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Effect of Ascorbic and Humic Compounds Pre-Treatment on Growth Characteristics of Some Sugarcane Varieties under Salinity Stress

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SUGARCANE (*Saccharum* spp.) shows high sensitivity to salinity at various growth stages. A pot experiment was conducted at the Agricultural Research Center, Giza (latitude of 28.76 ^{0}N and longitude of 29.23 ^{0}E) under natural conditions in November 2015/2016 and 2016/2017. The present work was carried out to find out the influence of four soaking treatments (without soaking, tap water, ascorbic and/or humic acid) and three levels of salt stress (tap water, 3000 and 6000ppm NaCl) on some growth traits of three sugarcane varieties (*viz.* G.84-47, G.2003-47 and G.2003-49). The concentration of both ascorbic and humic acid was 1.0mM. After soaking in ascorbic and/or humic acids, five pieces of 2-budded sets were grown in plastic pots (45x50cm) containing soil of clay mixed with sand at 2:1.

Emergence %, growth measurements (stalk height, stalk diameter, leaf area, stalk fresh weight, stalk dry weight, root fresh weight, root dry weight, total chlorophyll and proline content) were recorded. The results indicated that increasing salinity levels under all soaking treatments was accompanied with a gradual reduction in all studied traits of the evaluated sugarcane varieties, except proline content, which showed an opposite trend.

Under conditions of this work, the commercial G.84/47 cane variety showed higher tolerance to raising salinity level up to 6000ppm in irrigation water over the other two ones. Meanwhile, soaking cane cuttings of the tested varieties in ascorbic and/or humic acids can be recommended to improve their growth traits when canes irrigated with saline water.

Keywords: Ascorbic acid (AsA), Humic acid (HA), Proline, Salinity, Sugarcane.

Introduction

Salinity is an ever increasing environmental problem and is a substantial resistant to agriculture. The amount of salt affected land in Egypt is estimated to be 30% of the total land mass. High salt levels in soil results in hyper osmolarity ion disequilibrium, nutrient imbalance and reactive oxygen species, leading to plant growth retardation through molecular damage. The induction of salt tolerance in plants is crucial to maintain their economic yield. Plant growth regulating compounds is an efficient and technically simple approach to cope with the deleterious effects of salinity on plants. If the endogenous levels of growth regulators became low, it can be overcome by their exogenous application. Exogenous application of plant growth regulators has been successfully used to minimize the adverse effects of salinity on plant growth and yield (Tuna et al., 2008 and Kaya et al., 2010). Ascorbic acid (AsA) is regarded as one of the most effective growth regulators against abiotic stresses. Moreover, it does not only act as an antioxidant but also the cellular levels of AsA are correlated with the activation of complex biological defense mechanisms. Using of ascorbic acid not only alleviates the inhibitory effects of salt stress, but also induces the stimulatory effect on certain growth parameters (Anitha et al., 2015). On the other hand, humic acid hydrophilic groups increase soil water retention capacity (Stevenson, 1994), but application of biofertilizers, humic acid can be effective without environment destructive impact particularly under variable environmental conditions. Furthermore, application of AsA and HA may result in a significant increment of growth and yield. Sugarcane is moderately sensitive to

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salinity with reduced crop yield and quality under saline conditions (Saxena et al., 2010 and Welson et al., 2016). Anitha et al. (2015) found that CoC 24 cane variety displayed higher tolerance to NaCl than CoC 671. Also, stalk, root length and leaf area decreased in both varieties, while proline content increased under conditions of various level of salinity (0, 150 and 200mMNaCl). Also, (Welson et al., 2016) used six levels of salinity (0, 1.0, 2.0, 4.0, 6.0 and 8.0dS m^{-1}) and ten sugar cane varieties. They found that plant height, stem diameter, stalks, leaf area and fresh and dry mass of the aerial part and roots were reduced as soil salinity increased.

Therefore, this work was conducted to explore newer approaches and to test whether the application of AsA and HA could be mitigated the adverse effects of salt stress on sugar cane plants or not.

