Bull. Fac. Agric., Cairo Univ., 53 (2002):235-264.

TOLERANCE OF THREE TURFGRASSES GROWN IN THREE TYPES OF SOIL TO IRRIGATION WATER SALINITY

(Received: 29.8.2001)

By
H. A. Mansour and M. M. M. Hussein

Ornamental Horticulture Department, Faculty of Agriculture, Cairo University

ABSTRACT

This study was conducted at the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the two successive seasons of 1999/2000 and 2000/2001, with the aim of investigating the tolerance of three turfgrasses [Bermudagrass (*Cynodon dactylon* L.), Ugandagrass (*C. transvaalensis* Davy) and Tifway "Tifton 419" (*C. dactylon X C. transvaalensis*)] grown in different types of soil [clay, sand and clay+sand (1:1, v/v)], to saline irrigation water. The three turfgrasses were irrigated using water containing NaCl and $CaCl_2$ (1:1, w/w) at concentrations of 1500, 3000, 4500 and 6000 ppm. Control plants were irrigated with tap water.

Among the three turfgrasses, Ugandagrass had the best vegetative growth and the highest fresh and dry weights of underground parts, whereas Tifway gave the lowest values for most of the measured growth characteristics. Ugandagrass also had the highest contents of chlorophyll, carotenoids, Na, Ca and proline. On the other hand, Tifway had the highest total carbohydrates content, while Bermudagrass had the highest Cl content.

Raising the salt concentration resulted in steady reductions in all of the growth characteristics, as well as the contents of chlorophyll, carotenoids and total carbohydrates. No significant reduction in lawn coverage of the three turfgrasses used was detected at the lowest salt

concentration (1500 ppm), whereas higher salt concentrations (3000-6000 ppm) reduced it significantly, compared to the control. Only the highest salt concentration (6000 ppm) reduced the dry weight of clippings significantly, compared to the control. Raising the salt concentration increased the contents of Na, Ca, Cl and proline. The three turfgrasses were generally more sensitive to salinity when grown in sand compared to those grown in clay or clay+sand.

Also, plants of the three turfgrasses grown in sand gave lower values for lawn coverage, plant height before mowing, as well as the fresh and dry weights of clippings, compared to those grown in media containing clay. Plants grown in clay had higher contents of Na, Ca and Cl than those grown in sand or clay+sand, whereas the proline content was increased by raising the percentage of sand and/or lowering the percentage of clay in the growing medium.

From the above results, it can be concluded that growing Bermudagrass, Ugandagrass and Tifway in sand only should be avoided, especially in areas irrigated with saline water of concentrations higher than 1500 ppm. If these recommendations are followed, Ugandagrass can be used with no significant reduction in growth.

Key words: *cynodon, salinity, soil type, tifway, turfgrass.*

1. INTRODUCTION

Turfgrasses are among the most important plant groups that are used extensively in the landscape of new cities, coastal resorts and touristic villages. Most of these communities are built in desert areas where irrigation depends primarily on relatively saline water from wells or desalination units. Under such conditions, it becomes very important to select turfgrass species and varieties that are capable of tolerating high salinity levels, and to determine the maximum salt concentrations that can be used for irrigation without a significant effect on plant growth, quality and appearance.

Several studies have been conducted to investigate the tolerance of different turfgrass species to saline irrigation water. In general, turfgrasses were found to be capable of survival under a relatively wide range of salt concentrations, although growth is usually reduced as salinity increases. In a study on 5 turfgrass species (*Cynodon dactylon, Zoysia japonica, Festuca arundinacea, Poa pratensis* and

Lolium perenne), Lin *et al.* (1996) concluded that the turfgrasses were relatively tolerant to high Cl^- concentrations. In another study on 4 cultivars of *Stenotaphrum secundatum*, it was found that a salt concentration equal to that of seawater did not cause the plants to die, but severely reduced top growth (Dudeck *et al.*, 1993). Intermediate salinity even caused growth stimulation in *Sporobolus virginicus* and St. Augustine grass (Maraim, 1990).

Another factor to be considered in the landscape of desert areas is the type of soil. In many cases, chemical and physical analysis of the soil may reveal that it is unsuitable for plant growth. In such cases, the topsoil can be replaced with a layer of clay, sand or any other kind of soil that is available at a reasonable cost. Several studies have been conducted to determine the effect of different soil types on growth of turfgrasses [Skirde (1988), Devitt (1989), Shibata *et al.* (1989), Cullimore *et al.* (1990), El-Tantawy *et al.* (1993, a), Mitchell *et al.* (1994), Roberts *et al.* (1995), Ngoya *et al.* (1997), Baker *et al.* (1997 and 1998) and McCoy (1998)]. In Egypt, clay and sand are the two most common types of soil used for replacement of the topsoil in landscaped areas. Both types of soil have their advantages and disadvantages (regarding their water holding capacity, availability, cost, contamination with weed seeds and pathogens, ... etc.), and it is usually up to the landscaper to decide which type to use. Therefore, it would be very useful to have more information about the performance of different turfgrasses when grown on these two types of soil (or on a mixture of the two types).

2. MATERIALS AND METHODS

This study was conducted in the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the two successive seasons of 1999/2000 and 2000/2001, with the aim of investigating the tolerance of Bermudagrass (*Cynodon dactylon* L.), Ugandagrass (*C. transvaalensis* Davy) and Tifway "Tifton 419" (*C. dactylon* X *C. transvaalensis*) to irrigation with saline water, when grown in different types of soil.

One hundred and thirty five square beds (1 m X 1 m) were prepared by digging to a depth of 40 cm, then lined with perforated polyethylene sheets. One third of the total number of beds was filled with each of three different types of soil, viz. clay, sand, or a mixture of clay and sand (1:1 by volume). A non-selective weed killer (Roundup) was used at a rate equivalent to 1 l/fed. to eliminate all weed vegetation. The physical and chemical characteristics of the three types of soil are shown in Table (1).

A separate experiment was conducted for each type of soil. In each experiment, the three turfgrasses were used. On 1st March (in both seasons), seeds of Bermudagrass (*Cynodon dactylon* L.) were sown at the rate of 30 g/m^2, while the plugs of Ugandagrass (*C. transvaalensis* Davy) and Tifway (*Cynodon dactylon* X *C. transvaalensis*) were planted at a spacing of 15 cm (one square meter of sod gave enough plugs to plant about 8 m^2). Grasses were irrigated daily at the rate of 7 l/m^2/watering, during the active growing season (from March 1 to October 15), and every other day thereafter till January15. Tap water was used for irrigation from 1st March till 15th April (during the establishment of the turfgrass), then irrigation was carried out using saline water at concentrations of 1500, 3000, 4500 or 6000 ppm until the termination of the each season. The saline irrigation water was prepared using NaCl and $CaCl_2$ (1:1 by weight). In addition, control plants continued to be irrigated with tap water. All turfgrasses received chemical NPK fertilization in the form of ammonium nitrate (33.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48.5% K_2O), mixed at the ratio of 2:1:1 (N : P_2O_5 : K_2O), and applied monthly at the rate of 36.21 g/m^2, as recommended by Emarah (1998).

The layout of the experiment was a split-plot arrangement with the main plots in a randomized complete block design, with three blocks (replicates). The three turfgrasses were assigned to the main plots, while the five salt concentrations (including the control) were assigned to the sub-plots.

The three turfgrasses were mowed weekly to a height of 3 cm starting on 15th April. The following data were recorded throughout the growing season: the average plant height before mowing, and the average fresh and dry weights of the clippings (g/m^2/week).

At the termination of each season (on 15th January), the following data were also recorded:

- The coverage percentage (as described by Mahdi, 1953), lawn density (number of shoots/100 cm^2), and the fresh and dry weights of underground parts (g/m^2).
- The contents of total chlorophyll and total carotenoids (mg/g fresh matter) in clipping samples, using the method described by Saric *et al.* (1967).

Table (1): Physical and chemical composition of the growing media used in the experiment.

Soil type	Physical properties					Chemical properties							
	Coarse sand (%)	Fine sand (%)	Clay (%)	Silt (%)	Field capacity (%)	EC (mmhos/cm)	pH	N (ppm)	P (ppm)	K (ppm)	Na (ppm)	Ca (ppm)	Mg (ppm)
Clay	12.4	37.7	37.1	12.8	44.0	0.33	8.1	53.3	37.1	5.3	71.8	54.9	38.4
Sand	39.9	49.2	4.5	6.4	25.0	0.38	7.4	10.1	16.9	2.4	54.8	42.9	25.8
Clay+sand	23.1	47.0	21.5	8.4	37.0	0.35	7.8	34.6	20.9	4.8	66.4	51.1	30.6

- The contents of total carbohydrates in dried clipping samples, using the method described by Herbert *et al.* (1971).
- The contents of Na and Ca in dried clipping samples were determined by using an Atomic Absorption/Flame Spectrophotometer.
- The content of Cl in dried clipping samples was determined using the method described by Higinbothan *et al*. (1967).
- Proline content in fresh clipping samples, according to Bates *et al.* (1973).

The analysis of variance between the data was conducted, and the means were compared using the "Least Significant Difference" (L.S.D.) test at the 5% level, as described by Steel and Torrie (1980). Arc-sin transformation was conducted on the coverage percentage data, and the transformed data were statistically analysed.

3. RESULTS AND DISCUSSION

3.1. Effect of saline irrigation water on turf vegetative growth

3.1.1. Lawn coverage (%)

The results recorded in the two seasons (Table 2) show that significant differences were detected between the three turfgrasses with respect to their coverage percentage. In most cases, Ugandagrass gave a higher coverage percentage than Bermudagrass and Tifway (in the three types of soil), whereas Tifway gave the lowest coverage percentage. The only exceptions to this general trend were recorded in the second season, with Bermudagrass grown in clay giving an insignificant higher coverage percentage than Ugandagrass, while Tifway gave an insignificant lower coverage percentage than Ugandagrass. The data presented in Table (2) also show that when the plants were grown in clay, Bermudagrass gave a significantly higher coverage percentage than Tifway (in both seasons). Also, when these two turfgrasses were grown in sand or sand+clay in the first season, Bermudagrass gave a significantly higher coverage percentage than Tifway. However, no significant difference was detected between these two turfgrasses in the second season, when they were grown in sand or sand+clay.

