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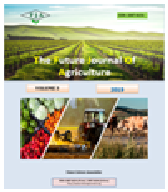

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EFFECT OF SPRAYING SOME ORGANIC ACIDS ON CERCOSPORA LEAF SPOT DISEASE, YIELD AND QUALITY OF SUGAR BEET

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ABSTRACT: Sugar beet (*Beta vulgaris var*. saccharifera, L.) is one of the main economical sugar crops in Egypt. It is infected with Cercospora leaf spot disease, which is caused by *Cercospora baticola* Sacc. Fungs, which negatively affect the vegetative growth, yield and quality of sugar beet. The results obtained indicated that Cercospora leaf spot disease severity% and relative efficacy% were significantly reduced by spraying beets with 20 g/ L humic acid followed by 2 g/ L boric acid and 50 Mm/ L citric acid compared with the other treatments, in both seasons. Spraying of 1.5 g/ L boric acid treatment led to significant increase in most of traits where, it achieved thickest and heaviest tops and roots/plant and higher values of (chlorophyll a, b and carotenoids), sucrose, purity percentages, root and sugar yields/fed in both seasons, as compared to other humic acid levels. Application of 15 g humic/ L significantly affected endogenous phytohormones (gibberellins, auxins, cytokinin and abscisic) and gave the highest values of root diameter, fresh and foliage weights/plant, sucrose and purity percentages as well, sodium and potassium contents, root and sugar yields/fed in both seasons, photosynthetic pigments in leaves in 1st season only compared to the rest of the used levels of humic acid. Foliar application of 50 citric acid/fed increased root diameter, (foliage and fresh weights/plant), sucrose and purity percentages as well, root and sugar yields/fed in both seasons in comparison to that those plants sprayed with (30 and 40 mM/L) and the check treatment. Based on, the previously mentioned combination can be recommended to increase root yield and quality of sugar beet as well as to reduce Cercospora leaf spot disease severity.

Key words: Boric, humic and ciric acids, *Cercospora beticola*, sugar beet.

INTRODUCTION

Recently, Sugar beet (*Beta vulgaris var.* saccharifera, L.) became the first crop for sugar production in Egypt in 2012, preceding sugar cane. In 2019, it contributed to the production of 62.2% of the total sugar yield, which amounted to 2.458 million tons. Cercospora leaf spot, incited by *Cercospora baticola* fungus, is the most world widespread foliar disease of sugar beet **(Holtschulte, 2000)**, which may cause a serious reduction of 42% in sugar yield. The fungus spreads quickly from one region to another in the same country. Accordingly, it causes high losses in root and extractable sucrose yields, and increases impurity concentrations, resulting in higher processing losses **(Lamey *et al.*, 1987)**. In an attempt to reduce its economic harmful impact, some investigators pointed to the use of some acids such as humic, boron and citric acids. **Scheuerell and Mahaffee (2006)** indicated that applying humic acid as a suspension of potassium humates can be used successfully as a plant growth activator or a soil conditioner to promote natural resistance against different plant diseases. Likewise, humic acid can be used for stimulation of plant growth through increasing cell division, improving nutrients availability and water uptake **(Chen *et al.*, 2004)**. Moreover, humic acid activates microorganisms in the soil **(Atiyeh *et al.*, 2002)**. Different studies reported the efficiency of humic acid in suppressing plant diseases. Humic acid is one natural antioxidant. It is absorbed into the plant tissue, resulting in various biochemical effects through elevating nutrient uptake and maintaining vitamins and amino acid levels in plant tissues. **Abdel Mawgoud *et al*. (2007)** indicated that humic acid has useful effects on growth increase, production, and quality improvement of agricultural products due to having hormonal compounds. **Zaky *et al.* (2006)** manifested that humic acid compounds may have various biochemical effects either at cell wall and membrane level or in the cytoplasm, such as increasing of photosynthesis and respiration rates in plants, enhancing protein synthesis and plant hormone-like activity. **Eyheraguibel *et al.* (2008)** manifested that humic acid compounds may have various biochemical effects either at the cell wall and membrane level or in the cytoplasm, such as increasing photosynthesis and respiration rates in plants, enhancing protein synthesis and plant hormone-like activity. Also, they may possibly enhance the uptake of macroelements (K, Ca and P) and some microelements. **Habashy *et al.* (2008)** revealed that humic acid increased photosynthetic pigments of sugar beet **(Fathy *et al*., 2009)**. **Hanafy *et al*. (2010)** found that applying humic acid at 0, 50, 100 ppm/l increased leaf area index and crop growth rate. They added that the net assimilation rate of potatoes responded to the consumption of humic acid **(Motaghi and Nejad, 2014)**. Humic materials exhibited auxin, gibberellin, and cytokinin-like activities of treating carrot cells with humic substances which increased their growth and induced morphological changes similar to those produced by auxins **(Muscolo *et al*., 1999)**. Likewise, **Razieh *et al.* (2012)** reported that humic acid increased hormone synthesis. **Abbas (2013)** revealed that humic acid increased auxins, and gibberellins in treating *Vicia faba* plant shoot, while abscisic acid decreased. Humic acid increased wheat endogenous hormones, which stimulate cell division and enlargement, and in turn improves plant growth and yield of crops **(El-Bassiouny *et al*., 2014).**

