A PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

TURFGRASS TRENDS

Volume 10, Issue 5 • May 2001

TURFGRASS PEST MANAGEMENT

Using Entomopathogenic Nematodes for Turfgrass Pest Management

By Parwinder Grewal

Entomopathogenic nematodes (Steinernema and Heterorhabditis) are microscopic roundworms that parasitize and kill insects in the soil. These nematodes have demonstrated potential for biological control of insect pests.

The entomopathogenic nematodes occur naturally in almost all soils and reproduce in dead hosts (see Fig. 1). The nematodes cause widespread mortality of insects in the soil and are often seen as crashes in insect populations or conspicuous epizootics. More than 30 of these nematode species have been discovered worldwide. Due to the ease in nematode mass production, several nematode-based products have been developed for use as biological insecticides. Entomopathogenic nematodes are well suited for pest control in turfgrass because they attack a broad range of pests and can be easily mass-produced and applied using conventional spray equipment.

Tests on home lawn turf have shown that S. carpocapsae is the most effective nematode species for the control of armyworms.

Life cycle

Under suitable environmental conditions, the infective juvenile nematodes seek insect larvae and pupae in soil. They penetrate host insects through natural body openings (mouth, anus, and spiracles) and release a bacterium that kills the insects within a day or two. Insects killed by the nematodes are flaccid, do not give off foul smell, and have conspicuous colors. For example, insects killed by Steinernema carpocapsae are yellow and those killed by Heterorhabditis bacteriophora are reddish brown.

After the death of the host, nematodes feed on the bacteria, and insect body contents, and reproduce. Within two to three weeks, hundreds of infective juveniles are released into the environment to seek out new insect hosts and continue their life cycle. For commercial uses, they are mass-produced either in live insects or in fermenters.

Species, strains and searching behavior

Nematode species and strains differ in their activity against different insect pests. These differences are due to the different search behaviors of nematodes, and also the type and number of bacteria carried by the infective juveniles. Steinernema carpocapsae will kill more mobile insects that live in the upper soil or thatch layer, such as billbugs, sod webworms,

AN ADVANSTAR ★ PUBLICATION

IN THIS ISSUE

TURFGRASS TRENDS

Executive Editor
Sue Gibson
440/891-2729; 440/891-2675 (fax)
sgibson@advanstar.com

Managing Editor
Curt Harler
440/238-4556; 440/238-4116
curt@curt-harler.com

On Line Editor
Lynn Brakeman

Senior Science Editor
Dr. Karl Danneberger

Group Editor
Vern Henry

Production Manager
Rene' Fall
218/723-9352; 218/723-9223 (fax)
rfall@advanstar.com

Senior Graphic designer
Jeff Landis
440/891-2702; 440/891-2675 (fax)
jlandis@advanstar.com

Circulation Manager
Cheryl Beeman
218/723-9271

Group Publisher
John D. Payne
440/891-2786; 440/891-2675 (fax)
jpayne@advanstar.com

Corporate & Editorial Office
7500 Old Oak Blvd.
Cleveland, OH 44130-3369

New Subscriptions
888/527-7008

Abstracts: 800/466-8443
Reprint: 440/891-2744
Permission: 440/891-2742
Single copy or back issues:
Subscription/Customer Service
888/527-7008; (fax) 218/723-9437
Web site address:
www.landscapemanagement.net

ADVANSTAR COMMUNICATIONS

Chairman and Chief Executive Officer
Robert L. Krakoff

Vice Chairman
James M. Alic

VP-Finance, CFO & Secretary
David W. Montgomery

Executive Vice Presidents
William J. Cooke
Alexander S. DeBarr
Morris R. Levitt
Daniel M. Phillips

Vice President & General Counsel
Eric I. Lisman

Treasurer and Controller
Adele D. Hartwick

cutworms, and armyworms. This nematode species uses an ambush approach to find insect hosts.

The infective juvenile nematodes stand on their tails and wait for long periods for insect to come into range. Steinernema glaseri and H. bacteriophora on the other hand use a more active search strategy called cruising, to find insect hosts. These nematodes are therefore, more effective against less mobile hosts such as white grubs. This distinction should be used as an overall guide for matching the right nematode species with the target pest. Turfgrass pests that can be successfully controlled by the nematodes are listed in Table 1.

Pests controlled

ARMYWORMS

The common armyworm, fall armyworm, and yellowstriped armyworm most commonly damage home lawns, and only occasionally are pests on golfcourse turf. Armyworms are also very susceptible to nematodes, as all larval stages and the pupae may be infected. Tests on home lawn turf have shown that S. carpocapsae is the most effective nematode species for the control of armyworms.

CUTWORMS

The black cutworm is found throughout North America and is a perennial problem on bentgrass turf of golf course greens, tees, and fairways, but rarely damages lawns. The bronzed, variegated, and glassy cutworms are pests of home lawn turf. Cutworms are semi-subterranean pests and usually dig a burrow into the ground or thatch and emerge at night to clip off grass blades and shoots. S. carpocapsae can be used effectively to manage all cutworm species. Black cutworm larvae can be controlled on golf course greens by applying nematodes at a rate of 1.0 billion per acre.

SOD WEBWORMS

The bluegrass, larger, western, striped, elegant, and vagabond sod webworms, along with the closely related cranberry girdler sometimes damage cool season grasses. The tropical sod webworm is the most damaging pest of warm-season grasses. Both S. carpocapsae and H. bacteriophora are effective against sod webworms in turfgrass.

WEEVILS

The annual bluegrass weevil or Hyperodes weevil is an important pest of Poa annua and annual bluegrass on golfcourses in the northeastern United States. S. carpocapsae, H. bacteriophora, and H. megidis have shown good results for the control of weevil larvae in golfcourse turf.

Two species of billbugs are most important in turfgrass. The bluegrass billbug damages most cool-season grasses, but mainly Kentucky bluegrass and perennial ryegrass. The hunting billbug causes damage to warm-season turfgrasses including bermudagrass and Zoysiagrass. Nematodes infect both adult and larval billbugs, but treatments against larvae are generally more effective. Trials often show nematodes to be more effective than standard insecticides when larval stages are treated. In fact nematodes are the most effective control method for the hunting billbug on golfcourses in Japan. Both S. carpocapsae and H. bacteriophora are equally effective.

Soil temperatures between 50° F to 85° F are favorable for application of most nematode species. If soil temperature is above 85° F, pre-application irrigation is usually recommended to reduce soil temperature prior to nematode application.

FLEAS

Larvae of the cat flea are highly susceptible to nematodes The cat flea is a cosmopolitan parasite on dogs and cats, and has also been reported feeding on humans. Flea adults spend most of their time feeding on mam-

mal hosts where mating and egg laying also occur. The eggs eventually drop off the animal and the emerging larvae feed on organic debris in pet beddings on lawns, carpeting, or upholstered furniture.

Nematodes have been extremely effective at controlling flea larvae and pupae in home lawns. In tests performed in North Carolina, S. carpocapsae applied at 1 billion per acre caused more than 90% mortality of flea larvae within 24 h. Steinernema carpocapsae also caused 91 to 97% mortality of flea pupae in cocoons in a test in Louisiana. Nematodes are most effective against flea larvae in turf and soil when the outdoor temperatures are above 14° C and the soil is moist. S. carpocapsae-based products Interrupt and bio Flea Halt became extremely popular in 1994 and 1995.

Crane flies or leather jackets

European crane fly is considered a pest of turfgrass in British Columbia, Nova Scotia, Oregon, and Washington. Substantial research conducted in Europe shows that the crane fly larva is highly susceptible to heterorhabditid nematodes.

Mole crickets

The tawny mole cricket and the southern mole cricket are the two most destructive crickets and are distributed throughout the coastal plain region of the southeast United States. Mole crickets are considered the most serious pests of turf and pasture grasses. Adult and nymphal mole crickets cause damage by feeding on grass roots and shoots, and by tunneling through the ground. A single mole cricket can create 10 to 20 feet of tunnel in just one night, drying out the soil and causing serious damage to plant roots. Annual costs of controlling mole crickets are estimated to exceed 50 million in Florida alone.

