Understanding winterkill of cool-season turfgrasses
March 7, 2011

Though winter of 2010-11 is nothing like winter of 2009-10, the extremely dry fall last year may have led to unusual and unforeseen problems over the winter. Winterkill questions always come up as cool-season turfs start to come out of dormancy. "Winterkill" is a general term that is used to define turf loss during the winter. Winterkill can be caused by a combination of factors including crown hydration, desiccation, low temperatures, ice sheets and snow mold. Because of the unpredictability of weather factors and differences in other contributors like species, cultivar, mowing height, management, exposure, and/or drainage, winterkill is extremely complex and can vary greatly throughout the north central states, Nebraska, and even on the same property or golf course.

Crown hydration
Crown hydration generally occurs in late winter when a day or two of warm daytime temperatures causes snowmelt and water standing in low areas. Though the crowns of cool-season turf maintain reduced moisture levels during the winter, warming weather and available water in the low areas enables the crowns to start absorbing water or hydrating. If warm weather is followed by a rapid drop to freezing temperatures, water taken up by the crown freezes, causing ice crystals which damage or rupture plant cells, and ultimately causing death. In general, annual bluegrass (*Poa annua*) golf course greens and fairways are the most susceptible to crown hydration injury. Not only is this the most common grass in the low areas on golf courses, it emerges from dormancy early and begins taking up water. Other cool-season grasses take longer to come out of winter dormancy, which delays water uptake and results in lower susceptibility to crown hydration injury during the late winter.

Preventing damage from crown hydration is almost entirely through improving drainage to minimize standing water. Correcting surface drainage or installing subsurface drainage with surface risers to low areas is most effective. This will also help control the annual bluegrass population which will also reduce winter damage from crown hydration.

Desiccation
Winter desiccation is the death of leaves or plants by drying during winter when the plant is either dormant or semi-dormant, and roots cannot resupply water. Desiccation injury is usually greatest on exposed or elevated sites and areas where surface runoff is great (Beard, 1973). Winter desiccation injury to turfgrass is common in Nebraska and the north central US when snow cover is not maintained through the winter.

Preventing damage from desiccation is primarily through a wide variety of turf covers, from fabrics to snow fences to late-season topdressing. Windbreaks can also help to slow the wind across an area and encourage longer snow cover. Finally, winter irrigation where feasible can help maintain plant and soil moisture.

Low-temperature kill
Direct low-temperature kill is caused by ice crystal formation at temperatures below 32F. This type of winterkill is most common with extremely rapid drops in temperature or extremely low temperatures. Direct low-temperature kill is probably the rarest type of the winterkill, but it is the most easily studied and grasses can be ranked or selected based on their tolerance to low temperature kill. Beard (1973) provided a general ranking of low-temperature hardiness for turfgrass species that were autumn-hardened (Table 1). However, it is difficult to provide absolute killing temperatures because of the numerous factors involved. Turfgrasses cultivars or biotypes within a species may vary in low temperature hardiness. For instance, annual bluegrass from Pennsylvania has much poorer low-temperature hardiness than annual bluegrass from Quebec (Dionne at al., 2001). Other factors affecting low-temperature kill include hardiness level, freezing rate, thawing rate, number of times frozen, and post-thawing treatment (Beard, 1973). Furthermore, the hardiness level can be affected by a number of plant processes which are in turn affected by weather, fertilization, mowing height, drainage, age of the plant, etc.

Finally, soil temperature plays a larger role than air temperature for low-temperature kill, because the crown of the plant is at or near the soil surface (Beard, 1973).

Preventing direct low-temperature kill is best accomplished with selecting the proper turf species at establishment and maximizing establishment/maturity of that grass prior to winter. Maintaining a healthy turf by proper soil management, fertilization, mowing height, irrigation, etc. will also reduce chances of low temperature kill. Avoiding lush turf by over-fertilizing and/or over-irrigating in the fall will also help as will limiting winter traffic.