Boron has an essential role in plants, where it plays an important role in functioning as cofactors or activators of enzyme systems, which play pivotal roles in disease resistance in the production of defense barriers **(Datnoff *et al*., 2007)**. Different rice disease incidence was reduced i.e., brown spot (*Drechslera oryzae*) and sheath blight (*Rhizoctonia solani*) diseases of rice were really reduced as a foliar spray with boron. Foliar applications of boron reduced disease severity% of Cercospora leaf spot, in addition to its effects on plant metabolism, cell wall structure and plant membranes **(Dordas, 2008)**. **Enan *et al.* (2016)** clarified that higher values of root diameter, fresh weight/plant, root, top and sugar yields/fed, sucrose, extractable sugar percentages and quality index were obtained by spraying boron at 100 ppm/fed. Also, Foliar applications of boron (H_3BO_3) reduced disease severity% of cercospora leaf spot disease compared and recorded the high value of sugar beet leaf dry weight. It increased the total soluble solid, sucrose % and purity% over the control **(Ghazy *et al.*, 2020).**

Citric acid was able to inhibit the mycelial growth of *Cercospora beticola in vitro* and disease severity *in vivo* when added to the medium and applied as foliar spraying at concentrations of 0, 10, 20, 30, 40 and 50 mM. The highest effect on the inhibition of growth of the pathogen was 83.70% at 50 mM. The results also revealed that spraying of diseased plants with citric acid was effective in decreasing disease severity of Cercospora leaf spot compared to untreated plants. Foliar application of citric acid enhanced significantly root yield and sugar percentage as compared to the control **(El-Fawy, 2018)**. Citric acid has a high ability to inhibit a wide range of microorganisms (**Thomas and Wimpenny, 1996)** and **(Blaszyk and Holley, 1998)**. Some mechanisms have been suggested to explain the inhibitory effect of citric acid on microorganisms. Such lowered pH resulting from this acid may influence the growth by acidifying the cell, which will consume a great amount of energy to maintain the intracellular pH homeostasis **(Cole and Keenan, 1987)**. Other possibilities have also been proposed including the membrane disruption **(Bracey *et al.*, 1998)** and **(Stratford and Anslow, 1998)**, the interruption of metabolic reactions **(Krebs *et al.*, 1983)** and the accumulation of toxic anions **(Eklund, 1985)**. Citric acid treatment increased plant height yield and its components **(Abd-Allah *et al.*, 2007)**.

Aim of the work

The present investigation is concerned with the effect of foliar application of humic, boric and citric acids on growth, yield characteristics and their relationship to Cercospora leaf spot disease of sugar beet.

