Salts Influence Nematodes in Seashore Paspalum

Are seashore paspalum roots affected by plant-parasitic nematodes under high-salinity irrigation?

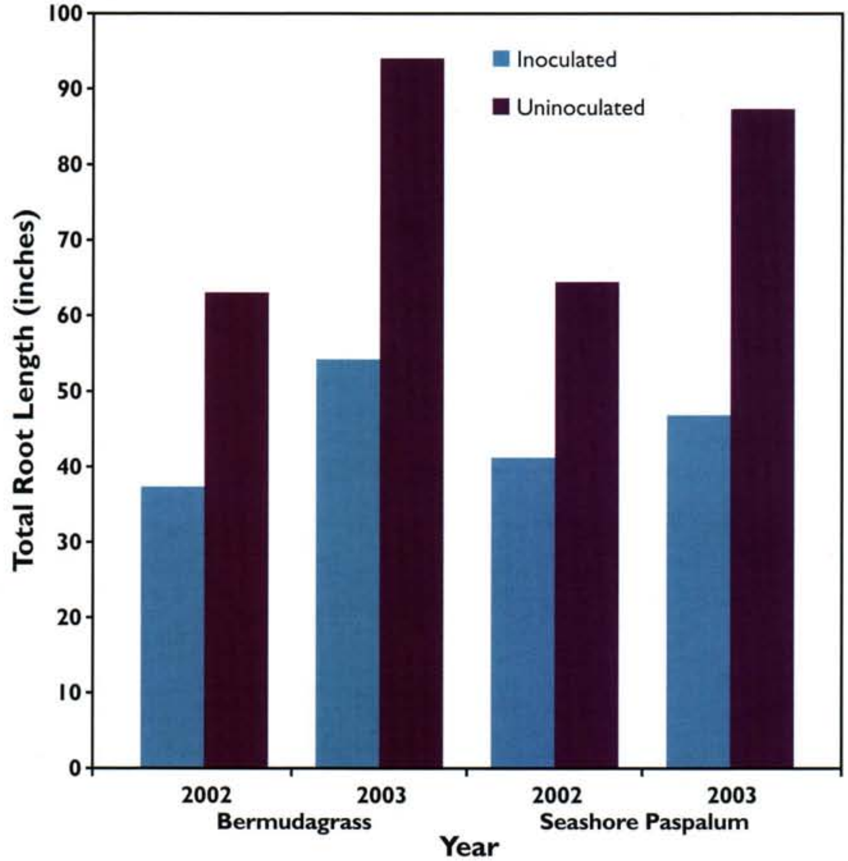
BY ADAM C. HIXSON, TODD LOWE, AND WILLIAM T. CROW

Seashore paspalum can quickly spread in saline conditions as long as proper nutrients and soil conditions are present.

Water quality is an ever-increasing issue on golf courses as the demand for potable water increases and alternative water sources are utilized for golf course irrigation. In fact, recycled water as the primary source of irrigation has increased for Florida golf courses from 8% in 1974 to nearly 50% in 2000.[3] As a result, salt-tolerant turfgrasses are becoming necessary in many areas because of groundwater use restrictions, salt accumulation in soil, and saltwater intrusion into groundwater. Seashore paspalum (*Paspalum vaginatum*) is a warm-season turfgrass adapted for saline conditions and has been utilized on salt-affected sites for the past 30 years. Breeding efforts over the past decade have provided several varieties with improved leaf texture, color, and overall quality, and its use on golf courses throughout Florida and the coastal southeastern U.S. is increasing.