Materials and Methods

A pots experiment was conducted at the Agricultural Research Center, Giza (latitude of 28.76 ^{0}N and longitude of 29.23 ^{0}E) under natural conditions in November 2015/2016 and 2016/2017. The present work included 36 treatments, represent the combinations of three varieties (*viz.* G.84-47, G.2003-47 and G.2003-49), 4 soaking treatments (without soaking and soaking in tap water, AsA and/or HA) and three levels of salt stress (tap water, 3000 and 6000ppm NaCl). The concentration of both ascorbic and humic acid was 1.0mM. After soaking in ascorbic and/or humic acids, fivepieces of 2-budded sets were grown in plastic pots (45x50cm) containing of clay mixed with sand at 2:1, which chemical and physical analysis was E.C (5.30dsm), pH (7.7), Mg^{++} (19mqr^1), Na^+ (11.2mqr^1), K^+ (0.61 mqr^{-1}), HCO_3 (3.72mqr^{-1}) and Cl^- (12.4mqr^{-1}). Humic was added as "potassium humate".

The statistical layout of the experiment was split split block design, where salt concentrations occupied the main plots, soaking treatments and varieties distributed in the sub and sub-sub plots, respectively, in three replicates.

The recorded data

1. Bud emergence%= Number of emerged stalks/total number of planted buds.
2. Stalk height (cm).
3. Stalk diameter (cm).
4. Stalk fresh weight (g): Stalks were weighed immediately after uprooting at age of 210 days from planting.
5. Stalk dry weight (g): Stalks were oven-dried at 65^{0}C for 5 days to a consonant dry weight.
6. Root fresh weight (g): Roots were weighed immediately after uprooting, washing with tap water.
7. Root dry weight (g): Roots were oven- dried at 65^{0}C for 5 days to a consonant dry weight.
8. Leaf area (cm^2): Blade area was measured using digital image analysis according to the method of Matthew et al. (2002). Digital image of the leaf blade -Cupertino, ca), image was scanned at dot per inch (100dpi), the blade area was measured using public domain software (scion image version 4.02).
9. Chlorophyll (mg/g): It was extracted in 80% acetone from the leaf samples according to the method of Arnon (1949). Extracts were filtrated and content of total chlorophyll was determined by spectrophotometry at 652nm and it was expressed as mg/g of fresh weight.
10. Proline (µmol/g of tissue): It was determined according to the method of Bates et al. (1973).

Statistical analysis

The collected data were statistically analyzed with one way analysis of variance that computed for each trait according to Steel & Torrie (1980). A combined analysis over the two growing seasons was done according to Gomez & Gomez (1984).Treatment means were compared using LSD at 5% level of probability.

Results and Discussion

Varietal difference

Data in Table 1 reveal that the tested sugarcane varieties differed significantly in all studied traits, which probably referred to their gene make-up. Sugarcane variety G.84-47 had 1.18 and 3.97% higher in leaf area compared with G.2003-47 and G.2003-49, respectively. Similar genotypic differences in leaf area were reported by Abdul Wahid et al. (1997). Besides, growth performance of G.84-47 was better than G.2003-47 and 49 by recording higher stalk height, stalk diameter and chlorophyll with the amount of (0.77 and 2.03cm), (0.13 and 0.17cm) and (0.11 and 0.25mg/g), over G.2003-47 and G.2003-49, respectively.

TABLE 1. Some growth parameters ofthe tested sugarcane varieties (combined over the two growing seasons).

Sugarcane varieties	Emergence %	Stalk height (cm)	Stalk diameter (cm)	Stalk fresh weight (g)	Stalk dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Leaf area (cm^2)	Total chlorophyll (mg/g)	Proline (µmol/g)
G. 2003-49	38.23	40.59	3.13	275.93	67.11	213.92	63.51	145.62	7.74	32.43
G. 2003-47	38.08	41.85	3.17	280.17	68.66	227.26	66.85	147.83	7.88	31.25
G. 84-47	40.12	42.62	3.30	295.64	72.06	231.33	68.56	149.57	7.99	30.71
Mean	38.81	41.69	3.20	283.91	69.28	224.17	66.31	147.68	7.87	31.46
LSD (5%)	0.30	0.52	0.06	1.92	0.81	4.88	1.15	1.66	0.08	0.30

Leaf and root fresh and dry weight showed significantly higher values for G.84-47 than those recorded by G.2003-47 and G.2003-49 varieties. Plants with larger leaf area may have greater production potential due to their higher capacity of intercepting solar radiation and biomass accumulation. This fact was observed in the variety which presented higher production of fresh and dry mass of the aerial part, which positively resulted in an increase in the translocated photoassimilates from leaves to be stored in stalks. Welson et al. (2016) working with ten sugar cane varieties under different levels of salinity and found a significant differences between genotypes in plant height, stem diameter, stalks and sprouts, leaf area and fresh and dry mass of the aerial part and roots.