MATERIALS AND METHODS

Field experiment, design and plant material

This work was carried out at Sakha Agricultural Research Station (latitude of 31.10^0 N and longitude 30.93^0 E, at an elevation of 14 m above sea level) Kafr El-sheikh Governorate, Egypt in 2018/2019 and 2019/2020 seasons. A randomized complete block design with three replicates was done. Plot area was 18 m2, including 5 rows of 6.0 m long and 60 cm width, with 20 cm apart between hills. Some organic acids were sprayed on beet tops to evaluate their influence in controlling such disease. Humic, boric and citric acids were applied at 80, 95 and 110 days from sowing, when disease symptoms were detected. Untreated plots were left as control. Phosphorous was added in the form of superphosphate (15%) at the rate of 30 kg P2O5/fed during seedbed preparation. Nitrogen fertilizer was applied at 80 kg N/fed as ammonium nitrate (33.5% N) in two equal doses; the 1st was applied after thinning (4 true leaf stage) and one month later. Multi-germ sugar beet variety viz " Oscarpoly" was sown in the 2nd week of September in 1st and 2nd seasons, it is susceptible to Cercospora leaf spot disease. while harvesting took place at age of 210 days after sowing in both seasons. All recommended cultural practices were performed in both treated and untreated (control) plots. The physical and chemical of the soil upper 30 cm depth of the experimental site showed that the soil was clay containing (19.97% and 18.10% sand), (19.53% and 22.5% silt) and (60.5% and% 59.4 clay) with pH of (8.0 and 8.1) and Ec of (3.34 and 3.45 ds/m) in 1st and 2nd seasons respectively. Soil analysis was done according to the method described by Jackson (1973).

Tested materials

Three organic acids were sprayed with three levels each, which were: humic acid as potassium humate (at 10, 15 and 20 g/ L), boric acid (at 1, 1.5, 2 g H_3BO_3/ L) and citric acid at (30, 40, 50 mM/ L). Potassium humate contained of 90.0% humic acid, 20.0% fulvic acid, 92.0% organic matter and 8.0% potassium (on dry basis). The three acids were obtained from Al-Gomhoria Company for Chemical and Glasses, Cairo, Egypt. All treatments were applied three times at two-week intervals.

Sampling and determined traits, at harvesting time

1- Disease severity% was ranged from 0 to 9 (death of older leaves and leaf spot progression to inner leaves) as modified scale of **Shane and Teng (1992)**. After15 days of the last treatment disease severity were recorded.

2- Efficacy % were determined according to the following equation

$$\text{Efficacy \%} = \frac{C-T}{C} x100$$

Where C = Control, T = Treatment

The following quality traits were determined in the Quality Control Laboratory at Alexandria Sugar Factory, Alexandria, Egypt.

3- Sucrose % (pol %) was polarimaterically determined using the pol method described in **A.O.A.C. (2005)**.

4- Purity percent was determined as described by **Carruthers and Oldfield (1962)**.

5- Sugars lost to molasses % (SLM %) was calculated according to the equation of **Devillers (1988)**:

SLM% = 0.14 (Na + K) + 0.25 (α-amino N) + 0.50

6- Sugar loss % and sugar yield losses/fed (ton).

At harvest, 10 guarded plants from each plot were uprooted, topped and weighed to determine.

7- Root diameter (cm).

8- Root and foliage fresh weights/plant (g).

9- Root yield/fed (ton): sugar beet roots per plot were weighed in kg and converted into tons per feddan.

10- Sugar yield/fed (ton) was calculated according to the following equation as described by **Mc Ginnus (1971)**:

Sugar yield/fed (ton) = root yield/fed (ton) × gross sugar %.

11- Impurities in terms of Alpha-amino-N, Na and K (meq/100 g beet) were determined in the lead acetate extract of fresh macerated root tissue using "Flame photometry" method as described by **Brown and Lilliand (1964),** while alpha amino-N content was determined using "ninhydrin hydrindantin" method according to the method of **Cooke and Scott (2006)**.