Figure 1

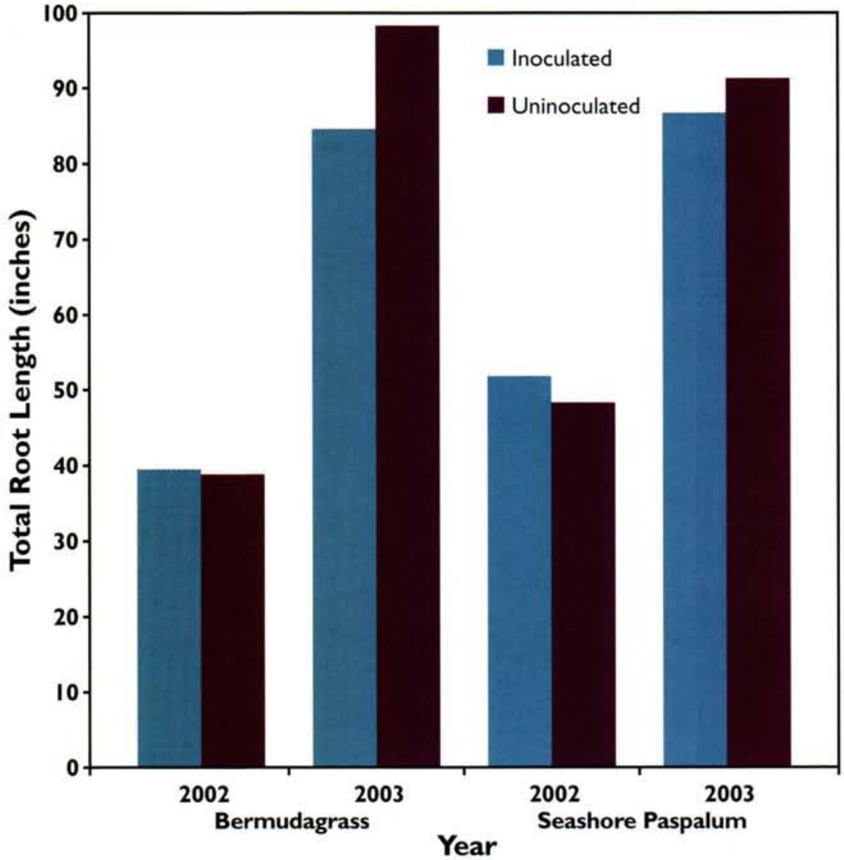
Effects of sting nematode (*Belonolaimus longicaudatus*) on total root lengths of SeaIsle 1 seashore paspalum compared to Tifdwarf bermudagrass. Total root lengths are the combined lengths of all roots present in a soil core taken from experimental pots, not actual root depth.



A major limitation of growing turfgrass in sandy soils throughout the southeastern U.S. is the destruction of roots by plant-parasitic nematodes. There are several types of plant-parasitic nematodes, but the most injurious nematodes throughout the southeastern U.S. are sting (*Belonolaimus longicaudatus*) and lance (*Hoplolaimus galeatus*) nematodes. Sting nematodes are ecto-parasites that live outside plant roots and damage lateral roots as soon as they are formed. Lance nematodes are migratory endo-parasites that enter turfgrass roots and cause damage by feeding as well as physically tunneling through cell walls. Ultimately, plant-parasitic nematodes decrease root growth and the plant's

Figure 2

Effects of lance nematode (*Hoplolaimus galeatus*) on total root lengths of SeaIsle I seashore paspalum compared to Tifdwarf bermudagrass. Total root lengths are the combined lengths of all roots present in a soil core taken from experimental pots, not actual root depth.



Lance nematodes are able to enter seashore paspalum roots, causing damage to the root cortex.

ability to take up water and nutrients. Aboveground symptoms of plant parasitic nematode damage become evident in the form of sporadic turf thinning and chlorosis.

Sting and lance nematodes are destructive pests on a variety of turfgrasses, but little is known about their damage to seashore paspalum. Seashore paspalum has only recently been determined to be susceptible to sting nematodes, while the effects of lance nematodes on seashore paspalum root health remain unclear (Figures 1 and 2). Maintaining acceptable turfgrass quality is increasingly difficult when the manager is forced to reduce water consumption or switch to alternative water sources. An additional unknown aspect is the effect of salinity levels on sting and lance nematode populations in seashore paspalum. Plant-parasitic nematodes are primarily aquatic animals residing in films of water surrounding soil particles. The premise of this research is to investigate if disruptions in this habitat, such as saline irrigation, can affect biological processes and possibly decrease nematode populations.

GREENHOUSE TRIALS

Experiments were performed to establish relationships between increasing irrigation salinity levels and population levels of sting nematodes and lance nematodes. Greenhouse experiments were conducted in 2002 from April to September and repeated in the spring and summer of 2003 at the University of Florida Turfgrass Envirotron research facility in Gainesville, Florida.

