture	clay	clay
II. Chemical analysis:		
$CaCO_3$ %	3.50	2.80
O. M. %	2.10	2.09
E.C. (1:5 dSm^{-1})	2.84	3.25
pH (1:2.5)	7.80	8.10
III. Available nutrients (ppm):		
N	44.1	36.5
P_2O_5	19.0	14.1
K_2O	338.6	321.8

A factorial experiment in randomized complete block design and four replicates was used, each plot area was $21m^2$ (5 rows, 7 m long and with 0.60 m apart). On October 25^{th} and 13^{th} a multigerm sugar beet variety Nejma was planted, in 2002/ 2003 and 2003/2004 seasons, respectively.

Nitrogen fertilizer was added in the form of urea (46 % N) at the rate of 80 kg N/fed in two equal doses, the first was applied after thinning that has been done at 4 leaf stage to insure one plant per hill, the other dose was one month later. The normal practices of sugar beet cultivation were maintained to assure optimum production.

Random samples were taken from each plot after 90 and 110 days from sowing to determine photosynthetic pigments, i.e. chlorophyll a, b and carotenoids (mg/g fw) according to Westtstein (1957).

Harvest was carried out after 7 months from sowing to determine the following:

1 - Growth traits.

a- Length and diameter of roots (cm).

b- Fresh and dry weights of root and top/plant (gm).

2- Sugar fractions (reducing sugars, non-reducing sugars and total soluble sugars) (A. O. A. C., 1990).

3-The content of minerals (N, P and k) in beet roots were determined according to A. O. A. C. (1990), in the second season.

4- Root quality and some technological parameters:

a- Root quality (sucrose pol %), impurities (K, Na and α- amino N g/100g beet), and juice purity were determined using an automatic French system (Hycel).

b- Some technological parameters (sugar lost in molasses, sugar extractable and alkalinity coefficient) were calculated as follows:

Sugar lost in molasses (SLM) = (VI +V2) 0.14 + V3 × 0.25 + 0.5 (Devillers.1988).

Sugar extractable % (SE %) =V4 – SLM - 0.6 (Dexter *et al.,* 1967).

Alkalinity coefficient (A.C) =V1+V2/V3

Where: V1=Sodium, V2=Potassium, V3=α-amino N and V4= pol %

5-Yields (roots and sugars ton/fed.).

Analysis of variance was computed for each trait according to Stell and Torrie (1980) and treatment means were compared at the 5 % level of probability.

RESULTS AND DISCUSSION

1- Growth traits:

a- Root length and diameter (cm).

Results in Table 2 show that foliar spray with citric, malic, α-ketoglutaric or ascorbic acids significantly increased root length and diameter in the first season, while, these increases were not significant in the second season. Citric and malic acids gave the best values for root length and root diameter respectively as compared with control treatment. Regarding the effect of organic acids concentrations, they caused not significant effects of root length and diameter in the first season and these effects reached the level of significance in the second season.

As for the effect of organic acids (O. A.) X their concentrations (C) interaction generally, was significant for root length in the first season and root diameter in both seasons. The best values of root length were obtained by citric acid or malic acid at 2000 mg l^{-1}, α-ketoglutaric acid at 3000 mg l^{-1} and ascorbic acid at 1000 mg l^{-1}. The same treatments gave the highest values of root diameter but citric acid had superior effect at 1000 mgl^{-1}.

b – Fresh and dry weights of root and top/plant.

- Fresh and dry weights of root.

Results in Table 2 show that, generally, average of fresh and dry weights of root were significantly increased in the two seasons by foliar spray with citric and α-ketoglutaric acid. While, these increases were not significant for malic or ascorbic acid in the both seasons.

Regarding the effect of organic acids concentrations, data in Table 2 clear that fresh and dry weights of roots were not significantly affected in both seasons except dry weights of root in the second season.

