Salinity alters growth habit of seashore paspalum

Seashore paspalum tolerates high salinity, but is not immune to its effects.

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Seashore paspalum (*Paspalum vaginatum* O. Swartz) is becoming more common on warm-season golf courses, at least in part, because it is able to tolerate relatively high levels of salinity. In many cases, highly saline conditions coexist with high expectations of turfgrass quality. Unfortunately for the superintendents in such situations, little practical information is available regarding the effects of salinity on the quality of seashore paspalum.

What is known is that, at some level, salinity exerts stress on plants. For example, a high level of dissolved salt in the soil solution reduces water uptake in turf (2,4,9,13), resulting in moisture stress, which has been linked to deleterious and/or adaptive morphological changes (5), such as decreased tillering, decreased leaf number, thinner leaves and reduced shoot elongation (2,13). Moisture stress has also been related to certain physiological modifications in turfgrasses. Thus, saline conditions usually affect overall plant quality.

Even though seashore paspalum is a true halophyte (7), there is probably some concentration of salinity that ultimately has a negative effect on plant density, texture, color and/or growth habit for each cultivar. With this in mind, a laboratory investigation involving established Sea Dwarf seashore paspalum was conducted at Edison College in Fort Myers, Fla., in spring 2002. The primary objective of this research was to determine whether turf quality changes in response to increasing levels of salinity administered through daily irrigation.

Materials and methods

Harvesting and establishment

Using a standard cup cutter 4.25 inches (13.3 centimeters) in diameter, 42 plugs of Sea Dwarf seashore paspalum were harvested from the practice putting green at Alden Pines Country Club, Bokeelia, Fla. Soil was removed from each of the plugs with water, and corresponding root tissue was removed with shears

IRRIGATION QUALITY

	Irrigation source						
	Tap water*	5:1†	4:1	3:1	2:1	1:1	Sea water‡
EC_w decisiemens/meter	0.52	10.10	11.70	14.70	19.10	27.40	49.40
TDS milligrams/liter	332	6,464	7,488	9,408	12,224	17,536	31,616
Mean pH	7.3	7.7	7.8	7.8	7.9	7.9	7.7
SAR (sodium adsorption ratio)	2.08	20.43	24.99	26.36	30.86	32.12	39.76
Na^+ (sodium) milligrams/liter	53	1,700	2,100	2,500	3,200	4,200	7,000
Ca^2 (calcium) milligrams/liter	35	80	90	100	130	200	330
Mg^{2+} (magnesium) milligrams/liter	8	260	260	340	400	640	1,180

*Potable tap water provided by Lee County, Fla., utilities.
†Denotes five parts tap water blended with one part sea water.
‡Sea water taken from the Gulf of Mexico at Fort Myers Beach, Fla.

Table 1. Water-quality analysis results for seven experimental irrigation water sources.

Photos courtesy of L. Berndt

Figure 2. Salinity had a negative effect on the growth of seashore paspalum. *Left,* irrigated with straight sea water; *middle,* irrigated with a 50:50 blend of the two water sources; *right,* irrigated with tap water.

SALINITY VS. QUALITY

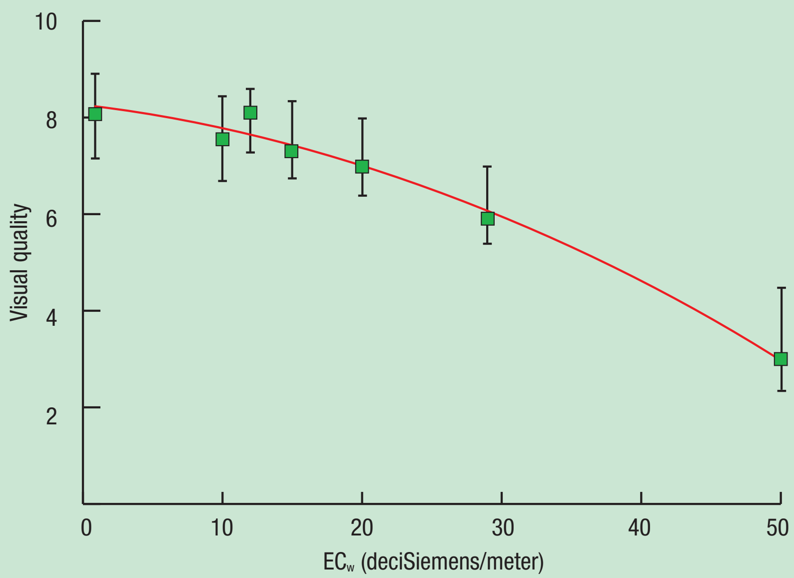

Figure 1. Salinity had a negative influence on visual turf quality. A minimum of 18 individuals participated in each of four rating events. Error bars represent the range in visual quality scores for a given level of salinity. For the *x*-axis, values of 10, 20, 30, 40 and 50 deciSiemens/meter correspond to TDS levels of 6,700, 13,400, 20,100, 26,800 and 33,500.

so that verdure and thatch remained intact. The clean plugs were then transplanted into 6-inch (15.2-centimeter)-diameter clay pots containing clean sand. Each plug was set into the pot so that the surface of the verdure was even with the rim of the pot.