The effect of saline irrigation water on lawn coverage was also considerable. In general, raising the salt concentration resulted in a steady reduction in the coverage percentage. In most cases, this reduction was insignificant at the lowest salt concentration (1500 ppm), whereas higher

Table (2): Effect of saline irrigation water on the coverage percentage of three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Coverage percentage							
		1st Season Turfgrasses*				2nd Season Turfgrasses*			
		S1	S2	S3	Mean**	S1	S2	S3	Mean**
Clay	Control	100.0 a	100.0 a	100.0 a	**100.0 a**	100.0 a	100.0 a	100.0 a	**100.0 a**
	1500	99.7 ab	100.0 a	99.3 ab	**99.7 ab**	99.7 ab	100.0 a	99.0 ab	**99.6 ab**
	3000	99.0 ab	99.3 ab	98.7 b	**99.0 b**	99.3 ab	99.7 ab	99.0 ab	**99.3 b**
	4500	80.7 de	89.7 c	78.3 e	**82.9 c**	86.0 c	84.3 cd	82.7 c-e	**84.3 c**
	6000	79.7 de	85.3 cd	74.7 e	**79.9 c**	83.7 cd	79.7 de	78.0 e	**80.5 d**
	Mean**	**91.8 a**	**94.9 a**	**90.2 b**	**92.3**	**93.7 a**	**92.7 ab**	**91.7 b**	**92.7**
Sand	Control	96.0 bc	98.0 a	93.3 cd	**95.8 a**	93.0 ab	95.3 a	94.7 a	**94.3 a**
	1500	94.7 cd	97.7 ab	92.0 d	**94.8 a**	92.0 bc	94.0 ab	92.0 bc	**92.7 b**
	3000	87.0 e	92.7 cd	86.7 e	**88.8 b**	85.0 ef	89.0 cd	81.7 fg	**85.2 c**
	4500	80.0 fg	84.7 ef	76.0 gh	**80.2 c**	78.0 g-i	86.0 de	76.0 i	**80.0 d**
	6000	76.7 gh	80.0 fg	72.7 h	**76.5 d**	77.3 hi	81.3 f-h	75.7 i	**78.1 d**
	Mean**	**86.9 b**	**90.6 a**	**84.1 c**	**87.2**	**85.1 b**	**89.1 a**	**84.0 b**	**86.1**
Clay+sand (1:1)	Control	100.0 a	100.0 a	100.0 a	**100.0 a**	100.0 a	100.0 a	100.0 a	**100.0 a**
	1500	99.7 ab	100.0 a	99.3 bc	**99.7 a**	99.3 ab	99.7 ab	99.0 ab	**99.3 a**
	3000	99.0 bc	99.3 bc	98.3 c	**98.9 b**	98.3 b	99.0 ab	98.3 b	**98.5 b**
	4500	86.3 d-f	90.3 d	85.0 ef	**87.2 c**	87.0 d	89.7 c	83.3 de	**86.7 c**
	6000	85.7 ef	88.7 de	82.0 f	**85.5 c**	84.3 de	87.0 d	78.3 e	**83.2 d**
	Mean**	**94.1 b**	**95.7 a**	**92.9 c**	**94.2**	**93.8 ab**	**95.1 a**	**91.8 b**	**93.5**

***S1= Bermudagrass (*Cynodon dactylon*) S2= Ugandagrass (*C. transvaalensis*) S3= Tifway (*C. dactylon* X *C. transvaalensis*)**

****Within the columns for salinity treatment means, the rows for turfgrass means, or the means for combinations of the two factors, means sharing one or more letters are insignificantly different at the 5% level, according to the "Least Significant Difference" test.**

salt concentrations (3000-6000 ppm) reduced lawn coverage significantly, compared to the control. Similar reductions in coverage percentage as a result of raising salt concentration have been reported by El-Tantawy *et al.* (1993, a and b).

Regarding the effect of the type of soil, it was noticed that the coverage percentage was generally lower in the sandy soil than in media containing clay (clay or clay+sand). Even with irrigation using tap water (control), plants grown in sand had a lower mean coverage percentage (95.8% and 94.3% in the first and second seasons, respectively) than plants grown in clay or clay+sand, which had a coverage percentage of 100%.

As a result of the interaction between the turfgrasses and the salt concentrations, the highest coverage percentage (100%) was recorded in the clay and clay+sand soils when the three turfgrasses were irrigated with tap water (control), whereas the highest coverage percentages recorded in the sandy soil (98.0% and 95.3%, in the first and second seasons, respectively) were obtained from Ugandagrass irrigated with tap water. On the other hand, the lowest coverage percentage in the three types of soil was obtained from Tifway plants receiving the highest salt concentration (6000 ppm).

3.1.2. Lawn density (number of shoots/100 cm^2)

Lawn density, in terms of the number of shoots/100 cm^2 (Table 3), was considerably affected by the type of turfgrass and salinity level of the irrigation water. In both seasons, Ugandagrass gave the greatest number of shoots/100 cm^2, followed by Tifway, whereas Bermudagrass gave the lowest values, in the three types of soil. In most cases, the differences between the three turfgrasses were significant, especially in the second season. In the first season, no significant difference was recorded between the densities of Ugandagrass and Tifway plants that were grown on a sandy soil.

Regarding the effect of saline irrigation water, the number of shoots/100 cm^2 (Table 3) decreased steadily with raising the salt concentration (in the three types of soil). In the clay and sand+clay soils, this decrease was insignificant at the lowest salt concentration (1500 ppm), whereas higher salt concentrations (3000-6000 ppm) reduced the number of shoots/100 cm^2 significantly, compared to the control (in both seasons). On the other hand, the adverse effect of salinity on lawn density was more evident in the sandy soil, with all salinity treatments resulting in significant reductions in the number of

Table (3): Effect of saline irrigation water on lawn density (number of shoots/100 cm^2) and average plant height (before mowing) of three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Lawn density (number of shoots/100 cm^2)								Average plant height before mowing (cm)							
		1st Season				2nd Season				1st Season				2nd Season			
		Turfgrasses*				Turfgrasses*				Turfgrasses*				Turfgrasses*			
		S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
Clay	Control	235.3	251.6	235.6	**240.8**	221.3	258.6	242.6	**240.8**	10.93	12.33	10.65	**11.30**	11.55	13.10	11.25	**11.97**
	1500	201.3	239.6	217.3	**219.4**	197.3	265.3	216.3	**226.3**	9.82	10.79	9.21	**9.94**	9.10	12.34	9.75	**10.40**
	3000	173.6	200.6	194.6	**189.6**	169.3	230.3	189.3	**196.3**	8.48	9.64	7.97	**8.70**	8.30	10.36	7.89	**8.85**
	4500	154.6	169.3	163.6	**162.5**	149.6	201.3	1	**172.7**	7.75	8.49	6.41	**7.55**	6.30	7.67	6.75	**6.91**
	6000	120.3	150.6	127.3	**132.7**	126.3	164.3	132.3	**141.0**	5.63	7.37	5.29	**6.10**	6.77	8.22	5.23	**6.74**
	Mean	**177.0**	**202.3**	**187.7**	**189.0**	**172.8**	**224.0**	**189.6**	**195.4**	**8.52**	**9.72**	**7.91**	**8.72**	**8.40**	**10.34**	**8.17**	**8.97**
	LSD-5% Sp.	9.1				8.3				0.46				0.49			
	Salt	22.6				16.9				1.45				1.66			
	Sp. X Salt	27.3				20.5				1.61				1.94			
Sand	Control	219.6	237.6	238.3	**231.8**	201.3	245.6	231.6	**226.2**	9.64	10.93	8.91	**9.83**	10.05	11.22	8.29	**9.85**
	1500	194.3	221.3	218.6	**211.4**	189.3	229.6	198.3	**205.7**	8.28	9.32	7.75	**8.45**	8.17	10.99	6.00	**8.39**
	3000	176.6	218.3	200.3	**198.4**	169.6	183.6	176.3	**176.5**	7.15	8.00	6.34	**7.16**	7.03	8.59	5.79	**7.14**
	4500	136.3	183.3	187.3	**169.0**	138.3	169.3	153.3	**153.6**	5.28	6.44	4.95	**5.56**	5.82	7.60	4.22	**5.88**
	6000	120.3	154.3	139.6	**138.1**	111.3	149.3	129.3	**130.0**	4.62	5.23	4.27	**4.71**	4.75	6.19	3.07	**4.67**
	Mean	**169.4**	**203.0**	**196.8**	**189.7**	**162.0**	**195.5**	**177.8**	**178.4**	**6.99**	**7.98**	**6.44**	**7.14**	**7.16**	**8.92**	**5.47**	**7.18**
	LSD-5% Sp.	8.7				9.3				0.34				0.63			
	Salt	16.3				15.1				0.73				0.91			
	Sp. X Salt	19.8				18.9				0.98				1.19			
Clay+sand (1:1)	Control	227.3	256.6	242.6	**242.2**	231.3	309.6	259.6	**266.8**	11.37	12.93	9.60	**11.30**	11.93	12.26	8.97	**11.05**
	1500	198.3	248.6	229.6	**225.5**	206.3	294.3	231.3	**244.0**	10.65	11.45	8.00	**10.03**	10.13	11.55	7.91	**9.86**
	3000	168.3	213.3	201.3	**194.3**	183.6	263.3	201.3	**216.1**	8.83	9.79	7.55	**8.72**	9.32	10.23	7.49	**9.01**
	4500	149.3	184.3	153.3	**162.3**	162.3	219.6	183.3	**188.4**	7.00	9.30	6.42	**7.57**	9.93	8.17	5.61	**7.90**
	6000	122.3	161.6	137.3	**140.4**	132.3	187.6	150.3	**156.7**	7.11	8.55	5.46	**7.04**	7.06	7.64	4.22	**6.31**
	Mean	**173.1**	**212.9**	**192.8**	**192.9**	**183.2**	**254.9**	**205.2**	**214.4**	**9.00**	**10.40**	**7.41**	**8.93**	**9.67**	**9.97**	**6.90**	**8.83**
	LSD-5% Sp.	11.4				11.9				0.49				0.57			
	Salt	18.3				23.7				1.59				1.33			
	Sp. X Salt	22.3				26.9				1.85				1.45			