Endogenous Phytohormones

Endogenous phytohormones were quantitatively determined in scion shoots after 90 days from sowing. The method of **Koshioke *et al.* (1983)** was used for HPLC {High- Performance Liquid Chromatography} determination of auxin (IAA), gibberellic acid (GA_3), abscisic acid (ABA) and Cytokinins were determined by HPLC according to the technique of **Nicander *et al.* (1993)**.

Extraction procedure

For hormonal analysis, 10 g of the fresh weight of leaves were cut into small pieces and macerated, extracted twice with 96 % methanol, then twice with 40 % methanol, each for 24 hours **(Shindy and Smith, 1975)**. The methanolic extract was filtered and evaporated in a rotary evaporator at 40 Cº to an aqueous solution. The solution was adjusted to a pH of 6.8 and extracted 4 times with 100 ml ethyl acetate. The alkaline ethyl acetate solutions were mixed together and purified with a hydrous sodium sulphate (one teaspoon / 100 ml). The ethyl acetate fraction was filtered and evaporated to dryness; the residue was dissolved in 4 ml absolute methanol. This extraction was used for determination of cytokinin, according to the method of **Nicander *et al.* (1993)**. The aqueous solution was acidified to a pH of 2.6-2.8 and extracted as described above. This extraction was used for the determination of gibberellic acid (GA_3), indole-3-acetic acid (IAA), abscisic acid by HPLC according to the methods described by **Koshioke *et al.* (1983)**. The identification of phytohormones was accomplished by comparing the peaks retention times with the retention times of authentic substances. The quality of individual plant hormones was determined by comparing the peak area produced by a known weight of the plant material with the standard curves of the authentic substances which expressed the relation between the different concentration and their peak areas. All results for endogenous phytohormone were calculated as µg/100 g fresh weight.

Photosynthetic pigments

Chlorophyll a, b, and carotenoids were calorimetrically determined in leaves of sugar beet plants at 90 days after growing time according to the methods described by **Wettstein (1957)** and calculated as mg/g fresh weight.

Statistical analysis

The obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for randomized complete block design as shown by **Gomez and Gomez (1984)** using (MSTAT-c) computer software package. Least significant difference (LSD) method was used to check the differences between treatment means at 5% level of probability as described by **Snedecor and Cochran (1982)**.

RESULTS AND DISCUSSIONS

1- Effect of organic acid on disease severity and efficacy of cercospora leaf spot

Data in Table 1 showed that disease severity of Cercospora leaf spot% was significantly reduced by all tested treatments of the three acids, compared to the control, in both seasons. The results indicated that disease severity was 0.3 to 6.0% compared to that recorded in un-treated plots (control), in the first season, corresponding to 3.0% to 8.0%, in the second one. It was found that applying humic acid at the rate of 20 g/ L resulted in the lowest disease severity% *i.e*, (0.3 and 3.0%), it had the highest efficacy% (98.8 and 88.9%) in suppressing Cercospora leaf spot (CLS) occurrence on tops of the susceptible Oscarpoly cultivar, in both seasons, compared to the other treatments (Table 1). On the other hand, the lowest CLS severity% was recorded by the highest rate of each of humic, boric and citric acids.

Table 1. Effect of the spraying organic acids on disease severity and efficacy of leaf spot of sugar beet in the two growing seasons

Treatment	Concentration	2018/2019 season		2019/2020 season	
		Disease severity %	Efficacy %	Disease severity %	Efficacy %
Humic Acid	10 g/l	2.0	92	5.0	81.48
	15 g/l	1.5	94	4.0	85.19
	20 g/l	0.3	98.8	3.0	88.89
Boric acid	1.0 g/l	6.0	76	7.0	74.10
	1.5 g/l	5.7	77.2	6.0	77.78
	2.0 g/l	2.0	92	6.7	77.78
Citric acid	30 mM/l	6.0	76	8.0	70.37
	40 mM/l	4.0	84	7.0	74.10
	50 mM/l	4.0	84	6.7	77.78
Control	without	25.0	-	27.0	-
LSD at 5% level		**0.938**	-	**0.415**	-