Nematodes have been successful in reducing damage to turfgrass by mole crickets. S. scapterisci, which was originally isolated from infected mole crickets in Uruguay, showed 75 to 100% infection of adult mole crickets under laboratory conditions. In an inoculative release effort, S. scapterisci was introduced into pastures during the summer of 1985. Based on the evaluation of field-collected mole crickets over a five-year period, the nematodes were found to be established at all the sites, with the mean number of adults infected being 11% for the entire period.

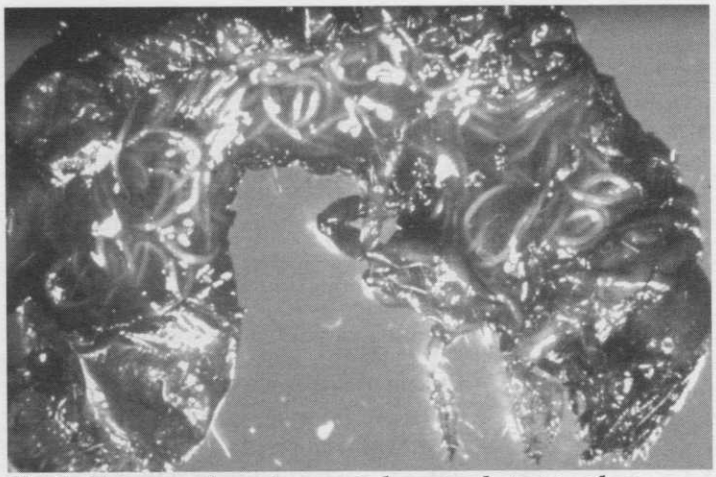


Fig. 1. Entomopathogenic nematodes reproducing inside a recently killed white grub.

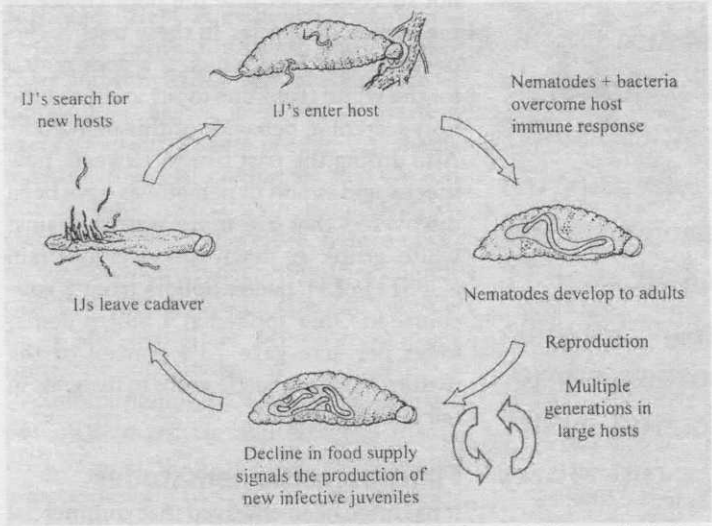


Fig. 2. Generalized life cycle of Steinernema and Heterorhabditis nematodes.

A British company has recently acquired a license for this nematode from the University of Florida and plans to develop a product in the near future.

Another nematode species, S. riobrave, has shown exceptional potential as a biological insecticide for mole crickets. S. riobrave, which was originally isolated from

soil in the Rio Grand Valley in Texas. In one test, 66-86% reduction in turf injury was observed with a single application of 1 billion S. riobrave per acre in South Carolina. A commercial product called Vector MC was marketed by Lesco, Inc. for the control of mole crickets in turf. ThermoTrilogy corporation is currently considering reintroduction of this product.

WHITE GRUBS

Certain strains of entomopathogenic nematodes can be quite effective for curative control of white grubs. White grub species differ in susceptibility to different nematode species. For example, the Japanese beetle is more susceptible to H. bacteriophora and H. zealandica nematodes than the European chafer. It also appears that young instars are more susceptible to nematodes than the fully grown grubs.

Earlier tests against white grubs were not successful because the poor choice of the nematode species. In these tests, S. carpocapsae was used which is a poor match for the white grubs due to the ambush type host searching behavior of this nematode. Also during the past five to 10 years, new species and strains of nematodes have been discovered that are more potent against white grubs. A newly discovered strain (GPS11) of H. bacteriophora from a golf-course in Ohio applied at 1 billion nematodes per acre gave 73% control of the mature Japanese beetle grubs in turfgrass in fall of 2000 (Fig. 3).

Plant-parasitic nematodes

It has often been observed that commercial applications of entomopathogenic nematodes also result in unexpected improvements in plant growth. Analysis of soil samples from the nematode-treated plots of turfgrass and citrus revealed fewer plant-parasitic nematodes than the untreated plots. Systematic evaluations in the field have provided support for the above observations.

In one trial, S. riobrave applied at 6 billion nematodes per acre provided 95 to 100% control of the root-knot nematode, sting nematode, and the ring nematode at a golf course in South Carolina. In another test, both S. riobrave and S. carpocapsae applied at one billion nematodes per acre provided 86 to 100% control of the root-knot, sting, and ring nematodes on golf-course fairways in Georgia. In a recent study conducted in Medina, Ohio, we found that heterorhabditid nematodes effectively controlled plant-parasitic nematodes in golf course roughs.

Where to buy

Entomopathogenic nematodes can be obtained directly from producers or retailers. The nematodes can also be purchased through gardening mail-order catalogs and at some agricultural and nursery supply stores. Below is a guide to lists of commercial suppliers of nematodes:

Commercial sources of insect-parasitic nematodes, 2000. Compiled by P. Grewal & K. Power. Ohio State University. http://www2.oardc.ohio-state.edu/nematodes/nematode_suppliers.htm

Retail suppliers of beneficial nematodes, 1994. Compiled by Robert Wright. Nebraska Cooperative Extension. http://www.ianr.unl.edu/pubs/insects/nf182.htm

Suppliers of beneficial organisms in North America, 1997. State of California, Department of Pesticide Regulation, Environment Monitoring & Pest Management. Mailing address: 830 K Street, Sacramento, CA 95814-3510

Phone 916/324-4100
http://www.cdpr.gov/docs/ipminov/bscover.htm or/bensuppl.htm

Quality

The quality of commercially produced nematodes aimed at a mail-order market in the USA was assessed in 1999 by three different university laboratories in New Jersey, California, and Ohio. They found that most companies were accessible, reliably shipped pure populations of the correct species on time, in sturdy containers, and often with superb accompanying instructions.

Nematodes were received in satisfactory condition with acceptable levels of viability.

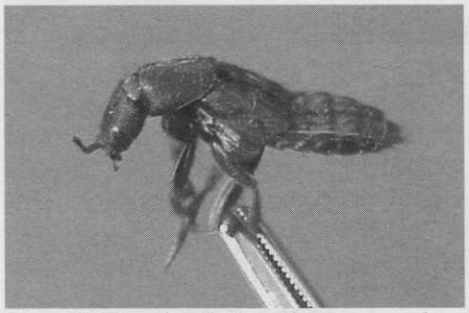


Figure 3. Rove beetles have been reported to be predators of various white grub species.

How and when to apply

Nematodes can be easily applied using conventional liquid pesticide, fertilizer, and irrigation equipment with pressures of up to 300 PSI. Electrostatic, fan, mist, and pressurized sprayers can be used. If the tanks are agitated through excessive sparging (recirculation of the spray mix), or if the temperature in the tank rises above 86 F, the nematodes will be damaged. Irrigation systems may also be used for applying most species; however, high pressure, recycling pumping systems are not good delivery systems. Screens smaller than 50 mesh should be removed from spray or irrigation equipment to allow nematodes to pass through the system.