*S1= Bermudagrass (*Cynodon dactylon*) S2= Ugandagrass (*C. transvaalensis*) S3= Tifway (*C. dactylon* X *C. transvaalensis*)

Table (3): Effect of saline irrigation water on lawn density (number of shoots/100 cm^2) and average plant height (before mowing) of three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Lawn density (number of shoots/100cm^2)								Average plant height before mowing (cm)							
		1[st] Season				2[nd] Season				1[st] Season				2[nd] Season			
		Turfgrasses*				Turfgrasses*				Turfgrasses*				Turfgrasses*			
		S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
Clay	**Control**	235.3	251.6	235.6	**240.8**	221.3	258.6	242.6	**240.8**	10.93	12.33	10.65	**11.30**	11.55	13.10	11.25	**11.97**
	1500	201.3	239.6	217.3	**219.4**	197.3	265.3	216.3	**226.3**	9.82	10.79	9.21	**9.94**	9.10	12.34	9.75	**10.40**
	3000	173.6	200.6	194.6	**189.6**	169.3	230.3	189.3	**196.3**	8.48	9.64	7.97	**8.70**	8.30	10.36	7.89	**8.85**
	4500	154.6	169.3	163.6	**162.5**	149.6	201.3	1	**172.7**	7.75	8.49	6.41	**7.55**	6.30	7.67	6.75	**6.91**
	6000	120.3	150.6	127.3	**132.7**	126.3	164.3	132.3	**141.0**	5.63	7.37	5.29	**6.10**	6.77	8.22	5.23	**6.74**
	Mean	**177.0**	**202.3**	**187.7**	**189.0**	**172.8**	**224.0**	**189.6**	**195.4**	**8.52**	**9.72**	**7.91**	**8.72**	**8.40**	**10.34**	**8.17**	**8.97**
	LSD-5% Sp.	9.1				8.3				0.46				0.49			
	Salt	22.6				16.9				1.45				1.66			
	Sp. X Salt	27.3				20.5				1.61				1.94			
Sand	**Control**	219.6	237.6	238.3	**231.8**	201.3	245.6	231.6	**226.2**	9.64	10.93	8.91	**9.83**	10.05	11.22	8.29	**9.85**
	1500	194.3	221.3	218.6	**211.4**	189.3	229.6	198.3	**205.7**	8.28	9.32	7.75	**8.45**	8.17	10.99	6.00	**8.39**
	3000	176.6	218.3	200.3	**198.4**	169.6	183.6	176.3	**176.5**	7.15	8.00	6.34	**7.16**	7.03	8.59	5.79	**7.14**
	4500	136.3	183.3	187.3	**169.0**	138.3	169.3	153.3	**153.6**	5.28	6.44	4.95	**5.56**	5.82	7.60	4.22	**5.88**
	6000	120.3	154.3	139.6	**138.1**	111.3	149.3	129.3	**130.0**	4.62	5.23	4.27	**4.71**	4.75	6.19	3.07	**4.67**
	Mean	**169.4**	**203.0**	**196.8**	**189.7**	**162.0**	**195.5**	**177.8**	**178.4**	**6.99**	**7.98**	**6.44**	**7.14**	**7.16**	**8.92**	**5.47**	**7.18**
	LSD-5% Sp.	8.7				9.3				0.34				0.63			
	Salt	16.3				15.1				0.73				0.91			
	Sp. X Salt	19.8				18.9				0.98				1.19			
Clay+sand (1:1)	**Control**	227.3	256.6	242.6	**242.2**	231.3	309.6	259.6	**266.8**	11.37	12.93	9.60	**11.30**	11.93	12.26	8.97	**11.05**
	1500	198.3	248.6	229.6	**225.5**	206.3	294.3	231.3	**244.0**	10.65	11.45	8.00	**10.03**	10.13	11.55	7.91	**9.86**
	3000	168.3	213.3	201.3	**194.3**	183.6	263.3	201.3	**216.1**	8.83	9.79	7.55	**8.72**	9.32	10.23	7.49	**9.01**
	4500	149.3	184.3	153.3	**162.3**	162.3	219.6	183.3	**188.4**	7.00	9.30	6.42	**7.57**	9.93	8.17	5.61	**7.90**
	6000	122.3	161.6	137.3	**140.4**	132.3	187.6	150.3	**156.7**	7.11	8.55	5.46	**7.04**	7.06	7.64	4.22	**6.31**
	Mean	**173.1**	**212.9**	**192.8**	**192.9**	**183.2**	**254.9**	**205.2**	**214.4**	**9.00**	**10.40**	**7.41**	**8.93**	**9.67**	**9.97**	**6.90**	**8.83**
	LSD-5% Sp.	11.4				11.9				0.49				0.57			
	Salt	18.3				23.7				1.59				1.33			
	Sp. X Salt	22.3				26.9				1.86				1.45			

*S1= Bermudagrass (*Cynodon dactylon*) S2= Ugandagrass (*C. transvaalensis*) S3= Tifway (*C. dactylon* X *C. transvaalensis*)

shoots/100 cm^2, even at the lowest salt concentration (1500 ppm). The reduction in number of shoots/100 cm^2 (*i.e.* branching) may be attributed to a reduction in the activity level of cytokinins as a result of the salinity treatments (Ghazi, 1976).

Regarding the interaction between the three turfgrasses and the salinity treatments, the data presented in Table (3) show that in most cases, the best combination of these two factors was Ugandagrass irrigated using tap water (control), whereas the lowest values were obtained from Bermudagrass irrigated with saline water at the highest concentration (6000 ppm). The data in Table (3) also show that there was a slight difference between the three turfgrasses in their response to the salinity treatments, with Ugandagrass showing no significant response to the lowest salt concentration (1500 ppm), whereas Bermudagrass and Tifway often showed a significant reduction in the plant density as a result of applying the lowest salt concentration, regardless of the type of soil. This may lead us to recommend the use of Ugandagrass for planting lawns in areas where the water contains a salt concentration of up to 1500 ppm.

3.1.3. Average plant height before mowing

Considerable differences were obtained between the average plant heights (before mowing) of the three turfgrasses (Table 3). In both seasons, Ugandagrass showed more regrowth between mowings (i.e. it had a significantly higher value of plant height), compared to Bermudagrass or Tifway. On the other hand, Tifway was the shortest turfgrass, regardless of the type of soil. In most cases, the differences between the values recorded for the three turfgrasses were significant, especially in the first season. In the second season, no significant difference was obtained between the heights of Bermudagrass and Tifway plants that were grown in clay. Also, no significant difference was obtained between the heights of Bermudagrass and Ugandagrass plants that were grown in clay+sand.

Regarding the effect of the salinity treatments, the data in Table (3) show that raising the salt concentration resulted in a steady decrease in the height of plants before mowing, regardless of the kind of turfgrass or the type of soil. The decrease in plant height under saline conditions was probably due to the insufficient uptake of water and nutrients, as well as sodic toxicity [Yasseen *et al.* (1987) and St. Arnaud and Vincent (1990)]. Another possible explanation for the reduction in plant height as a result of salinity may be the decrease in the activity levels of auxins and gibberellins within the plant, and/or the increase in the activity of growth inhibitors (Ghazi, 1976). This may lead to a reduction in meristematic activity, resulting in a decrease in the rate of cell elongation at the shoot tips.

In the sandy soil, the reduction in mean plant height of the three turfgrasses was significant even at the lowest salt concentration (1500 ppm), compared to the control. Moreover, turfgrasses grown in sand were generally more susceptible to salt injury at the high salt concentrations (with reductions of 52.1% and 52.6% being recorded at the 6000 ppm concentration, in the first and second seasons, respectively, compared to the control) than those grown in clay or clay+sand. On the other hand, the mean height of plants grown in clay or clay+sand was not significantly reduced by the lowest salt concentration (1500 ppm), but was significantly reduced by salt concentrations of 3000-6000 ppm, compared to the control (in both seasons).

Moreover, the data in Table (3) also show that the values recorded in the sandy soil were generally lower than those recorded in clay or clay+sand. This may be attributed to the greater water holding capacity of clay, as well as its higher cation exchange capacity, which lead to a higher availability of water and nutrients to the plants. It is, therefore, recommended that growing turfgrasses in pure sand should be avoided, especially under conditions of saline irrigation water.

The data recorded in the two seasons (Table 3) also show that the highest values recorded in the three types of soil (i.e. the highest ability to re-grow after mowing) were obtained from Ugandagrass plants that were irrigated with tap water (control), whereas the lowest values were those obtained from Tifway plants irrigated with saline water at the highest concentration (6000 ppm).

3.1.4. Fresh and dry weights of clippings

The data presented in Table (4) show that, in most cases, Ugandagrass plants gave the heaviest fresh and dry weights, followed by Bermudagrass, whereas Tifway gave the lowest weights, regardless of the type of soil. The only exception to this general trend was observed in the clay soil during the second season, with Bermudagrass giving an insignificantly higher fresh weight than Ugandagrass.