After transplanting, the 42 pots were placed in full sun and allowed to establish. Pots were irrigated daily with tap water and fertilized weekly with complete fertilizer (20-20-20) at a rate of 0.25 pound nitrogen/1,000 square feet (12.2 kilograms/hectare). Turf was clipped daily with cordless electric shears at a height of 0.25 inch (6.4 millimeters).

Irrigation

After turf was fully established, the pots were randomly arranged into seven groups of six each. Each group was randomly assigned to one of seven different irrigation treatments. The sources for the irrigation water were sea water from the Gulf of Mexico at Fort Myers Beach, Fla., and potable tap water from Lee County, Fla., utilities. There were also five blends of sea water and tap water, created by mixing one part sea water with one to five parts tap water (5 tap:1 sea, 4 tap:1 sea, 3 tap:1 sea, 2 tap:1 sea, 1 tap:1 sea). Each of the seven different water types had a different level of irrigation suitability in terms of salinity and dissolved nutrients (Table 1). Because of its high salt content, sea water was considered the poorest-quality irrigation source, whereas potable tap water, which had the lowest concentration of dissolved salt, was considered the best and served as a control.

Each pot within a group was watered once daily according to treatment for 50 consecutive days beginning Feb. 11, 2002. Fertilization and mowing were discontinued. A sufficient volume of water (≈250 milliliters) was applied to each pot to exceed field capacity and cause some leaching. Excess water drained freely from each pot. During the 50-day treatment period, all pots were exposed to full sun but protected from rainfall or supplemental irrigation. Chlorothalonil fungicide was applied several times to prevent incidence of large brown patch.

Ratings

During the 50-day treatment period, visual quality ratings (10 = good, 1 = poor) were taken four different times. A minimum of 18 different evaluators contributed scores to each visual quality rating. On day 50 of the study, a turf texture rating (10 = coarse, 1 = fine) was taken. For this rating, 22 evaluators contributed scores. Next, the total number and corresponding length (in millimeters) of stolons present in each pot was determined and recorded. Finally, the remaining verdure from each pot was harvested and oven-dried at 140 F (60 C) for 48 hours and weighed (in grams) to determine clipping yield. Dried clippings were then stored in plastic bags in the dark to prevent deterioration.

Several grams of dried verdure were finely ground with a Wiley mill. Grinding was necessary for subsequent analytical procedures. Total dry matter (%) and ash content (%) of the ground tissue were determined using a procedure outlined in earlier research (12). Total moisture (%) was calculated by subtracting the total percentage of dry matter from 100%. Chlorophyll concentrations of ground tissue were determined using methods from earlier research (10) to provide indications of color. Lastly, the electrical conductivity of the soil (ECe in deciSiemens/meter) was determined on duplicate samples of 1.8 ounces (50 grams) of soil suspended in 1.7 fluid ounces (50 milliliters) of distilled, de-ionized water after 24 hours of equilibration. (The ECe was measured with a Hanna DIST WP4 conductivity cell to give an estimate of salt accumulation in the soil.)

Results and discussion

Effects of salinity

Visual quality scores fell progressively as salinity increased (Figures 1, 2). This suggests that salinity altered key visual attributes that contribute to perceived turf quality. For example, increasing the level of salinity caused leaf color to fade slightly and leaf texture to become much finer (data not shown). It also reduced shoot growth (data not shown) and had a pronounced effect on the emergence and elongation of lateral stems (data not shown; Figure 3). Increasing the salinity of the irrigation water (EC_w) from 348.4 to 7,169 ppm (0.52-10.1 deciSiemens/meter) resulted in a 75% reduction in the number of stolons. The length of those stolons was reduced by 65%. Perhaps most interesting, stolon emergence was completely suppressed when the EC_w was at or above 12,797 ppm (19.1 deciSiemens/meter).

Interpreting the data

One interpretation of these data is that

Figure 3. The number and corresponding length of stolons decreased in response to increasing the levels of irrigation water salinity. The 1:3 irrigation treatment had approximately 9,400 ppm TDS (14.0 deciSiemens/meter), and the 1:4 and 1:5 treatments had approximately 7,400 ppm TDS (11.0 deciSiemens/meter)and 6,400 ppm TDS (9.6 deciSiemens/meter), respectively.