Volumes of two to six gallons of water per 1,000 square feet (86 to 260 gallons per acre) are recommended on most labels. A broadcast application rate of 1 billion nematodes per acre is generally recommended to control most soil insects. For smaller areas, the recommended application rate is 250,000 nematodes per square meter.

Nematodes require moist soil for optimum activity and will not kill insects if soil temperatures are below 50° F. They are also extremely sensitive to heat and sunlight, and will perish in a matter of minutes when exposed to full sun. Therefore, nematodes should be applied in early morning or late in the day to prevent exposure to sunlight. Also turf may need to be irrigated before treatment if the soil is too dry, and irrigated again with at least 1/2 inch of water immediately after application to rinse off nematodes from the foliage and move them into the soil and thatch.

Nematodes require a thin film of water for movement, but are not capable of movement under flooded conditions. Maintenance of optimum soil moisture after application usually enhances nematode activity and efficacy. In general, nematode activity and survival is lower in heavy clay soils than in sandy-loam soils. Soil temperature during and after application can also affect nematode efficacy. Warmer temperatures usually reduce nematode survival while cooler temperatures reduce activity and infectivity.

Soil temperatures between 50° F to 85° F are considered favorable for application of most nematode species. If soil temperature is above 85 F, a pre-application irrigation is usually recommended to reduce soil temperature prior to nematode application.

Compatibility

Although there is evidence that nematodes are compatible with most herbicides and fungicides, they are sensitive to certain insecticides, nematicides, wetting agents, and surfactants used in turf maintenance. A list of chemicals that should not be tank mixed with nematodes in given in Table 2. Therefore, before tank-mixing the nematodes with other chemicals, the label should be checked carefully or the nematode producer/supplier should be consulted.

Entomopathogenic nematodes have the potential to recycle and establish in the environment following use as biological insecticides or if used in inoculative releases as in the case of parasites and predators. However, studies documenting the long-term persistence of nematodes are limited. Steinernema glaseri was reported to have maintained itself in the field for 14 years in New Jersey with a Japanese beetle larval densities of less than five per square foot. Steinernema scapterisci has been shown to maintain its population in mole crickets in Florida for 5 years.

Other studies have reported that a single application of nematodes can impact more than a single generation of white grubs.

The annual bluegrass weevil or Hyperodes weevil is an important pest of Poa annua and annual bluegrass on golf courses in the northeastern United States. S. carpocapsae, H. bacteriophora and H. megidis have shown good results for the control of weevil larvae in golf course turf.

TABLE 1. TARGET PESTS OF COMMERCIALLY AVAILABLE ENTOMOPATHOGENIC NEMATODES

Target pest	Target life stage	Best nematode species
Armyworms (Noctuidae: Lepidoptera)		
Armyworm	Larva/pupa	S. carpocapsae
Fall armyworm	Larva/pupa	S. carpocapsae
Yellowstriped armyworm	Larva/pupa	S. carpocapsae
Lawn armyworm	Larva/pupa	S. carpocapsae
Cutworms (Noctuidae: Lepidoptera)		
Black cutworm	Larva/pupa	S. carpocapsae
Bronze cutworm	Larva/pupa	S. carpocapsae
Variegated cutworm	Larva/pupa	S. carpocapsae
Glassy cutworm	Larva/pupa	S. carpocapsae
Sod webworms (Pyralidae: Lepidoptera)		
Bluegrass webworm	Larva/pupa	S. carpocapsae, H. bacteriophora
Larger sod webworm	Larva/pupa	S. carpocapsae, H. bacteriophora
Western lawn moth	Larva/pupa	S. carpocapsae, H. bacteriophora
Striped sod webworm	Larva/pupa	S. carpocapsae, H. bacteriophora
Elegant sod webworm	Larva/pupa	S. carpocapsae, H. bacteriophora
Vagabond sod webworm	Larva/pupa	S. carpocapsae, H. bacteriophora
Cranberry girdler	Larva/pupa	S. carpocapsae, H. bacteriophora
Tropical sod webworm	Larva/pupa	S. carpocapsae, H. bacteriophora
Burrowing sod webworm	Larva/pupa	S. carpocapsae, H. bacteriophora
Fleas (Policidae: Siphonaptera)		
Dog flea larvae	Larva/pupa	S. carpocapsae
Cat flea larvae	Larva/pupa	S. carpocapsae
Mole crickets (Gryllotaplidae: Orthoptera)		
Tawny mole cricket	Nymph/adult	S. scapterisci, S. riobrave
Southern molecricket	Nymph/adult	S. scapterisci, S. riobrave
Short winged mole cricket	Nymph/adult	S. scapterisci, S. riobrave
Native mole cricket	Nymph/adult	S. scapterisci, S. riobrave
Crane flies or leather jackets (Tipulidae: Diptera)		
European crane fly	Larva/adult	H. bacteriophora, H. megidis
Weevils (Curculionidae: Coleoptera)		
Annual bluegrass weevil	Larva/adult	H. bacteriophora, S. carpocapsae
Bluegrass billbug	Larva/adult	S. carpocapsae, H. bacteriophora
Hunting billbug	Larva/adult	S. carpocapsae, H. bacteriophora
Phoenician billbug	Larva/adult	S. carpocapsae, H. bacteriophora
Denver billbug	Larva/adult	S. carpocapsae, H. bacteriophora
White grubs (Scarabaeidae: Coleoptera)		
Asiatic garden beetle	Larva	H. bacteriophora, H. zealandica
Black turfgrass ataenius	Larva	H. bacteriophora
Green June beetle	Larva	H. bacteriophora
Japanese beetle	Larva	H. bacteriophora, H. zealandica, S. glaseri
May or June beetles	Larva	H. bacteriophora
Oriental beetle	Larva	H. bacteriophora, H. zealandica
European chafer	Larva	Steinernema sp.
Northern masked chafer	Larva	H. bacteriophora, H. zealandica
Southern masked chafer	Larva	H. bacteriophora
Southwestern masked chafer	Larva	H. bacteriophora, S. glaseri
Plant-parasitic nematodes (Nematoda)		
Sting nematodes	Juvenile/Adult	S. carpocapsae, S. riobrave
Ring nematodes	Juvenile/Adult7	S. carpocapsae, S. riobrave
Root-knot nematodes	Juvenile/Adult	S. carpocapsae, S. riobrave, S. feltiae
Lance nematodes	Juvenile/Adult	H. bacteriophora
Lesion nematodes	Juvenile/Adult	H. bacteriophora
Stunt nematodes	Juvenile/Adult	H. bacteriophora
Spiral nematodes	Juvenile/Adult	H. bacteriophora
Pin nematodes	Juvenile/Adult	H. bacteriophora

Conservation

Whether they are applied or occur naturally, conservation of entomopathogenic nematodes in the turf should be a goal. There are several factors that influence nematode persistence in the soil. Extremely dry soil conditions, absence of host insects for extended periods, and the application of toxic chemicals may reduce nematode numbers in soil. Studies are continuing to shed light on the complex ecology of entomopathogenic nematodes to develop practical approaches to effectively conserve and augment their populations in turfgrass.

Nematodes are safe to apply and are exempt from government registration. They do not harm the environment, plants, animals, pets or wildlife, or non-target invertebrates. They are found naturally in various soil types, in turfgrass lawns, cultivated sites, and in undisturbed natural areas. No worker protection measures are necessary for nematode applications and turf can be used immediately after treatment.

Parwinder Grewal is assistant professor in the Department of Entomology, OARDC, Ohio State University, Wooster, Ohio. He invites everyone to visit the insect-parasitic nematode Web site at www.oardc.ohio-state.edu/nematodes .

TABLE 2

CHEMICALS THAT SHOULD NOT BE TANK MIXED WITH ENTOMOPATHOGENIC NEMATODES.