Effect of salinity

The photosynthetic rate depends upon leaf area and canopy structure, which in turn affects dry matter production. Data in Table 2 indicated that mean values of all determined growth traits were substantially reduced as affected by the gradual increasein the concentration of NaCl salt in root media to 3000 and 6000ppm, as compared with those recorded by irrigating plants with tap water. On the contrary, proline content was increased. Raising salinity level from tap water to 6000ppm resulted in a significant reduction in leaf area and chlorophyllcontent amounted to 53.71 and 22.05%, respectively, which led to a reduction in root fresh and dry weight of 50.12 and 51.56%, which in turn contributed to a reduction in cane stalk fresh and dry weight estimated to be 56.92 and 58.42 % as well as 64.62 and 44.24% reduction in cane stalk height and diameter, successively. These results could be primarily due to the fact that besides reducing total biomass, salinity stress also affects the sink growth. Leaf area and stalk height are highly correlated to yield. The resistant genotypes performed better because of high leaf area and stalk height. The obtained findings are also in accordance with those of (Muniaswamy, 1998 and Nasir et al., 1999), who mentioned that, unlike other crops, yield of sugar cane is directly related the vegetative growth as the stalks are main components for yield, hence yield of sugar cane is determined by stalk height, cane diameter and single cane weight which are highly influenced by soil, genetic and environmental factors.

Gmathi et al. (2014) mentioned that the endogenous level of free proline increased to the tune of 45.18% under salinity condition. In many plants, free proline accumulates in response to the imposition of a wide range of biotic and abiotic stresses. High levels of proline synthesized during stress conditions and also maintain the NAD (P) +/NAD (P) H. (Singh et al., 2014).

Effect of soaking treatments

The results in Table 3 revealed that the determined growth traits of sugarcane were significantly influenced by the used soaking treatments. It was found that soaking cane cuttings in tap water, ascorbic or humic acid caused an increase in the percentage of emerged buds amounted to 2.00, 11.01 and 12.41%, compared to that detected in un soaked cane setts (control), successively. These results are in line with those reported by Hsia (1972) and Alexander (1973), who mentioned that, the act of soaking seed pieces in water or chemical solutions promoted bud emergence. In addition,

Yang & Hsieh (1977) stated that soaking of seed materials is an effective way of promoting germination. Young & Hsieh (1977) added that the ability to germinate was closely related to the rate of inversion of sucrose (di-saccharide) into mono-saccharides sugar (glucose and fructose) and that the higher the inversion rate, the quicker the germination. Moreover, LO & Yang (1981), explained that soaking seed canes in running or large volumes of water resulted in the leaching of growth and germination inhibitors, thus enhancing germination (as the number of sprouts from each pot over total of buds planted).

The results in Table 3 pointed to an appreciable increase of 3.43, 22.78 and 24.97% in stalk height and 8.30, 25.63 and 28.15% in stalk diameter, which contributed to increasing stalk fresh weight by 13.06, 31.23 and 34.99% and stalk dry weight by 8.77, 27.54 and 27.62%, in response to soaking cane setts in tap water, AsA and HA, in comparison with the check treatment, respectively. These results were probably the increase in leaf area by 7.54, 14.54 and 19.78% and chlorophyll content 2.88, 26.86 and 23.91% as affected by soaking cane setts in tap water, ascorbic and humic acids, compared to those un-treated, successively (Table 3). These results may be attributed to the physiological role of leaves as a source in manufacturing assimilates translocated to the sink, i. e., cane stalks. However, proline content showed an opposite trend and tended to decrease by 5.77, 15.96 and 16.82%, in response to soaking cane cuttings in tap water, ascorbic and humic acids, compared to the control, indicating that soaking treatments had a mitigating influence of salinity. Junior et al. (2008) cleared that the effects of humic acids are reflected in root growth, being observed of the surface area, height and dry mass of the root system and also increase over the vegetal biomass. The obtained results are also in accordance with Fahramand et al. (2014), who found a beneficial effect of humic substances, represented in promoting greater foliage area in the end of the tillering periods. In addition, Olinik et al. (2011) assured that this biostimulants, i. e., HA increase all characteristics analyzed being height, fresh mass of the shoot and root.

TABLE 2. Effect of salinity on some growth parameters of sugar cane (combined over the two growing seasons).