Nematode-free plugs of SeaIsle 1 seashore paspalum were planted into 6-inch clay pots filled with 100% USGA specification sand in a climate-controlled greenhouse. Sting and lance nematodes were then inoculated into the clay pots and exposed to salinity irrigation levels ranging from 3,200 to 35,200 total dissolved salts (TDS) and deionized water (0 TDS) to serve as a control. Nematode population densities

Plant parasitic nematodes significantly reduce bermudagrass root growth, reducing the turf's ability to take up nutrients and water.

were evaluated 120 days after salinity irrigation treatments began.

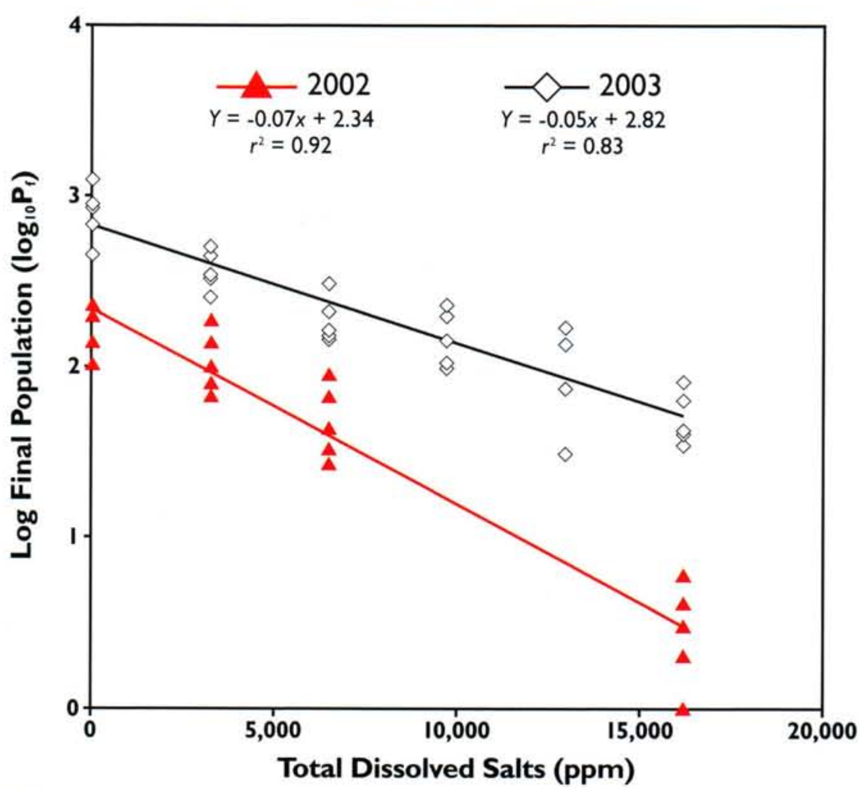
In 2003, root length analysis was performed in addition to the nematode population measurements. Stained root samples were placed into a glass-bottom tray and scanned using a desktop scanner to create a black-and-white bitmap image of the roots. The GSRoot (Louisiana State University, Baton Rouge, Louisiana) software program was used to analyze the bitmap images. This program measures root lengths and surface areas from scanned images. Root length data were recorded for seven root diameter ranges, and the resulting values were summed to determine the total root length of each root sample.

RESULTS AND DISCUSSION

In both years of the study, reproduction of sting and lance nematodes was affected by increasing salinity levels (Figures 3 and 4). Lance nematode populations decreased linearly with increasing salinity irrigation treatments (Figure 3). Lower salinity treatments, 0

Figure 3

Relationship between log transformation of final population densities (P_f) of lance nematodes (*Hoplolaimus galeatus*) (nematodes 100 cm^{-3} of soil) (Y) and salinity treatment (x) in 2002 and 2003 greenhouse experiments.



to 6,400 TDS, resulted in higher lance nematode reproduction than the higher salinity irrigation treatments (Figure 3). The ability of lance nematodes to enter roots as migratory endoparasites also decreased as salinity levels increased. The nematodes were probably not able to escape the effects of the salinity by entering the roots because the root cortex tissue does not exclude the elevated ion concentrations associated with saline water. Their ability to enter the roots typically gives them the capability to escape the effects of most nematicides[2]; therefore, irrigating with high-salinity irrigation may increase nematicide efficacy.