Chemical Trade Name:

- Anilazine Dyrene
- Azadirachtin Azatin
- Azinphosmethyl Guthion
- Bendiocarb Turcam
- Carbofuran Furadon
- Carbaryl Sevin
- Chlorpyriphos Dursban
- Ethoprop Mocap
- Fenamiphos Nemacur
- Fipronil Chipco Choice
- Insecticidal Soap Various
- Isazophos Triumph Methomyl Lannate
- Oxamyl Vydate
- 2-4-D Various
- Trichlorfon Dylox
- Triclorpyr Turflon
- Confront

FURTHER READING

Gaugler, R., Grewal, P. S., Kaya, H. K. and Smith-Fiola, D. (2000). Quality assessment of commercially produced entomopathogenic nematodes. Biological Control 17, 100-109.

Georgis, R. and Poinar, G. O. Jr. (1989). Field effectiveness of entomophilic nematodes Neoaplectana and Heterorhabditis. In: Leslie A. R. and Metcalf, R. L. (eds.) Integrated Pest Management for Turfgrass and Ornamentals. Environmental Protection Agency, Washington, DC, pp. 213-224.

Niemczyk, H. D. and Shetlar, D. J. (2000). Destructive Turf Insects. Second Edition, HDN Books, Wooster, OH.

Grewal, P. S. (1997). Using nematodes for turfgrass pest management. Insect-parasitic nematode website at www2.oardc.ohio-state.edu/nematodes.

Grewal, P. S. and Georgis, R. (1998). Entomopathogenic nematodes. In: Hall, F.R. and Menn, J. (eds.) Methods in Biotechnology: Biopesticides: Use and Delivery. Humana Press Inc., Totowa, New Jersey, pp. 271-299.

Grewal, P. S., Martin, W. R., Miller, R. W. and Lewis, E. E. (1997). Suppression of plant-parasitic nematodes in turfgrass by entomopathogenic nematodes. Biocontrol Science and Technology 7, 393-399.

Two More Unconventional Grass Families to Know and Love

By Doug Brede, Ph.D.

Editor's note: This article is the third in a series for TurfgrassTrends describing in detail two families of little-used turfgrasses from among the hundreds you can know and grow.

Charlie Gouveia had a problem: His maintenance department was slowly poisoning his turfgrass and there was nothing he could do to stop it.

For many years, Gouveia was the Maintenance Director for the Illinois Department of Transportation, responsible for the miles of urban and rural thoroughfares throughout the state. It was Charlie's job to maintain the green ribbons along byways from Winthrop Harbor on the Wisconsin border north of Chicago, to Future City, Illinois, at the extreme southern tip of the state.

Years of winter deicing salts were taking their toll. In metropolitan areas, the 40 feet of turf next to the pavement was slowly dying, giving way to mud and weeds. Gouveia considered all possible solutions, most of which were either prohibitively expensive (digging out and replacing the contaminated soil) or blatantly dangerous (abandoning their winter salt applications).

Instead, he turned to seed specialist, Mark Grundman, for advice on unconventional grasses. After considerable study and testing, Grundman and Gouveia discovered a salt-tolerant turfgrass that could persist in this hostile environment. Later in this article, I'll explain how a Colorado professor came to their aid to save Illinois' roadsides.

In this edition of "Unconventional Grasses to Know and Love," I'm going to highlight two grass families that have been used extensively on American roadsides – the alkaligrasses and the lovegrasses – and explain where they can function for higher managed turfs, such as golf courses and sports.

TABLE 1

Survival of Lemmon and weeping alkaligrass over a 15-month period, in a sand-based experiment by Ali Harivandi, et al. (8). The two species were watered with concentrations of synthetic seawater every 15 days. The experiment demonstrates that these salt-tolerant grasses can bear pure seawater irrigation for short periods and can withstand 50% seawater irrigation for extended periods.

% sea water	Growth at 4 months	Months until 90% dead
0%	*Normal growth*	*Indefinite*
25%	*Normal growth*	*Indefinite*
50%	*Retarded growth*	*More than 15 months*
75%	*Retarded growth*	*11 months*
100%	*Retarded growth*	*4 to 7 months*

Salt? No problem

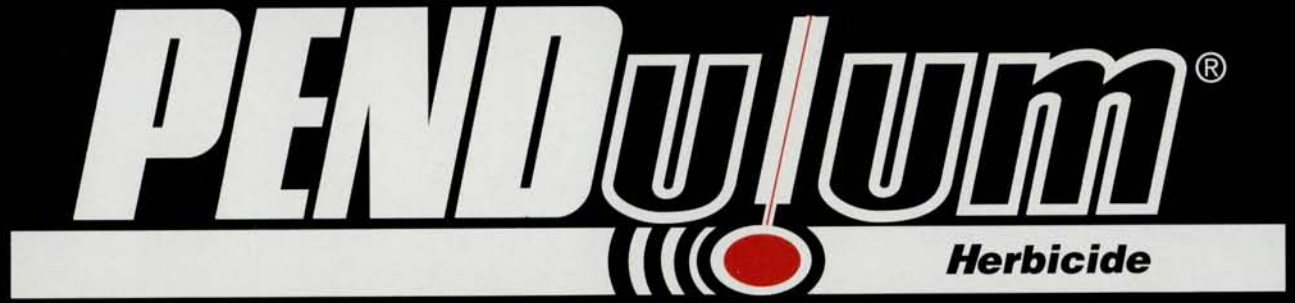
Stan Metsker is not a scientist or plant breeder. But he knew something good when he saw it. Metsker was the superintendent at Boulder Country Club, Boulder, Colorado, back in the 1970s. Located on the eastern fringe of the Rockies, Metsker's course — like many golf courses of the Plains — had elevated salt levels in the soil and irrigation water.

One warm day when the majority of his golf course was experiencing the first telltale signs of salt stress — a general purpling of the blades — Metsker noticed a particularly vibrant patch of grass on one fairway, seemingly unfazed by the white, salt-encrusted soil.