2- Effect of organic acid on photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids)

Data in Table 2 manifested that chlorophyll a, chlorophyll b, and carotenoids content in leaves were significantly affected by spraying acids levels. Spraying beet plants with 15 g/ L humic acid resulted in the highest values of these traits in 1st season only compared to the other organic acids levels. However, the differences in those traits failed to reach the level of significance in the 2nd season in their effect on photosynthetic pigments in leaves. This result could be deduced that the elevated chlorophyll a, b and carotenoids contents in leaves is likely related to a higher nutrient uptake due to humic acid and, leading to enhance many biochemical processes, among them photosynthesis in leaves.

The increase in photosynthetic pigments in leaves may be due to citric acid is one of a series of the compound involved in physiological oxidation of protein and carbohydrates to CO_2 and water hence, a means of defense for plants for any unfavorable conditions.

Table 2. Effect of sparying of organic acids on photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) of sugar beet in the two growing seasons

Treatments	Concentrations	Chlorophyll a (mg/g leaf fresh weight) 1st season	Chlorophyll a 2nd season	Chlorophyll b 1st season	Chlorophyll b 2nd season	Carotenoids 1st season	Carotenoids 2nd season
Humic acid	10 g/l	2.97	3.08	1.13	1.20	1.48	1.60
	15 g/l	4.41	4.52	2.62	2.69	1.84	1.96
	20 g/l	3.86	3.97	2.53	2.60	1.38	1.50
Boric acid	1.0 g/l	2.97	3.08	1.96	2.03	1.20	1.32
	1.5 g/l	3.03	3.14	2.13	2.20	1.57	1.69
	2.0 g/l	3.01	3.12	2.00	1.73	1.31	1.43
Citric acid	30 mM/l	2.84	2.95	1.81	1.88	1.17	1.49
	40 mM/l	3.18	3.50	1.61	1.68	1.26	1.38
	50 mM/l	3.28	3.50	2.23	2.30	1.37	1.49
control	Without	1.79	1.90	0.81	0.91	0.74	0.86
LSD at 5% level		**0.08**	**NS**	**0.22**	**NS**	**0.31**	**NS**

3- Effect of organic acid on endogenous phytohormones

The results in Table 3 revealed that the phytohormones gibberellins, auxins, cytokinin's and abscisic were significantly affected by the used three acids in both seasons. Application of 15 g humic/ L resulted in a pronounced increase in levels of abscisic compared to the rest of the used levels of humic acid. This finding is in line with **Abbas (2013)**. likewise, gibberellins, and cytokinin's positively responded to fertilizing beet plants some citric/ L, where were recorded a significant increase in levels of these Endogenous phytohormones in both seasons. These findings may point to the important roles of humic, boric and citric acids to improve the morphological and metabolically performances of the sugar beet plant, which promote most growth aspects (growth promoters, auxins, gibberellin and cytokinin) were significantly affected and achieved a positive increased as a result to spraying these acids. These favorable effects of humic, boric and citric acids were mentioned by those **Muscolo *et al.* (1999); Datnoff *et al*. (2007)** and **El-Fawy (2018)** respectively.