As for the effect of the interactions between O. A. and their concentrations, results in Table (2) show that generally, there are significant increases in fresh and dry weights of root except fresh weight of root in the first season. Organic Acids differ in their effectiveness on fresh and dry weights of root according to the concentrations, where citric acid gave the best result at 2000 mg l^{-1} while α-ketoglutaric acid was at 3000 mg l^{-1} and ascorbic acid was at 1000 mg l^{-1}.

- Fresh and dry weights of tops.

Fresh and dry weights of tops were significantly increased in the both seasons by foliar sprays with citric, malic, α-ketoglutaric and ascorbic acids except malic acid on dry weight in the second season.

Data also showed that organic acids concentrations were not significantly increased fresh weights of top in the two seasons and dry weights in the first season only.

Organic Acids and their concentrations interactions significantly increased fresh weights of top in the both seasons while these increases were non significant for dry weights of top. Fresh weights of top increased by increasing malic acid concentrations from 1000 to 3000 mg l^{-1}. Whereas, the contrary trend was obtained by foliar spray with ascorbic acid. These results are in agreement with Givan (1979) and Nofal *et al.*

(1996) who found that supplying organic acids to higher plant tissues can greatly reduce their internal NH_3 concentration to produce insoluble form of nitrogen which reflects upon plant growth. The primitive effects of ascorbic acid could be attributed in part to its effect on many metabolic and physiological processes (Negm *et al*, 1996). Similar results were also mentioned by Bassiem and Anton (1998) and El-Guibali *et al.* (2003).

2- Photosynthetic pigments (mg/g fresh weight):

Results in Table 3 indicate that foliar sprays with citric, malic, α-ketoglutaric and ascorbic acids exhibited significant and positive effects on photosynthetic pigments namely : chl. a, b and carotenoids except α-ketoglutaric acid for carotenoids at 90 days from sowing in the first season. Citric acid was the most effective than other organic acids on chl. a and chl b while malic acid had the same effect on carotenoids.

Regarding the concentration of organic acids, data cleared that their concentrations induced not significant effects of chl. a, b and carotenoids at 90 and 110 days from sowing in the first season and these effects reach to the level of significant in the second season.

Interaction between O. A. x C significantly increased chl. a, b and carotenoids at both samples in the two seasons. The positive response of photosynthetic pigments may be due to the effect of organic acids on the activities of some enzymes which are important in the regulation of photosynthetic carbon reduction (Helsper *et al.*, 1982). In this respect, Elwan *et al.* (2002) and El-Gubali *et al.* (2003) found similar results.

3- Sugar fractions (g/100 g dw):

It is evident from data presented in Table 4 that foliar sprays with citric, malic, α-ketoglutaric and ascorbic acids significantly increased the concentrations of reducing, non reducing and total soluble sugars of sugar beet roots at harvest in both seasons except of ascorbic acid on non reducing sugars in the first season as compared with the control. Citric acid followed by malic acid were the most effective than other organic acids .On the other hand, ascorbic acid was the only organic acid which significantly increased reducing sugar in both seasons.

Data also showed that the concentration of organic acids had a significant increase on all studied sugars. Also, the interaction between organic acids and their concentrations gave the same results.

It is worth to notice, that O. A. had difference in their effectiveness on sugars according to the concentration. The best findings were obtained by foliar spray with citric acid at the moderate level (2000 mg l^{-1}) followed by malic acid or α-ketoglutaric acid at the high level (3000 mg l^{-1}), where, they recorded the highest non-reducing sugars and in the same time gave the lowest reducing sugars. The beneficial effect of organic acids may be due to their vital role through glucose metabolism (Helsper *et al.,* 1982).

4 – Nutrient composition:

Results in Table 4 show that N, P and K contents in beet roots were increased by foliar spray with all used organic acids, the positive effects were non significant for P % and K % while it was significant for N %. Data also showed that α-ketoglutaric acid was more effective on accumulated N % in beet root while, citric acid had the same effect on P and K contents.