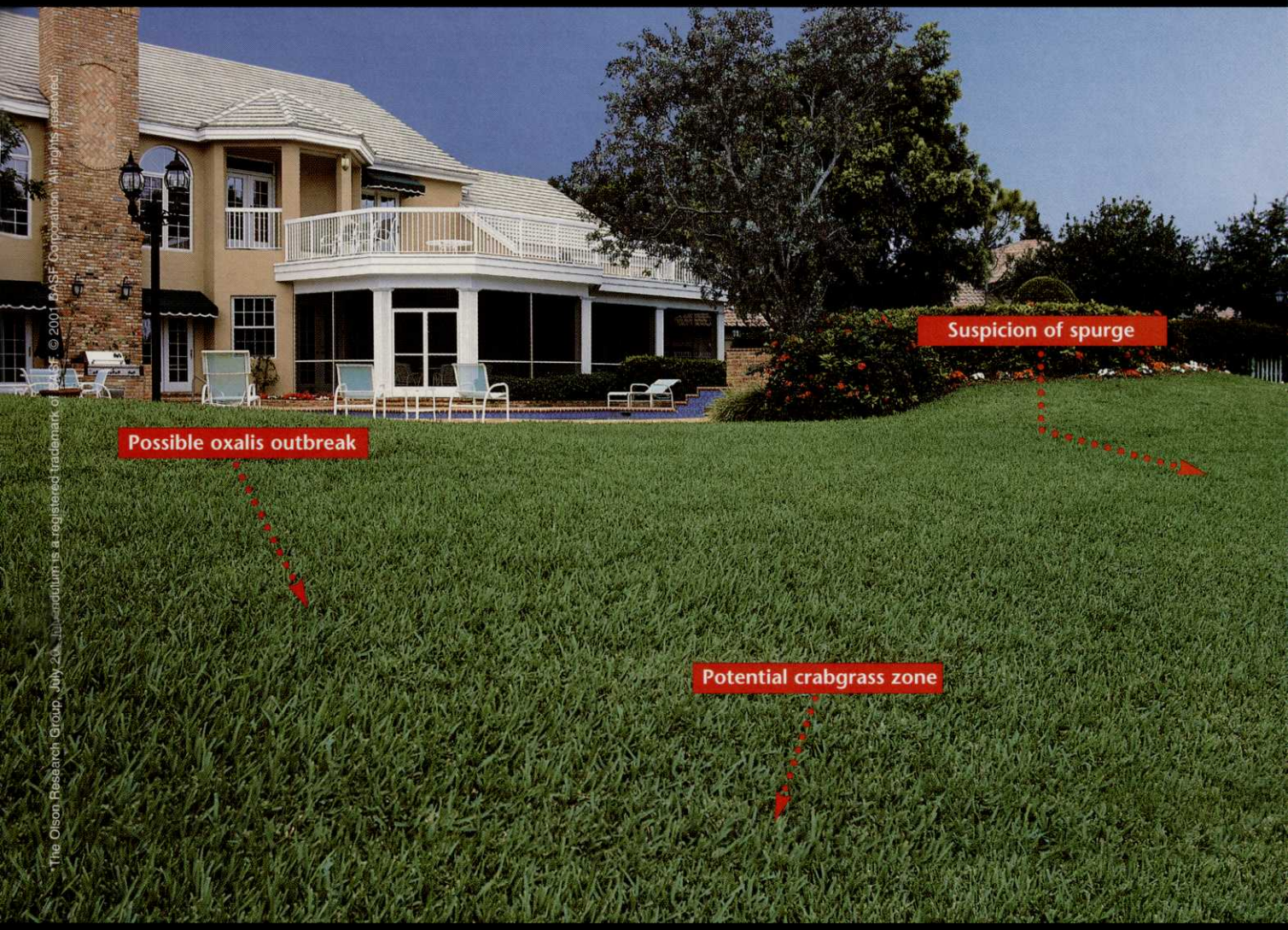
BASF
PROFESSIONAL
TURF™

BASF
PROFESSIONAL
TURF™

BASF
PROFESSIONAL
TURF™


PENDULUM®
Herbicide

IMPEDE THE SEED.



*The Olson Research Group, July 20... Pendulum is a registered trademark of BASF. © 2001 BASF Corporation. All rights reserved.

BASF PROFESSIONAL TURF

WEEDS NEVER SEE THE LIGHT OF DAY.

Lurking just beneath the surface are thousands of tiny weed seeds, threatening to ravage lawns and established ornamentals. Fortunately, **Pendulum® preemergent herbicide** stops more than 40 broadleaf and grassy weeds dead.

Pendulum is a proven performer, offering well over a decade of unsurpassed, season-long control and unmatched value to maximize your profit margins.

It's a combination that's earned **Pendulum** a higher satisfaction rating from LCOs than any other preemergent.*

To learn more about how **Pendulum** can make sure weeds never see the light of day, call 1-800-545-9525, ext. T3257 or visit *www.turffacts.com*.

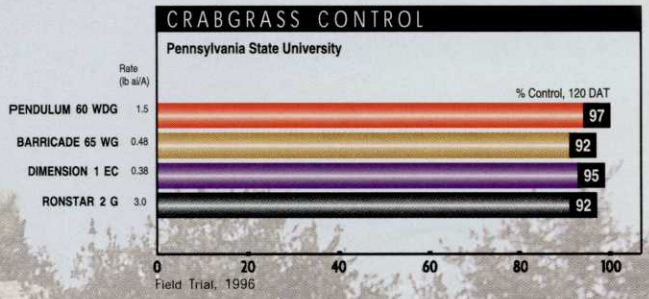
Always read and follow label directions.

PENDULUM® Herbicide

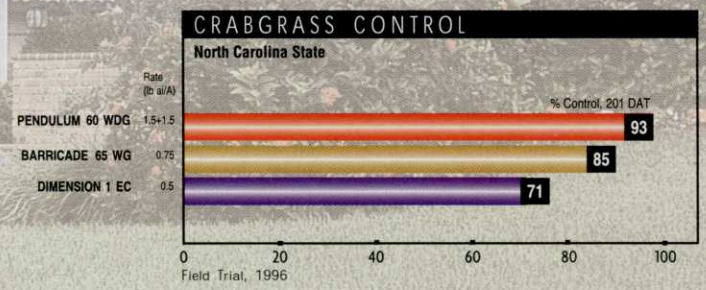
BASF

THE BROADEST CONTROL AVAILABLE.

Pendulum® preemergent herbicide controls 21 annual grassy weeds and 24 annual broadleaf weeds—including crabgrass, goosegrass, oxalis and spurge in turf. **Pendulum** is also labeled for over-the-top weed control of numerous ornamental species and can minimize hand weeding in ornamental beds for up to 8 months.



THE FULL-SEASON HERBICIDE.



Pendulum herbicide provides control throughout the entire season, even in warm climates with extended periods of weed germination. The reason? Its low volatility and slow decomposition characteristics keep it active in the soil longer.

FLEXIBILITY FOR CUSTOM CONTROL.

The **Pendulum®** preemergent herbicide product line includes sprayable 3.3 EC and 60 WDG formulations, as well as a 2% granular formulation. Application rates vary from 1.5 lb. a.i./acre to 3.0 lb. a.i./acre for turfgrasses, and up to 4.0 lb. a.i./acre for ornamentals, depending on the weeds controlled and duration of control desired.

WEEDS NEVER SEE THE LIGHT OF DAY.

Broad-spectrum, season-long control. Application flexibility. Exceptional turf-grass tolerance. And cost-efficiency. That's the combined power of **Pendulum**.

PENDulum® Herbicide

For additional information, please call 1-800-545-9525 Ext. T3257. Or visit our website at *www.turffacts.com*.

Always read and follow label directions.

BASF

Metsker contacted Jesse Fults, a professor at Colorado State's Weed Lab, who identified the grass as weeping alkaligrass (Puccinellia distans). Fults took samples of the grass and began raising test quantities of seed.

At about the same time, Jackie Butler, a turf professor at the University of Illinois, was making the move to Colorado State University. Butler was aware of Gouveia's salt problems on Illinois roadsides. Butler later conducted many of the early turf evaluations of Metsker's alkaligrass strain, which was released in 1979 as the variety 'Fults.'

Three species of alkaligrass

Many people have heard of Fults weeping alkaligrass, but most don't know that there are actually three similar but distinct species of alkaligrass with adaptation to turf. Of them, only weeping alkaligrass (P. distans) is not a native to North America. The other two are native to the Great Plains and West

Early on, botanists believed alkaligrass was a Poa – a direct relative of Kentucky bluegrass. In fact, you'll find it listed that way in early textbooks. That's because unmowed plants of alkaligrass bear an eerie resemblance to bluegrass: They have the same plant shape and size, the same boat-shaped leaf tips, and the same parallel light lines on either side of the blade midrib (see Fig. 2).

Unmowed, weeping alkaligrass grows to about 16 inches tall. Lemmon's and Nuttal alkaligrass are slightly taller, maturing at one to three feet. I've seen claims in the literature that alkaligrass can withstand "mowing down to one-half inch." One writer even claims it can be used for winter putting green overseeding (7). My experience has been that alkaligrass can persist down to about one-inch cut and no lower. It does its best work at traditional lawn heights of two to three inches. Under mowing its leaves resemble creeping red fescue more so than bluegrass.

Alkaligrasses do not need salt to grow. True halophytes require a jigger of salt as part of their diet. Alkaligrass simply becomes more competitive as the level of salt rises, while traditional turfgrasses become weaker and weaker. Soils with a high saline content will skew a mixture of alkaligrass into a nearly pure stand. On the converse, in unsalty soils, alkaligrass will virtually disappear from mixtures with ryegrass and bluegrass. Some turf managers routinely add a component of alkaligrass to seed mixtures to insure against future salt problems, either from deicing products or from effluent irrigation.

