Moss Control: New Data and Management Strategies

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Bottom line

Based on newly generated research data, a program to control mosses on putting greens was developed. In our 1998 research trials, we found that broadcast applications of chlorothalonil (Daconil, Echo 720) or quaternary ammonia (Monterey RD-20) provided good control of moss infestations. Spot or drench treatments with UltraDawn dishwashing liquid provided excellent control – even when moss infestations were heavy. When these products are used in combination with cultural methods that promote turf health (aerification, fertility, increased mowing heights), moss infestations can be effectively managed.

NOTE: None of the products mentioned above are currently labeled for moss control on turf. However, Daconil and RD-20 are labeled for control of algae.

In the April, 1998 issue of *PACE Insights,* we reported on the increased incidence of mosses on putting greens, and the lack of information that was available on control methods. To respond to this gap in knowledge, we conducted two research trials at Friendly Hills Country Club during the summer of 1998. With the assistance of David Michael, superintendent, and with support provided by Zeneca and Rohm and Haas, we were able to identify some management practices (which we've summarized below) that should help you manage this difficult, new pest.

Moss appearance and identification

The moss present at the Friendly Hills test site (a poa/bent putting green) was identified as *Bryum argenteum,* sometimes known as silvery thread moss. This moss has been identified on putting greens throughout the United States, and appears to be the dominant species of moss inhabiting golf course greens. When moss infestations first start, the moss plants are barely visible, which is one of the key reasons why this pest gains a foothold so insidiously. To catch moss infestations BEFORE they become serious, greens should be scouted regularly, particularly in areas of thinning turf (scalped areas, problem areas), and particularly during the warmer months when moss grows most rapidly. To see these small (no more than 2/10" in height) plants, you'll need to get down to ground level and look for individual moss plants interspersed among the blades of grass. The photograph in Figure 1 shows a small area of turf that is moderately infested with *Bryum argenteum.*

Figure 1. Close-up of a moderate moss infestation.

When turf is heavily infested with *B. argenteum*, moss plants may outnumber turf plants (Figure 2), and the area, when viewed from a distance, can take on a silvery appearance, as shown in Figure 5—thus the name, silvery thread moss. However, don't wait to see this symptom before acting, since it occurs only after moss infestations are very serious.

Figure 2. Close-up of a heavy moss infestation.

The Moss-Algae Connection

When the sample shown in Figure 2 was incubated in the dark for 12 hours, blue-green algae present at the base of the moss plants migrated to the top of the moss and turf plants in search of light (Figure 3). This unidentified blue-green algae was found in all samples of *Bryum argenteum* examined, but is rarely seen. This is because it has the tricky habit of residing at the base of the moss and turf plants during the day (because it receives sufficient light there), and only comes to the surface of the plants

when light intensity decreases. There is some sketchy evidence that the algae and the moss have a **symbiotic** relationship, where the algae benefits the moss by fixing nitrogen, and the moss benfits the algae by secreting nutrients that are essential to the moss. The results of our tests (see below), which indicate that control of the algae results in control of the moss, also supports the concept of a close dependency between the moss and the algae. More research is needed, however, to confirm the nature and the frequency of this very interesting interaction.

Figure 3. The same area shown in Figure 2, following incubation in the dark for 12 hours. The dark material is an unidentified blue-green algae that occurs in association with the moss, *B. argenteum.*

Moss Control: Broadcast vs. Spot Trealtments

There are two different application strategies for controlling mosses. **Broadcast treatments** are made through conventional sprayers at relatively low spray volumes (1 – 4 gallons/1000 square feet) or through spreaders, if the product is a granule. **Spot treatments** are made when small areas are drenched with spray solutions at very high volumes (greater than 20 gallons per 1000 square feet). In our 1998 research, we looked at both strategies.