Salinity concentrations	Emergence %	Stalk height (cm)	Stalk diameter (cm)	Stalk fresh wight (g)	Stalkdryweight (g)	Root fresh weight (g)	Root dry weight (g)	Leaf area (cm^2)	Total chlorophyll (mg/g)	Proline (µmol/g)
Control	48.05	57.98	3.91	375.72	93.39	271.03	80.62	193.11	8.57	21.40
3000ppm	41.39	46.57	3.51	314.18	75.62	266.31	79.25	160.53	8.37	32.90
6000ppm	26.98	20.51	2.18	161.83	38.83	135.17	39.05	89.39	6.68	40.09
Mean	38.81	41.69	3.20	283.91	69.28	224.17	66.31	147.68	7.87	31.46
LSD (5%)	0.18	0.87	0.06	2.16	0.68	5.09	1.14	2.25	0.16	0.23

TABLE 3. Effect of soaking treatments on growth parameters for sugar cane varieties.

Soaking treatments	Emergence %	Stalk height (cm)	Stalk diameter (cm)	Stalk fresh weight (g)	Stalk dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Leaf area (cm^2)	Total chlorophyll (mg/g)	Proline (µmol/g)
Control	36.49	36.96	2.77	236.94	59.73	205.06	61.08	135.26	6.94	34.82
Water	37.22	38.23	3.00	267.89	64.97	204.79	60.68	145.46	7.14	32.81
AsA	40.51	45.38	3.48	310.96	76.18	238.84	70.25	154.94	8.81	29.26
HA	41.02	46.19	3.55	319.85	76.23	247.99	73.22	155.04	8.60	28.96
Mean	38.81	41.69	3.20	283.91	69.28	224.17	66.31	147.68	7.87	31.46
LSD (5%)	0.26	0.77	0.07	3.33	0.95	4.89	1.66	1.76	0.10	0.24

Effect of the interaction

Effect of the interaction between variety and salinity level

Data in Table 4 manifest that, except stalk height and total chlorophyll, the other growth traits were significantly influenced by the interaction between cane variety and salinity levels. The results cleared that bud emergence % of both G.2003-49 and G.2003-49 was similarly and sharply depressed, when they were irrigated with water contained 6000ppm NaCl, compared to the control. Although the emergence % of the commercial variety G.84-47 was negatively affected at the highest salinity level, it recorded higher value compared with the other two cane varieties, indicating that G.84-47 variety had more advantage in respect to salinity tolerance. Also, lower reduction in stalk diameter of G.84-47 variety was detected as compared with that recorded by G.2003-49 and/or G.2003-49, which had higher reduction value in this growth trait, at 6000ppm NaCl, compared with values recorded at the check treatment.

There was insignificant variance in root fresh weight (RFW) and root dry weight (RDW) in case of irrigating G.2003-47 and G.84-47 varieties with 3000ppm salt or tap water. Meanwhile, RFW and RDW of G.2003-49 was greatly and significantly reduced by raising salinity level to 3000ppm, compared with tap water. The results showed insignificant difference between G.2003-47 and each of G.2003-49 and G.84-47 in leaf area when they were irrigated with water including 3000ppm NaCl, with a significant variance between G.2003-49 and G.84-47 in this growth character was significant at the same level of salinity.

Insignificant differences between stalk fresh weight (SFW) and stalk dry weight (SDW) of G.2003-49 and G.2003-47 as affected by irrigation water of 6000ppm NaCl. However, the variance between any of the two varieties and the commercial variety G.84-47 was significant at the same salt concentration. It can be noticed that SFW and SDW of G.84-47 was the least affected by the highest salinity level, since it recorded the highest values of these two traits, compared with the other two cane varieties.

TABLE 4. Effect of the interaction among sugarcane varieties and salinity concentrations on growth parameters (combined over the two growing seasons).

Sugarcane varieties	Salinity concentrations	Emergence %	Stalk height (cm)	Stalk diameter (cm)	Stalk fresh weight (g)	Stalk dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Leaf area (cm^2)	Total chlorophyll (mg/g)	Proline (µmol/g)
	Control	46.99	56.85	3.89	365.83	89.93	261.27	78.00	187.88	8.48	21.28
G.2003-49	3000ppm	41.02	45.43	3.47	303.54	73.60	249.75	74.62	159.25	8.22	32.73
	6000ppm	26.69	19.50	2.04	158.42	37.80	130.73	37.91	89.75	6.53	43.29
	Control	47.43	58.44	3.89	366.75	93.63	275.62	81.38	195.08	8.54	21.52
G.2003-47	3000ppm	40.32	46.70	3.53	315.00	74.80	270.21	81.38	160.04	8.41	33.27
	6000ppm	26.49	20.42	2.08	158.75	37.56	135.94	37.81	88.38	6.69	38.95
	Control	49.75	58.65	3.95	394.58	96.60	276.19	82.50	196.38	8.69	21.39
G.84-47	3000ppm	42.85	47.58	3.53	324.00	78.45	278.96	81.75	162.29	8.46	32.70
	6000ppm	38.81	47.58	2.42	168.33	41.12	138.85	41.44	90.04	6.81	38.05
Mean		38.81	41.69	3.2	295.64	72.06	231.33	68.56	149.57	7.99	30.71
LSD (5%)	V x S	0.51	N.S	0.11	3.33	1.41	8.45	1.99	2.87	N.S	0.52