Weeping alkaligrass reportedly has the highest salt tolerance of the three species – able to withstand soil-paste EC's1 of 46 dS m-1. David Major, in his graduate thesis at Cal. Poly (10), found that alkaligrass could routinely tolerate EC's "in the 50's." Even short-term irrigation with undiluted seawater is possible. Seashore paspalum (a warm-season grass) has similar tolerance. Only saltgrass (Distichlis spp.) – a rather stemmy, unattractive turfgrass – has better salt tolerance. Lemmon's alkaligrass has the least salt tolerance of the three species, but it is still greater than that of bermudagrass (2).

Tony Koski (3) says alkaligrass; Greens up early in the spring, earlier than bluegrass, usually in late March (in Colorado), retains its color well into late fall, exhibits summer dormancy similar to fine fescue – it goes dormant in hot weather regardless of water status.

As its name implies, alkaligrass prefers a basic pH of 7 to 8 and will tolerate even higher values. It seems to grow well in neutral or mildly acid pH's also.

Its bluish-green color becomes darker under increasing salt or alkali.

Seeding rates for turf plantings are 1 to 3 lbs. per 1000 ft2. Considerably lower rates can be used for soil stabilization or vista-type plantings, in the range of 10 lbs./acre, when used in conservation mixtures. Early fall is its ideal sowing time.

Seedlots may contain some annual plant forms; these die out the first year and perennial forms later dominate the stand.

Test trials

I'm usually suspicious of greenhouse studies when it comes to turf. Not much commercial turfgrass is grown in greenhouses. But when other forms of research are

absent, they serve as a good starting point for inquiry.

Ali Harivandi and his colleagues (8) performed a neat greenhouse study on the tolerance of two alkaligrasses toward high levels of salt (Table 1). For the most part, they found that the two species, weeping and Lemmon's alkaligrass, responded similarly at low to moderate salt levels. Rapid germination occurred even in 50% seawater. Harivandi gave a slight edge to weeping alkaligrass over Lemmon's in enduring prolonged salty conditions. He also reported that mature plants handled salt better than seedlings.

A greenhouse study at the University of Nebraska compared alkaligrass with five popular turfgrass cultivars (Fig. 3). Ed Kinbacher and his associates (9) rated turf quality for more than two months, while subirrigating their pots with 0.8%-NaCl solution.

The salt effect is seen in the drop-off of performance over time. 'Adelphi' Kentucky bluegrass, the most salt-sensitive cultivar, steadily declined in quality as it endured saltwater. Alkaligrass, on the other hand, remained constant over the test period. Even buffalograss – a tough warm-season prairie species – declined sharply over time in quality.

Of course, the real proof-of-the-pudding comes from outdoor studies, like the one conducted at the Central Highlands Golf Club in Alberta, Canada (11). In this study, C.E. Miluch of Olds College tested 6 grasses under naturally saline conditions (Fig. 4). The plots were maintained at 1.5-inch cut for four years. Miluch found that alkaligrass, red fescue, and tall fescue performed the best. Crested hairgrass and the wheatgrasses were inferior in quality.

Results in Figure 4 show averages over

Grass	Growth habit and comments
Weeping lovegrass	Weeping lovegrass has become the gold standard of cascading grasses on slopes, and, if anything, has been over-used for that purpose. Medium-green, fine bladed foliage, turning light to dark green by autumn. Retains slender, seedless stalks into early winter. Acid soil tolerant. Sunlight benefits seed germination. Starts growing in mid to late spring. Relatively poor wildlife feed but good cover. Tolerates mowing as turf as long as it's above 6 inches (15 cm).
Boer lovegrass	More drought tolerant than weeping lovegrass but lacks cold tolerance. Develops chlorosis on alkaline soils. Sunlight and shallow planting benefit seed germination.
Plains lovegrass	Shorter-growing ornamental for dry, low humidity sites. Tall gray to bronze-tipped spikes, turning reddish in alkaline soils.
Lehmann lovegrass	A low maintenance grass for drier sites. Shorter growing than weeping lovegrass. Seed germinates readily with no dormancy problems. Ideal germination temperature 60 to 100 F (14 to 36 C). Its creeping habit makes for better erosion control than weeping lovegrass.
Wilman lovegrass	Desert grass. Good germination. Unique seedheads resemble rattlesnake rattles.
Sand lovegrass	Wispy pink seedheads. Drought hardy and persistent. pH tolerant down to 4.0. Cool, moist conditions for 6 weeks needed for germination. Will tolerate moist, sandy soils. Greens up as much as 2 weeks earlier than other warm-season grasses.
Atherstone lovegrass	A finer leafed alternative to weeping lovegrass. Some ecotypes have stolons but most are bunch-type. Larger, more vigorous plants than Lehmann or weeping lovegrass, but with the same weeping habit. Good seedling vigor and cold tolerance.
Nuttal alkaligrass	Tolerant to flooding, poor drainage and alkaline soils. Smooth, yellow-green foliage.
Weeping alkaligrass	Persistent, stemmy turfgrass. Widely adapted. Sometimes becomes a weed.
Lemmons alkaligrass	Prefers moist soils. Has problems with sluggish seed germination. Cool, moist conditions favor germination.

the duration of the trial. They do not document the declining quality of the red fescue over the course of the study. Miluch concluded that "the trend appears to be that the red fescue declined in quality while the alkaligrass maintained a more consistent quality."

In summary, alkaligrass is a cool-season bunchgrass with the best salt tolerance of any improved turfgrass. Seed supplies of weeping alkaligrass are plentiful and inexpensive, and quantities of the two native species, Nuttal and Lemmon's alkaligrass, can also be found through the reclamation grass seed trade.

Love, stink in the same family

Take a drive along Interstate-40 between Raleigh, NC and Oklahoma City and you're bound to see more weeping lovegrass than any other grass. Weeping lovegrass is a member of one of the largest clans of warm-season grasses: the Eragrostis. It is ideally suited to the southern Transition Zone climate of the US and similar climates throughout the world.

Weeping lovegrass (E. curvula) originated in South Africa; Boer and sand lovegrass are native to America (5).

The Eragrostis genus, which takes its name from Eros, the Greek word for love, is comprised of some 250 species of annual and perennial grasses (4). By the way, if you're thinking what I'm thinking, bear in mind that the lovegrasses are not ideally suited for outdoor whoopee, due to the stiff, rather abrasive leaves. Most have narrow, upright or weeping leaves, with a panicle seedhead similar to that of Poa (bluegrass) (Fig. 2).

The majority of Eragrostis are bunchgrasses, but a few, like Lehmann lovegrass, have rhizomes and even stolons (see Table 2).

Many of the Eragrostis are desirable agricultural grasses, useful for turf, ornamental purposes, soil stabilization, or wildlife. A few, like E. cilianensis (stinkgrass), are serious weeds. Stinkgrass is a prevalent summer-annual weed throughout much of America, noteworthy for its foul odor emitted when mown.

Weeping lovegrass is prized for its graceful, cascading appearance on slopes, and tight binding of soil from its deep, fibrous roots. As a result you'll find it spec'ed in many a southern low maintenance turf seed mix, in plantings from hillslopes surrounding putting greens, to roadcuts along Appellation highways.

WEEPING ALKALINE GRASS ILLUSTRATION: BY JENNIFER SHOEMAKER.

Figure 2. Plant shape and appearance of weeping alkaligrass and weeping lovegrass. Left-Puccinellia distans, or Weeping alkaligrass. Right-Eragrostis curvula, Weeping lovegrass

Lovegrass has a small seed, similar in size to Kentucky bluegrass. Yet it germinates with remarkable vigor, comparable with perennial ryegrass. More importantly, it germinates reliably under some pretty adverse conditions. That fact has endeared it to builders and landscape architects who can plant it and not worry whether or not it will fill.