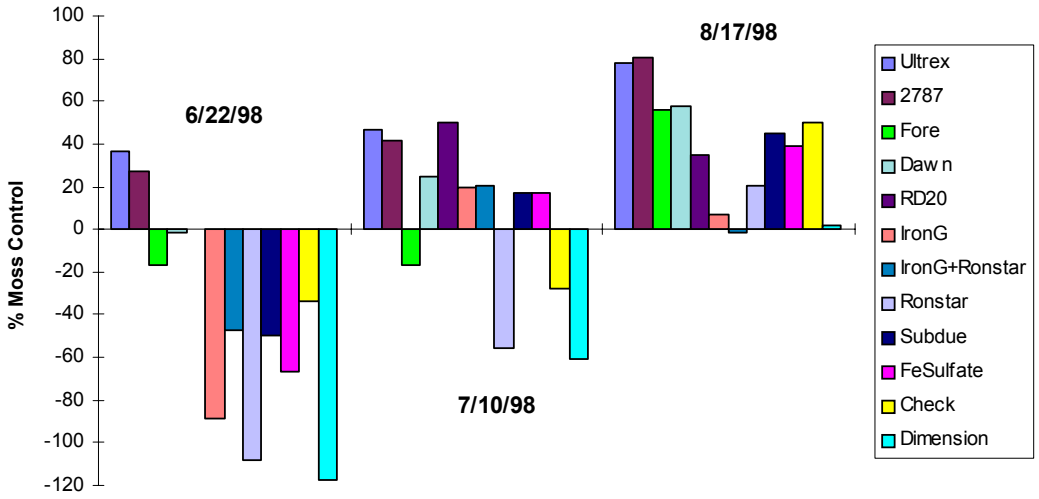
Broadcast treatment results: In these tests, we looked at 12 different spray and granular treatments (Table 1). The results broke the products down into three distinct groups: 1) those that did a good job in controlling moss; 2) those that had no effect on moss populations; and 3) those that actually resulted in an increase in the moss infestation!

In the first group, we found that the most effective treatments tested were products that are labeled for control of algae!! Chlorothalonil (Daconil Ultrex or 2787) or quaternary ammonia (RD-20) provided up to 80% control of moss when they were applied every two weeks over a 6 week period (Figure 4). The control achieved was gradual, with no obvious signs of unsightly dead or dying moss. This is a positive attribute, especially in a situation where moss populations are heavy, as it avoids the development of large patches of browning, dying moss. Although the mode of action is not understood, it is possible that chlorothalonil and quaternary ammonia interfered with moss growth and competitiveness by injuring the blue-green algae that was seen in association with the moss. Whatever the mechanism, application of these products appears to have allowed the turf to compete more effectively with the moss. No phytotoxicity was observed with these treatments.

Table 1. Broadcast treatments tested at Friendly Hills Country Club for moss control.

Treatment	Active Ingredient	Rate/ 1000 sq ft	Frequency of Application	Control Rating
Daconil Ultrex	chlorothalonil	7.3 oz	every 2 weeks	Good
Daconil 2787	chlorothalonil	11.0 oz	every 2 weeks	Good
Fore Flo	mancozeb	12.0 oz	every 2 weeks	No effect
Ultra Dawn	anionic & non-ionic surfactants	4.0 oz	every 2 weeks	No effect
RD-20	quaternary ammonia	1.6 oz	every 2 weeks	Good
Lesco Iron Plus (0-0-0, 18% iron)		14.3 lb	monthly	Increased moss
Lesco Iron Plus + Ronstar 2G	oxadiazon	14.3 lb + 1.7 lb	monthly	Increased moss
Ronstar 2G	oxadiazon	1.7 lb	monthly	No effect
Subdue 2E + Lesco Spreader Sticker + Lesco Wet	metalaxyl	2.0 + 1.3 + 1.3 oz	monthly	No effect
Iron Sulfate	iron sulfate	5 oz	every 2 weeks	No effect
Check (no treatment)				No effect
Dimension EC	dithiopyr	1.5 oz	monthly	Increased moss

Figure 4. Percent Moss Control on Three Different Evaluation Dates (6/22, 7/10 and 8/17/98). Friendly Hills Country Club, Whittier, CA. Percent control was determined by comparing the moss infestation levels in each plot, on each evaluation date, against the pre-treatment moss infestation levels on 5/11/98.



Several products appeared to have no effect on moss infestations, even though these products (Ferrous sulfate, Ultra Dawn, Subdue 2E mixtures) had been reported to control moss at other locations. This may be due to the fact that all treatments were made using broadcast applications (3 gallons spray solution/1000 sq ft), rather than spot (drench) treatments. The effective use of drench applications of UltraDawn is reported below.

There were also several products that actually increased the amount of moss present. Although these products -- Lesco Iron Plus, Ronstar 2G and Dimension – initially injured moss plants, they injured the turfgrass even more. As a result, when the moss began to recover and grow, it was able to out-compete the weakened turfgrass, therefore increasing moss density and area covered.

Spot treatment results: In this test, we looked at a different application strategy – use of spot treatments at high application volumes that drenched the turf. Based on reports of its efficacy elsewhere, we focused this study on an unusual product – the household dishwashing liquid, UltraDawn. The study was designed to find out for which rates and which application volumes the best results (high moss control, low turf damage) would be achieved. We did this by treating 10 inch diameter circles of moss-infested turf (Figure 5) with UltraDawn at a variety of rates and application volumes (Table 2).