Table 3. Effect of spraying of organic acids on endogenous phytohormones of sugar beet in the two growing seasons

Treatments	Concentrations	Endogenous phytohormones (µg/100g f.w) Gibberellins 1st season	Gibberellins 2nd season	Auxins 1st season	Auxins 2nd season	Cytokinin's 1st season	Cytokinin's 2nd season	Abscisic 1st season	Abscisic 2nd season
Humic Acid	10 g/l	183.64	176.09	15.87	21.81	10.27	10.66	0.58	0.82
	15 g/l	218.85	202.68	27.74	27.68	11.39	11.44	1.05	1.03
	20 g/l	187.92	166.50	27.62	15.37	10.49	8.13	1.01	0.80
Boric acid	1.0 g/l	187.95	285.96	13.48	16.03	10.81	9.07	0.82	0.68
	1.5 g/l	415.48	345.33	18.58	18.36	10.69	10.65	0.99	0.78
	2.0 g/l	320.93	251.73	18.13	10.63	10.51	09.37	0.77	0.71
Citric acid	30 mM/l	180.31	237.54	11.12	11.95	10.81	8.44	0.86	0.89
	40 mM/l	218.85	288.90	12.78	15.58	10.86	10.20	0.92	0.77
	50 mM/l	446.61	315.13	18.38	10.75	12.12	11.49	0.97	0.94
control	Without	183.64	188.40	3.12	7.12	4.76	7.79	0.58	0.72
LSD at 5% level		**29.007**	**36.45**	**0.22**	**1.146**	**0.17**	**1.25**	**0.032**	**0.4**

4- Effect of organic acid on root fresh weight (g), diameter (cm) and foliage fresh weight (g)

Results in Table 4 manifested a significant effect of the applied three acids on root diameter and root fresh weight and foliage fresh weights/plant. Spraying sugar beet plants with 15 and/or 20 g/l humic acid recorded a significant increase in values of root diameter and foliage weights/plant compared to the lowest dose of humic acid. This increase in growth traits of sugar beet by increasing humic acid levels may be attributed to its effect on providing plant with a determined dose of essential nutrients and trace elements, which enhancing growth, nutrient uptake, hence leaf canopy of sugar beet plants which was affected by the level of humic acid **(Zaky *et al.*, 2006).**

Fertilizing beet plants with 1.5 and/or 2 g/ L boric acid significantly increase root diameter compared to untreated plants in both seasons, while supplying beet plants with 1.5 g/ L gave the highest values of foliage fresh weight/plant through spraying beet plants by boric acid compared to the other two levels. This finding of boron may point to the important role of boron with respect to sugar accumulation as a transformation catalyst which reflected on root growth. These results are in line with those recorded by **(Datnoff *et al*., 2007**) **.**

Concerning the effect of citric acid levels, the data cleared that the thickest, heaviest roots and the most in the leaves were obtained when sprayed sugar beet with 50 mM/ L citric acid compared to the check treatment (without spraying). This result showed the relative importance of applying citric acid and in agreement with **Maleki, *et al*. (2013)** who explained that foliar spraying of citric acid significantly increased root fresh and foliage weights/plant compared to untreated treatment.

Table 4. Effect of spraying of organic acids on root fresh weight (g), diameter (cm) and foliage fresh weight (g) of sugar beet in the two growing seasons

Treatments		Root fresh weight/plant (g)		Root diameter (cm)		foliage fresh weight /plant (g)	
	Concentration	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Humic Acid	10g/l	1266.7	1207.3	13.1	11.79	323.2	320.29
	15g/l	1366.7	1383.3	13.2	13.47	501.9	501.90
	20g/l	1363.4	1266.6	13.0	13.67	501.7	493.67
Boric acid	1.0g/l	1150.0	912.3	11.8	12.03	290.7	325.33
	1.5g/l	1433.3	1276.6	13.2	13.20	448.3	429.32
	2.0g/l	1416.7	1200.0	12.7	11.73	358.6	323.33
Citric acid	30 mM/l	1950.0	1550.0	11.1	10.83	238.7	276.74
	40 mM/l	2100.0	1725.6	11.6	11.27	315.7	315.79
	50 mM/l	2133.3	1743.3	13.2	13.33	502.2	391.50
Control	without	1016.7	1043.3	10.9	10.33	201.9	225.30
LSD at 5% level		416.6	449.7	1.04	1.58	83.24	58.53

5- Effect of organic acid on sucrose, purity percentages and Sugar lost to molasses %

Results illustrated in table (5) showed that Sucrose, purity percentages and sugar lost to molasses were significantly increased by raising the foliar-applied humic, boric and citric acids in 1st and 2nd seasons. Application of 15 and/or 20 g/ L humic acid attained the highest values of sucrose, purity percentages and sugar lost to molasses%. Moreover, both of 15 and 20 g/ L humic/fed surpassed the check treatment in its impact on these traits in the two growing seasons. This finding agrees with that mentioned by **Jana *et al*. (2005)**.