The results in Table 4 point to insignificant variance between proline contents in G.2003-49 and G.84-47 varieties irrigated with water contained 3000ppm NaCl, while the two varieties differed markedly with G.2003-47 in this trait. In addition, it was found that G.2003-49 variety had the highest content of proline at 6000ppm NaCl, while the commercial G.84-47 variety contained the lowest value, indicating that the first was relatively the most sensitive, while the latter was the most tolerant one to salinity.

Effect of the interaction of variety x soaking treatments

Data in Table 5 reveal that the interactions among cane varieties and pre-soaking treatments markedly affected emergence%, stalk height (SH), stalk diameter (SD), stalk fresh weight (SFW), soot dry weight (SDW) and proline content. Meantime, root fresh weight, leaf area and chlorophyll content were insignificantly influenced.

The results elucidated that soaking cuttings of both G.2003-49 and 2003-47 cane varieties in tap water before planting resulted in a positive and significant increase in their bud emergence % compared with those un-soaked ones (control), while the difference in emergence % of the commercial G.84-47 variety was insignificant as affected by these two soaking treatments. Moreover, G.2003-49 and 2003-47 varieties appreciably responded to the soaking pre-treatment in ascorbic and humic solutions, recording higher emergence percentages by soaking their seeds in the second one. However, emergence % of G.84-47 variety was not influenced by soaking in ascorbic and/or humic acids.

Soaking seeds of both G.2003-47 and G.84-47 varieties in tap water resulted in a significant increase in SH in comparison to the control, while SH of G.2003-49 was not affected. Meantime, the variance between ascorbic and humic acids was insignificant in its effect on SH of G.2003-49 and G.2003-47, while SH of G.84-47 variety was significantly higher as a result of soaking in humic acid solution.

TABLE 5. Effect of the interaction among soaking treatments and sugarcane varieties on growth parameters (combined over the two growing seasons).

Varieties	Soaking treatments	Emergence %	Stalk height (cm)	Stalk diameter (cm)	Stalk fresh wight (g)	Stalk dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Leaf area (cm^2)	Total chlorophyll (mg/g)	Proline (µmol/g)
G.2003-49	Control	35.41	35.89	2.68	220.00	56.49	196.97	58.50	135.0	6.70	36.24
	Water	36.33	35.93	2.97	259.11	63.53	197.42	58.80	142.5	7.04	34.24
	AsA	40.32	45.03	3.44	314.89	76.39	225.39	66.75	151.39	8.75	29.51
	HA	40.87	45.52	3.44	309.72	72.04	235.89	70.00	153.61	8.49	29.76
G.2003-47	Control	35.70	37.04	2.08	240.28	60.5	207.08	61.25	135.39	6.98	34.55
	Water	36.64	39.33	2.98	265.67	64.11	204.58	60.0	145.5	7.1	31.98
	AsA	39.7	45.4	3.29	303.06	74.47	244.89	73.00	155.5	8.82	29.53
	HA	40.28	45.64	3.60	311.67	75.57	252.47	73.17	154.94	8.63	28.93
G.84-47	Control	38.37	37.94	2.82	250.56	62.21	211.11	63.50	135.39	7.14	33.68
	Water	38.71	39.42	3.06	278.89	67.28	212.36	63.25	148.39	7.28	32.23
	AsA	41.52	45.69	3.72	314.94	77.67	246.25	71.00	157.94	8.86	28.73
	HA	41.89	47.42	3.61	338.17	81.08	255.61	76.50	156.56	8.68	28.21
Mean		40.12	42.62	3.30	283.91	69.28	224.17	66.31	147.68	7.87	31.46
LSD (5%)	V x T	0.45	1.33	0.12	5.77	1.65	N.S	2.88	N.S	N.S	0.41

The results showed that the difference between ascorbic and humic acids in their influence on SD of G.2003-49 and G.84-47 varieties was insignificant, but soaking seeds of G.2003-47 in humic acid solution resulted significantly in thicker stalks, compared with soaking in ascorbic acid.