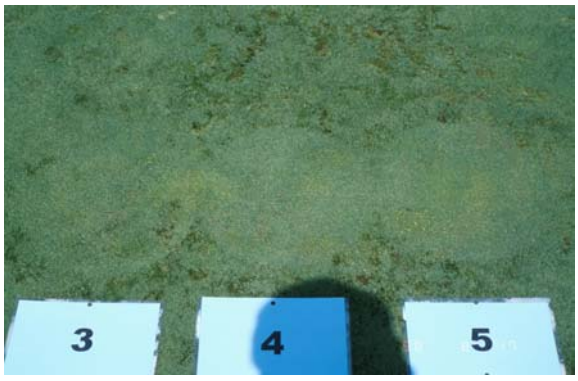
We found that when the right application volumes were used, UltraDawn provided excellent, long lasting control (10 weeks or more of control, from a single application) of even the heaviest moss infestations. High volumes of application (80 gallons/1000 square feet or more) provided the best control, with the least amount of turf damage, when UltraDawn was used at a rate of 4 oz/gallon. At these volumes, the turf is treated in a drench fashion, as opposed to the very light, almost invisible spray coverage that is typically seen with broadcast applications. At lower application volumes (less than 40 gallons/1000 square feet) almost no moss control was observed (Table 2, figure 6).

Figure 5. Test area following application of UltraDawn dishwashing detergent, June 8, 1998. Each circle represents one of eleven treatments tested. Note also the heavy moss infestation (gray or silvery patches) occurring around the plot area.

Table 2. Moss Control on a Poa annua/Bentgrass Green. Friendly Hills Country Club, Whittier, CA. Treatments which resulted in good moss control, with minimal damage to turf are noted in green shaded boxes.

			6/22/98		7/10/98		8/17/98	
Trt #	UltraDawn rate/gallon	Volume/ 1000 sq ft	% moss control	Turf quality	% moss control	Turf quality	% moss control	Turf quality
1	UltraDawn 4 oz	10 ga	0	6	0	6	0	6
2	UltraDawn 4 oz	20 ga	5	6	5	6	10	6
3	UltraDawn 4 oz	40 ga	75	5	50	5.5	75	6
4	UltraDawn 4 oz	80 ga	80	5	100	5	100	6
5	UltraDawn 4 oz	160 ga	80	5.5	100	5	100	6
6	UltraDawn 1 oz	10 ga	0	6	0	6	0	6
7	UltraDawn 2 oz	10 ga	0	6	30	5.5	0	6
8	UltraDawn 8 oz	10 ga	20	5.5	30	5.5	0	6
9	UltraDawn 16 oz	10 ga	20	5	30	5.5	10	6
10	UltraDawn 32 oz	10 ga	80	4	30	5.5	80	6
11	No treatment		0	6	0	6	0	6

Figure 6. Efficacy of UltraDawn dishwashing liquid (4 oz/gallon) when delivered at three different spray volumes: 40 gallons (trt 3), 80 gallons (trt 4) and 160 gallons (trt 5) per 1000 square feet. Note the complete lack of moss in treatments 4 and 5, 10 weeks after treatment.



The rate of UltraDawn used is also important, especially from the standpoint of avoiding damage to turf. Rates above 4 oz/gallon spray solution resulted in some damage to turfgrass (Figure 7), and are not necessary to achieve optimal moss control.

Based on these results, drench applications of UltraDawn (4 oz/gallon spray solution) applied at application volumes of 80 gallons/1000 square feet, provided excellent control of moss. Levels of control reached 100%, with continued control for 10 weeks after application. However, some damage to turf was observed. To avoid turf damage, it is possible that lower rates of UltraDawn (1-2 oz/gallon), applied more frequently (every 3-4 weeks) would be effective.

Conclusions

If moss infestations are heavy, gradual removal of moss, as was observed using chlorothalonil or quaternary ammonia, is the most desirable strategy, since it avoids the appearance of large areas of dead or dying moss. However, if moss infestations are light, spot treatments with products that rapidly kill the moss (such as UltraDawn dishwashing liquid) may be the most effective strategy. Whichever products are used, maintenance of healthy turf, with an emphasis on the cultural practices below, is the most important strategy for avoiding moss infestations.

- Raise mowing heights to 3/16 inches
- Increase ntirogen fertilization
- Implement a regular verticutting and brushing program
- Implement a spring core cultivation program to improve drainage and relieve compaction
- Physicially remove new patches of moss

Figure 7. Phytotoxicity when high rates of UltraDawn (Treatment 9 = 16 oz and Treatment 10 = 32 oz/gallon) are used. Although these rates controlled moss, significant damage to turf was noted on two weeks after treatment. Turf eventually recovered from this damage, however.