THE ROLE OF HUMIC ACID IN REDUCING THE HARMFUL EFFECT OF IRRIGATION WITH SALINE WATER ON TIFWAY TURF

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Abdel-Fatah, Gehan H.; Boshra A. El-Sayed and S.M.Shahin,

Hort. Res. Inst., ARC, Giza, Egypt.

ABSTRACT

A field experiment was conducted at the golf greens of the 6th Oct. City, Giza, Egypt during 2006 and 2007 seasons to detect how far humic acid (HA) application at the rates of 0, 10 and 20 ml/L. as a soil drench can help Tifway Bermudagrass hybrid (*Cynodon dactylon* × *C. transvaalensis*) to resist salinity of irrigation water at the levels of 0, 4000, 8000, 12000 and 16000 ppm when grown in beds (100 × 100 × 30 cm.) filled with a mixture of sand and loam (1:1 v/v).

The obtained results in both seasons indicated that plant height (cm), density (%), number of plants/m^2 and herb fresh and dry weights (g) were progressively increased with significant differences as a result of increasing HA rate regardless of saline water concentration, but they were significantly decreased in response to all saline water treatments. A similar trend was also gained with regard to pigments content (mg/g F.W.) and the percentages of N, P and K in the leaves. The opposite was the right concerning the content of Na and Cl (mg/g D.W.), as they were gradually increased with increasing salinity level, but were cumulatively reduced with raising HA rate. Proline content (μ mol/g D.W.), however showed a progressive increment due to elevating the rate of either HA or salinity.

Hence, under the condition of such work, it could be summarized that Tifway Bermudagrass can proportionally tolerate salinity of irrigation water up to 16000 ppm, especially if treated with HA at 20 ml/L. as a soil drench that greatly improved growth, density, colour and chemical constituents under salinity stress.

Key words: Tifway turf, *Cynodon dactylon* × *C. transvaalensis* hybrid, humic acid (HA), salinity, saline water, vegetative growth, chemical composition.

INTRODUCTION

The importance of lawn as the major part of gardens, public parks or athletic playlands, and as the basis of landscape design is well known at present. It is the part of garden where one may rest, play and really enjoy the garden. Lawns provide useful outdoor living space, and do much to make the environment more pleasant. They protect and improve the soil, hold down dust, ameliorate temperatures in both summer and winter and contribute to biological balance (Bailey, 1976).

Grasses, however are especially well adapted for lawns, among of them Tifway Bermudagrass, a hybrid resulted from *Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt-Davy (Fam. Gramineae), native to tropical and subtropical areas, so thrives well in warm or hot weather under full sun. It is a long-lived perennial with a spreading habit of growth; leaves are fine, soft and mostly near base of clum and on the runners. It withstands constant close mowing, forming a compact dense turf suitable for athletic fields, parks and home-lawns. Propagated from cuttings (runners division), underground root stocks and seeds (Huxley *et al.,* 1992).

Increasing need for salt-tolerant turfgrasses is still continuous due to increase growth in arid and semi-arid regions, where potable water is limited, and the underground or other water sources are salty. Salinity however may cause some harms for turfgrass plants. In this connection, Mansour and Hussein (2002) found that increasing salinity of irrigation water up to 6000 ppm reduced the growth, as well as the chlorophylls, carotenoids and total carbohydrates contents of Tifway plants grown in sand, clay or sand + clay (1:1, v/v). Lawn coverage, plant height and clippings fresh and dry weights were significantly reduced, especially for plants grown in sand, while those grown in clay had higher Na, Ca and Cl contents. Peacock *et al.,* (2004) mentioned that diluted sea water at the rates between 7000 and 27000 ppm resulted a great reduction in shoot weight of Tifway which reached 43%, while root and crown weights were unaffected.

Similarly, were those results attained by Lee *et al.,* (2004) on 4 bermudagrass (*Cynodon dactylon* × *C. transvaalensis*) cultivars (Tifgreen, Tifway, Tifsport and TifEagle), Adavi *et al.,* (2006) on Tifway and Pessarakli and Touchane (2006) who indicated that root and shoot lengths of Tifway-419 and seashore paspalum were stimulated at the low levels of NaCl (5000 and 10000 ppm), but substantially decreased at the high levels (20000 and 30000 ppm). As the exposure time to salt stress progressed, shoot and root fresh and dry weights were more severly affected than the shoot and root lengths. Tifway-419 was more affected than paspalum under any levels of NaCl applications. Uptake of Na and Cl was increased, whereas K uptake was decreased.

