

Cultural practices and silvery-thread moss control

Topdressing and nitrogen can enhance the efficacy of a herbicide on silvery-thread moss.

Silvery-thread moss (*Bryum argenteum* Hedw.), a problematic bryophytic weed in putting greens, has become more prevalent in recent years. Reasons cited for the increase of silvery-thread moss on creeping bentgrass (*Agrostis palustris*) greens include the restriction of mercury-based fungicides and turfgrass stress caused by the lower fertility levels and reduced mowing heights necessary to produce faster greens (1,3,9,14).

Silvery-thread moss is a perennial plant that can reproduce sexually via spores and asexually through displaced fragments (2,9). Infestations are commonly spread by golfers tracking fragments lodged in golf spikes from green to green (14). Silvery-thread moss lacks phloem and xylem and cannot translocate foliar-absorbed nutrients throughout the entire plant (2,4). Therefore, systemic herbicides are not likely to be effective in controlling silvery-thread moss (14).

Newer products for moss control

Quicksilver

In 2005 Quicksilver (carfentrazone), a protoporphyrinogen-oxidase inhibitor previously used to control broadleaf weeds, was labeled — and quickly became the industry standard — for silvery-thread moss control on creeping bentgrass greens (5,10). Numerous trade journal reports concluded that Quicksilver provides effective control of silvery-thread moss over a broad temperature spectrum (1,2,5,9,12,14).

Junction

Mancozeb-based fungicides are also labeled for the control of silvery-thread moss on creeping bentgrass greens. Junction (mancozeb) contains

zinc ion, manganese ethylenebisdithiocarbamate and copper hydroxide and is 46.1% copper hydroxide (30% metal equivalent) (11). Other researchers (4) have found that five applications of Junction applied once every other week at 4.3 to 6.5 pounds (4.85 to 7.27 kilograms) of copper/hectare controlled silvery-thread moss for up to two years.

Hypothesis

We have observed that silvery-thread moss forms a layer of organic residue within the putting green surface. The layer retains water, thereby creating anaerobic conditions at the soil surface. When this moss-organic residue layer becomes dry, it creates a hydrophobic layer that is difficult to rewet. We hypothesize that the integration of management practices to chemically control moss and degrade the layer of organic residue could be beneficial for long-term silvery-thread moss control.

Research was initiated to evaluate Quicksilver (carfentrazone) and Junction (mancozeb) for silvery-thread moss control on creeping bentgrass putting greens. In addition, increased fertility and increased sand topdressing also were evaluated, as the lack of these practices is often linked with increased silvery-thread moss infestation.

Materials and methods

Field studies were initiated in summer 2006 at The Honors Course, Ooltewah, Tenn., and in summer 2007 at The Crossings Golf Club, Jonesborough, Tenn. Studies evaluated silvery-thread moss control of Quicksilver alone; Quicksilver applied in conjunction with cultural practices; cultural practices alone; and Junction alone.



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Silvery-thread moss forms a layer of organic residue within the putting green surface. Photo by S. McElroy

The Honors Course putting greens were built to USGA recommendations: 85% to 90% sand, >15% peat, <1% silt and humic matter, and a pH of 6.7. The Crossings Golf Club greens were constructed as California greens with only a sand mix and a pH of 6.8. Both creeping bentgrass greens were mowed daily to keep a 0.125-inch (3.2-millimeter) cutting height. Annually, The Honors Course greens received 210 pounds of nitrogen/

acre (235 kilograms/hectare) and The Crossings Golf Club received 152.6 pounds/acre (171 kilograms nitrogen/hectare).

Research was conducted in a randomized complete block design and replicated three times.

Treatments

Treatments included Quicksilver alone applied in two sequential applications of 6.67 fluid ounces/acre (0.5 liter/hectare), Quicksilver followed by sand topdressing at 200 pounds/1,000 square feet (0.98 kilogram/square meter), Quicksilver followed by nitrogen at 0.25 pound/1,000 square feet (1.2 grams/square meter), Quicksilver followed by nitrogen plus topdressing, Junction alone at 4 ounces/1,000 square feet (12.2 kilogram/hectare), nitrogen alone, topdressing alone, or nitrogen plus topdressing (Table 1). All Quicksilver treatments were made at trial initiation and two weeks after initial treatments.