The positive response of nutrients in sugar beet plants subjected to organic acids application could be explained on the basic that these acids contributes in the respiration system which reflects upon the nutrients uptake and transport. In this regard, Negm *et al.* (1996) cleared that ascorbic acid had no significant effect on the contents of P and K. There results are also confirmed by Nofal *et al.* (1996).

Generally, there were significant effects in N, P and K percentages with the increase of organic acids concentrations.

The interaction between O. A. and their concentration, Table 4, clear that α-ketoglutaric acid at 3000 mg l^{-1} gave the highest N or P and the lowest K %. While, citric acid at the same concentration gave the highest K % and the lowest N % as compared with other treatments.

5-Root quality and some technological parameters:

a- Root quality.

Root quality comprises several parameters, i.e. sugar content, impurities (K, Na and α-amino N) and juice purity (De Nie and Vanden Hill, 1989). Dealing with sucrose %, data in Table 5 show that at harvest all the used organic acids except ascorbic acid significantly increased sucrose % as compared with control. Results also cleared that all the concentrations of organic acids gave significant effects. From results of interaction, it is important to mention that citric acid at 2000 mg l^{-1} followed by malic or α-ketoglutaric acid at high level 3000 mg l^{-1} recorded the maximum sucrose %.

As for impurities (K, Na and α-amino N), data showed that organic acids or their concentrations significantly increased K, Na and α-amino N. Generally, the highest impurities were detected with the highest concentration of O. A. Data also cleared that the highest Na and α-amino N contents were obtained by using ascorbic acid at 1000 and 3000 mg l^{-1}, respectively. While, citric acid at 3000 mg l^{-1} gave the highest K content.

Regarding juice purity, data cleared that spraying with citric, malic, α-ketoglutaric and ascorbic acids decreased juice purity as compared with control. These decreases were significant for citric and ascorbic acids only. The concentrations of organic acids and their interactions afforded significant results.

It is important to notice that citric acid at 2000 mg l^{-1} was the only treatment which significantly increased purity as compared with control.

b- Some technological parameters.

Generally, foliar applications of organic acids or their concentrations significantly affected sugar lost in molasses (SLM) and sugar extractable % (Sex %).

The interaction between O. A. x C cleared that the best treatments gave the lowest values of SLM were malic acid at 1000 and 2000 mg l^{-1} followed by α-ketoglutaric acid at 1000 mg l^{-1}. While, the highest SEx was obtained when beet sprayed by citric acid at 2000 mg l^{-1}.

As for alkalinity coefficient (A C), results showed that citric, malic, α-ketoglutaric and ascorbic acids not significantly affected (A C). Also, increasing the level of organic acids from 1000 mg l^{-1} to 3000 mg l^{-1} non significantly affected A C. Meantime, ascorbic acid at 2000 mg l^{-1} afforded the highest (A C).

c- Root and sugar yields (ton/fed):

Generally, (O. A.) and their concentrations increased root and sugar yields (Table 5). These increases were significant for citric and α-ketoglutaric acid only in both seasons. Data also manifested that the moderate concentration of citric acid followed by α-ketoglutaric acids at 3000 mg l^{-1} exhibited the highest root and sugar yields values than other treatments.

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Table 2. Effect of foliar application with some organic acids (O. A.) on growth traits of sugar beet plants.*