The other species of lovegrass are not as reliable in germination. Sand lovegrass is a native grass, more drought tolerant than weeping lovegrass. But like some of its cousins, its germination is somewhat erratic. Bob Ahring, professor emeritus at Oklahoma State University, notes that "a full stand [of sand lovegrass] may be obtained the second season or even later if conditions are unfavorable in the season of planting (1)."

The Association of Official Seed Analysts recommend prechilling the seed for six

TABLE 2

Plant characteristics of the major agronomic species in the lovegrass and alkaligrass genera

Common name *Latin name /Authority*	Varieties	Native to U.S.	Unmowed ht. (in feet)	Season	Growth habit	Seeds per 1000lb.	Min. precip. (inches)	Cost rating	Seed availability	TOLERANCES				
										Wetland	Salt	Alkaline	Clipping	Shade
Weeping lovegrass *Eragrostis curvula (Schrad.) Nees.*	Consol, Ermelo, Morpa	No	3	Warm	Bunch	1463	17	$	Excl.	No	Yes	No	Fair	Fair
Boer lovegrass *Eragrostis curvula (Schrad.) Nees. var. conferta Stapf*	Catalina, OTA-S	No	3	Warm	Bunch	3000	12	$	Good	No	No	No	Mod.	Fair
Plains lovegrass *Eragrostis intermedia Hitchc.*	—	Yes	2	Warm	Bunch	3500	11	$$	Good	No	No	No	n/a	Fair
Lehmann lovegrass *Eragrostis lehmanniana Nees.*	A-68, Cochise (hybrid), Kuivato, Puhuima	No	2	Warm	Rhizomes & stolons	4245	12	$	Good	No	Yes	Yes	Mod.	Fair
Wilman lovegrass *Eragrostis superba Peyr.*	Palar	No	4	Warm	Bunch	1100	12	$$$	Poor	No	Yes	Yes	Mod.	Fair
Sand lovegrass *Eragrostis trichodes (Nutt.) Wood*	Bend, Mason, Neb. 27	Yes	3	Warm	Bunch	1779	12	$	Good	No	No	No	Fair	Fair
Atherstone lovegrass *Eragrostis trichophora Coss. & Dur.*	Cochise (hybrid)	No	3	Warm	Stolons	n/a	10	$	Good	No	No	No	n/a	Fair
Nuttal alkaligrass *Puccinellia airoides (Nutt.) Wats. and Coult.*	Quill	Yes	2	Cool	Bunch	2789	14	$	Good	Yes	Yes	Yes	Mod.	Good
Weeping alkaligrass *Puccinellia distans (L.) Parl.*	Chaplin, Fults, Salty	No	1	Cool	Bunch	1200	15	$	Excl.	Yes	Yes	Yes	Tol.	Good
Lemmons alkaligrass *Puccinellia lemmoni (Vasey) Scribn.*	—	Yes	1	Cool	Bunch	1027	—	$	Good	No	Yes	Yes	Mod.	Good

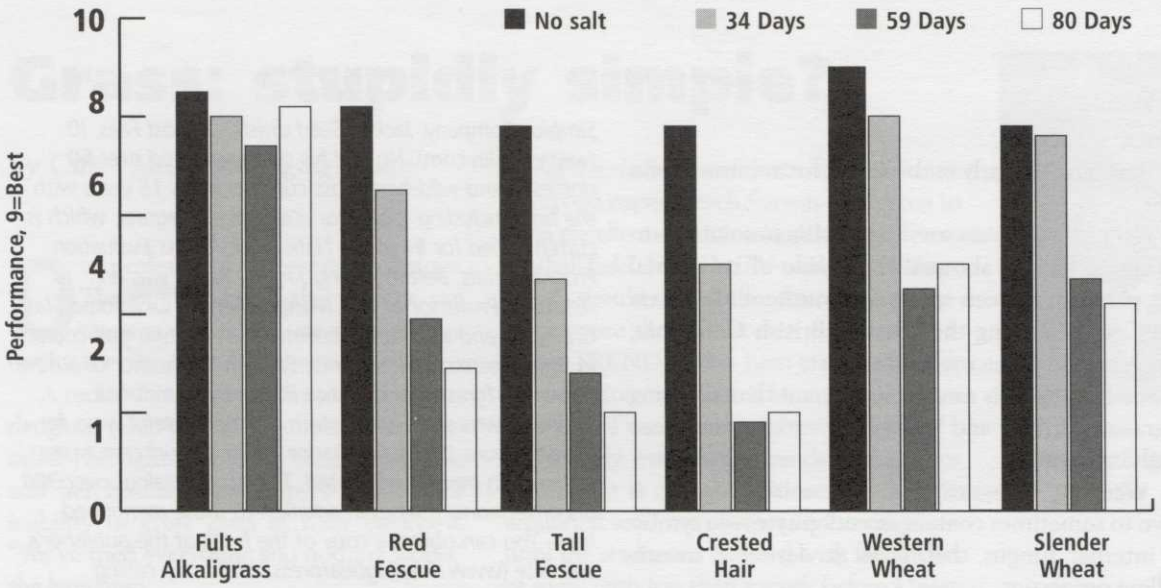


Fig. 3. Salinity trial at the University of Nebraska (9), showing the continuing tolerance of weeping alkaligrass to salt. Ten replicates of each variety were grown in greenhouse pots, watered with 0.8% NaCl salt solution. The turf was visually rated for more than 2 months (the rating dates are shown in the lower-left corner). The experiment was repeated using calcium salts. Results of the two salts were similar, with one exception: 'K-31' tall fescue was more salt tolerant to NaCl than 'Nugget,' but Nugget was more tolerant to CaCl2.

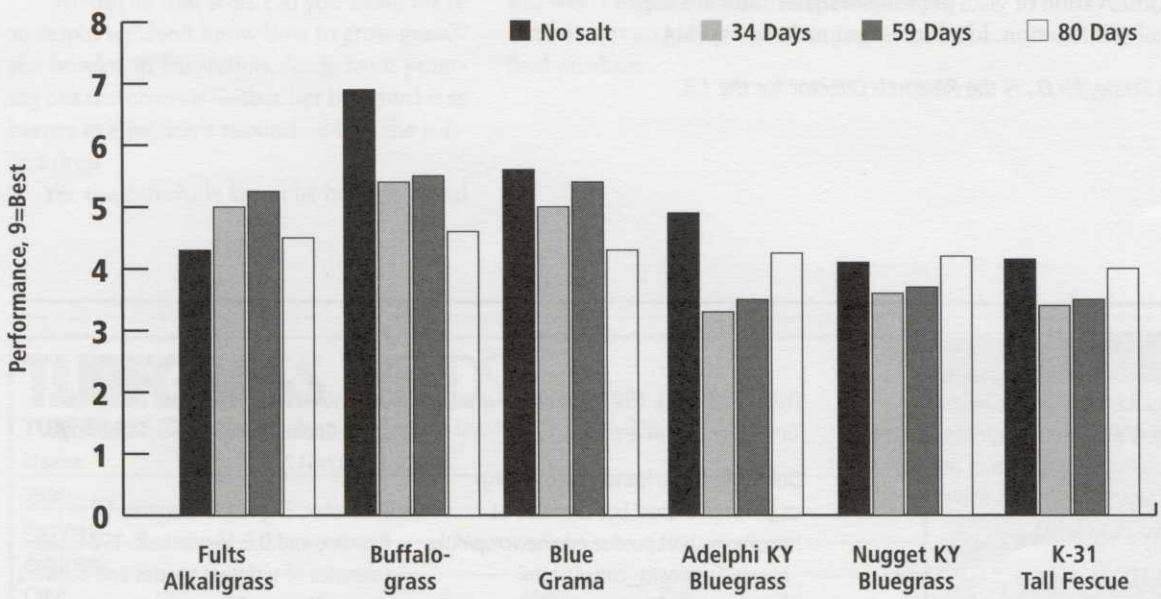


Fig. 4. Salinity trial at the Olds Central Highlands Golf Club in Olds, Alberta, Canada (11). A total of 12 cultivars were tested under saline conditions of 7.1-mmho/cm EC (the EC was measured at the initiation of the test). The graph above shows the cultivars: 'Fults' alkaligrass, 'Boreal' strong creeping red fescue, 'Crewcut' tall fescue, 'Barkoel' crested hairgrass, 'Walsh' western wheatgrass, and 'Highlander' slender wheatgrass. LSD0.05 values were 0.46, 0.51, 0.71, and 0.36 for color, density, ground cover, and overall, respectively.

weeks and then using the chemical KNO3 to help break the seed dormancy. This procedure has discouraged more than one potential user from trying this grass.