Soaking cane setts of both G.2003-47 and G.84-47 varieties in humic acid solution resulted in higher significant increase in SFW compared with those soaked in ascorbic acid. However, the difference between these two acids was insignificant in its influence on SFW of G.2003-49.

The results cleared that difference between the pre-planting soaking of cane cuttings of G.2003-49 and G.84-47 varieties in ascorbic and humic acids was significant in their effect on SDW, without an appreciable influence on SDW of G.2003-47 due to the two acids. Similar results were obtained concerning the effect of the same interaction on root dry weight.

The difference between ascorbic and humic acids was insignificant in their influence on proline content of G.2003-49 variety, but the difference between these two acids reached the level of significance in their effect, with higher values of this trait in response to soaking cuttings of G.2003-47 and G.84-47 varieties in ascorbic acid.

In general, it can be noticed that soaking cane cuttings of the tested varieties in ascorbic and/or humic acids resulted in recording higher and significant increases in the studied traits, compared with those soaked in tap water and the control.

Effect of the interactions among soaking treatments and salinity concentrations

Data in Table 6 clear that the interaction among soaking treatments and salinity concentrations significantly affected the determined growth traits of sugarcane, except root dry weight.

Insignificant difference in each of emergence % and root fresh weight, was detected,when cane cutting were soaked in AsA and/or HA and irrigated with water containing 3000ppm NaCl. However, the difference in this trait between AsA or HA and the other soaking treatments was significant, at the same salinity level. Similar results were found for cane stalk height and diameter, leaf area and proline content, at the highest salinity level, i. e., 6000ppm NaCl, in case of soaking seeds in AsA and/or HA.

The ascendant increase in stalk fresh weight (SFW) recorded at the lowest salinity level, i. e., tap water, as cane cutting were soaked in water, AsA acid and HA, respectively show that importance and positive role of these soaking substances. However, values of SFW were gradually decreased, under all of soaking treatments, as salinity level was raised.

Insignificant difference in stalk dry weight (SDW) was noticed at 6000ppm NaCl as a result of soaking cane setts in water or left without soaking. However, the difference in SDW between any of two soaking treatments and the other ones was significant, at the same level of salinity.

The results pointed to insignificant difference in chlorophyll content in case of soaking cane cuttings in water or AsA acid and irrigation with water contained 6000ppm NaCl, while the variance between these two soaking treatments and the others was significant at the same level of saline water.

Effect of the second order interaction among the studied factors

Data in Table 7 show that cane growth characters were significantly affected by the second order interactions among the studies factors, except stalk height and leaf area.

Regardless the level of significance, an over view on this interaction show that increasing salinity levels under all soaking treatments was accompanied with a gradual and distinguished reduction in all studied traits of the evaluated cane varieties, except proline content, which showed an opposite trend. These results indicate that salinity level of irrigation water was the principal effective factor on cane growth traits. On the other hand, it seemed that soaking cane cuttings in AsA and/or HA relatively improved values of the studied traits,which may be due to relieving the negative influence of raising salinity level (Table 7).

TABLE 6. Effect of the interaction among soaking treatments and salinity concentrations on growth parameters of sugarcane (combined over the two growing seasons).

Soaking treatments	Salinity concentrations (ppm)	Emergence %	Stalk height (cm)	Stalk diameter (cm)	Stalk fresh weight (g)	Stalk dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Leaf area (cm^2)	Total chlorophyll (mg/g)	Proline (µmol/g)
	Control	46.19	50.58	3.26	311.94	79.66	255.28	76.50	175.61	7.13	25.9
Control	3000ppm	38.98	41.98	3.03	263.33	65.58	244.72	73.00	142.83	7.05	34.82
	6000ppm	24.31	18.31	2.00	135.56	33.96	115.17	33.75	87.33	6.64	43.75
	Control	46.94	52.06	3.69	352.89	87.17	255.42	76.00	195.33	7.28	22.23
Water	3000ppm	39.03	44.11	3.41	299.44	72.86	245.83	72.50	152.56	7.32	35.22
	6000ppm	25.70	18.52	1.91	151.33	34.88	113.11	33.55	88.50	6.82	40.99
	Control	49.44	62.58	4.42	413.06	106.72	282.19	83.00	200.00	9.99	18.78
AsA	3000ppm	43.71	51.54	3.57	343.67	79.75	286.33	84.00	174.17	9.69	31.22
	6000ppm	28.38	22.01	2.46	176.17	42.06	148.00	43.75	90.67	6.74	37.76
	Control	49.65	66.69	4.27	425.00	100.00	291.22	87.00	201.5	9.88	18.68
HA	3000ppm	43.86	48.66	4.03	350.28	84.28	288.33	87.50	172.56	9.41	30.34
	6000ppm	29.54	23.22	2.35	184.28	44.42	164.42	45.17	91.06	6.51	37.87
Mean		41.02	46.19	3.55	319.85	76.23	247.99	73.22	155.04	8.60	28.96
LSD (5%)	T x S	0.45	1.33	0.12	5.77	1.65	8.47	N.S	3.04	0.18	1.41