On the other hand, turf managers generally recognize the importance of fertilization for turfgrass maintenance, especially under drought or salt stress (Snyder and Cisar, 2005). Humate, a salt of humic acid reactions, is one of several humic substances that being marketed as soil conditioners for turfgrasses. They can provide soil microbes with energy, improve nutrients retention in the soil and enhance the water holding capacity (Dorer and Peacock, 1997). Doak *et al.,* (2005) confirmed that humic acid at 3.5 or 7.0 g./100m^2 of *Agrostis palustris* turf reduced the negative effects of NaCl at 6000 ppm, whereas Na and proline contents were increased. On the same line, were those results of Zhang and Schmidt (2000) on *Festuca arundinacea* and *Agrostis palustris*, Zhang *et al.,* (2003) on *Agrostis stolonifera*, Zhang and Ervin (2004) on *Agrostis palustris*, Hunter and Anderos (2004) on *Agrostis stolonifera* and Hunter and Butler (2005) who reported that humic acid significantly increased fresh and dry weights of *Agrostis stolonifera* herb with improving leaf colour and P content. A nutrient leaching was minimized when humic acid treatment was applied.

The present work however is an attempt to improve growth and performance of Tifway Bermudagrass hybrid exposed to salinity stress by adding the growth stimulant, humic acid.

MATERIALS AND METHODS

A field experiment was performed at the golf courses of the 6th Oct. City, Giza, Egypt during the two successive seasons of 2006 and 2007 to study the effects of saline irrigation water, humic acid and their interaction on growth behaviour, quality and chemical composition of Tifway hybrid turf.

Cuttings of *Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt-Davy hybrid "Tifway" (about 2 cm long) were planted on April, 15th for each season in beds (100 × 100 × 30 cm; for length, width and depth, respectively) filled with an equal mixture of sand and loam (1:1, v/v). The physical and chemical analyses of the used sand and loam in the two seasons are shown in Table (1).

Table (1): Some physical and chemical properties of the used soil textures during 2006 and 2007 seasons.

Soil texture	Season	Particle size distribution (%)				S.P	E.C. (ds/m)	pH	Cations (meq/L)				Anions (meq/L)		
		Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^-
Sandy	2006	89.03	2.05	0.40	8.52	23.00	3.16	7.92	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2007	90.10	1.95	0.50	7.45	22.06	3.74	7.00	19.42	0.33	7.20	0.75	1.60	7.00	27.10
Loamy	2006	10.18	46.17	19.53	24.12	35.00	3.30	8.89	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	2007	10.30	46.54	10.00	24.20	33.00	3.51	0.16	18.00	8.95	20.50	0.05	3.65	10.20	34.45

The cuttings (200 g/bed, as such weight contains about 1200-1300 cuttings), were regularly scattered (as large-sized seeds) on the surface of the beds, then gently pressed with a flat and smooth piece of wood for more contact with the soil mixture, and finally covered with a thin layer (about 0.5 cm) of the same soil mixture. After planting, the beds were daily sprayed with fresh water (about 750-800 ml/bed) to wet only the zone in which cuttings are imbedded using a watering cane with fine pores until sprouting, which were completely established within 10 days. The beds were afterwards irrigated once every two days with 2 liters of fresh water/bed until May, 15th as they were subjected to the following treatments:

A. Saline water treatments:

NaCl salt was mixed well with $CaCl_2$ salt at the ratio of 1:1 by weight. Saline water was then prepared from the salts mixture at the levels of 0, 4000, 8000, 12000 and 16000 ppm. Each bed was irrigated with 5 L of different water treatments twice a week till fifteenth of October (end of the experiment).

B. Humic acid treatments:

Actosol, a humic acid NPK (10:10:10) liquid organic fertilizer was added as a soil drench at the rates of 0, 10 and 20 ml/L monthly after each cut. The different constituents of the applied liquid organic fertilizer were determined and illustrated in Table (2).

Table (2): Main characteristics of the used liquid organic fertilizer during 2006 and 2007 seasons.

