

## CONTROL OF SILVERY THREAD MOSS (*BRYUM ARGENTIUM*) IN PUTTING GREENS

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### Introduction

In the pursuit of faster putting greens and higher levels of surface quality, golf course superintendents often lower mowing heights and reduce fertilizer inputs. Over extended periods of time such cultural practices may lead to an overall reduction in vigor and plant density of bentgrass and *Poa annua* putting greens. Under these conditions moss can easily invade putting green surfaces. Isolated moss colonies can rapidly spread into more serious infestations that can be more difficult to control.

Silvery thread moss (*Bryum argentium*) is a significant problem on golf course putting greens in California and on many golf courses throughout the country. This very competitive moss species creates a fine textured mat on putting green surfaces and under favorable conditions can develop into a thick, dense layer that creates a barrier against air and water movement, ultimately out competing desirable grasses.

Silvery thread moss is adapted to a wide range of environments and can be found growing just about anywhere, from the mortar between patio bricks to the shingles on your roof. Silvery thread moss can grow on either USGA sand profile greens or push-up soil greens and has been observed growing in many different grasses including *Poa annua* and Penncross, Pennlinks, A4 and G2 creeping bentgrass. It is also well adapted to both shade and full sunlight conditions. Silvery thread moss has also been shown to survive long periods of desiccation, in some cases up to two years, and can withstand high temperatures in a dormant state. Research information provided by Dr. Larry Stowell, PACE Consulting, San Diego, California shows that mosses can survive extended periods of dormancy by living symbiotically with blue-green algae. In some ways algae may be viewed as a precursor to moss encroachment.

Mosses exhibit a two-stage life cycle. The green leafy phase most frequently observed on golf courses is called the 'gametophyte'. In this phase a germinating spore gives rise to a green filament called the protonema from which the moss plant with its stems, leaves and rhizoids develops. Upon maturity the production of egg and sperm give rise to a fertilized egg or zygote. With germination the zygote produces a slender stalk with a capsule containing spores. The spores are then released from the capsule and give rise to new moss plants, thus completing the life cycle.

Over the years a significant amount of field research and quality field observations have developed a 'best practices management program' for the suppression or control of silvery thread moss in putting greens. The key concepts within this program are directly primarily toward the enhancement of vigorous turfgrass growth and review of proper agronomic perspectives including drainage, height of cut, fertilizer use, irrigation practices and topdressing programs.

While strong cultural programs are essential to aid in the prevention of moss encroachment, what types of chemical control strategies are available for golf course superintendents who already have significant moss problems? A tremendous amount of university field research has been conducted over the years in the hope of finding a 'silver bullet' for control of moss in putting greens. A wide range of products and program concepts have been reviewed for moss control including the use of iron products such as ferrous sulfate, different fertilizer sources such as ammonium sulfate or urea, soap or fatty acid products, preemergent and postemergent herbicides as well as fungicides. The results of this work have been highly variable. In some

cases treatments that performed well in research evaluations did not perform as well under actual golf course management use or the best performing products/treatments for control of moss also exhibited unacceptable injury levels on desirable turf.

Over the last several years field research trials conducted by Professor Thomas Cook at Oregon State have shown high levels of moss control on bentgrass putting greens with multiple applications of Junction™ (Fore + copper hydroxide: Griffin Corporation). Results of moss control field trials conducted in Southern California by Dr. Larry Stowell, PACE Consulting, have shown acceptable levels of control with the use of Dawn Ultra (2.0 oz/gal) detergent at very high drench volumes (60 gal/M).

TerraCyte (sodium percarbonate: BioSafe Systems, Glastonbury, Connecticut) is a new granular product that has shown potential for moss control in field trials when applied with a drop spreader at rates of 8 to 16 pounds of product/1000 ft<sup>2</sup>. Field research was conducted on a *Poa annua* putting green at Carmel Valley Ranch Golf Club in Carmel, California by Mark M. Mahady & Associates, Inc. to evaluate the performance of multiple applications of these products for control of silvery thread moss. The key question was: can silvery thread moss be controlled without injuring or reducing the surface quality of annual bluegrass putting greens?

### **Moss Control Programs on Putting Greens**

Three replicated field research trials for moss control on putting greens were conducted at Carmel Valley Ranch Golf Club in Carmel, California from 1999 to 2002. During January of 2002 a new product, TerraCyte (sodium percarbonate: BioSafe Systems), was evaluated in a replicated field trial at Carmel Valley Ranch Golf Club for control of silvery thread moss.

TerraCyte performed well for control of silvery thread moss when applied with a drop spreader at rates of eight to twelve pounds of product per thousand square feet (lb/1000 ft<sup>2</sup>). Pre and post application irrigation is required for activation of TerraCyte. The three-treatment sequence applied at five-day intervals showed the best level of moss control. Three 8.0 lb./1000 ft<sup>2</sup> treatments of TerraCyte applied at five-day intervals showed 66% moss control and three 12.0 lb./1000 ft<sup>2</sup> treatments applied at the same interval showed 90% control. Although the 12.0 pound rate showed a higher level of control (90%) with three repeat applications than the 8.0 pound rate (66%), the degree of injury and color loss observed on annual bluegrass at the 12.0 lb./M rate may be too severe for most golf course superintendents. Creeping bentgrass exhibited more tolerance than *Poa annua* to TerraCyte applications.