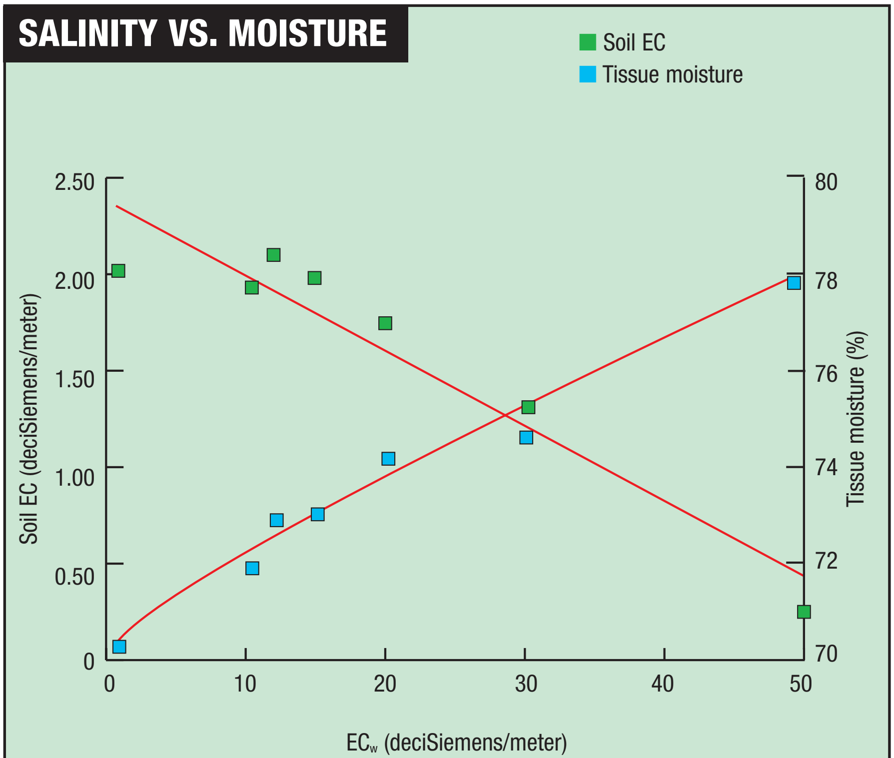

Figure 4. Salinity had a negative effect on plant tissue moisture and on the accumulation of salts in the supporting soil. Mathematical analysis indicated that tissue water content was very strongly associated with the level of salinity. Irrigating turf with saline water also resulted in the salinization of the soil after only 50 days. For the *x*-axis, 10, 20, 30, 40, and 50 deciSiemens/meter = 6,700, 13,400, 20,100, 26,800 and 33,500 ppm. For the *y*-axis, 0.5, 1.0, 1.5, 2.0 and 2.5 deciSiemens/meter = 335, 670, 1,005, 1,340 and1,675 ppm.

salinity acted as a plant growth regulator. Inhibition of plant growth processes by salinity is not fully understood but likely involves the development of moisture stress coupled with the development of an ionic stress inside the plant (16). In other words, when excess salt reduced plant moisture content, growth was directly inhibited. As the concentration of salt became greater, so did the effect. This conclusion would seem reasonable because turfgrass growth processes depend strictly on the uptake of water from the soil solution for both cell enlargement and production of organic constituents (2,3,15). In this study, plant tissue moisture level declined (Figure 4) and the uptake of ions (sodium [Na+] and boron [B]) increased (data not shown) with increasing levels of salinity. It was not determined whether the observed responses were the direct result of salt-induced moisture stress in the plant, and/or the toxic effect of ions accumulated in tissues.

Exposure to salinity may have caused the seashore paspalum to generate plant growth hormones such as abscisic acid (ABA) or ethylene, which in turn affected plant growth processes. It has been reported that abscisic acid mediates many kinds of responses to environmental stresses such as salinity or drought in many kinds of plants (1,6,8,11,14). Some researchers (16) have suggested that the generation of growth hormones in plant tissues may be in response to a stress-related molecular signal that ultimately affects specific sets of stress-regulated genes. That is, the plant somehow perceives the presence of a stressor in the environment and then, in turn, generates molecular messengers that induce specific growth responses. Whether growth-regulating hormones played a role in the observed responses in the current study is also unknown. But it would seem reasonable to consider that seashore paspalum may possess molecular and/or genetic mechanisms that help it to adapt to perceived changes in the environment, which, in this case, would be increasing levels of salinity.

Conclusion

Regardless of the response mechanism involved, salinity had an observable effect on the quality of Sea Dwarf seashore paspalum. Irrigating with water with a high salt content in this study ultimately resulted in a relatively poor-quality turf that lost its stoloniferous growth habit. This suggests that turf quality could be affected in field situations where even moderate levels of salinity exist. Even though this turf has the reputation of being tolerant to the effects of salt, it would seem reasonable, based on the results of this study, to irrigate it with the freshest water available. Irrigating Sea Dwarf with water having less than 12,000 TDS would help to preserve active growth and turf quality.

THE RESEARCH says . . .

- **Seashore paspalum is** tolerant of high levels of salts, but little information is available about managing this species under highly saline conditions.
- **The seashore paspalum** cultivar Sea Dwarf was established in pots and irrigated with seven different water sources with differing levels of salinity.
- **As salinity increased,** visual turf quality and turf texture ratings decreased over a 50-day period.
- **High salinity also** inhibited plant growth and completely suppressed stolon growth.
- **Although seashore paspalum** can tolerate high levels of salinity, it should be irrigated with the freshest available water for maximum quality.

Acknowledgments

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