Cultural measures were applied four weeks after the initial treatment or two weeks after the last Quicksilver treatments and continued once every other week until 10 weeks after the initial treatment. Junction was applied once every other week for the 10 weeks. Spray applications were applied with a carbon-dioxide pressurized backpack sprayer calibrated at 29.9 gallons/acre (280 liters/hectare) equipped with 8002 XR flat-fan nozzles. Initial applications were made in the middle of May in

% silvery-thread moss control

Treatment [†]	Rate [‡]	Visual silvery-thread moss control [§]			
		Weeks after initial treatment			
		3	5	11	16
		% control (SE)			
Quicksilver (carfentrazone)	6.67 fluid ounces/acre	68 (15.1)	43 (14.4)	36 (13.4)	54 (12.6)
Quicksilver + topdressing	6.67 fluid ounces/acre fb 200 pounds/1,000 square feet	75 (11.5)	63 (16.6)	77 (11.6)	76 (12.3)
Quicksilver + nitrogen	6.67 fluid ounces/acre fb 0.25 pound/1,000 square feet	85 (4.5)	54 (16.8)	68 (14.1)	68 (13.8)
Quicksilver + nitrogen + topdressing	6.67 fluid ounces/acre fb 0.25 pound/1,000 square feet + 200 pounds/1,000 square feet	78 (9.8)	67 (12.1)	77 (4.8)	78 (5.0)
Junction (mancozeb)	4 ounces/1,000 square feet	11 (6.9)	13 (9.8)	4 (4.2)	7 (6.7)
Nitrogen	0.25 pound/1,000 square feet	0 (0)	3 (3.3)	23 (12.9)	32 (11.5)
Topdressing	200 pounds/1,000 square feet	0 (0)	9 (5.2)	25 (15.8)	34 (13.4)
Nitrogen + topdressing	0.25 pound/1,000 square feet + 200 pounds/1,000 square feet	0 (0)	10 (6.8)	20 (13.2)	29 (11.5)
LSD [¶]		15	25	32	31

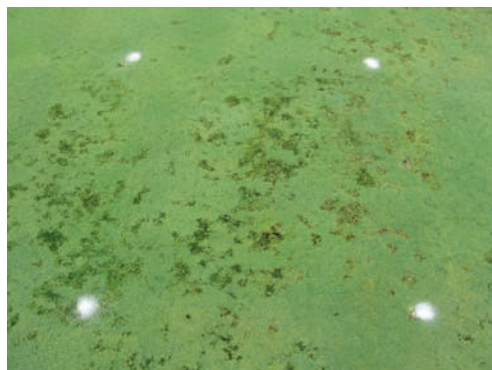
[†]Quicksilver (carfentrazone) treatments were applied 0 and 2 weeks after initial treatment; Junction (mancozeb) treatments were applied 0, 2, 4, 6, 8 and 10 weeks after initial treatment; and all cultural practices were applied at 4, 6, 8 and 10 weeks after initial treatment.

[‡]Quicksilver was applied at 6.67 fluid ounces/acre = 0.12 kilogram a.i./hectare; Junction was applied at 4 ounces/1,000 square feet = 1.8 kilograms a.i./hectare; nitrogen was applied at 0.25 pound/1,000 square feet = 12.2 kilograms nitrogen/hectare; and topdressing was applied at 200 pounds/1,000 square feet = 3,920 kilograms/hectare.

[§]Percent silvery-thread moss visual control was evaluated for each plot at each timing.

[¶]LSD, least significant difference.

Table 1. Percent visual silvery-thread moss control on creeping bentgrass putting greens treated with Quicksilver (carfentrazone), Junction (mancozeb) and cultural practices.



As seen in the nontreated plot (**left**) and the plot treated with Junction (**right**), Junction applications in the spring did not control silvery-thread moss. Photos by S. Borst

2006 and 2007. Granular nitrogen applications were applied by hand over individual plots, and sand treatments were brushed into the turf canopy. Overhead irrigation was used to water-in granular nitrogen and topdressing treatments.

Percent silvery-thread moss control was evaluated visually on a scale of 0% (no control) to 100% (complete control) at three, five, 11 and 16 weeks after the initial treatment. No creeping bentgrass injury was observed with any treatment, timing or location (data not shown).

Data were analyzed according to the randomized complete block design. Silvery-thread moss was analyzed by date of observations. Because the treatments performed the same in each location, the data were pooled and both studies were combined for analysis.

Results and discussion

Quicksilver

All Quicksilver applications provided greater than 68% silvery-thread moss control at three weeks after the initial treatment. However, our research showed silvery-thread moss regrowth and recovery when Quicksilver was applied alone: control decreased from 68% at three weeks after the initial treatment to 36% at 11 weeks after the initial treatment. We observed that Quicksilver applications burned surface silvery-thread moss tissue but would leave a layer of silvery-thread moss organic residue that resembled thatch. Previous trade journal articles also have concluded that Quicksilver at the recommended label rate effectively controls silvery-thread moss in creeping bentgrass greens (1,9,12,14).