C.D. Foy and his colleagues (6) at the USDA in Beltsville, MD, have tested weeping and Lehmann lovegrass for use on acid soils. They found that the variety 'Morpa' could withstand acid mine spoilage of pH 3.5. Other varieties and common lovegrass were able to tolerate down to pH 4.3.

Other characteristics of weeping lovegrass and its

relatives:

- Starts growth early in the spring for a warm-season grass.
- Weeping lovegrass survives in climates with temperatures generally above 0°F. Outside of its normal range, plants have been spotted in southern Maine, on Cape Cod, and along the coast of British Columbia, wherever suitable microclimates exist.
- Sand lovegrass is more cold tolerant than weeping lovegrass; Lehmann and Wilman lovegrasses are more drought tolerant.
- Weeping lovegrass, like perennial ryegrass, is known to sometimes contain an endophyte — a symbiotic internal fungus that gives it desirable insect-repelling properties.
- Lovegrass is managed best in pure stands, because its explosive seedling vigor tends to force out competitors. However, it can be combined with bluestem or other taller prairie grasses for a naturalized appearance.
- Seeding rates of 1 to 10 lbs. per acre are common for conservation or vista plantings. Higher rates are used for soil stabilization. Ideal sowing time is late spring.

Doug Brede, Ph.D., is the Research Director for the J.R. Simplot Company, Jacklin Seed division in Post Falls, ID (www.jacklin.com). He and his staff have bred over 60 domestic and wild-type grass cultivars in his 15 years with the firm, including 'Liberator' Kentucky bluegrass, which is currently tied for #1 in the National Turfgrass Evaluation Program trials. Before joining Jacklin, Brede was an Associate Professor of Turf Management at Oklahoma State University and assistant superintendent for two golf courses in southwestern Pennsylvania. Brede is the author of a new book, "Turfgrass Maintenance Reduction Handbook – Sports, Lawns and Golf," which describes useful ways for lowering your turf maintenance – making turf care easier rather than more complicated. The book catalogs over 300 unconventional grasses in addition to those mentioned here. You can obtain a copy of the book at the publisher's web site (www.sleepingbearpress.com) or by calling 734/475-8787.

REFERENCES

Ahring, R.M., N.L. Dunn, Jr., and J.R. Harlan. 1963. Effect of various treatments for breaking seed dormancy in sand lovegrass, Eragrostis trichodes (Nutt.) Wood. Crop Sci. 3:131-133.

Butler, J.D., J.L. Fults, and G.D. Sanks. 1974. Review of grasses for saline and alkali areas. In E.C. Roberts (ed.), Proc. 2nd Intern. Turfgrass Res. Conf. p. 551-556.

Cunay, R.L. and A. Koski. 1990. Development of dryland western turfgrass cultivars. USGA/GCSAA Annual Turfgrass Res. Rep. p. 5-6.

Darke, Rick (ed.). 1994. Manual of grasses. Timber Press, Portland, OR..

Duke, J.A. 1983. Handbook of energy crops. Unpublished but available at http://www.hort.purdue.edu/newcrop/duke_energy/Eragrostis_curvula.html

Foy, C.D., P.W. Voight, and J.W. Schwartz. 1980. Differential tolerance of weeping lovegrass genotypes to acid coal mine spoils. Agron. J. 72:859-862.

Hall, R. 1994. Salt tolerant grasses to the rescue. Landscape Management, December, p. 14-16.

Harivandi, M.A., J.D. Butler, and P.N. Soltanpour. 1982. Effects of sea water concentrations on germination and ion accumulation in alkaligrass (Puccinellia spp.). Commun. in Soil. Sci. Plant Anal. 13:507-517.

Kinbacher, E.J., R.C. Shearman, T.P. Riordan, and D.E. Vanderkolk. 1981. Salt tolerance of turfgrass species and cultivars. Agron. Abstr. p. 88.

Major, D.P. 1978. The influence of salinity levels on two highly salt tolerant turfgrasses. M.S. thesis, Calif. Polytechnic State Univ., San Luis Obispo.

Miluch, C.E. 1997. Salinity tolerant grass cultivar trial. Prairie Turfgrass Research Center, Alberta, Canada.

Grass: stupidly simple?

By Curt Harler/Managing Editor

Our profession is deceptively obvious. The popular belief that anyone can manage a patch of grass holds true until some disaster befalls the turf.

A recent one-sided conversation with my daughter (aren't all such conversations one-sided?) brought that truism back to light. She and her husband were upset about their inability to grow grass in their backyard. "We've tried everything and nothing works," she lamented.

So I took off my "Daddy" cap and put on my extension agent hat, rattling off a half dozen questions about the grass variety she'd tried, her fertility program and the soil's condition.

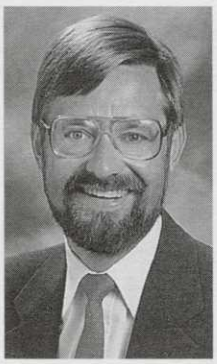
"We did all that stuff. Do you think we're so stupid we don't know how to grow grass?" she howled in frustration. Aside from pointing out the obvious — that her backyard is as barren as a pitcher's mound — I let the subject drop.

Yet the interlude brought back to mind one of the challenges of the turfgrass industry. Everyone expects each fairway and green to be in excellent condition in all seasons. Every football field should be TV-ready all the time. Lawns should never suffer from grubs.

I'm sure there's not one reader of TurfGrass TRENDS who hasn't had a similar conversation, whether it be with a client, a member of the country club or a neighbor.

Nobody ever lists grounds manager or agronomist as one of the more stressful jobs around. It seems so obvious and so simple — until the stadium is covered with five inches of snow with less than a week before Opening Day.

Good turfgrass management is like hitting a 90-mph fast ball, tying one's shoe, painting a picture, or dealing with daughters. It's so stupidly simple…until one has to do it correctly and well. Only then do the uninitiated appreciate the art and technique that goes into the final product.



Curt Harler
Managing Editor

TURFGRASS TRENDS

TurfGrass Trends is published monthly. ISSN 1076-7207.

Subscription rates: One year, $199 (US); $230 (all other countries.)

ADVANSTAR COMMUNICATIONS

Postmaster: Send address changes to TurfGrass TRENDS, 131 West First St., Duluth, MN 55802-2065.

TURFGRASS TRENDS

131 West First Street
Duluth, MN 55802-2065

QUICK REFERENCE NUMBERS

Editorial: *440-891-2729*

Subscription: *888-527-7008*

Permission: *440-891-2740*

Reprints: *440-891-2744*

Single copy or back issues: *218-723-9477*

Website: *www.landscapemanagement.net*

USE OF TGT ARTICLES

PERMISSION MAY BE GRANTED ON REQUEST FOR TGT ARTICLES AS COURSE MATERIAL AND FOR REPRINTS IN PUBLICATIONS.

For course material: We can group articles by subject for you.

Please send request to:
TurfGrass Trends
Advanstar, Attn: Permissions
7500 Old Oak Blvd.
Cleveland, OH 44130
800-225-4569, ext. 742

Index and abstracts are available electronically through: www.landscapegroup.com and Michigan State University, TGIF 800-446-8443, http://www.lib.msu.edu/tgif