Among the three types of soil, the mixture of clay and sand was generally the most suitable soil for the growth of turfgrasses (in terms

Table (4): Effect of saline irrigation water on the fresh and dry weights of clippings of three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Fresh weight of clippings (gm/m²/week)								Dry weight of clippings (gm/m²/week)							
		1st Season				2nd Season				1st Season				2nd Season			
		Turfgrasses*				Turfgrasses*				Turfgrasses*				Turfgrasses*			
		S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
Clay	Control	30.15	33.46	27.42	**30.34**	31.42	32.82	29.64	**31.29**	4.30	4.48	3.01	**3.93**	4.48	4.68	3.23	**4.13**
	1500	28.26	32.00	25.36	**28.54**	30.47	31.88	26.55	**29.63**	4.01	4.22	2.65	**3.63**	4.25	4.34	3.02	**3.87**
	3000	25.64	30.48	23.85	**26.66**	29.88	28.97	25.90	**28.25**	3.76	3.82	2.33	**3.30**	3.98	4.04	2.87	**3.63**
	4500	24.10	29.16	22.85	**25.37**	27.66	25.58	22.10	**25.11**	3.41	3.55	1.20	**2.72**	3.66	3.71	2.54	**3.30**
	6000	23.45	26.48	19.52	**23.15**	25.73	23.13	22.79	**23.88**	3.27	3.20	0.98	**2.48**	3.41	3.43	2.16	**3.00**
	Mean	**26.32**	**30.31**	**23.80**	**26.81**	**29.03**	**28.47**	**25.39**	**27.63**	**3.75**	**3.85**	**2.03**	**3.21**	**3.95**	**4.04**	**2.76**	**3.59**
	LSD-5% Sp.	1.79				1.63				0.81				0.93			
	Salt	2.13				2.07				0.95				0.97			
	Sp. X Salt	2.34				2.35				1.14				1.16			
Sand	Control	28.13	32.75	24.51	**28.46**	27.82	29.79	25.91	**27.84**	4.01	4.67	3.50	**4.06**	3.97	4.25	3.70	**3.97**
	1500	25.30	31.22	21.87	**26.13**	26.00	26.88	14.34	**22.41**	3.75	4.25	3.13	**3.71**	3.57	4.10	3.60	**3.76**
	3000	24.80	29.54	20.77	**25.04**	25.13	23.10	15.64	**21.29**	3.34	3.99	2.74	**3.36**	3.33	3.85	3.42	**3.53**
	4500	22.77	28.46	17.11	**22.78**	21.34	20.44	17.00	**19.59**	3.11	3.68	2.44	**3.08**	3.01	3.41	3.15	**3.19**
	6000	21.69	26.34	16.50	**21.51**	18.26	20.34	19.39	**19.33**	2.92	3.52	2.38	**2.94**	2.84	3.05	2.81	**2.90**
	Mean	**24.53**	**29.66**	**20.15**	**24.78**	**23.71**	**24.11**	**18.45**	**22.09**	**3.42**	**4.02**	**2.83**	**3.43**	**3.34**	**3.73**	**3.33**	**3.47**
	LSD-5% Sp.	2.03				1.98				0.92				N.S.			
	Salt	2.37				2.31				0.96				0.81			
	Sp. X Salt	2.51				2.53				1.15				0.92			
Clay+sand (1:1)	Control	35.55	38.82	29.50	**34.62**	33.80	39.36	30.18	**34.45**	5.07	5.54	4.21	**4.94**	4.82	5.62	4.31	**4.92**
	1500	32.10	37.41	25.22	**31.58**	30.49	37.55	28.13	**32.06**	4.84	5.22	4.10	**4.72**	4.64	5.41	3.97	**4.67**
	3000	28.64	35.91	24.10	**29.55**	28.71	35.61	23.75	**29.36**	4.41	5.02	3.98	**4.47**	3.98	5.11	3.67	**4.25**
	4500	26.00	31.84	23.99	**27.28**	25.44	32.82	21.88	**26.71**	4.01	4.80	3.81	**4.21**	3.55	4.85	3.22	**3.87**
	6000	25.33	28.00	23.18	**25.50**	22.52	31.28	20.67	**24.82**	3.57	4.45	3.88	**3.97**	3.24	4.51	2.81	**3.52**
	Mean	**29.52**	**34.39**	**25.19**	**29.71**	**28.19**	**35.32**	**24.92**	**29.48**	**4.38**	**5.00**	**3.99**	**4.46**	**4.04**	**5.16**	**3.59**	**4.25**
	LSD-5% Sp.	1.87				1.74				0.87				0.91			
	Salt	2.15				2.26				0.94				0.96			
	Sp. X Salt	2.24				2.38				1.08				1.13			

*S1= Bermudagrass (*Cynodon dactylon*) S2= Ugandagrass (*C. transvaalensis*) S3= Tifway (*C. dactylon* X *C. transvaalensis*)

of fresh weight), followed by clay. A similar favourable effect of media containing clay on the fresh and dry weights of clippings has been reported by El-Tantawy *et al.* (1993, a) on Bermudagrass. On the other hand, plants grown in sand had the lowest mean fresh weight in both seasons.

The results recorded in the two seasons also show that raising the salt concentration resulted in a gradual reduction in the mean fresh and dry weights of clippings, regardless of the type of soil. However, the reduction in mean fresh weight of turfgrasses grown in clay was insignificant at the lowest salt concentration (1500 ppm), but was significant at salt concentrations of 3000-6000 ppm (in both seasons). On the other hand, the reduction in mean fresh weight of clippings of plants grown in sand or in clay+sand was significant even at the lowest salt concentration (in most cases). Also, the reduction in mean dry weight was generally insignificant at salt concentrations of 1500-3000 ppm (especially in the second season), whereas the highest salt concentration (6000 ppm) reduced the mean dry weight significantly as compared to the control, regardless of the type of soil. These results are in agreement with the findings of El-Tantawy *et al.* (1993, b) who mentioned that the fresh and dry weights of Bermudagrass clippings were reduced by raising salt concentration in the irrigation water. Also, Smith *et al.* (1993) reported that all shoot growth parameters of Bermudagrass (*Cynodon dactylon*), creeping bentgrass (*Agrostis stolonifera* L. var. palustris) and St. Augustinegrass (*Stenotaphrum secundatum*) were reduced by increasing salt levels. Moreover, Nabati *et al.* (1994) found that as salinity increased, clipping dry weight of Kentucky bluegrass (*Poa pratensis* cv. Plush) decreased.

Regarding the fresh and dry weights obtained from the different combinations of turfgrasses and salt concentrations, the data in Table (4) show that, in both seasons, Ugandagrass plants receiving no salinity treatment (control) gave higher values than those obtained from any other turfgrass at the different salt concentrations, regardless of the type of soil. On the other hand, Tifway plants receiving the highest salt concentration (6000 ppm) gave the lowest fresh weight in the first season (in all three types of soil), as well as the lowest fresh weight in the second one among plants grown in clay+sand. Also, Tifway plants receiving salt at 6000 ppm gave the lowest dry weight among plants grown in clay or sand in the first season, and the lowest dry weight among plants grown in any of the three types of soil in the second one.

Table (4) indicates that in the first season, the three turfgrasses

grown in the clay medium tolerated the lowest salt concentration (1500 ppm) without a significant reduction in fresh weight, whereas higher salt concentrations (3000-6000 ppm) reduced fresh weight significantly. On the other hand, Ugandagrass grown in sand or clay+sand was insignificantly affected by salinity at 1500 ppm, while Bermudagrass and Tifway showed a significant reduction in fresh weight, compared to the control. This trend was not clear in the second season. Also, within each of the three turfgrasses, the dry weight was not significantly reduced, in most cases, by salt concentrations of 1500-4500 ppm, compared to the control, regardless of the type of soil. On the other hand, although the highest salt concentration (6000 ppm) gave the lowest values in the three turfgrasses, the significance of its effect varied from one kind of turfgrass to the other, and from one season to the other.

3.1.5. Fresh and dry weights of underground parts

The results presented in Table (5) show considerable differences among the three turfgrasses with respect to the fresh and dry weights of underground parts. In most cases, Ugandagrass had the heaviest fresh and dry weights, followed by Bermudagrass, whereas the lowest values were those of Tifway. The differences among the three turfgrasses were significant in most cases, especially in the first season, regardless of the type of soil. However, in the second season, two exceptions to this general rule were recorded. The first exception was obtained from Bermudagrass plants grown in clay, which had insignificantly heavier fresh underground parts than those of Ugandagrass grown in the same type of soil. The second exception to the general trend was obtained in the sandy soil, with the underground parts of Ugandagrass having an insignificantly higher dry weight than those of Bermudagrass.

The different salinity treatments also had a considerable effect on the fresh and dry weights of the underground parts. In general, raising the salt concentration resulted in a steady decrease in the values recorded for these two parameters, regardless of the type of soil. In the clay soil, this reduction was mostly insignificant at the lowest salt concentration (1500 ppm), whereas higher concentrations reduced the fresh and dry weights of underground parts significantly, compared to the control. On the other hand, plants grown in sand or clay+sand showed a significant reduction in the fresh and dry weights of their

Table (5): Effect of saline irrigation water on the fresh and dry weights of underground parts of three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Fresh weight of underground parts (gm/m^2)								Dry weight of underground parts (gm/m^2)							
		1st Season				2nd Season				1st Season				2nd Season			
		Turfgrasses*				Turfgrasses*				Turfgrasses*				Turfgrasses*			
		S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
Clay	Control	126.1	140.5	108.1	**124.9**	129.2	138.6	112.6	**126.8**	68.7	76.3	58.6	**67.9**	64.8	73.2	56.1	**64.7**
	1500	118.9	127.3	100.2	**115.5**	125.3	131.5	103.5	**120.1**	63.3	68.6	51.3	**61.1**	62.3	66.8	53.2	**60.8**
	3000	100.7	125.2	86.2	**104.0**	116.0	112.3	98.3	**108.9**	51.4	63.6	41.2	**52.1**	54.7	58.6	48.9	**54.1**
	4500	78.5	111.7	78.7	**89.6**	111.8	97.1	87.8	**98.9**	37.8	51.2	37.4	**42.1**	51.9	53.6	48.4	**51.3**
	6000	71.2	109.4	63.0	**81.2**	98.6	92.9	83.7	**91.7**	34.5	51.9	28.7	**38.4**	48.0	48.5	43.6	**46.7**
	Mean	**99.1**	**122.8**	**87.2**	**103.0**	**116.2**	**114.5**	**97.1**	**109.3**	**51.1**	**62.3**	**43.4**	**52.3**	**56.3**	**60.1**	**50.1**	**55.5**
	LSD-5% Sp.	4.7				4.1				3.6				2.8			
	Salt	9.8				7.3				4.2				4.5			
	Sp. X Salt	12.5				8.2				5.9				6.1			
Sand	Control	110.3	131.7	92.2	**111.4**	113.9	126.1	100.1	**113.4**	64.8	77.1	53.9	**65.3**	66.3	72.3	56.2	**65.0**
	1500	101.9	128.2	86.9	**105.7**	109.5	114.4	83.1	**102.3**	61.4	77.6	51.4	**63.5**	65.1	69.1	49.3	**61.2**
	3000	96.8	119.8	81.7	**99.4**	98.6	98.7	69.3	**88.9**	56.2	72.3	49.6	**59.4**	61.7	58.4	43.5	**54.5**
	4500	87.1	116.8	64.3	**89.4**	84.8	81.4	63.2	**76.5**	52.6	71.1	42.3	**55.3**	50.6	52.6	39.6	**47.6**
	6000	81.6	101.4	61.1	**81.4**	68.2	74.9	51.6	**64.9**	49.6	65.8	38.2	**51.2**	46.4	48.0	34.8	**43.1**
	Mean	**95.5**	**119.6**	**77.2**	**97.5**	**95.0**	**99.1**	**73.5**	**89.2**	**56.9**	**72.8**	**47.1**	**58.9**	**58.0**	**60.1**	**44.7**	**54.3**
	LSD-5% Sp.	4.6				3.2				2.1				2.4			
	Salt	5.9				6.8				3.3				3.6			
	Sp. X Salt	7.4				8.5				4.9				5.1			
Clay+sand (1:1)	Control	152.3	171.7	125.9	**150.0**	141.2	168.5	120.6	**143.4**	90.4	98.3	70.1	**86.3**	83.3	100.8	70.4	**84.8**
	1500	138.8	156.5	109.6	**135.0**	129.6	156.2	111.2	**132.3**	77.2	90.3	64.5	**77.3**	76.7	94.0	65.6	**78.8**
	3000	118.1	149.2	100.4	**122.6**	121.2	147.4	95.1	**121.2**	72.1	88.7	59.8	**73.5**	72.4	84.2	54.5	**70.4**
	4500	111.6	127.1	96.6	**111.8**	99.8	132.3	82.4	**104.8**	65.6	76.4	54.2	**65.4**	56.2	75.2	49.3	**60.2**
	6000	100.8	112.2	92.5	**101.8**	87.0	124.1	77.4	**96.2**	59.9	69.2	53.2	**60.8**	50.1	70.8	43.1	**54.7**
	Mean	**124.3**	**143.3**	**105.0**	**124.2**	**115.8**	**145.7**	**97.3**	**119.6**	**73.0**	**84.6**	**60.4**	**72.7**	**67.7**	**85.0**	**56.6**	**69.8**
	LSD-5% Sp.	4.6				5.9				3.7				3.9			
	Salt	6.1				6.7				3.9				4.6			
	Sp. X Salt	8.7				9.1				6.4				6.9			

