TURFGRASS TRENDS

INSECT CONTROL

Mole Crickets Succumb to Parasitic Nematodes

By Eileen A. Buss

Natural enemies can help reduce pest problems, golfer complaints and the frequency or amount of insecticide applications. But how to integrate them into an existing management program can be tricky. It pays to know their strengths and weaknesses.

In particular, insect parasitic nematodes offer several benefits to superintendents. These beneficial nematodes are living organisms, not Environmental Protection Agency-registered pesticides, so re-entry intervals don't exist, they can be applied near water, they're non-toxic to people and wildlife, they can be applied using standard spray equipment, and personal protective equipment (PPE) is unnecessary.

But because they are alive, containers of nematodes should not be left in hot vehicles for hours, mixed into a tank and stored without agitation overnight or be frozen and then applied.

The Nematac S infects large mole cricket nymphs and adults and releases bacteria into the insect's blood, which kills the mole cricket.

Anything that could kill a plant parasitic nematode, including nematacides, will likely kill beneficial nematodes. And as is true of all natural enemies, nematodes will not kill all of their hosts, so they do not lose their food source.

One nematode marketed against mole crickets (*Scapteriscus* spp.) in the southern United States is *Steinernema scapterisci*, or Nematac S. This nematode infects large mole cricket nymphs and adults and releases bacteria into the insect's blood, which kills the mole cricket. The nematodes eat the bacteria, reproduce inside the body, and infective juvenile nematodes leave the

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A nematode application increased the mortality rate of mole crickets (above) for eight months at one golf course and 17 months at another, according to one study.

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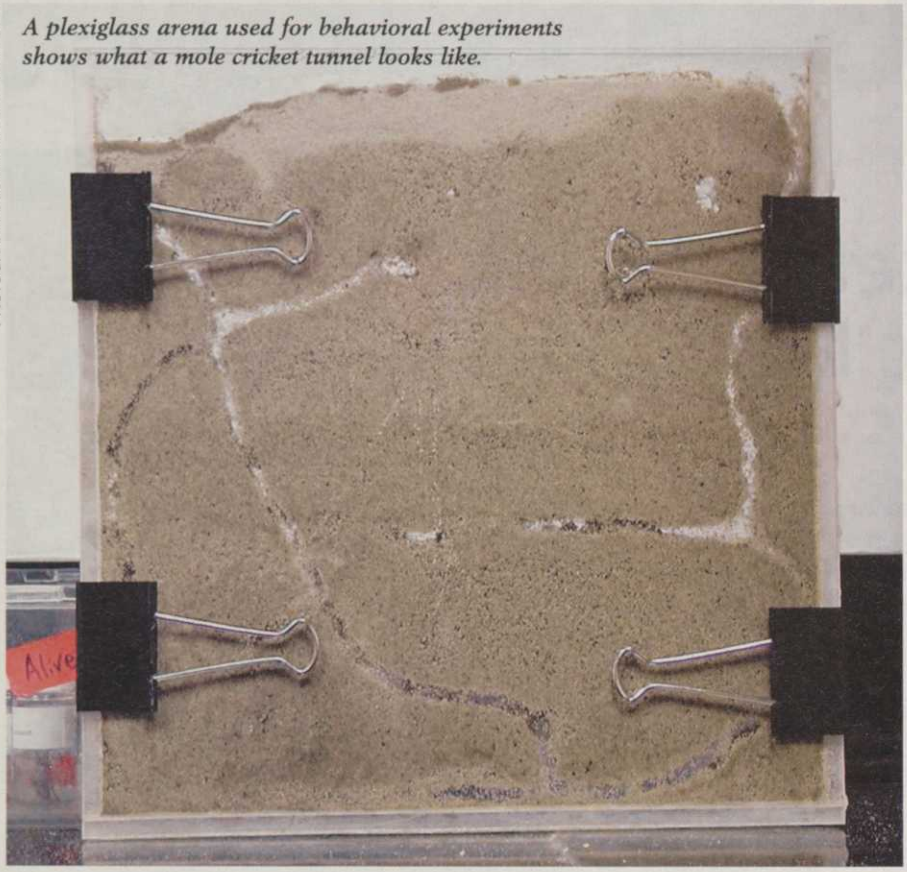

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A plexiglass arena used for behavioral experiments shows what a mole cricket tunnel looks like.

determined if the nematodes were still present and treated half of the hot spots again with Nematac S in October 2001.

Ten percent to 15 percent of mole crickets trapped before the 2001 nematode treatment were infected by *S. scapterisci*, indicating its persistence for at least 12 years. The 2001 application increased mole cricket mortality for eight months and 17 months at both golf courses. The percentage of mole crickets infected on treated plots equaled or exceeded pretreatment levels after about four weeks to eight weeks post-application.

Mole cricket mortality in untreated plots equaled the mortality in treated plots five months after treatment. Mole cricket numbers and infection levels were lower in 2003, possibly because of nematode suppression in 2002.

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body to infect other mole crickets in the soil.

Field crickets are the only known nontargets affected by *S. scapterisci*. Insecticides are usually targeted against newly hatched mole crickets, so Nematac S provides an option for controlling adults. My Ph.D. student, Kathryn Barbara, conducted the following studies to see how well *Steinernema scapterisci* fits into mole cricket management practices on golf courses (Barbara 2005).

Persistence and augmentation

These nematodes can establish after one application and spread into untreated areas in pastures through host movement in the soil (Walker and Nickle 1981). But no one knew how long a population could survive on golf courses or if a second or augmentative application was worthwhile.