TABLE 7. Effect of the interaction among sugarcane varieties, soaking and salinity treatments on its growth parameters (combined over the two growing seasons).

Varieties	Soaking treatments	Salinity treatments	Emergence %	Stalk height (cm)	Stalk diameter (cm)	Stalk fresh weight (g)	Stalk dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Leaf area (cm^2)	Total chlorophyll (mg/g)	Proline (µmol/g)
G.2003-49	Control	Control	44.53	49.75	3.21	300.00	76.67	256.67	76.5	173.33	7.03	25.64
		3000ppm	38.02	41.33	3.02	238.33	60.83	227.5	67.5	143.33	6.96	34.24
		6000ppm	23.68	16.58	1.83	121.67	31.96	106.75	31.5	88.33	6.09	48.83
	Water	Control.	45.20	49.25	3.62	341.67	85.50	241.25	72.00	186.67	7.28	22.31
		3000ppm	38.46	41.50	3.48	285.00	71.33	240.83	72.00	151.00	7.26	35.23
		6000ppm	25.32	17.05	1.81	150.67	33.75	110.17	32.40	89.83	6.60	45.17
	AsA	Control	49.07	62.83	4.42	418.33	107.00	274.50	82.50	193.33	9.84	18.08
		3000ppm	43.72	50.42	3.53	344.17	80.42	257.33	75.00	170.00	9.65	31.17
		6000ppm	28.16	21.85	2.37	182.17	41.75	144.33	42.75	90.83	6.75	39.27
	HA	Control	49.17	65.58	4.29	403.33	90.54	272.67	81.00	198.17	9.76	19.10
		3000ppm	43.87	48.48	3.87	346.67	81.83	273.33	84.00	172.67	9.03	30.28
		6000ppm	29.58	22.50	2.17	179.17	43.75	161.67	45.00	90.00	6.69	39.88
G.2003-47	Control	Control	45.17	50.33	3.28	302.5	80.17	251.67	75.00	176.67	7.09	26.17
		3000ppm	38.02	41.77	3.07	283.33	67.25	253.33	75.00	142.33	7.10	35.20
		6000ppm	23.92	19.02	2.03	135.00	34.08	116.25	33.75	87.17	6.75	42.28
	Water	Control	46.33	54.75	3.68	343.67	86.73	258.33	7500	198.33	7.22	21.98
		3000ppm	38.07	44.58	3.31	301.67	72.42	241.67	72.00	152.33	7.22	35.25
		6000ppm	25.51	18.67	1.94	151.67	33.17	113.75	33.00	85.83	6.86	38.7
	AsA	Control	49.08	62.33	4.37	399.17	105.83	289.17	85.50	202.50	10.03	19.32
		3000ppm	42.41	52.38	3.33	343.33	77.83	298.33	90.00	174.17	9.57	32.17
		6000ppm	27.61	21.5	2.18	166.67	39.75	147.17	43.50	89.83	6.85	37.1
	HA	Control	49.12	66.33	4.23	421.67	101.78	303.33	90.00	202.83	9.82	18.61
		3000ppm	42.79	48.08	4.41	331.67	81.68	287.50	88.50	171.33	9.76	30.47
		6000ppm	28.94	22.50	2.15	181.67	43.25	166.58	41.00	90.67	6.30	37.70

TABLE 7. Cont.

