The Winter Environment

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The first snows of early winter are usually a happy time for golf course superintendents in Wisconsin. It means a definitive end to the management of turf for the year, deer hunting is here or just around the corner, and the holidays and a short respite from the shop are just a few weeks beyond that. However, worries about turf often begin once everyone returns to the shop early in the new year. If there is too little snow then the worry is about desiccation or an early start to the golfing season. Too much snow leads to concerns about snow mold, and wild winter weather with rain and extreme temperature swings raise the hairs on Poa managers necks as thoughts of widespread crown hydration or ice damage race through their head.

But what is the winter environment really like for the turf? We recently concluded a research project investigating the impact of snow cover on the persistence of iprodione and chlorothalonil. As part of this project, PJ Liesch, Sam Soper, and myself were tasked with keeping half of the research plot clear of snow the entire winter and half the plot covered with snow the entire winter to determine differences in fungicide degradation. Every time it snowed throughout the four years of the study, we would head out to the research plot at the OJ Noer center and shovel the snow from the inner 'non-snow' portion of the plot and place it on the outer 'snow-covered' portion of the plot (Figure 1). Following snowmelt each spring, the differing appearance between the two portions of the plots was striking. Those plots that had been covered with snow for the duration of the winter were green and almost looked ready for play. Those plots that had been kept free of snow were sand brown and took weeks to green up (though they always did eventually green up). Clearly, the environmental conditions under snow and in the absence of snow have a marked effect on the plants throughout the winter months, which in turn has an impact on their appearance for much of the spring.

As part of this same study we measured several different environmental conditions both under snow and in the absence of snow. Among the conditions measured were soil temperature at a 2-inch depth (Figure 2), surface temperature (Figure 3), relative humidity 3 inches above ground (Figure 4), and sunlight 3 inches above ground (Figure 5). Please note that the values presented here are the daily average of 24 hourly readings, and that actual daily highs or lows were often significantly higher or lower. Data presented in the figures was collected from the winter of 2010-2011, though data was collected each winter from 2009-2010 to 2012-2013.

Looking first at the 2-inch soil temperture it should be immediately obvious that snow is a great insulator. While soil temperatures dropped as low as 18°F in the absence of snow, they stayed nearly constant between 30 and 33°F for most of the winter. The only exceptions were in early January, when they dropped below 30°F for a few days, and in March when they climbed above 33°F for the remainder of the winter. Looking at the other figures, especially the sunlight penetration in Figure 5, it seems clear these temperature alterations in early January and March were the result of either short term (January) breaks in snow cover or longer term (March) snowmelt signaling the onset of spring.

Figure 1. The inner portion of the winter degradation research plot was kept free of snow by shoveling the snow onto the outside of the plot following every snowfall. Several weather stations can be seen on the non-snow covered plots.

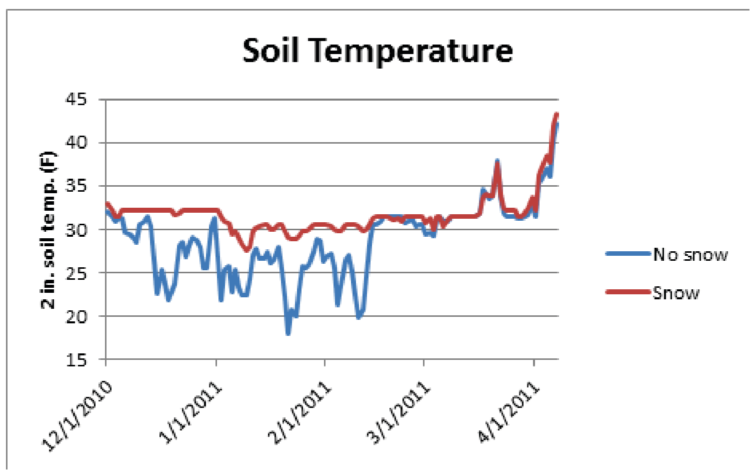

Figure 2. Soil temperature at a 2-inch depth from both snow and non-snow covered turfgrass throughout the winter of 2010-2011 in Madison, WI.

So the presence of a snow cover depth of at least 4 inches kept soil temperatures nearly constant around 32°F no matter how cold or warm it got outside. In addition, soil temperature under snow cover actually increased following the arrival of more snow in mid-January. This signals that not only does snow cover prevent soil temperatures from falling significantly but can also act to warm up soils that have falled well below 32°F. Think of snow cover like a blanket, which acts to trap the heat produced by microbial activity in the soil and allow the entire system to warm up.

If snow is an excellent insulator for soil temperature, it should also be an excellent insulator for surface temperature, and figure 3 shows exactly that. The surface temperature sensor was placed on the turf surface on top of fairway height bentgrass, and despite rapid swings in surface temperature in the absence of snow the surface temperature under the snow rarely went below 28-30°F (except during the short break in snow cover in early January). The most glaring example of the insulatory effects of snow came in mid-February when the non-snow sensor daily average was -5°F and the snow-covered daily average was 28°F, that's a 33 degree difference!

Snow cover also had a significant impact on relative humidity and sunlight. In the absence of snow, relative humidity fluctuated between 50 and 100%. However, when significant snow cover was present (at least 4 inches), then relative humidity stayed constant near 100% regardless of the temperature. Not surprisingly, snow cover also completely blocked out any sunglight from penetrating to the turf surface. In addition, it was interesting to note how the overall strength of sunlight gradually increased beginning in early February by measuring the Watt per sq. m. from turf without snow cover. In fact, by April 1st the sun's rays in Madison were 60% stronger than they were in late December.