Treatments (O. A.)	Root length (cm)		Mean	Root diameter (cm)		Mean	F. W. of root (kg/plant)		Mean	D. W. of root (g/plant)		Mean	F. W. of top (g/plant)		Mean	D.W of top (g/plant)		Mean
	I	II		I	II		I	II		I	II		I	II		I	II	
Control	29.8	28.7	29.2	11.3	10.9	11.1	0.95	0.92	0.94	224	228	226	504	485	494	52.4	50.2	51.3
C. A. 1000	35.6	33.6	34.6	13.9	14.0	14.0	1.09	1.11	1.10	283	269	276	669	633	651	67.6	65.1	66.4
2000	34.6	37.1	35.9	14.0	13.8	13.9	1.18	1.21	1.20	290	327	308	686	703	695	70.3	77.0	73.7
3000	34.4	33.6	34.0	13.5	12.6	13.0	1.05	1.01	1.03	257	248	253	613	615	614	61.2	64.1	62.7
Mean	34.9	34.9	34.9	13.8	13.5	13.6	1.11	1.11	1.11	277	281	279	656	650	653	66.5	68.8	67.6
M. A. 1000	28.4	30.1	29.3	14.6	13.6	14.2	0.95	0.94	0.95	219	218	218	536	512	524	54.9	48.3	51.6
2000	33.7	32.2	33.0	13.0	13.3	13.2	0.99	0.99	0.99	249	227	238	542	541	541	58.8	50.8	54.8
3000	32.3	33.3	32.8	13.7	13.9	13.8	0.96	1.01	0.99	235	243	239	560	588	574	59.4	59.7	59.5
Mean	31.5	31.9	31.7	13.8	13.6	13.7	0.97	0.98	0.98	234	229	232	546	547	547	57.7	52.9	55.6
α-k. A. 1000	32.2	31.8	32.0	12.8	12.2	12.5	1.03	0.94	0.99	251	225	238	575	551	563	62.1	55.3	58.7
2000	33.6	32.0	32.7	13.2	13.5	13.4	1.09	1.05	1.07	267	256	262	594	576	585	63.9	60.4	62.2
3000	34.0	34.5	34.3	13.7	14.0	13.8	1.13	1.14	1.14	285	280	283	620	613	616	65.7	63.1	64.4
Mean	33.3	32.8	33.0	13.2	13.2	13.2	1.08	1.04	1.06	268	254	261	596	580	588	63.9	59.6	61.8
A. A., 1000	34.0	32.1	33.0	13.4	13.6	13.5	1.05	1.01	1.03	250	248	249	558	665	562	60.3	60.7	60.5
2000	31.0	31.2	31.1	12.4	12.5	12.5	0.96	0.97	0.97	241	235	238	530	513	522	56.5	58.3	57.4
3000	29.5	28.2	28.9	11.7	11.5	11.6	0.94	0.95	0.95	203	215	209	508	487	498	55.1	51.3	53.2
Mean	31.5	30.6	31.1	12.5	12.5	12.5	0.98	0.98	0.98	231	233	232	532	522	527	57.3	56.8	57.1
Concentrations mean (C) :																		
Control	29.8	28.7		11.3	10.9		0.95	0.92		224	228		504	485		52.4	50.2	
1000 mgl^{-1}	32.6	31.9		13.7	13.4		1.03	1.00		251	240		584	565		61.2	57.4	
2000 mgl^{-1}	33.2	33.1		13.2	13.3		1.06	1.06		262	261		588	583		62.4	61.6	
3000 mgl^{-1}	32.6	32.4		13.2	13.0		1.02	1.03		245	247		575	576		60.4	59.6	
L.S.D. at 5 % level of significant for:																		
(O. A.)	1.05	N.S		0.52	N.S		0.07	0.07		10.6	11.8		16.8	13.4		4.11	5.84	
(C)	N.S	2.42		N.S	0.62		N.S	N.S		N.S	11.8		N.S	N.S		N.S	5.84	
(O. A . x C)	2.11	N.S		1.04	1.24		N.S	0.14		21.3	23.6		33.9	26.8		N.S	N.S	

*(O. A.): Organic acids C. A.: Citric acid M. A.: Malic acid α-k. A. : α-ketoglutaric acid A. A. : Ascorbic acid

I: The first season II: The second season

Table 3. Effect of foliar application with some organic acids (O. A.) on photosynthetic pigments (mg/g f. w.) of sugar beet plants.*