In 2003, second-stage juveniles or J2 (the life stage of the nematode that hatches from the egg) of sting nematodes comprised a majority of the population in the 9,600 and 12,800 TDS treatments, and an abundance of J2 at moderate salinity levels resulted in elevated total population numbers (Figure 4). Usually, J2 can be easily separated from other life stages by their dark color and stout body shape, but J2 in our study had a clear body cavity, indicating they were probably unable to feed. Root length data in 2003 support this hypothesis, with normal root growth at salinity levels between 9,600 and 16,000 TDS as opposed to nematode feeding that occurred on roots in lower salinity treatment levels (Figure 5). Reproduction and maturation of the nematodes at higher salinity treatments probably occurred early in the experiment, before the salinity was able to build up in the soil. These results indicate that the ability of sting nematodes to stunt root growth decreased as salinity levels increased above 9,600 TDS.

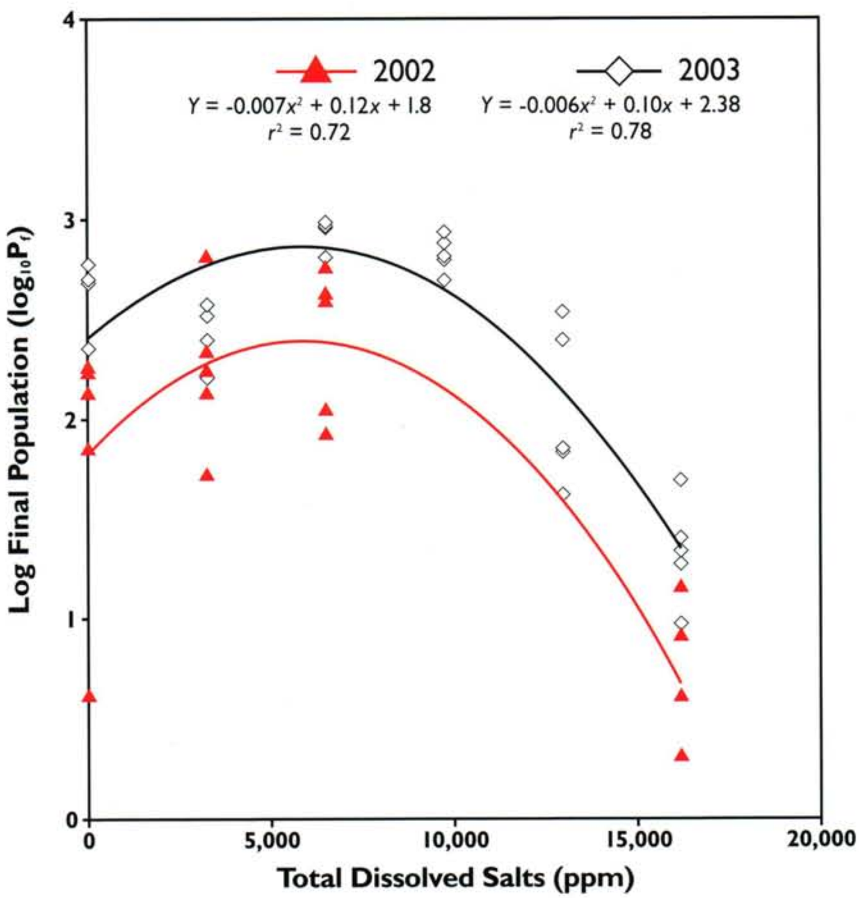
> Moderate- to high-salinity irrigation had an impact on sting and lance nematode reproduction.

In 2002, repeated applications of high-salinity irrigation (25,600 and 35,200 TDS) caused nearly complete mortality for both nematodes, but the shoot growth of the grass was stunted and yellowed. Even though sting and lance nematodes were effectively controlled, the turfgrass was visually unacceptable. Seashore paspalum can be irrigated with seawater (34,560 TDS) in the field when soil conditions and increased irrigation allow for sufficient leaching to occur and turfgrass managers fertilize, amend, and cultivate the soil properly.[1] In the greenhouse, we were unable to provide sufficient leaching, proper amendments, and cultivation of soil necessary for seashore paspalum survival at salinity levels near that of seawater, which may account for the poor turfgrass quality that occurred.