What does all this information mean for us as turfgrass managers? In my opinion, the biggest takeaway was that despite the winter extremes we all experience living in Wisconsin the conditions remain remarkably consistent under the snow. The temperature stays around 32°F, its dark, and its humid. These relatively mild temperatures and high humidity keeps the turf greener throughout the winter, but they are also perfect conditions for gray/speckled snow mold fungi to infect. Since the Typhula fungi grow very slowly, they require months to infect even under optimal conditions. A break in the optimal conditions, even for just a period of several days, can set back the fungal infection significantly and prevent symptom development from occurring. This constant need for optimal infection conditions is why 2 or 3 months of continuous snow cover is required for gray and speckled snow mold to occur. In fact, if you replace snow with another medium (winter green covers, leaves, etc) that can hold temperatures consistently around 32°F and keep humidity near 100% for prolonged periods of time, its likely you would see snow mold develop without any snow around.

Knowing the precise environment that snow mold pathogens thrive in is important for developing more effective and efficient means for controlling them. Hopefully future research focusing on the pathogen's environment and relationship with the plant will allow us to not only make highly effective fungicide applications, but also to develop low-input management strategies that will significant reduce snow mold development and provide high quality turfgrass. But that's certainly a few years off, so as you peer out the window at the white expanse of turf, remember that while it may look peaceful, and the turf underneath is likely cozy and warm, its also cozy and humid…and may be under attack.

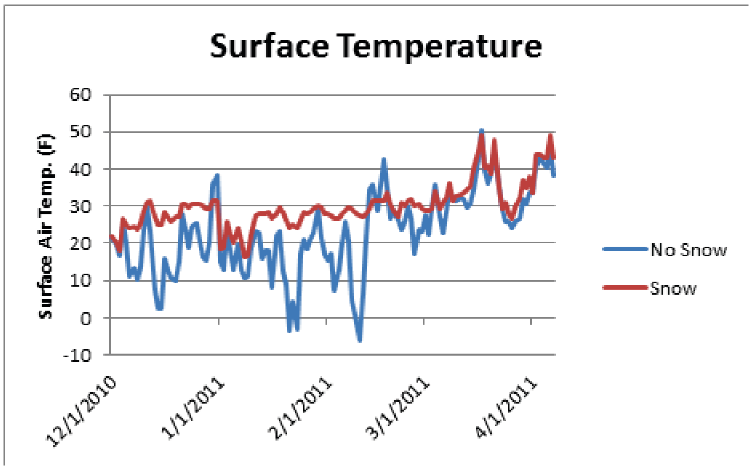

Figure 3. Surface temperature on top of fairway height bentgrass from both snow and non-snow covered turfgrass throughout the winter of 2010-2011 in Madison, WI.

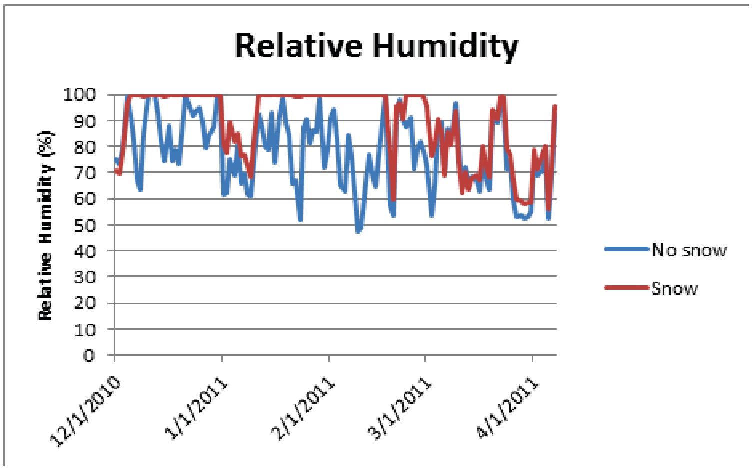

Figure 4. Relative humidity 3 inches above the turf surface from both snow and non-snow covered turfgrass throughout the winter of 2010-2011 in Madison, WI.

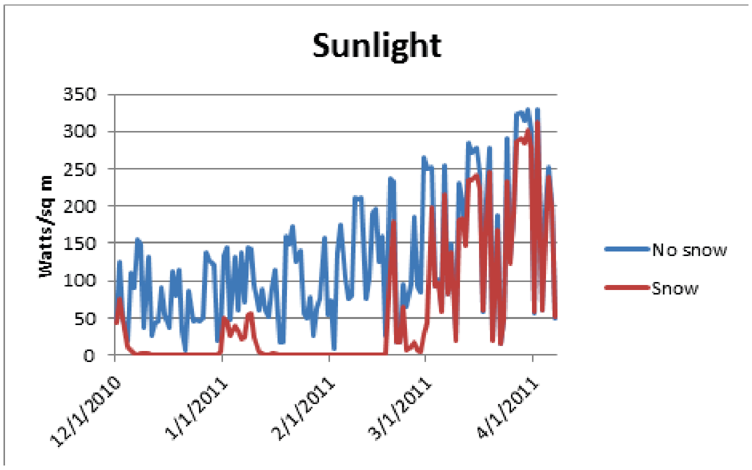

Figure 5. Sunlight measured 3 inches above the turf surface from both snow and non-snow covered turfgrass throughout the winter of 2010-2011 in Madison, WI.