Treatments (O. A.)	90 days									110 days								
	Chl. a		Mean	Chl. b		Mean	Carotenoids		Mean	Chl. a		Mean	Chl. b		Mean	Carotenoids		Mean
	I	II		I	II		I	II		I	II		I	II		I	II	
Control	2.09	2.58	2.33	1.16	1.25	1.21	0.47	0.50	0.49	3.22	3.18	3.20	1.98	2.00	1.99	1.56	1.51	1.53
C. A. 1000	3.81	3.83	3.82	1.91	1.95	1.93	0.71	0.85	0.77	5.58	5.62	5.60	3.72	3.99	3.85	2.00	2.28	2.14
2000	3.65	3.40	3.52	1.77	1.87	1.62	0.60	0.69	0.65	4.79	4.88	4.84	3.11	2.75	2.93	2.28	2.00	2.14
3000	3.37	3.18	3.28	1.62	1.79	1.51	0.51	0.53	0.52	4.40	4.23	4.32	2.57	2.60	2.59	1.85	1.99	1.92
Mean	3.61	3.47	3.54	1.77	1.87	1.82	0.61	0.69	0.65	4.92	4.91	4.92	3.13	3.13	3.13	2.04	2.09	2.06
M. A. 1000	3.05	3.22	3.13	1.36	1.54	1.45	0.78	0.83	0.81	3.77	3.83	3.80	2.53	2.34	2.44	2.18	2.25	2.21
2000	3.00	2.94	2.97	1.30	1.37	1.33	0.64	0.72	0.68	3.90	3.95	3.92	2.67	2.56	2.61	2.23	2.29	2.26
3000	2.43	2.87	2.65	1.25	1.38	1.32	0.59	0.54	0.56	4.35	4.29	4.32	2.43	2.32	2.38	2.43	2.14	2.29
Mean	2.83	3.01	2.92	1.31	1.43	1.37	0.67	0.70	0.69	4.00	4.02	4.01	2.52	2.41	2.46	2.28	2.23	2.22
α-k. A. 1000	3.24	3.51	3.37	1.90	1.69	1.80	0.51	0.61	0.56	4.51	4.38	4.44	2.72	2.68	2.70	1.84	2.06	1.96
2000	3.92	3.22	3.07	1.71	1.60	1.65	0.50	0.51	0.51	4.82	4.77	4.80	3.00	2.90	2.95	2.13	2.24	2.18
3000	2.39	2.87	2.63	1.65	1.22	1.44	0.47	0.54	0.50	5.12	5.02	5.07	3.24	3.13	3.18	2.12	2.31	2.21
Mean	2.85	3.20	3.02	1.75	1.50	1.62	0.49	0.55	0.52	4.82	4.72	4.77	2.98	2.90	2.94	2.03	2.20	2.12
A.A. 1000	3.13	4.33	3.73	1.48	1.97	1.73	0.57	0.90	0.74	3.99	3.76	3.88	2.63	2.53	2.58	1.90	1.87	1.88
2000	3.09	3.25	3.17	1.40	1.63	1.52	0.54	0.67	0.61	3.73	3.65	3.69	2.33	2.32	2.33	1.78	1.75	1.77
3000	2.57	2.64	2.62	1.28	1.28	1.28	0.48	0.51	0.49	3.25	3.44	3.34	2.09	2.12	2.11	1.56	1.69	1.63
Mean	2.93	3.41	3.17	1.39	1.63	1.51	0.53	0.69	0.61	3.66	3.62	3.64	2.35	2.32	2.34	1.75	1.77	1.76
Concentrations mean (C) :																		
Control	2.09	2.58		1.16	1.25		0.47	0.50		3.22	3.18		1.98	2.00		1.56	1.51	
1000 mgl^{-1}	3.31	3.72		1.66	1.79		0.52	0.80		4.46	4.40		2.90	2.89		1.98	2.11	
2000 mgl^{-1}	3.17	3.20		1.55	1.62		0.57	0.65		4.31	4.31		2.78	2.65		2.11	2.07	
3000 mgl^{-1}	2.69	2.89		1.20	1.42		0.51	0.53		4.28	4.25		2.58	2.54		1.99	2.03	
L.S.D. at 5% level of significant for :																		
(O.A.)	0.12	0.15		0.07	0.09		0.06	0.04		0.15	0.21		0.12	0.14		0.10	0.10	
(C)	N.S	0.15		N.S	0.09		N.S	0.04		N.S	0.21		N.S	0.14		N.S	0.10	
(O.A. x C)	0.24	0.30		0.14	0.18		N.S	0.08		0.30	0.42		0.24	0.28		0.20	0.20	