As the same Table, fertilizing sugar beet with 1.5 and/or 2 g/ L boric acid improved purity in both seasons and gave the highest values of sucrose% in 2nd season, but the effect was more pronounced by adding 1.5 g/ L only superior to that of other doses of boric acid surpassed the other levels of boric acid recording the highest values of sucrose% in 2nd season. This view is in agreement with this concluded by **Enan (2016)**.

Concerning the citric acid effect, results showed that spraying beet plants with 50 mM/l recorded a significantly increase in the values of sucrose and purity percentages, but sugar lost to molasses decreased compared to the other two levels applied of citric acid. This result showed the important role and the desired impact of applying citric acid in sugar beet as an antioxidant.

Table 5. Effect of spraying of organic acids on sucrose, purity percentages and sugar lost to molasses% of sugar beet in the two growing seasons

Treatments	Concentration	Sucrose%		Purity%		Sugar lost to molasses %	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Humic Acid	10g/l	19.35	19.13	89.88	84.98	0.52	0.69
	15g/l	23.29	22.84	90.33	90.32	0.76	0.90
	20g/l	22.96	22.38	90.24	90.32	0.72	0.65
Boric acid	1.0g/l	20.43	18.91	83.32	86.67	0.86	0.74
	1.5g/l	20.64	22.51	85.00	83.97	1.39	0.97
	2.0g/l	20.18	21.07	84.65	83.28	1.12	0.69
Citric acid	30 mM/l	19.95	19.03	86.64	84.32	0.73	1.01
	40 mM/l	21.26	19.72	86.98	83.65	1.21	1.16
	50 mM/l	22.62	22.67	89.99	87.32	1.37	1.30
Control	Without	16.51	17.57	79.30	79.51	0.52	0.99
LSD at 5% level		**1.09**	**1.26**	**3.00**	**2.83**	**0.50**	**0.40**

6- Effect of organic acid on potassium, sodium and alpha-amino N contents

Data presented in table (6) showed that impurities were significantly affected by organic acid during the two growing seasons. Fertilizing sugar beet with 10 g/ L humic acid led to the lowest values of alpha-amino N content compared to other levels in both seasons. At the same time, it was found that supplying beets with 15 g/ L attained the highest values of sodium and potassium contents in both seasons. This finding is in accordance with that mentioned by **Abdel Mawgoud *et al.* (2007)**.

Results in the same Table revealed that the application of 1.5 g/ L boric acid produced the highest values of alpha-amino N and potassium contents being (2.12 and 2.10 meq/100 g beet) and (6.22 and 6.49 meq/100 g beet) For both of them in the first and second seasons, respectively. On the other hand, the highest value of sodium content was recorded in the first season only by spraying plants with the same rate compared to other levels of boric acid. This result is in agreement with that reported by **Enan (2011)** who indicated that boron application promoted the formation of new leaves on sugar beet plants thus might be responsible for higher foliage and root in plants grown under boron application treatments. There was an increase in foliage yield of sugar beet with the ascending the level of applied boron over that untreated plant's

As for the citric acid effect, data showed that raising citric acid levels from 30 up to 50 mM/l resulted in a significant reduction in values of alpha-amino N, sodium and potassium contents in both seasons compared to those gained 30 mM/l citric acid in both seasons.