Cultural practices

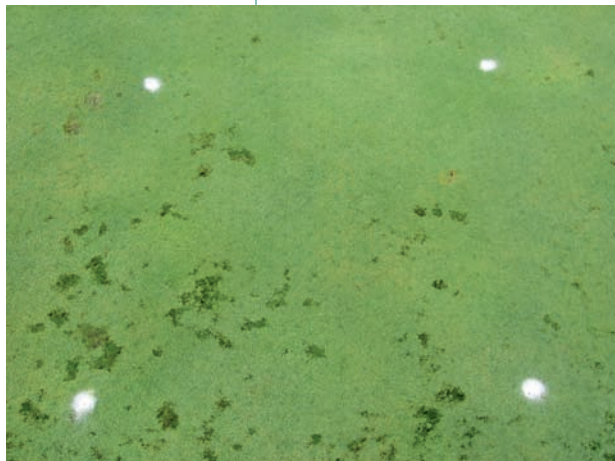
Cultural practices improved the long-term efficacy of Quicksilver. Quicksilver applied with topdressing achieved 76% control of silvery-thread moss at 16 weeks after the initial treatment. Topdressing is used on greens to control thatch by diluting the organic matter generated by the turf

(13). Researchers who observed that topdressed plots maintained excellent water infiltration and turf quality compared to nontreated plots (8) also theorized that the addition of topdressing maintained a constant level of organic matter in the top layer of soil. In our research, we theorized that topdressing aided Quicksilver control of silvery-thread moss by diluting the organic residue left by silvery-thread moss after Quicksilver applications. Nitrogen applications also improved Quicksilver control of silvery-thread moss. When nitrogen was applied after the Quicksilver treatment, silvery-thread moss was still controlled by 68% at 16 weeks after the initial treatment.

An increase in silvery-thread moss infestations on putting greens has been attributed to lower mowing heights, discontinued use of mercury-based fungicides and reduced fertility (3,4,6). Allowing dead silvery-thread moss patches to remain without promoting creeping bentgrass growth increases the chance of silvery-thread moss recovery and regrowth. We theorize that increasing nitrogen rates promotes creeping bentgrass growth, which enables the turf stand to compete with necrotic silvery-thread moss patches. Quicksilver followed by nitrogen plus topdressing and Quicksilver followed by topdressing both controlled silvery-thread moss better than Quicksilver alone at 11 weeks after the initial treatment. Both treatments also controlled silvery-thread moss by 77% at 11 weeks after the initial treatment.

Junction

Junction did not provide more than 13% control of silvery-thread moss at any evaluation (Table 1), and, in some cases, an increase in silvery-thread moss population was observed within Junction plots. All treatments containing Quicksilver were more effective than Junction in controlling silvery-thread moss at all rating dates. Junction controlled silvery-thread moss at levels equivalent to control by topdressing alone, nitrogen alone, or topdressing plus nitrogen at all rating dates.



Quicksilver alone (left) was not as effective in controlling silvery-thread moss as Quicksilver followed by treatment with topdressing or nitrogen or a combination treatment of Quicksilver, topdressing and nitrogen (right).

At 16 weeks after the initial treatment, the rate of silvery-thread moss control was 7% for Junction, 32% for nitrogen, 34% for topdressing and 29% for nitrogen plus topdressing. Junction might be more effective if it were applied in fall rather than in spring as it was in this research. Earlier work (7) showed minimal silvery-thread moss control when Junction was applied in summer months, but fall applications have provided good silvery-thread moss control the following spring.

Preventing silvery-thread moss

A healthy turf stand is one of the best ways to prevent silvery-thread moss invasion (4). Previous research has attributed increased encroachment of silvery-thread moss in turf to lower mowing heights, reduced fertility and the elimination of mercury-based fungicides (3,6,9,14). Any stress applied to the turf that reduces turf density or decreases plant vigor can add to the risk of silvery-thread moss encroachment. Our research suggests that applying topdressing and/or nitrogen in conjunction with Quicksilver can increase control of silvery-thread moss over Quicksilver applications alone. Junction did not control silvery-thread moss in any of the treatments in this study.

Acknowledgments

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The research says

→ Increased infestation by silvery-thread moss has been attributed to the restriction of mercury-based herbicides and an increase in cultural practices that stress creeping bentgrass greens.

→ Quicksilver and Junction are two herbicides labeled for silvery-thread moss control on greens.

→ Our research found that increased nitrogen applications and/or topdressing applications increased control of silvery-thread moss by Quicksilver.

→ Spring applications of Junction were not effective in controlling silvery-thread moss; future research should explore the efficacy of fall applications.