Nematodes were initially applied to two golf courses in Gainesville, Fla., in 1988 and '89. We installed two linear pitfall traps on 10 fairways on each of the two golf courses (20 traps per course) near mole cricket hot spots,

Mole cricket monitoring

Soap flushes are used to determine the size, age, number and species of mole crickets present, which helps determine if or when to apply an insecticide. A typical soap flush involves mixing 1 to 2 tablespoons of liquid dish soap with a gallon of water, pouring it over damaged turfgrass, and observing which insects emerge. However, we suspected that soap could kill nematodes on a mole cricket's body, making superintendents think that the nematodes were not working.

So we tried to determine which drenching solution could effectively flush out mole crickets and not kill the nematodes or reduce their infectivity. In the lab, nematodes were mixed into solutions containing water (control), azadirachtin (Safer Brand BioNeem), citrus oil (Green Sense), garlic extract (Garlic Barrier), lemon dishwashing detergent (Joy), lemon juice (ReaLemon), insecticidal soap (Safer Soap), permethrin (Spectracide Bug Stop) or cyfluthrin (Bayer Advanced Lawn and Garden).

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Insecticidal soap, lemon dishwashing soap and the label rate of permethrin killed nematodes, but none of the treatments affected nematode infectivity. Only the insecticidal soap and label rate of permethrin flushed more infected mole crickets than the standard lemon dish soap in the field.

Thus, to determine the effectiveness of a nematode application, a dilute permethrin drench can flush mole crickets from the soil and provide accurate infection results.

Compatibility with insecticides

Combinations of insecticides and insect parasitic nematodes may have a synergistic effect on nematode infection rates against white grubs (Koppenhöffer and Kaya 1998, Koppenhöffer et al. 2000).

Grubs treated with imidacloprid became sluggish and could not move normally, which allowed cruiser nematodes to invade the grubs' bodies. We wanted to determine if this could also occur for fast-moving mole crickets and an ambush nematode.

The half and full label rates of five insecticides used to control mole crickets were evaluated in the laboratory, including acephate (Orthene Turf, Tree and Ornamental Spray), bifenthrin (Talstar GC Flowable), deltamethrin (DeltaGard T&O), fipronil (Chipco Choice) and imidacloprid (Merit 75 WP). Submerging nematodes in these solutions for 24 hours did not harm nematode health or ability to infect mole crickets. More than 95 percent of the nematodes survived.

Mole crickets exposed to acephate, bifenthrin, deltamethrin or fipronil died within two days, and most of those exposed to imidacloprid died within 26 days. Nematodes infected nearly half or more of the treated crickets (range: 40 percent to 100 percent). Thus, tank-mixing nematodes and insecti-

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Impact of insecticides on nematode survival and subsequent infectivity of tawny mole crickets in laboratory assays.

Trade name	Rate	Percent survival of nematodes held in insecticide solutions for 24 hrs (n=5)	Avg. no. days until mole cricket death, after a 24-hr exposure to insecticide-treated nematodes (n=5)	Avg. no. days until mole cricket death after insecticide treatment, then 24-hr exposure to nematodes (n=5)
Orthene TT&O	1 kg AI/ha	96.3 a	1.4 b	1.0 b
	2 kg AI/ha	97.5 a	1.4 b	1.0 b
Talstar GC Flowable	112 g AI/ha	95.9 a	2.8 b	1.0 b
	224 g AI/ha	95.6 a	1.6 b	1.0 b
DeltaGard T&O	73 g AI/ha	--	--	1.0 b
	146 g AI/ha	--	--	1.0 b
Chipco Choice	140 g AI/ha	--	--	1.0 b
	280 g AI/ha	--	--	1.4 b
Merit 75 WP	275 g AI/ha	100.0 a	23.2 a	25.6 a
	451 g AI/ha	98.2 a	22.2 a	17.4 a
Untreated control	N/A	99.8 a	17.0 ab	39.6 a

Mean ± standard error of the mean (SEM), means within columns followed by different letters are significantly different at _ = 0.05 using Tukey's honestly significant difference means separation test.

Editor's note: g = gram, kg = kilogram, ha = hectare, AI = active ingredient

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A tawny mole cricket infected with nematodes.

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cides may be possible for a quick knockdown and long-term suppression.

Behavioral effects of infection

Finally, we wanted to see if nematode infection changed mole cricket tunneling, egg laying or avoidance behavior.

Tunnel distances and depths began decreasing after six days in mole crickets that were exposed to 500 or 10,000 *S. scapterisci*, but the total distance tunneled in 10 days and tunnel dimensions were consistent among healthy and infected mole crickets.

When placed into arenas with half of the sand treated with nematodes and the other half left untreated, mole crickets tunneled normally and equally in both halves, indicating that the nematodes were nonrepellent. When allowed to choose between nematodes or insecticides in lab assays, acephate, bifenthrin, imidacloprid and deltamethrin repelled mole crickets, but crickets seemed to prefer fipronil over *S. scapterisci*.

Egg chamber depth and the number of eggs laid was similar among healthy and nematode-infected female mole crickets. Thus, healthy females could become infected while laying eggs or infected females could still oviposit before dying, and offspring would escape immediate infection because nematodes cannot penetrate their bodies.

As a result, Nematac S may provide greater control when applied during the fall adult activity period because mole crickets are not laying eggs, and nematode populations could increase during the winter before mole cricket mating flights and egg-laying occur.

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