TerraCyte aids in the suppression and control of moss in annual bluegrass and bentgrass putting greens by dynamically shifting the competitive balance between moss and turf. Unfortunately, TerraCyte is not yet registered in California. Registration is anticipated by spring of 2005. Once registered, TerraCyte will be a very valuable tool to control silvery thread moss in creeping bentgrass putting greens. If TerraCyte is presently not available, what other products and agronomic strategies are available to reduce silvery moss invasion and promote the growth of creeping bentgrass?

Many superintendents have achieved acceptable burn down of moss with soaps such as Dawn Ultra. However, it is illegal to use this product for moss control on putting greens because it is not registered for this use. Soap applications do burn down moss rapidly. Spiking and seeding bentgrass back into these thin areas may speed recovery. Unfortunately, in our experience, soaps do not prevent regrowth of moss or enhance the competitive balance of creeping bentgrass.

Another program option to consider is the use of Daconil (chlorothalonil) Weather Stick. Several researchers throughout the country have reported positive results with multiple treatments of

Daconil applied at 5.3 ounces per 1000 ft<sup>2</sup> at seven-day intervals. A minimum of four applications is necessary for effective control. Daconil is effective for algae control with multiple applications and many researchers believe there is a symbiotic relationship between moss and algae. Other researchers have reported that **the key to successful moss control with Daconil is multiple applications during hot summer days (85 degrees+).**

Research from Professor Tom Cook at Oregon State University has shown that multiple applications of copper hydroxide products such as Kocide (copper hydroxide) or Junction (copper hydroxide and mancozeb) reduce infestations following 5 to 7 treatments at two-week intervals. Unfortunately, these products have not performed well in our moss control trials. We are suspicious that the high pH of our well water precipitates much of the copper out of solution, thus reducing efficacy. Professor Cook has also found that multiple applications of Quick Silver (Carfentrazone, FMC) selectively injure moss with minor injury potential on creeping bentgrass. Spring use is recommended.

Baking soda (sodium bicarbonate) is not registered for moss control. However, reports show that carefully sprinkling the dry product on moss patches with a small-holed spice dispenser, or mixing 6.0 ounces of product in one gallon of water and spraying with back pack sprayers every 14 days discolors moss (brown) and reduces infestations.

Moss is susceptible to metal ion toxicity. Research has shown that high rates of iron, copper and zinc will discolor moss and reduce infestations. Research conducted by Mark Mahady in 1984 showed that lawn moss could be successfully controlled in the Pacific Northwest by applying 12.0 ounces of ferrous sulfate/1000 ft<sup>2</sup> at a spray volume of 4.0 gallons/1000 ft<sup>2</sup>. During the cool wet winter months from January through March two treatments applied at six-week intervals on home lawns mowed at a cutting height of 2-3 inches provided a very high level of control. Because conditions were cool and wet there was no turf injury and the greening effect on lawns was dynamic within 24 hours.

This concept can be extrapolated to the golf course industry for moss control on greens. Increase spray volumes to a minimum of 4.0 gallons/1000 ft<sup>2</sup> in order to reduce the potential for turf injury. TeeJet Turbo FloodJet nozzles (TF-VS10, wide angle flat fan spray tips) set at 40 psi and 20 inch nozzle spacing will deliver 4.5 gallons per 1000 ft<sup>2</sup> at a speed of 3 mph. The higher the spray volume the less potential there is for turf injury. If the boom is changed to 10 inch spacing and pressure and speed remain the same the spray volume increases to 6-9 gallons/1000 ft<sup>2</sup> depending on the size of the intake hose.

Choose the highest spray volume that can be delivered consistently with a single pass from a standard spray boom system equipped with 10-inch nozzle spacing (6-9 gallons/1000 ft<sup>2</sup>). Choose two ferrous sulfate rates of 8 and 16 ounces of product/1000 ft<sup>2</sup>. Conduct a simple evaluation on a practice green at this high spray volume and test these two rates during winter, spring and late summer to evaluate potential turf injury, moss control and surface quality. A 7-day interval is recommended.

Establish a monthly soil and tissue testing program prior to and during the test program. Each test green site should also have an untreated area as a check comparison. Monitor soil and tissue nutrients to ensure that these additional nutrient programs do not detrimentally influence plant growth and surface quality. Always schedule these high spray volume applications when tissue and soil moisture is adequate.

Moss control is in most cases a long-term program. Moss control programs should be a combination of those agronomic practices that encourage vigorous growth of desirable grasses plus a selective suppressant or control product that will place the moss under additional stress.

Today in California there are two program concepts that have shown encouraging potential to control silvery thread moss in *Poa annua* and creeping bentgrass putting greens. On *Poa annua* greens three repeat applications of TerraCyte showed by far the best reactive control of silvery thread moss. For bentgrass greens either the TerraCyte program or high rates of ferrous sulfate applied at high spray volumes dynamically reduced moss cover while greatly enhancing bentgrass growth.

The following cultural practices should also be considered to reduce the incidence of moss on putting greens. Check the green surround and green irrigation uniformity. Make sure that the green surround irrigation is not overlapping onto green surfaces. Water deeply. Keep surfaces as dry as possible, while still maintaining adequate moisture for good turf vigor. Hand water hot spots. Increase mowing heights to between 160/1000ths to 170/1000ths of an inch. Maintain sound fertility programs to improve turfgrass vigor. Use hollow tine aeration as frequently as possible to disrupt the surface. Pursue an aggressive light and frequent sand topdressing program. Check sand profile depths in problem greens to determine if variation in sand depth is contributing to moss problems. If wet areas exist around green perimeters use smile drains to enhance water movement away from the green.

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