Components	Value	Components	Value	Components	Value
Humic acid (%)	2.9	EC(dS/m)	59.3	B (mg/L.)	70.00
Organic matter/total solid (%)	42.51	N (%)	10.00	Fe (mg/L.)	900.00
Total humic acids/total solid (g/L0 (g/L.)	165.80	P (%)	10.00	Mn (mg/L.)	90.00
Organic carbon (%)	24.64	K (%)	10.00	Zn (mg/L.)	90.00
C/N ratio	2.46	Ca (%)	0.06	Cu (mg/L.)	90.00
pH	8.20	Mg (%)	0.05		

C. Saline water and humic acid interaction treatments:

Each treatment of saline water was combined with each treatment of humic acid to form fifteen interaction treatments.

After two months from planting date (at June, 15^{th}), first cut was handly done with a very sharp stainless steel shear to leave stubbles with one inch long. Other four cuts were carried out monthly thereafter. Each treatment was replicated three times of one bed each, in a randomized complete blocks design (Mead *et al.,* 1993).

Before each cut, mean plant height (cm) was recorded, whereas density% (Mahdi, 1953), number of plants/m^2 and fresh and dry weights (g) of the resulted clippings after mowing were monitored after each cut. However, means of each parameter mentioned above in the five taken cuts were collected and expressed in the tables as an average for all cuts.

In fresh leaf samples taken from the last cut, photosynthetic pigments content (chlorophyll a, b and carotenoids, mg/g. F.W.) was measured according to the method described by Moran (1982), while in dry samples taken also from the herb of the last cut, the percentages of N, P and K and the content of Na and Cl (mg/g. D.W.) were determined according to the methods indicated by Jackson (1973), as well as proline content (μ mol/g D.W.) by the method explained by Bates *et al.*, (1973).

Data obtained were statistically analyzed according to SAS program (1994) using Duncan's Multiple Range Test (1955) for verifying the significant differences among means of the different treatments.

RESULTS AND DISCUSSION

Effect of saline water, humic acid and their interaction on:

1. Vegetative growth parameters:

From data averaged in Table (3), it is clear that the height of Tifway plant (cm.) was significantly increased with increasing HA rate in the two seasons, but progressively decreased as salinity level in irrigation water was raised with significant differences in most cases of both seasons.

However, the tallest plants in the first and second seasons were found due to irrigation with fresh water under HA treatment at the rate of 20 ml/L., whereas the shortest ones were obtained in the two seasons from those plants didn't receive HA under the various salinity levels. Addition of HA on the other hand, significantly elevated such parameters, even under the high concentration of saline water indicating that HA application at either 10 or 20 ml/L. improved plant growth due to decreasing the harmful effects of salinity, and that this improvement was augmented with raising humic acid rate.

A similar trend was also gained concerning density % (Table, 3) and number of plants/m^2 (Table, 4) with the superiority of 4000 and 8000 ppm saline water treatments, which significantly increased these two parameters in the two seasons to the highest means comparing with control treatment irrespective of HA treatments, except for 20 ml/L. humic acid treatment which raised density of control plants in the two seasons to 100%. In general, covering rate under the highest level of saline water (16000 ppm) was more than 60% for control plants in the two seasons, and significantly increased in response to either rates of HA to become more than 70% or so, indicating the ability of Tifway plants to withstand high salinity level, especially if amended with humic acid.

Table (3) Effect of saline water, humic acid and their interaction on plant height and density of *Cynodon dactylon* x *C. transvaalensis* (Tifway) (L.) Pers. plants during 2006 and 2007 seasons.