Table 6. Effect of spraying of organic acids on potassium, sodium and alpha-amino N contents of sugar beet in the two growing seasons

Treatments	Concentration	Alpha- amino N content (meq/100 g beet)		Sodium content (meq/100g beet)		Potassium content (meq/100 g beet)	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Humic Acid	10 g/l	2.01	1.77	1.46	1.37	4.50	4.23
	15 g/l	2.27	2.02	2.63	2.51	6.22	6.49
	20 g/l	2.03	2.03	2.43	1.51	4.95	4.97
Boric acid	1.0 g/l	1.92	1.88	2.03	2.07	5.37	5.72
	1.5 g/l	2.12	2.10	2.91	1.51	6.36	6.38
	2.0 g/l	2.01	2.10	1.46	2.49	5.83	6.07
Citric acid	30 mM/l	2.01	1.99	2.15	2.13	5.54	5.64
	40 mM/l	2.04	1.98	1.57	1.65	5.13	6.38
	50 mM/l	2.16	1.99	2.28	2.49	6.17	6.47
Control	Without	2.43	2.44	3.15	3.59	6.99	6.79
LSD at 5% level		**0.25**	**0.26**	**0.98**	**0.74**	**0.61**	**0.32**

Effect of organic acid on root, sugar yields/fed, and sugar

Root and sugar yields/fed were significantly affected by the applied three acids in the two growing seasons according to Table 7. Supplying sugar beet with 15 g/ L humic acid led to an increase in the root, sugar yields/fed amounted to 1.25- and 0.26-tons roots/fed and 1.13- and 0.85-tons sugar/fed in 1st and 2nd seasons, respectively compared to that gained by fertilizing beet with 10 g/ L humic acid in both seasons. This result may be due to the positive impacts of humic acids on the plant growth and nutrient contents of plants. The favorable effect of humic substance on yield was reported by **Abdel Mawgoud *et al*. (2007)**.

As for, fertilizing sugar beet plants with 1.5 g/ L boric acid gave the highest values of root and sugar yields/fed in both seasons amounted to 1.67, 1.29 -ton roots/fed and 0.18, 1.02 -ton sugar/fed, compared with the lowest dose of boric acid (1 g/ L) in the 1st and 2nd seasons, respectively. These results were mainly due to the enhanced role of boron element on photosynthesis translocation from leaves to roots **(Enan *et al*., 2016)**.

In the same Table, results showed that raising citric acid levels from 30 up to 50 mM/ L resulted in a significant increase in values of root and sugar yields/fed. spraying beet plants with 50 Mm/l citric acid gave (1.3, 2.7 tons roots) and (0.84, 1.68 ton sugar) increases in root and sugar yields/fed compared to that those gained 40 mM/l in 2018/2019 season and 2018/2019 season respectively. This finding is in accordance with that mentioned by **(Abd-Allah *et al.*, 2007)**.

Generally, it was found that root and sugar yields/fed were increased by spraying beet plants with a combination of 15g/ L humic acid, 1.5 g/ L boric acid and 50 mM/ L citric acid in both seasons.

Table 7. Effect of spraying of organic acids on root, sugar yields/fed, of sugar beet in the two growing seasons

Treatments		Root yield/fed (ton)		Sugar yield/fed (ton)	
	Concentration	2018/2019	2019/2020	2018/2019	2019/2020
Humic acid	**10 g/l**	21.35	21.29	4.13	4.07
	15 g/l	22.60	21.55	5.26	4.92
	20 g/l	22.27	20.22	5.11	4.52
Boric acid	**1.0 g/l**	19.43	20.52	3.96	3.88
	1.5 g/l	21.10	21.81	4.14	4.90
	2.0 g/l	18.77	19.88	3.78	4.18
	30 mM/l	36.67	35.88	7.31	6.82
Citric acid	**40 mM/l**	37.02	36.24	7.87	7.14
	50 mM/l	38.32	38.94	8.71	8.82
Control	**Without**	19.23	19.82	3.17	3.48
LSD at 5% level		**1.02**	**1.45**	**1.35**	**0.62**

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