* (O. A.): Organic acids C. A. : Citric acid M. A. : Malic acid α-k. A : α-ketoglutaric acid A. A.: Ascorbic acid

I: The first season II: The second season

Table 4. Effect of foliar application with some organic acids (O. A.) on sugar fractions (g/100g d.w.) and mineral compositions of sugar beet plants.*

Treatments (O.A.)	Reducing sugars I	Reducing sugars II	Mean	Non reducing sugars I	Non reducing sugars II	Mean	Total soluble sugars I	Total soluble sugars II	Mean	mineral compositions (%) N	P	K
Control	5.12	5.68	5.40	58.5	54.6	56.6	63.6	60.3	62.0	0.70	0.08	0.95
C. A. 1000	6.18	6.23	6.21	64.5	65.8	65.2	70.7	72.0	71.4	1.20	0.12	1.12
2000	5.81	5.91	5.86	70.1	71.6	70.9	75.9	77.5	76.7	0.85	0.17	1.18
3000	6.23	6.25	6.24	63.6	64.3	64.0	69.8	70.6	70.2	0.75	0.15	1.20
Mean	6.07	6.13	6.10	66.0	67.2	66.6	72.1	73.4	72.7	0.93	0.15	1.17
M. A. 1000	6.83	6.95	6.89	62.7	56.0	59.4	69.5	63.1	66.3	1.00	0.09	0.95
2000	6.51	6.42	6.47	63.7	63.5	63.6	70.2	69.8	70.0	1.25	0.11	1.10
3000	5.62	5.75	5.69	65.4	68.4	66.9	71.0	74.2	72.6	1.30	0.15	1.15
Mean	6.32	6.37	6.35	63.9	62.6	63.3	70.2	69.0	69.6	1.18	0.12	1.07
α -k. A. 1000	6.11	6.35	6.23	57.3	57.5	57.5	63.4	64.0	63.7	1.15	0.10	1.00
2000	6.40	6.49	6.45	63.3	62.0	62.7	69.6	68.5	69.1	1.25	0.14	1.16
3000	6.64	6.73	6.69	64.4	62.8	63.6	70.9	69.5	70.2	1.40	0.18	0.86
Mean	6.38	6.52	6.45	61.6	60.8	61.2	68.0	67.3	67.7	1.27	0.14	1.00
A. A. 1000	6.41	6.51	6.46	63.2	63.9	63.6	69.6	70.4	70.0	1.00	0.15	1.08
2000	6.68	6.83	6.75	58.3	58.5	58.4	65.0	65.3	65.2	1.35	0.13	1.12
3000	7.12	7.13	7.13	54.2	56.8	55.5	61.3	63.9	62.6	1.36	0.13	0.90
Mean	6.74	6.82	6.78	58.6	59.7	59.2	65.3	66.5	65.9	1.23	0.14	1.03
Concentrations mean (C) :												
Control	5.12	5.68		58.5	54.6		63.6	60.3		0.70	0.08	0.95
1000 mgl^{-1}	6.38	6.51		61.9	60.9		68.3	67.4		1.09	0.12	1.04
2000 mgl^{-1}	6.35	6.41		63.8	63.9		70.2	70.3		1.18	0.14	1.14
3000 mgl^{-1}	6.40	6.47		61.9	63.1		68.3	69.5		1.21	0.15	1.03
L.S.D. at 5% level of significant for :												
(O. A.)	0.04	0.05		1.36	1.08		1.36	1.10		0.08	N.S	N.S
(C)	0.04	0.05		1.36	1.08		1.36	1.10		0.08	0.02	0.12
(O. A X C)	0.09	0.09		2.73	2.17		2.72	2.20		0.16	0.04	0.25