Humic acid rate (ml/L.) / Saline water conc. (ppm)	Plant height (cm.)			Mean	Density (%)			Mean
	00.00	10.00	20.00		00.00	10.00	20.00	
	First season: 2006							
00.00	8.82 d	15.43 ba	17.82 a	14.02 a	79.10 cb	98.50 a	100.00 a	92.53 a
4000	8.17 d	13.20 b	14.08 b	11.82 b	83.90 bc	100.00 a	100.00 a	94.63 a
8000	6.50 fe	10.76 dc	11.96 c	9.74 c	85.36 b	100.00 a	100.00 a	95.12 a
12000	5.41 f	7.38 e	8.78 d	7.19 d	71.00 c	79.50 cb	87.45 b	79.32 b
16000	4.33 f	6.63 ef	7.56 e	6.17 d	63.19 d	71.33 c	72.80 c	69.11 c
Mean	6.65 c	10.68 b	12.04 a		76.51 b	89.87 a	92.05 a	
	Second season: 2007							
00.00	9.48 d	17.60 a	18.58 a	15.22 a	80.67 cb	96.33 a	100.00 a	92.33 a
4000	9.10 d	15.52 b	16.76 ab	13.79 b	85.70 bc	100.00 a	100.00 a	95.23 a
8000	7.86 ef	12.80 c	13.95 cb	11.54 c	89.17 b	100.00 a	100.00 a	96.39 a
12000	6.68 f	8.76 e	9.56 d	8.33 d	71.58 c	78.43 cb	86.90 b	78.97 b
16000	5.33 f	7.26 fe	8.03 e	6.87 e	62.79 d	69.30 c	70.66 c	67.58 c
Mean	7.69 b	12.39 a	13.38 a		77.98 b	88.81 a	91.51 a	

Means within column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

Table (4) Effect of saline water, humic acid and their interaction on number of plants/m^2 of *Cynodon dactylon* x *C. transvaalensis* (Tifway) (L.) Pers. plants during 2006 and 2007 seasons.

Humic acid rate (ml/L.) / Saline water conc. (ppm)	First season: 2006			Mean	Second season: 2007			Mean
	00.00	10.00	20.00		00.00	10.00	20.00	
00.00	1200.00 ^{fe}	1356.00 ^{ed}	1687.00 ^{b}	1414.33 ^{c}	1156.00 ^{g}	1400.33 ^{d}	1680.76 ^{bc}	1412.36 ^{c}
4000	1270.60 ^{e}	1428.76 ^{d}	1776.35 ^{a}	1491.90 ^{b}	1213.80 ^{f}	1470.00 ^{dc}	1764.00 ^{b}	1482.60 ^{b}
8000	1335.13 ^{ed}	1500.46 ^{c}	1865.80 ^{a}	1567.13 ^{a}	1279.50 ^{ef}	1548.50 ^{c}	1868.21 ^{a}	1565.40 ^{a}
12000	1104.00 ^{g}	1247.52 ^{e}	1553.17 ^{c}	1301.56 ^{d}	1061.70 ^{b}	1394.00 ^{d}	1656.00 ^{cb}	1370.57 ^{c}
16000	1016.68 ^{g}	1150.73 ^{f}	1425.88 ^{d}	1197.73 ^{e}	978.44 ^{h}	1300.65 ^{e}	1521.58 ^{c}	1266.89 ^{d}
Mean	1185.28 ^{c}	1336.70 ^{b}	1661.64 ^{a}		1137.89 ^{c}	1422.70 ^{b}	1698.11 ^{a}	

Means within column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

Regarding herb fresh and dry weights (g.), data in Table (5) show that HA treatments induced a gradual significant increment in such two characters with increasing HA rate in both seasons, even under the highest salinity level, whereas saline water treatments significantly depressed them. However, the heaviest fresh and dry weights were recorded in the two seasons by plants irrigated with fresh water and fertilized with 20 ml/L humic acid.

The positive effects of HA on improving vegetative growth of Tifway plants could be ascribed to the role of humic acid in increasing the availability of nutrients in the soil through influences on soil microbial activity. These results go in line with those of Doak *et al.*, (2005) on *Agrostis palustris* and Hunter and Butler (2005) on *Agrostis stolonifera.* On the other hand, the reduction of growth due to saline water treatments may be attributed to a decrease in all volume at a constant all number caused by salinity (Adavi *et al.,* 2006). Likewise, Pessarakli and Touchane (2006) revealed that mechanism of salt may result in cell division inhibitory and hence, reduces the rate of plant development. However, Jou *et al.,* (2006) indicated that ATPase participates in the endoplasmic reticulum Golgi mediated protein sorting machinery for both housekeeping function and compartmentalization of excess Na^+ under high salinity. On the same line, were those results attained on Tifway by Mansour and Hussein (2002), Peacock *et al.,* (2004), Lee *et al.,* (2004) and Adavi *et al.,* (2006).