*S1= Bermudagrass (*Cynodon dactylon*)   S2= Ugandagrass (*C. transvaalensis*)   S3= Tifway (*C. dactylon* X *C. transvaalensis*)

underground parts in response to all the salinity treatments (in most cases), even at the lowest salt concentration (1500 ppm). The only exception to this general trend was recorded in the first season, with plants grown in sand and receiving the lowest salt concentration (1500 ppm) having insignificantly lower fresh and dry weights, compared to the control.

Regarding the interaction between the turfgrasses and the salinity treatments, the data in Table (5) show that, in general, the highest values for the fresh and dry weights of underground organs were obtained from Ugandagrass plants irrigated using tap water (control), whereas the lowest values were those obtained from Tifway plants receiving the highest salt concentration (6000 ppm), regardless of the type of soil.

3.2. Effect of saline irrigation water on turf chemical composition

3.2.1. Leaf pigments

3.2.1.1. Chlorophyll contents

The data recorded in the two seasons (Table 6) show that no significant difference was detected between Bermudagrass and Ugandagrass in their contents of total chlorophylls, regardless of the type of soil. On the other hand, Tifway had significantly lower chlorophyll contents, in both seasons, than Bermudagrass or Ugandagrass plants.

Also, the data in Table (6) show that the mean chlorophyll contents were decreased steadily with raising the salt concentration, regardless of the type of soil. However, in many cases this reduction was insignificant, especially when the plants were grown in clay or in clay+sand. In plants grown in clay+sand, only the highest salt concentration (6000 ppm) reduced the mean total chlorophyll content significantly in the second season. On the other hand, plants grown in sand were the most susceptible to the salinity treatments. In the first season, these plants suffered a significant reduction in their total chlorophyll content with all salinity treatments. In the second season, a significant reduction was detected at salt concentrations of 4500 ppm or 6000 ppm. The general reduction that was recorded in the total chlorophyll content as a result of raising the salt concentration in the irrigation water is in agreement with the findings of Fathi (1989) on apple leaves, and Farahat (1990) on *Schinus terebenthifolius* and *Myoporum acuminatum*.

Table (6): Effect of saline irrigation water on the total chlorophylls and carotenoids contents of three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Total chlorophylls (mg/gm fresh matter)								Carotenoids (mg/gm fresh matter)							
		1st Season				2nd Season				1st Season				2nd Season			
		Turfgrasses*				Turfgrasses*				Turfgrasses*				Turfgrasses*			
		S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
Clay	**Control**	3.30	3.55	2.84	**3.23**	3.42	3.75	2.95	**3.37**	0.82	0.95	0.74	**0.84**	0.84	0.93	0.74	**0.84**
	1500	3.19	3.51	2.77	**3.16**	3.40	3.51	2.88	**3.26**	0.79	0.85	0.70	**0.78**	0.81	0.90	0.69	**0.80**
	3000	3.00	3.44	2.61	**3.02**	3.33	3.32	2.84	**3.16**	0.77	0.81	0.62	**0.73**	0.77	0.85	0.61	**0.74**
	4500	2.94	3.25	2.50	**2.90**	3.24	3.29	2.71	**3.08**	0.75	0.77	0.60	**0.71**	0.75	0.81	0.55	**0.70**
	6000	2.90	3.10	2.42	**2.81**	3.12	3.15	2.60	**2.96**	0.71	0.74	0.59	**0.68**	0.70	0.75	0.45	**0.63**
	Mean	**3.06**	**3.37**	**2.62**	**3.02**	**3.30**	**3.40**	**2.79**	**3.17**	**0.76**	**0.82**	**0.65**	**0.75**	**0.77**	**0.84**	**0.60**	**0.74**
	LSD-5% Sp.	0.40				0.45				0.07				0.09			
	Salt	0.44				0.47				0.11				0.12			
	Sp. X Salt	0.58				0.62				0.16				0.18			
Sand	**Control**	3.28	3.65	2.75	**3.23**	3.85	3.50	2.99	**3.45**	0.62	0.66	0.64	**0.64**	0.78	0.83	0.68	**0.76**
	1500	3.16	2.61	2.43	**2.73**	3.71	3.31	2.54	**3.19**	0.55	0.61	0.62	**0.59**	0.75	0.79	0.65	**0.73**
	3000	2.94	2.58	1.85	**2.46**	3.53	3.21	2.31	**3.02**	0.50	0.54	0.59	**0.54**	0.72	0.78	0.60	**0.70**
	4500	2.71	2.55	1.55	**2.27**	3.33	2.98	2.00	**2.77**	0.48	0.49	0.57	**0.51**	0.69	0.75	0.57	**0.67**
	6000	2.55	2.54	1.20	**2.10**	3.10	2.77	1.33	**2.40**	0.42	0.46	0.57	**0.48**	0.67	0.74	0.54	**0.65**
	Mean	**2.92**	**2.78**	**1.95**	**2.56**	**3.50**	**3.15**	**2.23**	**2.97**	**0.51**	**0.55**	**0.59**	**0.55**	**0.72**	**0.77**	**0.60**	**0.70**
	LSD-5% Sp.	0.39				0.42				0.05				0.06			
	Salt	0.47				0.56				0.09				0.12			
	Sp. X Salt	0.61				0.69				0.11				0.15			
Clay+sand (1:1)	**Control**	3.77	3.99	2.85	**3.54**	3.71	3.98	2.92	**3.54**	0.86	0.97	0.70	**0.84**	0.87	0.98	0.71	**0.85**
	1500	3.70	3.89	2.80	**3.46**	3.66	3.87	2.76	**3.43**	0.81	0.95	0.66	**0.81**	0.80	0.96	0.66	**0.81**
	3000	3.62	3.80	2.61	**3.34**	3.51	3.72	2.69	**3.31**	0.76	0.94	0.61	**0.77**	0.77	0.95	0.63	**0.78**
	4500	3.59	3.73	2.41	**3.24**	3.35	3.68	2.51	**3.18**	0.74	0.90	0.59	**0.74**	0.74	0.90	0.61	**0.75**
	6000	3.55	3.65	2.20	**3.13**	3.14	3.64	2.45	**3.08**	0.70	0.88	0.54	**0.71**	0.71	0.88	0.58	**0.72**
	Mean	**3.64**	**3.81**	**2.57**	**3.34**	**3.47**	**3.77**	**2.66**	**3.31**	**0.77**	**0.92**	**0.62**	**0.77**	**0.77**	**0.93**	**0.63**	**0.78**
	LSD-5% Sp.	0.36				0.34				0.10				0.09			
	Salt	0.43				0.41				0.12				0.12			
	Sp. X Salt	0.48				0.47				0.16				0.15			

*S1= Bermudagrass (*Cynodon dactylon*) S2= Ugandagrass (*C. transvaalensis*) S3= Tifway (*C. dactylon* X *C. transvaalensis*)

Regarding the interaction between the three turfgrasses and the different salinity treatments, the data in Table (6) show that, in most cases, Ugandagrass plants irrigated with regular unsalted water (control) had higher contents of total chlorophyll than any of the other two turfgrasses receiving any of the salinity treatments, in all types of soil. The only exception to this general trend was obtained in the second season in plants grown in sand, with Bermudagrass plants that received no salinity treatment (control) having the highest total chlorophyll content. On the other hand, the lowest chlorophyll contents recorded in both seasons were those of Tifway plants receiving the highest salt concentration (6000 ppm).

3.2.1.2. Carotenoid content

The values recorded in the two seasons for the three turfgrasses (Table 6) show that, in most cases, Ugandagrass plants had the highest carotenoids content, followed by Bermudagrass, whereas Tifway gave the lowest values, in all types of soil, but in the first season, Tifway plants grown in sand had a higher carotenoids content than those of Bermudagrass or Ugandagrass. The data in Table (6) also show that when the grasses were grown in clay or sand, the difference between the carotenoids contents of Bermudagrass and Ugandagrass was insignificant (in both seasons), but Ugandagrass grown in clay+sand gave significantly higher values than Bermudagrass.