Results from greenhouse experiments are difficult to extrapolate to field conditions, but we can conclude that moderate- to high-salinity irrigation had an impact on sting and lance nematode reproduction. The treatment salinity levels were routinely applied throughout the experiment; therefore, nematodes did not recover from salinity stress. A discontinuous high-salinity irrigation regime would be more similar to irrigation of poor quality on golf courses where rainfall can leach salt from the soil profile.[4] Our data suggest that irrigation with pure seawater or with seawater as a high percentage of the blended irrigation water may have potential as an effective option for suppression of sting and lance nematodes. This information may be vital to turfgrass managers currently maintaining seashore paspalum known to have a nematode problem. Further investigation

Figure 4

Relationship between log transformation of final population densities (P_f) of sting nematodes (*Belonolaimus longicaudatus*) (nematodes 100 cm^{-3} of soil) (Y) and salinity treatment (x) in 2002 and 2003 greenhouse experiments.



is necessary to determine if frequency and timing of high-salinity irrigation, in addition to salinity concentration, reduces nematode reproduction and feeding.

LITERATURE CITED

1. Carrow, R. N., and R. R. Duncan. 1998. Salt-affected turfgrass sites: assessment and management. Ann Arbor Press, Chelsea, Michigan.

2. Giblin-Davis, R. M., P. Busey, and B. J. Center. 1995. Parasitism of *Hoplolaimus galeatus* on diploid and polyploid St. Augustinegrasses. *Journal of Nematology* 27:472-477.

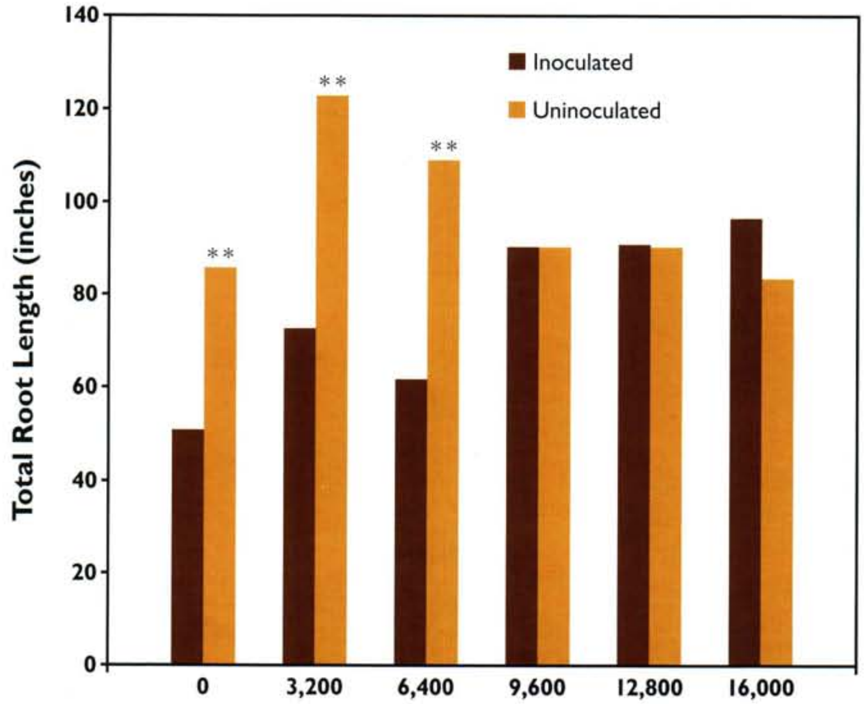
3. Haydu, J. J., and A. W. Hodges. 2002. Economic impacts of the Florida golf course industry. Institute of Food and Agricultural Sciences, Gainesville, Florida: University of Florida.

4. Mashela, P., L. W. Duncan, J. H. Graham, and R. McSorley. 1992. Leaching soluble salts increases population densities of *Tylenchulus semipenetrans*. *Journal of Nematology* 24:103-108.

ADAM HIXSON *is a Ph.D. candidate at North Carolina State University in Raleigh (and former Florida Region Green Section intern);* TODD LOWE *is an agronomist for the Green Section's Florida Region; and* DR. BILLY CROW *is an assistant professor of nematology at the University of Florida in Gainesville.*

Figure 5

Effects of sting nematodes (*Belonolaimus longicaudatus*) and salinity level on root length of SeaIsle I seashore paspalum (*Paspalum vaginatum*). Total root lengths are the combined lengths of all roots present in a soil core taken from experimental pots, not actual root depth.



* * Indicates a statistical difference from inoculated

Plant-parasitic nematodes feed on bermudagrass roots, causing irregular chlorotic and drought-like patches.