Table (5) Effect of saline water, humic acid and their interaction on fresh and dry weights of *Cynodon dactylon* x *C. transvaalensis* (Tifway) (L.) Pers. herb during 2006 and 2007 seasons.

Humic acid rate (ml/L.) / Saline water conc. (ppm)	Fresh weight (g.)			Mean	Dry weight (g.)			Mean
	00.00	10.00	20.00		00.00	10.00	20.00	
	First season: 2006							
00.00	56.22 ed	79.37 b	85.99 a	73.86 a	17.99 dc	25.28 ab	27.50 a	23.59 a
4000	51.42 e	73.09 cb	81.27 ba	68.59 b	16.33 d	23.36 b	25.96 a	21.88 b
8000	48.40 ef	73.98 cb	80.74 ba	67.71 bc	15.49 d	23.50 b	25.60 a	21.53 b
12000	45.16 f	64.87 dc	68.00 c	59.34 c	14.43 d	20.74 c	21.76 cb	18.98 c
16000	40.59 f	58.33 de	60.76 d	53.23 d	12.98 e	19.50 c	19.50 c	17.33 d
Mean	48.36 c	69.93 b	75.35 a		15.45 c	22.48 b	24.06 a	
	Second season: 2007							
00.00	59.13 e	76.24 cb	88.71 a	74.69 a	18.93 c	24.38 ba	28.36 a	23.89 a
4000	52.74 f	75.91 c	82.00 b	70.22 b	16.86 d	24.00 b	26.10 a	22.32 b
8000	49.92 gf	71.58 dc	77.23 cb	66.24 c	15.97 d	22.88 bc	24.65 ba	21.17 c
12000	43.50 g	63.45 ed	67.10 d	58.02 d	13.78 ed	20.40 cb	21.46 bc	18.55 d
16000	39.15 g	57.00 fe	60.30 e	52.15 e	12.50 e	18.24 cd	19.20 c	16.65 e
Mean	48.89 c	68.84 b	75.07 a		15.61 c	21.98 b	23.95 a	

Means within column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

2- Chemical composition:

Data in Tables (6, 7 and 8) exhibit that pigments content (chlorophyll a, b and carotenoids) as mg/g F.W. and the percentage of N, P and K in the leaves of Tifway plants were gradually decreased as a result of irrigation with various levels of saline water, but progressively increased with increasing HA rate. The opposite was the right in the matter of Na and Cl content (mg./g. D.W.) , as they were augmentatively increased with various significant levels as salinity concentrations increased, but significantly decreased in the leaves of plants fertilized with HA. So, applying of humic acid caused a limitation in absorption of both Na and Cl elements, which usually cause coagulation and toxicity when exist at high concentrations in plant tissues.

Table (6) Effect of saline water, humic acid and their interaction on pigments content (mg/g F.W.) in the leaves of *Cynodon dactylon* x *C. transvaalensis* (Tifway) (L.) Pers. plants during the second season (2007).

Humic acid rate (ml/L.) / Saline water conc. (ppm)	Chlorophyll a			Mean	Chlorophyll b			Mean	Carotenoids			Mean
	0.00	10.00	20.00		0.00	10.00	20.00		0.00	10.00	20.00	
00.00	0.552 ^{a}	0.911 ^{b}	0.994 ^{a}	0.819 ^{a}	0.228 ^{d}	0.291 ^{a}	0.387 ^{a}	0.302 ^{a}	0.426 ^{a}	0.479 ^{b}	0.561 ^{a}	0.489 ^{a}
4000	0.426 ^{f}	0.876 ^{a}	0.889 ^{bc}	0.730 ^{b}	0.210 ^{f}	0.298 ^{a}	0.374 ^{bc}	0.291 ^{bc}	0.354 ^{cd}	0.398 ^{cd}	0.479 ^{b}	0.410 ^{b}
8000	0.410 ^{fg}	0.589 ^{de}	0.607 ^{d}	0.535 ^{c}	0.189 ^{gf}	0.261 ^{d}	0.321 ^{b}	0.257 ^{b}	0.331 ^{e}	0.372 ^{d}	0.426 ^{c}	0.376 ^{c}
12000	0.346 ^{g}	0.561 ^{ef}	0.583 ^{de}	0.497 ^{d}	0.158 ^{g}	0.233 ^{e}	0.263 ^{cd}	0.218 ^{c}	0.299 ^{f}	0.322 ^{e}	0.364 ^{de}	0.328 ^{d}
16000	0.303 ^{g}	0.494 ^{fg}	0.526 ^{d}	0.441 ^{e}	0.124 ^{h}	0.209 ^{f}	0.236 ^{e}	0.190 ^{d}	0.261 ^{g}	0.288 ^{f}	0.321 ^{e}	0.290 ^{e}
Mean	0.407 ^{c}	0.686 ^{b}	0.720 ^{a}		0.182 ^{c}	0.257 ^{b}	0.316 ^{a}		0.334 ^{c}	0.372 ^{b}	0.430 ^{a}	