* (O. A.): Organic acids C. A.: Citric acid M. A.: Malic acid α-k. A.: α-ketoglutaric acid A. A.: Ascorbic acid

I: The first season II: The second season

Table 5. Effect of foliar application with some organic acids (O. A.) on juice quality and yields of sugar beet plants.*

Treatments (O.A.)	Root quality					Technological parameters			Yields (ton/fed.)					
	Sucrose %	Impurities (meq / 100 beet)			Purity %									
		K	Na	α-amino N		SLM	S.Ex	AC	Roots		Mean	Sugars		Mean
									I	II		I	II	
Control	15.5	5.49	1.63	1.27	91.6	1.81	13.0	5.61	23.5	22.8	23.1	3.59	3.53	3.56
C. A. 1000	16.6	6.03	1.67	1.35	91.6	1.92	14.0	5.70	27.5	27.3	27.4	4.51	4.53	4.52
2000	17.3	5.82	1.77	1.42	91.9	1.92	14.7	5.35	29.1	29.0	29.0	4.97	5.01	4.99
3000	14.8	6.16	1.81	1.54	90.2	2.00	12.2	5.18	26.5	25.3	25.9	3.86	3.74	3.80
Mean	16.2	6.00	1.75	1.44	91.2	1.95	13.6	5.41	27.7	27.2	27.4	4.45	4.43	4.44
M. A. 1000	15.1	5.53	1.62	1.30	91.4	1.83	12.6	5.50	23.6	23.3	23.4	3.51	3.51	3.51
2000	15.3	5.39	1.68	1.43	91.4	1.85	12.8	4.94	24.7	24.8	24.7	3.72	3.79	3.76
3000	17.1	5.99	1.70	1.32	91.8	1.91	14.5	5.83	23.9	25.3	24.6	4.03	4.32	4.18
Mean	15.8	5.64	1.67	1.35	91.5	1.86	13.3	5.42	24.1	24.5	24.2	3.75	3.87	3.82
α-k. A. 1000	15.7	5.73	1.65	1.33	91.4	1.87	13.2	5.55	24.1	23.2	23.6	3.73	3.64	3.68
2000	16.0	5.85	1.86	1.37	91.3	1.92	13.4	5.63	27.5	26.4	26.9	4.34	4.22	4.28
3000	17.1	5.94	1.93	1.45	91.6	1.96	14.5	5.42	28.5	27.8	28.1	4.81	4.75	4.78
Mean	16.3	5.84	1.81	1.38	91.4	1.92	13.7	5.54	26.7	25.8	26.2	4.29	4.20	4.25
A. A. 1000	16.8	6.11	2.02	1.39	91.3	1.99	14.2	5.85	26.4	25.3	25.8	4.38	4.25	4.31
2000	15.2	5.95	1.72	1.28	91.0	1.89	12.7	5.99	23.8	24.2	24.0	3.57	3.67	3.62
3000	14.9	5.38	1.64	1.95	90.8	1.97	12.3	3.63	23.4	23.5	23.5	3.43	3.50	3.47
Mean	15.6	5.69	1.79	1.54	91.0	1.89	13.1	5.14	24.5	24.3	24.4	3.79	3.81	3.80
Concentrations mean (C) :														
Control	15.5	5.49	1.63	1.27	91.6	1.81	13.0	5.61	23.5	22.8		3.59	3.53	
1000 mgl^{-1}	16.1	5.85	1.74	1.34	91.4	1.91	13.5	5.65	25.4	24.8		4.03	3.98	
2000 mgl^{-1}	15.9	5.66	1.76	1.38	91.3	1.89	13.4	5.48	26.3	26.1		4.15	4.17	
3000 mgl^{-1}	16.0	5.87	1.77	1.57	91.1	1.96	13.4	5.01	25.6	25.5		4.03	4.08	
L.S.D. at 5% level of significant for :														
(O.A)	0.24	0.10	0.20	0.08	0.21	0.03	0.24	N.S	1.99	1.84		0.33	0.30	
(C)	0.24	0.10	0.20	0.08	0.21	0.03	0.24	N.S	1.99	1.84		0.33	0.30	
(O. A. X C)	0.48	0.20	0.40	0.16	0.42	0.06	0.48	0.57	N.S	3.68		0.66	0.60	