As with the chlorophyll contents, the carotenoids content was also decreased steadily by raising the salt concentration, in all types of soil. However, the data recorded in the first season show that plants grown in clay+sand appeared to be less affected by salinity (in terms of the carotenoids content) than those grown in clay only or sand only, since plants grown in clay+sand showed no significant reduction in their carotenoids content when they received salt concentrations of 1500-4500 ppm (compared to the control). Only the highest salt concentration (6000 ppm) reduced the carotenoids content significantly in those plants, compared to the control. On the other hand, plants grown in clay alone or sand alone showed a significant reduction in their carotenoids content when they were treated with salt concentrations of 3000 ppm or higher. In the second season, plants grown in clay+sand or clay only followed almost similar trends to those recorded in the first season, but plants grown in sand only were able to tolerate all the salinity treatments (1500-6000 ppm) with no significant reduction in their carotenoids content. The reduction in the carotenoid content as a result of saline irrigation is similar to that reported by Reddy and Vora (1986) on wheat, and Fathi (1989) on apple rootstocks.

Among the different combinations of turfgrasses and salt concentrations, Ugandagrass plants irrigated with tap water (control) had the highest carotenoids content, while in most cases, the lowest value was found in Tifway plants receiving the highest salt concentration (6000 ppm). In only one case (plants grown in sand in the first season) the lowest value was that of Bermudagrass plants irrigated with saline water at 6000 ppm.

3.2.2. Total carbohydrate content

The results presented in Table (7) show that Tifway had the highest content of total carbohydrates in the clippings, followed by Ugandagrass, while Bermudagrass gave the lowest values, in all types of soil (in both seasons). Moreover, when the plants were grown in sand or in clay, Tifway always gave significantly higher values than Bermudagrass or Ugandagrass. On the other hand, when the plants were grown in clay+sand, the difference between the carbohydrates content of Tifway and that of Ugandagrass was insignificant in both seasons.

The data in Table (7) also show that the content of total carbohydrates was decreased steadily by raising the salt concentration, in all types of soil. These results are in agreement with the findings of El-Tantawy *et al.* (1993, b), who reported that salinity treatments reduced the total carbohydrates content in Bermudagrass. The reduction in carbohydrates content under saline conditions was explained by Moursi *et al.* (1976), who attributed this phenomenon to an increase in the respiration rate, in order to produce enough energy to overcome the relatively low availability of water and nutrients under saline conditions.

The reduction in the total carbohydrates content was more pronounced in plants grown in sand only, with salt concentrations of 4500 or 6000 ppm resulting in significant reductions in the values recorded, compared to those of the control (in both seasons). On the other hand, media containing clay (clay only or clay+sand) seemed to diminish the harmful effect of salinity on sugar synthesis and accumulation, where plants grown in these two media were often able to tolerate salt concentrations of up to 4500 ppm with no significant

Table (7): Effect of saline irrigation water on the contents of total carbohydrates in dried clippings of three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Total carbohydrates (% of dry matter)							
		1st Season				2nd Season			
		Turfgrasses*				Turfgrasses*			
		S1	S2	S3	Mean	S1	S2	S3	Mean
Clay	Control	13.10	13.80	14.55	**13.82**	12.90	13.95	14.99	**13.95**
	1500	13.03	13.55	14.40	**13.66**	12.71	13.77	14.65	**13.71**
	3000	12.89	13.10	14.25	**13.41**	12.55	13.52	14.32	**13.46**
	4500	12.80	12.87	13.95	**13.21**	12.20	13.40	14.00	**13.20**
	6000	12.75	12.65	13.45	**12.95**	11.85	13.25	13.85	**12.98**
	Mean	**12.91**	**13.19**	**14.12**	**13.41**	**12.45**	**13.57**	**14.36**	**13.46**
	LSD-5% Sp.	0.74				0.71			
	Salt	0.79				0.77			
	Sp. X Salt	0.87				0.84			
Sand	Control	12.30	13.25	17.50	**14.35**	12.55	13.65	17.60	**14.60**
	1500	11.85	12.85	17.32	**14.01**	12.15	13.21	17.33	**14.23**
	3000	11.46	12.46	17.11	**13.68**	11.88	12.75	17.10	**13.91**
	4500	11.00	12.10	16.50	**13.20**	11.69	12.10	16.85	**13.55**
	6000	10.75	11.85	16.10	**12.90**	11.25	11.45	16.50	**13.07**
	Mean	**11.47**	**12.50**	**16.90**	**13.63**	**11.90**	**12.63**	**17.07**	**13.87**
	LSD-5% Sp.	0.89				0.83			
	Salt	0.93				0.92			
	Sp. X Salt	1.08				0.99			
Clay+sand (1:1)	Control	13.55	15.65	16.35	**15.18**	13.85	15.75	16.00	**15.20**
	1500	13.24	15.30	15.97	**14.84**	13.60	15.34	15.76	**14.90**
	3000	13.11	14.85	15.77	**14.58**	13.24	14.99	15.31	**14.51**
	4500	12.85	14.66	15.58	**14.36**	13.01	14.78	14.85	**14.21**
	6000	12.25	14.35	15.15	**13.92**	12.90	14.60	14.55	**14.02**
	Mean	**13.00**	**14.96**	**15.76**	**14.58**	**13.32**	**15.09**	**15.29**	**14.57**
	LSD-5% Sp.	0.86				0.81			
	Salt	0.91				0.87			
	Sp. X Salt	1.12				0.96			

* S1= Bermudagrass (*Cynodon dactylon*) S2= Ugandagrass (*C. transvaalensis*)
S3= Tifway (*C. dactylon* X *C. transvaalensis*)

reduction in their content of total carbohydrates (compared to those of the control).

In both seasons, Tifway plants irrigated using tap water (control) had higher contents of total carbohydrates, compared to Bermudagrass or Ugandagrass plants receiving any of the different salt concentrations. On the other hand, Bermudagrass plants irrigated using the highest salt concentration (6000 ppm) gave the lowest values (in most cases).

3.2.3. Na, Cl and Ca contents

The data recorded in the two seasons (Tables 8 and 9) show that raising the salt concentration resulted in steady increases in the contents of the three elements (Na, Cl and Ca) in the dried clippings of Bermudagrass, Ugandagrass and Tifway plants grown in the three types of soil. The accumulation of these three elements at relatively high concentrations in the plant tissues may result in some toxic effects, which may be responsible for the reduction in vegetative growth characteristics that were recorded. Also, the accumulation of these elements at high concentrations may interfere with the mechanisms responsible for the closure of stomata, thus resulting in an increase in the rate of transpiration from the plant. This may eventually lead to plant wilting or death (Meidner and Mansfield, 1968).

Among the three turfgrasses, Ugandagrass always had higher Na content (Table 8) than Bermudagrass and Tifway (in both seasons). Ugandagrass also had the highest Ca content (Table 9) in the three types of soil, followed by Tifway, whereas Bermudagrass always had the lowest Ca content. On the other hand, when the plants were grown in clay or clay+sand, Bermudagrass had the highest Cl content (Table 8) in the two seasons, followed by Tifway, whereas Ugandagrass had the lowest content. The same trend was also observed in the sandy soil during first season, but during the second season, Tifway had the highest Cl content, followed by Bermudagrass.

The data presented in Tables (8 and 9) also show that plants grown in clay had generally higher contents of the three nutrients (Na, Cl and Ca), compared to those grown in sand or clay+sand, regardless of the type of turfgrass. Regarding the interaction between the turfgrasses and the salt concentrations, the data recorded in the two seasons (Tables 8 and 9) show that, in most cases, Ugandagrass plants irrigated with water containing the highest salt concentration (6000 ppm) had higher Na and Ca contents, compared to any other combination of turfgrasses and salinity treatments, in all types of soil. The only exception to this general trend was recorded in the first season with Tifway plants grown in clay+sand and supplied with saline water at 6000 ppm, which had a higher Na content than Bermudagrass or Ugandagrass plants grown in the same type of soil, and supplied with different salt concentrations. On the other hand, the highest Cl content (in most cases) was cbtained in Bermudagrass plants treated with the highest salt concentration (6000 ppm), in all

Table (8): Effect of saline irrigation water on the contents of Na and Cl in three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Na (% of dry matter)								Cl (% of dry matter)							
		1st Season				2nd Season				1st Season				2nd Season			
		Turfgrasses*				Turfgrasses*				Turfgrasses*				Turfgrasses*			
		S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
Clay	Control	0.45	0.58	0.43	**0.49**	0.48	0.51	0.46	**0.48**	0.66	0.60	0.64	**0.63**	0.62	0.56	0.56	**0.58**
	1500	0.49	0.59	0.52	**0.53**	0.51	0.58	0.49	**0.53**	0.73	0.63	0.68	**0.68**	0.71	0.64	0.67	**0.67**
	3000	0.67	0.78	0.76	**0.74**	0.73	0.76	0.78	**0.76**	0.89	0.84	0.87	**0.87**	0.93	0.81	0.84	**0.86**
	4500	0.87	0.93	0.84	**0.88**	0.90	0.98	0.87	**0.92**	1.18	0.98	1.03	**1.06**	1.19	1.09	1.13	**1.14**
	6000	0.94	1.31	0.89	**1.05**	0.96	1.42	0.93	**1.10**	1.56	1.43	1.46	**1.48**	1.57	1.50	1.46	**1.51**
	Mean	**0.68**	**0.84**	**0.69**	**0.74**	**0.72**	**0.85**	**0.71**	**0.76**	**1.00**	**0.90**	**0.94**	**0.94**	**1.00**	**0.92**	**0.93**	**0.95**
Sand	Control	0.32	0.41	0.35	**0.36**	0.39	0.46	0.37	**0.41**	0.53	0.44	0.48	**0.48**	0.61	0.56	0.63	**0.60**
	1500	0.31	0.48	0.39	**0.39**	0.43	0.48	0.44	**0.45**	0.59	0.53	0.56	**0.56**	0.64	0.61	0.66	**0.64**
	3000	0.38	0.67	0.45	**0.50**	0.51	0.58	0.49	**0.53**	0.81	0.73	0.78	**0.77**	0.89	0.83	0.91	**0.88**
	4500	0.80	0.85	0.86	**0.84**	0.64	0.71	0.68	**0.68**	1.13	0.91	1.09	**1.04**	1.11	0.90	1.24	**1.08**
	6000	0.87	1.10	0.96	**0.98**	0.83	0.92	0.79	**0.85**	1.54	1.33	1.48	**1.45**	1.23	1.07	1.30	**1.20**
	Mean	**0.54**	**0.70**	**0.60**	**0.61**	**0.56**	**0.63**	**0.55**	**0.58**	**0.92**	**0.79**	**0.89**	**0.86**	**0.90**	**0.79**	**0.95**	**0.88**
Clay+sand (1:1)	Control	0.31	0.43	0.38	**0.37**	0.37	0.41	0.43	**0.40**	0.58	0.47	0.51	**0.52**	0.61	0.54	0.59	**0.58**
	1500	0.36	0.44	0.42	**0.41**	0.48	0.47	0.45	**0.47**	0.63	0.56	0.58	**0.59**	0.68	0.61	0.65	**0.65**
	3000	0.51	0.63	0.58	**0.57**	0.63	0.69	0.61	**0.64**	0.87	0.77	0.83	**0.82**	0.87	0.85	0.81	**0.84**
	4500	0.73	0.79	0.65	**0.72**	0.71	0.79	0.76	**0.75**	1.28	0.93	1.14	**1.12**	1.17	1.02	1.18	**1.12**
	6000	0.84	0.88	0.91	**0.88**	0.83	0.95	0.86	**0.88**	1.59	1.38	1.41	**1.46**	1.43	1.13	1.38	**1.31**
	Mean	**0.55**	**0.63**	**0.59**	**0.59**	**0.60**	**0.66**	**0.62**	**0.63**	**0.99**	**0.82**	**0.89**	**0.90**	**0.95**	**0.83**	**0.92**	**0.90**