Means within column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

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Increasing the content of some minerals in the leaves of Tifway plants fertilized with HA may indicate the role of such biostimulant in releasing more nutrients necessary for healthy growth and decreasing the phosphate fixing capacity of the soil (Heng, 1989). On the other hand, the higher salt concentration in the nutrient medium usually leads to an increase in the uptake of some highly hydrophillic ions, e.g. Na or borate (Doak *et al.*, 2005).

Table (7) Effect of saline water, humic acid and their interaction on N, P and K content in the herb of *Cynodon dactylon* x *C. transvaalensis* (Tifway) (L.) Pers. plants during the second season (2007).

Humic acid rate (ml/L.) / Saline water conc. (ppm)	N (%)			Mean	P (%)			Mean	K (%)			Mean
	0.00	10.00	20.00		0.00	10.00	20.00		0.00	10.00	20.00	
00.00	2.18 d	2.86 bc	3.00 a	2.68 a	1.31 a	1.78 ab	1.90 a	1.66 a	1.87 a	2.11 ab	2.74 a	2.24 a
4000	2.18 d	2.68 ab	2.97 a	2.68 ab	1.18 d	1.67 b	1.69 bc	1.48 bc	1.66 d	1.87 a	2.31 b	1.91 bc
8000	2.01 e	2.33 cd	2.71 b	2.36 b	1.02 e	1.28 e	1.50 b	1.27 b	1.40 ef	1.73 cd	2.20 bc	1.78 b
12000	1.85 fe	2.18 d	2.43 c	2.15 c	0.82 ef	0.99 e	1.06 cd	0.96 c	1.11 f	1.51 de	1.91 c	1.51 c
16000	1.31 f	1.78 fe	2.06 cd	1.72 d	0.63 f	0.94 ef	0.88 f	0.78 d	0.99 f	1.18 fe	1.36 e	1.18 d
Mean	1.91 c	2.35 b	2.64 a		0.99 c	1.29 b	1.41 a		1.39 c	1.68 b	2.11 a	

Means within column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

Table (8) Effect of saline water, humic acid and their interaction on proline, Na and Cl content in the herb of *Cynodon dactylon* x *C. transvaalensis* (Tifway) (L.) Pers. plants during the second season (2007).

Humic acid rate (ml/L.) / Saline water conc. (ppm)	Proline (µ mol/g D.W.)			Mean	Na (mg/g D.W.)			Mean	Cl (mg/g. D.W.)			Mean
	0.00	10.00	20.00		0.00	10.00	20.00		0.00	10.00	20.00	
00.00	2.70 f	3.61 f	4.36 fe	3.62 d	1.28 cd	1.10 f	1.10 f	1.16 d	3.18 de	1.99 h	1.68 i	2.28 d
4000	4.85 fe	5.33 ef	6.50 e	5.32 d	1.72 cd	1.18 e	1.21 e	1.37 cd	3.29 d	2.10 g	1.83 h	2.37 d
8000	6.75 e	7.93 de	9.36 d	8.01 c	1.83 c	1.39 d	1.28 cd	1.50 c	3.45 c	2.50 f	2.07 g	2.67 c
12000	11.58 cd	13.41 c	15.88 bc	13.60 b	2.10 b	1.68 de	1.43 d	1.74 b	3.90 b	2.99 e	2.36 fg	3.08 b
16000	17.48 b	21.86 ba	25.51 a	21.62 a	2.51 a	1.83 c	1.76 cd	2.03 a	4.45 a	3.27 d	2.84 e	3.62 a
Mean	8.50 c	10.41 b	12.34 a		1.89 a	1.44 b	1.36 b		3.66 a	2.67 b	2.16 c	

Means within column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

As for proline content (µ mol/g D.W.) in the leaves, it was cumulatively increased with raising either HA rate or salinity level. So, the highest record in this trait was registered by plants treated with the highest levels of both salinity (16000 ppm) and HA (20 ml/L.). It was suggested that accumulation of some amino acids and amides in the leaves of salinity-stressed plants may be due to *de novo* synthesis and not to the result of degradation (Gilbert *et al.,* 1998).