Ice sheets

Ice sheets are often blamed for killing turf when, in fact, it is crown hydration and subsequent refreezing that causes the lethal effect. The reason for the confusion is that as snow melts and refreezes, creating ice sheets, the ice sheets are often in poorly drained areas where crown hydration can occur because of the standing water. As the ice sheet melts away, the area damaged closely mirrors where the ice occurred, and therefore, the conclusion is that ice sheets caused the kill. Beard (1998) reported that Kentucky bluegrass and creeping bentgrass survived 150 days of ice cover without significant injury, whereas annual bluegrass was killed somewhere between 75 and 90 days of ice cover (Beard,). The author concluded that cause of death for the annual bluegrass was most likely from toxic gas accumulation or lack of oxygen under the ice sheet. However, others suggest death from ice covers is due to damaged crowns unable to produce new roots in spring (Beard and Olien, 1963), or crown dehydration as ice formed around the crown immediately after ice formation (Valverde and Minner, 2007). These conclusions indicate how complex the effects of ice covers can be on cool-season turf. Therefore, most will recommend removing ice layers over annual bluegrass almost immediately, whereas ice should be removed from creeping within 30-45 days, if at all (Tompkins et al,. 2010).

Snow mold

Gray snow mold requires extended periods of snow cover, whereas pink snow mold can occur either with or without snow cover. While their outward appearance is similar, circular patches of tan turf—sometimes with orange/brown margins, the pathogens have different temperature requirements for infection. Infection by gray snow mold occurs within a narrow range of cold temperatures (32-36 degrees F). Snow cover offers extended periods when these temperatures are maintained at the turf surface. Gray snow mold is relatively uncommon in the north central states, and normally increases as you move north where extended snow cover is more common. If snow mold injury is a recurring problem, applying a preventive fungicide in late autumn is the best control option. Symptoms that develop after snow melts -- during cold wet weather in spring -- are attributed to the *Microdochium* patch or pink snow mold. The pathogen produces spores (called conidia) at the edge of circular patches. The spores may move down slope, causing new infections, especially on golf course putting greens. Young (less than one year old) creeping bentgrass is especially susceptible to snow mold damage. On high-maintenance turf (i.e., golf course tees and putting greens), fungicide application to pink snow mold may be justified if numerous patches developed over the winter. A contact fungicide (chlorothalonil) will limit spread while turf remains dormant. Once turf is actively growing, a penetrant type fungicide (such as a DMI) may provide more effective control.

Roch Gaussoin and Zac Reicher, Professors, Turfgrass Science

Literature Cited

1. Beard, J.B. 1973. Turfgrass: Science and Culture. Englewood Cliffs, N.J.: Prentice-Hall.
2. Beard, J.B. 1998. Winter ice cover problems? TURFAX. 9(1):1-2,5.
3. Beard, J. B. and C. R. Olien. 1963. Low temperature injury on the lower portion of Poa annua L. crowns. Crop Sci 3:362-363.
4. Dionne, J., Y. Castonguay, P. Nadeau, and Y. Desjardins. 2001. Freezing tolerance and carbohydrate changes during cold acclimation of green-type annual bluegrass (Poa annua L.) ecotypes. Crop Sci. 41(2):443-451.
5. Hoffman, L. M. DaCosta, J. S. Ebdon, and E. Watkins. 2010. Physiological changes during cold acclimation of perennial ryegrass accessions differing in freeze tolerance. Crop Sci. 50:1037-1047
6. Tompkins, D. K., J. B. Ross, and D. L. Moroz. 2004. Effects of ice cover on annual bluegrass and creeping bentgrass putting greens. Crop Sci. 44(6): 2175-2179.
7. Valverde, F. J., and D. D. Minner. 2007. Field evaluation of winterkill in annual bluegrass and creeping bentgrass: Creeping bentgrass is unaffected by ice cover, but annual bluegrass can suffer substantial injury. Golf Course Manage. 75(9): 88-93.

Table 1. Relative ranking of low-temperature hardiness of cool-season turf species (Beard, 1973)

Low-temperature hardiness	Turfgrass species
Excellent	Rough bluegrass
	Creeping bentgrass
Good	Kentucky bluegrass
	Colonial bentgrass
Medium	Annual bluegrass
	Tall fescue
	Red fescue
Poor	Perennial ryegrass