*S1= Bermudagrass (*Cynodon dactylon*)   S2= Ugandagrass (*C. transvaalensis*)   S3= Tifway (*C. dactylon* X *C. transvaalensis*)

Table (9): Effect of saline irrigation water on the contents of calcium and proline in three turfgrasses (Bermudagrass, Ugandagrass and Tifway) grown in clay, sand or clay + sand (1:1) during the two successive seasons of 1999/2000 and 2000/2001.

Media	Salt conc. (ppm)	Ca content (% of dry matter)								Proline (μ moles/gm fresh matter)							
		1st Season				2nd Season				1st Season				2nd Season			
		Turfgrasses*				Turfgrasses*				Turfgrasses*				Turfgrasses*			
		S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
Clay	Control	0.86	0.93	0.90	**0.90**	0.86	0.96	0.93	**0.92**	5.8	7.3	3.6	**5.6**	6.5	7.8	4.2	**6.2**
	1500	0.88	0.97	0.93	**0.93**	0.94	1.02	0.97	**0.98**	7.6	10.1	5.4	**7.7**	8.4	9.1	5.9	**7.8**
	3000	0.98	1.17	1.11	**1.09**	1.10	1.16	1.18	**1.15**	9.9	12.6	7.3	**9.9**	10.1	11.1	8.4	**9.9**
	4500	1.22	1.28	1.28	**1.26**	1.28	1.34	1.28	**1.30**	11.1	13.5	8.9	**11.2**	12.1	14.8	9.3	**12.1**
	6000	1.38	1.82	1.46	**1.55**	1.29	1.38	1.35	**1.34**	12.6	14.9	10.7	**12.7**	13.7	15.6	10.6	**13.3**
	Mean	**1.06**	**1.22**	**1.14**	**1.15**	**1.09**	**1.17**	**1.14**	**1.13**	**9.4**	**11.7**	**7.2**	**9.4**	**10.2**	**11.7**	**7.7**	**9.9**
Sand	Control	0.66	0.79	1.78	**0.74**	0.76	0.83	0.80	**0.80**	8.8	9.1	6.3	**8.1**	8.4	11.4	5.9	**8.6**
	1500	0.76	0.88	0.86	**0.83**	0.83	0.87	0.80	**0.83**	9.5	10.4	8.2	**9.4**	11.1	12.3	7.8	**10.4**
	3000	0.81	0.99	0.90	**0.90**	0.95	1.02	0.95	**0.97**	11.8	13.8	9.8	**11.8**	12.8	14.6	10.1	**12.5**
	4500	1.19	1.27	1.21	**1.22**	1.05	1.11	1.09	**1.08**	13.1	15.6	10.5	**13.1**	14.6	16.9	11.4	**14.3**
	6000	1.20	1.55	1.27	**1.34**	1.21	1.26	1.21	**1.23**	14.6	16.8	12.1	**14.5**	15.9	18.1	13.1	**15.7**
	Mean	**0.92**	**1.10**	**1.00**	**1.01**	**0.96**	**1.02**	**0.97**	**0.98**	**11.6**	**13.1**	**9.4**	**11.4**	**12.6**	**14.7**	**9.7**	**12.3**
Clay+sand (1:1)	Control	0.74	0.83	0.80	**0.79**	0.73	0.78	0.81	**0.77**	7.4	9.4	5.4	**7.4**	6.9	10.1	5.1	**7.4**
	1500	0.76	0.91	0.86	**0.84**	0.82	0.84	0.85	**0.84**	9.1	11.5	6.7	**9.1**	9.6	11.3	6.3	**9.1**
	3000	0.93	1.02	0.98	**0.98**	0.98	1.04	0.99	**1.00**	10.9	13.8	8.9	**11.2**	11.5	13.4	9.6	**11.5**
	4500	1.14	1.02	1.22	**1.22**	1.05	1.13	1.10	**1.09**	13.1	14.9	10.9	**13.0**	13.7	16.1	11.1	**13.6**
	6000	1.19	1.34	1.29	**1.27**	1.18	1.28	1.22	**1.23**	14.2	16.1	11.8	**14.0**	14.5	16.9	12.2	**14.5**
	Mean	**0.95**	**1.07**	**1.03**	**1.02**	**0.95**	**1.01**	**0.99**	**0.99**	**10.9**	**13.1**	**8.7**	**10.9**	**11.2**	**13.6**	**8.9**	**11.2**

*S1= Bermudagrass (*Cynodon dactylon*) S2= Ugandagrass (*C. transvaalensis*) S3= Tifway (*C. dactylon* X *C. transvaalensis*)

types of soil, whereas the lowest Cl content was that of Ugandagrass plants irrigated with tap water (control). The only exception to this trend was recorded in the second season, with Tifway plants grown in sand and supplied with the highest salt concentration (6000 ppm) having a higher Cl content than plants of the other two turfgrasses that received the different salinity treatments (in the same type of soil).

3.2.4. Proline content

Considerable differences were obtained in the two seasons between the proline contents in the three turfgrasses (Table 9). Among the three turfgrasses, Ugandagrass plants always had the highest proline content, followed by Bermudagrass, whereas Tifway had the lowest values, regardless of the type of soil. In this respect, it should be noted that Ugandagrass plants also had the most vigorous vegetative growth (in terms of mean plant height, as well as fresh and dry weights of clippings), while Tifway had the least vigorous vegetative growth. This means that plants with high proline contents were those that were able to show a relatively high tolerance to different salinity levels, and to grow vigorously even at relatively high salt concentrations.

The data recorded in the two seasons (Table 9) also show that the proline content was increased steadily by raising the salt concentration, in all types of soil. This can be considered as an indication that proline synthesis and accumulation in the plant may be one of the mechanisms by which the plant resists the adverse effects of salinity on plant growth. Similar increases in the proline content of 4 *Zoysia* species and 4 hybrids grown under saline conditions have been recorded by Lee *et al.* (1994), who suggested that a significant increase in proline content could be a good parameter for salt tolerance index of *Zoysia* grasses. Also, Maraim (1990) and Marcum and Murdoch (1994) concluded that proline accumulation in turfgrasses grown under saline conditions can make a substantial contribution to cytoplasmic osmotic adjustment.

Among the different combinations of turfgrasses and salt concentrations, Ugandagrass plants receiving the highest salt concentration (6000 ppm) had a higher proline content than those obtained with Bermudagrass or Tifway plants irrigated using the different salinity levels. On the other hand, the lowest proline content was that of Tifway plants irrigated using tap water (control).

It is also clear from the data in Table (9) that proline content was increased by decreasing the percentage of clay and/or increasing the percentage of sand in the growing medium. Accordingly, plants grown in clay had lower proline contents (with values of 3.6-14.9 µ moles/gm, and 4.2-15.6 µ moles/gm in the first and second seasons, respectively) than those grown in clay+sand (with values of 5.4-16.1 µ moles/gm and 5.1-16.9 µ moles/gm in the two seasons, respectively) or sand (with values of 6.3-16.8 µ moles/gm and 5.9-18.1 µ moles/gm in the two seasons, respectively). This observation may be attributed to the higher water holding capacity of clay, which leads to a dilution of the soil solution, and a diminishing of the adverse effect of salinity on the root and its ability to absorb water and nutrients.

Recommendations

From the above results, it can be recommended that growing Bermudagrass, Ugandagrass and Tifway in sand only should be avoided, especially in areas irrigated with saline water. In any case, the salt concentration should not exceed 1500 ppm. If these recommendations are followed, Ugandagrass can be used with no significant reduction in growth and quality, compared with lawns irrigated using tap water.

4. REFERENCES

Baker S. W., Binns D. J. and Cook A. (1997). Performance of sand-dominated golf greens in relation to rootzone characteristics. J. Turfgrass Sci., 73: 43-57. (Hort. Abst., 68: 1514).

Baker S. W., Cook A. and Binns D. J. (1998). The effect of soil type and profile construction on the performance of cricket pitches. I. Soil properties and grass cover during the first season of use. J. of Turfgrass Sci., 74: 80-92. (Hort. Abst., 69: 4269).

Bates L. S., Waldern R. P. and Teare L. D. (1973). Rapid determination of free proline under water stress studies. Plant and Soil, 39: 205 - 207.

Cullimore D. R., Nilson S., Taylor S. and Nelson K. (1990). Structure of a black plug layer in a turfgrass putting sand green. J. Soil and Water Conserv., 45 (6): 657-659. (Hort. Abst., 62: 6721).

Devitt D. A. (1989). Bermudagrass response to leaching fractions, irrigation salinity and soil types. Agron. J., 81 (6): 893-901.