Such results, in general showed a similar trend to those of Pessarakli and Touchane (2006) on Tifway-419 and seashore paspalum and Hunter and Butler (2005) on *Agrostis stolonifera.*

From the previous findings, it could be concluded that Tifway Bermudagrass can relatively tolerate irrigation with saline water up to 16000 ppm, specially if treated with humic acid at 20 ml/L to improve growth, density, colour and internal constituents.

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دور حمض الهيوميك في خفض التأثير الضار لملوحة مياه الري على مسطح التيف واي

جيهان حسن عبد الفتاح، بشرة عبد الله السيد و سيد محمد شاهين

معهد بحوث البساتين-مركز البحوث الزراعية، الجيزة، مصر

أجريت تجربة حقلية بملاعب الجولف بمدينة السادس من أكتوبر، الجيزة ، مصر خلال موسمي ٢٠٠٦ ، ٢٠٠٧ و ذلك لاكتشاف الدور الذي يمكن أن يلعبه حمض الهيوميك عند إضافته في صورة محلول للتربة بمعدلات: صفر، ١٠ ، ٢٠ مل/لتر على تحمل مسطح هجين البرمودا (تيف واي) (*Cyndon dactylon* x *C. transvaalensis* hybrid Tifway) لملوحة مياه الري بتركيزات صفر ، ٤٠٠٠، ٨٠٠٠ ، ١٢٠٠٠ و ١٦٠٠٠ جزء في المليون عند زراعته في أحواض (١٠٠ × ١٠٠ × ٣٠ سم) ملئت بمخلوط متساوي من الرمل و الطمي (1:1 حجماً).

و لقد أوضحت النتائج المتحصل عليها في كلا الموسمين حدوث زيادة معنوية متدرجة في ارتفاع النبات (سم)، الكثافة (%)، متوسط عدد النباتات/م^{2} والوزن الطازج والجاف للعشب الناتج نتيجة لزيادة معدل حمض الهيوميك المضاف بصرف النظر عن تركيز ملوحة مياه الري، بينما انخفضت هذه القياسات معنوياً و بشكل متزايد كلما زاد تركيز الملوحة في مياه الري. و لقد تم الحصول أيضاً على اتجاه مشابه فيما يتعلق بمحتوى الأوراق من الصبغات للنبات (ملجم/جم وزن طازج) و النسبة المئوية لعناصر النيتروجين و الفوسفور و البوتاسيوم (حيث زادت بزيادة معدل إضافة حمض الهيوميك و انخفضت بزيادة تركيز الملوحة)، بينما كان العكس صحيحاً بالنسبة لمحتوى الأوراق من عنصري الصوديوم و الكلوريد (ملجم/جم وزن جاف)، و اللذان زادا تدريجياً بزيادة مستوى ملوحة مياه الري بينما انخفضا تدريجياً بزيادة معدل إضافة حمض الهيوميك. أما بالنسبة لمحتوى البرولين (ميكرومول/جم مادة جافة) فقد زاد تصاعدياً سواء بزيادة معدل إضافة حمض الهيوميك أو زيادة تركيز الملوحة.

و عليه، فانه طبقاً لظروف هذا العمل البحثي، يمكن القول بإيجاز أن مسطح هجين البرمودا (تيف واي) يستطيع إلى حد ما تحمل ملوحة مياه الري حتى ١٦٠٠٠ جزء في المليون، خاصة عند معاملته بحمض الهيوميك بمعدل ٢٠ مل/لتر، و الذي أدى بشكل كبير الى تحسين النمو، الكثافة (معدل التغطية)، اللون و المحتويات الكيماوية رغم إجهاد الملوحة.