* (O. A.): Organic acids C. A.: Citric acid M. A.: Malic acid α-k. A. : α-ketoglutaric acid A. A. : Ascorbic acid

I: The first season II: The second season

تأثير الرش ببعض الأحماض العضوية على نبات بنجر السكر

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أقيمت تجربتان حقليتان بمحطة بحوث سخا– محافظة كفر الشيخ– خلال موسمي عام ٢٠٠٢/٢٠٠٣ و ٢٠٠٣/٢٠٠٤ لدراسة تأثير الرش ببعض الأحماض العضوية (الستريك– ماليك– الفاكيتو جلوتاريك والأسكوربيك) بمعدلات صفر، ١٠٠٠، ٢٠٠٠، ٣٠٠٠ مليجرام للتر على نمو وصفات الجوده والثوابت التكنولوجية والمحصول لنبات بنجر السكر.

وقد أوضحت النتائج المتحصل عليها ما يلي:

أولاً : أدى الرش بالأحماض العضوية تحت الدراسة إلى زيادة كلاً من طول وقطر الجذر وكانت معنوية في الموسم الأول كما زاد الوزن الطازج والجاف للجذر والقمة والصبغات النباتية (كلورفيل أ، ب والكاروتين) والسكريات الكلية الذائبة(السكريات المختزلة وغير المختزلة) في الموسمين وكانت أيضا الزيادة معنوية لكلاً من النسبة المئوية للنتروجين وبعض القياسات التكنولوجية(السكر المفقود في المولاس– السكر المستخلص) بينما كانت الزيادة غير معنوية بالنسبة إلى كلاً من النسبة المئوية لكل من الفسفور والبوتاسيوم ومعامل القلوية وكانت زيادة حاصل الجذر والسكر زيادة معنوية . بينما انخفضت النسبة المئوية للنقاوة انخفاضاً معنوياً– وكان لحمض الستريك تأثير أكبر من الأحماض الأخرى على الصفات سابقة الذكر.

ثانياً : أعطى تركيز الأحماض العضوية نفس الاتجاه السابق– حيث أثر التركيز ٢٠٠٠ مليجرام/ لتر إيجابيا على معظم الصفات تحت الدراسة مقارنةً بالتركيزات الأخرى بينما أعطى التركيز ١٠٠٠ مليجرام/ لتر أعلى قيم للكلوروفيل أ، ب والكاروتينات.

ثالثاً : أظهر التفاعل بين الأحماض العضوية وتركيزها تأثيراً إيجابيا معنوياً على معظم الصفات تحت الدراسة – وتوصي الدراسة بالرش مرتين عند عمر ٩٠ و ١١٠ يوماً من الزراعة بحمض الستريك عند مستوى ٢٠٠٠ مليجرام/ للتر لزيادة إنتاجية وجودة بنجر السكر.