Dudeck A. E., Peacock C. H. and Wildman J. C. (1993). Physiological and growth responses of St. Augustinegrass cultivars to salinity. HortScience, 28 (1): 46-48.

El-Tantawy A., Hanafy M. S. and Hossney Y. A. (1993, a). Effect of different growing media and mowing dates on growth of bermuda-grass (*Cynodon dactylon* L.). Minia J. Agric. Res. and Develop., 15: 1079-1098.

El-Tantawy A., Hanafy M. S. and Hossney Y. A. (1993, b). Effect of saline water irrigation and mowing dates on growth of bermuda-grass (*Cynodon dactylon* L.). Minia J. Agric. Res. and Develop., 15: 1205-1226.

Emarah M. M. H. (1998). Effect of chemical fertilization and mowing height on growth of some turfgrasses. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Farahat M. M. (1990). Salinity and drought tolerance of *Schinus molle*, *Schinus terebenthifolius* and *Myoporum acuminatum*. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Fathi M.A. (1989). Effect of salinity of irrigation water on some apple rootstocks. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Ghazi S.M. (1976). Physiological studies of cycocel and alar in relation to salt tolerance of *Vicia faba*, L. plants. Ph. D. Thesis, Fac. Sci., Ain-Shams Univ., Egypt.

Herbert D., Philipps P.J. and Strange R.E. (1971). Determination of total carbohydrates. Methods in Microbiology. 5.B: 204-244.

Higinbothan N., Etherto B. and Foster R.J. (1967). Mineral ion contents and cell transmembrane electropotential of pea and oat seedling tissue. Plant Physiol., 42: 37-46.

Lee G. J., Yoo Y. K. and Kim K. S. (1994). Comparative salt tolerance study in zoysiagrasses. III. Changes in inorganic constituents and proline contents in eight zoysiagrasses (*Zoysia* spp.). J. Korean Soc. Hort. Sci., 35 (3): 241-250. (Hort. Abst., 65: 3245).

Lin W., JanQuo C., Van Mantgem P. and Harivandi M. A. (1996). Regenerant waste water irrigation and ion uptake in five turfgrass species. J. Plant Nutrition, 19 (12): 1511-1530. (Hort. Abst., 67: 7105).

Mahdi M.Z. (1953). The influence of management on botanical composition and quality of turf. Doctorate Thesis, University of California, Los Angeles, U.S.A.

Maraim K.B. (1990). Physiological parameters of salinity tolerance in C_4 turfgrasses. Dissertation Abstracts International. B, Sciences and Engineering, 51 (2): 484B. (Hort. Abst., 61: 10274).

Marcum K. B. and Murdoch C.L. (1994). Salinity tolerance mechanisms of six C_4 turfgrasses. J. Amer. Soc. Hort. Sci., 119 (4): 779-784.

McCoy E.L. (1998). Sand and organic amendment influences on soil physical properties related to turf establishment. Agron. J., 90 (3): 411-419.

Meidner H. and Mansfield T. A. (1968). Physiology of Stomata. McGraw-Hill Book Co., Maidenhead, England, 179 pp.

Mitchell W. H., Molnar C. J. and Barton S. S. (1994). Using composts to grow wildflower sod. BioCycle, 35 (2): 62-63. (Hort. Abst., 65: 8176).

Moursi M. A., El-Tabbakh A. and Kirk E. T. (1976). Combined sugar metabolism in *Ricinus communis* and *Hyoscyamus muticus* in relation to adaption to salinity. Egypt. J. Agron., 2:265-272.

Nabati D. A., Schmidt R. E. and Parrish D. J. (1994). Alleviation of salinity stress in Kentucky bluegrass by plant growth regulators and iron. Crop Science, 34 (1): 198-202.

Ngoya C., Hensley D. and Murdoch C. (1997). Evaluation of recycled glass and compost as a turfgrass media. J. Turfgrass Management, 2 (1): 1-14. (Hort. Abst., 67: 8772).

Reddy M.P. and Vora A.B. (1986). Salinity induced changes in pigment composition and chlorophyllase activity of wheat. Ind. J. Plant Physiol., 29(4): 330-334. (Field Crop Abst., 40: 4936).

Roberts B. R., Kohorst S. D., Decker H. F. and Yaussy D. (1995). Shoot biomass of turfgrass cultivars grown on composted waste. Environmental Management, 19 (5): 735-739. (Hort. Abst., 65: 10927).

Saric M., Kastrori R., Curic R., Cupina T. and Geric I. (1967). Chlorophyll determination. Univ. Unoven Sadu Par Ktikum is fiziologize Biljaka, Beogard, Hauncna, Anjiga, P. 215.

Shibata M., Hayakawa I. and Hayashibara T. (1989). Artificial soil and construction of bed soil for putting green using artificial soil. United States Patent, US 4, 812, 339. (Hort. Abst., 60: 1898).

Skirde W. (1988). Utilization of water and nutrients from root zones of different composition and density. I. Sward characters, biomass production and soil physical changes. Zeitschrift für Vegetationstechnik im Landschafts- und Sportstättenbau, 11 (4): 137-146. (Hort. Abst., 60: 4518).

Smith M. A. L., Meyer J. E., Knight S. L. and Chen G. S. (1993). Gauging turfgrass salinity responses in whole-plant microculture and solution culture. Crop Science, 33 (3): 566-572.

St. Arnaud M. and Vincent G. (1990). Influence of high salt levels on the germination and growth of five potentially utilizable plants for median turfing in northern climates. J. Environ. Hort., 6 (4): 118-121. (Hort. Abst., 61: 10052).

Steel R. G. and Torrie S. H. (1980). Principles and Procedures of Statistics. Second edition, McGraw-Hill Inc.

Yasseen B. T., Mohammed H. A. and Soliman E. D. (1987). Growth of prophyll, and proline accumulation due to salt stress in three barley cultivars. Iraqi J. Agric. Sci. "Zanco" 5, (2):155-166. (Field Crop Abst., 40: 5633).

تحمل الملوحة في ثلاثة من نباتات المسطحات الخضراء المنزرعة في ثلاثة أنواع من التربة

حازم عبد الجليل منصور ـ محمد موسى محمد حسين

قسم بساتين الزينة، كلية الزراعة، جامعة القاهرة

ملخص

أجريت هذه الدراسة بمشتل تجارب قسم بساتين الزينة، كلية الزراعة، جامعة القاهرة، خلال الموسمين المتتاليين ١٩٩٩/٢٠٠٠ و ٢٠٠٠/٢٠٠١ . و إستهدف البحث دراسة مدى تحمل نباتات النجيل البلدي (البرمودا) و النجيل السوداني و التيفواي ٤١٩ ، النامية في ثلاثة أوساط زراعة مختلفة (هي الطمي ، الرمل ، و خليط من الرمل و الطمي بنسبة ١:١ بالحجم) لملوحة ماء الري، حيث رويت النباتات بماء يحتوي على تركيزات مختلفة من كلوريد الصوديوم و كلوريد الكالسيوم (١:١ وزنا) و هي ١٥٠٠، ٣٠٠٠ ، ٤٥٠٠ ، ٦٠٠٠ جزء في المليون، بالإضافة إلى نباتات المقارنة (الكنترول) التي رويت بماء الصنبور.

بينت النتائج المتحصل عليها أن النجيل السوداني كان أقوى النباتات الثلاثة في النمو الخضري، و كذلك الأوزان الطازجة و الجافة للأجزاء الأرضية، في

حيـــن أعطـــت نباتات التيفواي أقل القيم لغالبية الصفات المدروسة. كذلك أعطى النجـــيل الســـــوداني أعلى محتوى من الكلوروفيل و الكاروتينات و الصوديوم و الكالســـيوم و البروليـــن. و مـــن جهـــة أخرى أعطى التيفواي أعلى محتوى من الكربوهيدرات الكلية، في حين أعطت نباتات البرمودا أعلى محتوى من الكلورين.

هذا وقد أدى رفع تركيز الملوحة في ماء الري إلى إنخفاض طردى في كل صفات النمو التي تم دراســـتها، و كذلك في محتوى الكلوروفيل و الكاروتينات و الكربوهـــيدرات الكلية. و لم يحدث إنخفاض معنوي في النسبة المئوية للتغطية عند أقل تركيز ملوحة (١٥٠٠ جزء في المليون)، في حين أدت التركيزات الأعلى من ذلك (٣٠٠٠-٦٠٠٠ جزء في المليون) إلى خفض معنوي في هذه الصفة، مقارنة بالكنـــترول. هذا و لم يحدث إنخفاض معنوي للوزن الجاف لناتج القص، مقارنة بالكنترول، إلا عند أعلى تركـــيز من الملوحـــة (٦٠٠٠جزء في المليون). و أدى رفـــع الملوحـــة إلـــى زيادة محتـــوى الصوديـــوم و الكالســـيوم و الكلـــورين و البروليـــن في النبات، و كانت النباتات النامية في الرمل أكثر حســـاســـية للملوحة (مقارنة بتلك النامية في طمي أو طمي+رمل).

أعطـــت النـــباتات النامـــية في الرمل قيماً منخفضة لصفات النسبة المئوية للتغطية ، و إرتفاع النباتات قبل القص، و الأوزان الطازجة و الجافة لناتج القص، و ذلـــك بالمقارنة بالنباتات النامية في تربة تحتوي على طمي. و من جهة أخرى، فـــإن النـــباتات النامـــية في الطمي أعطت محتويات من الصوديوم و الكالسيوم و الكلوريـــد أعلى من مثيلاتها في النباتات النامية في رمل أو طمي+رمل، في حين إرتفـــع محـــتوى البروليـــن بزيادة نسبة الرمل و/أو خفض نسبة الطمى فى وسط الزراعة.

يمكـــن مـــن النـــتائج السابقة، إستنتاج أنه يفضل تجنب زراعة مسطحات البرمودا و النجيل السودانى و التيفواى ٤١٩ في وسط من الرمل فقط، خاصة في المناطق التي تروى بماء يزيد فيه تركـــيز الملوحة عن ١٥٠٠ جزء في المليون. و فـــي حالـــة إتباع هذه التوصيات، فإنه يمكن زراعة النجيل السوداني بدون أى إنخفاض معنوي في النمو.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (٥٣) العدد الثانى
(إبريل ٢٠٠٢) : ٢٣٥-٢٦٤.