Varieties	Soaking treatments	Salinity treatments	Emergence %	Stalk height (cm)	Stalk diameter (cm)	Stalk fresh weight (g)	Stalk dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Leaf area (cm^2)	Total chlorophyll (mg/g)	Proline (µmol/g)
G 84-47	Control	Control	48.88	51.67	3.29	333.33	82.13	257.50	78.00	176.83	7.25	25.88
		3000ppm	40.90	42.83	3.01	268.33	68.67	253.33	76.50	142.83	7.10	35.02
		6000ppm	25.33	19.33	2.15	150.00	35.83	122.50	36.00	86.50	7.06	40.13
	Water	Control	49.29	52.17	3.78	373.33	89.27	266.67	81.00	201.00	7.33	22.41
		3000ppm	40.56	46.25	3.43	311.67	74.83	255.00	73.50	154.33	7.49	35.17
		6000ppm	26.27	19.83	1.98	151.67	37.73	115.42	35.25	89.83	7.00	39.12
	AsA	Control.	50.17	62.58	4.46	421.67	107.33	282.92	81.00	204.17	10.10	18.94
		3000ppm	45.00	51.83	3.86	343.50	81.00	303.33	87.00	178.33	9.84	30.33
		6000ppm	29.38	22.67	2.84	179.67	44.67	152.50	45.00	91.33	6.63	36.92
	HA	Control	50.65	68.17	4.29	450.00	107.67	297.67	90.00	203.5	10.07	18.33
		3000ppm	44.92	49.42	3.81	372.50	89.32	304.17	90.00	173.67	9.42	30.28
		6000ppm	30.10	24.67	2.73	192.00	46.27	165.00	49.50	92.50	6.53	36.03
LSD (5%)		STG	0.78	N.S	0.21	9.99	2.85	14.66	4.99	N.S	0.31	0.71

Conclusion

Under conditions of this work, the commercial G.84/47 cane variety showed higher tolerance to raising salinity level up to 6000ppm in irrigation water over the other two ones(G.2003-47 and G.2003-49). Meanwhile, soaking cane cuttings of the tested varieties in ascorbic and/or humic acids can be recommended to improve their growth traits when canes irrigated with saline water.

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تأثير المعاملة المُسبقة بمركبات الأسكوربيك والهيوميك على صفات النمو لبعض أصناف قصب السكر تحت ظروف الإجهاد الملحي

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قصب السكر محصول حساس بدرجة كبيرة للملوحة فى مراحل النمو المُختلفة، ولذلك نُفِّذت تجربة بالأُصُص فى مركز البحوث الزراعية بالجيزة (دائرة عرض 28.76 درجة شمالاً وخط الطول 29.23 درجة شرقاً) تحت الظروف الطبيعية فى نوفمبر موسمى 2015/2014 و2017/2016 لمعرفة تأثير أربع مُعاملات لنقع عُقل تقاوى القصب قبل الزراعة (بدون نقع، نقع فى ماء الصنبور، نقع فى حمض الأسكوربيك ونقع فى حمض الهيوميك) وثلاثة مستويات من الملوحة لماء الرى (ماء الصنبور، 3000، 6000 جزء فى المليون كلوريد صوديوم) على بعض صفات النمو لثلاثة أصناف من قصب السكر (جيزة 84-47، جيزة 2003-47 و جيزة 2003-49). كان تركيز محلول كلاً من حمض الأسكوربيك والهيوميك (هيومات البوتاسيوم) 0.1 ملليمول. خمس عُقل بكل منها بُرعُمان بعد النقع فى الأسكوربيك والهيوميك لمدة 24 ساعة زُرِعَت فى أُصُص بلاستيكية (50 ×45 سم) مملوءة بتربة طينية مخلوطة برمل بنسبة 1:2.

تم تقدير النسبة المئوية للإنبات ، طول الساق، قطر الساق، مساحة الورقة، الوزن الغض والجاف للمجموع الخضرى، الوزن الغض والجاف للجذر، محتوى الكلوروفيل الكُلّى بالأوراق ومحتوى البرولين.

أوضحت النتائج أن زيادة مستوى الملوحة أدى إلى نقص معنوى لكل صفات نمو قصب السكر المدروسة، فى حين إزداد محتوى النباتات من البرولين– كما دلت النتائج على أن نقع عقل تقاوى القصب فى محلول الأسكوربيك و/أو الهيوميك لم يخفف فقط من تأثير الملوحة، ولكنه أحدث تأثيراً مُحفِّزاً لكل صفات نمو القصب.

تحت ظروف هذا البحث، اعطى الصنف التجارى جيزة 47/84 اعلى تحمل لإرتفاع ملوحة ماء الرى حتى 6000 جزء فى المليون مقارنة بالصنفين الآخرين. يمكن التوصية بنقع عقل تقاوى القصب قبل زراعتها فى محلول من حمض الأسكوربيك أو الهيوميك (هيومات البوتاسيوم) بتركيز(10جم/لتر) لتخفيف الأثر السلبى الذى تُحدِثُه ملوحة ماء الرى فى صفات نمو القصب.