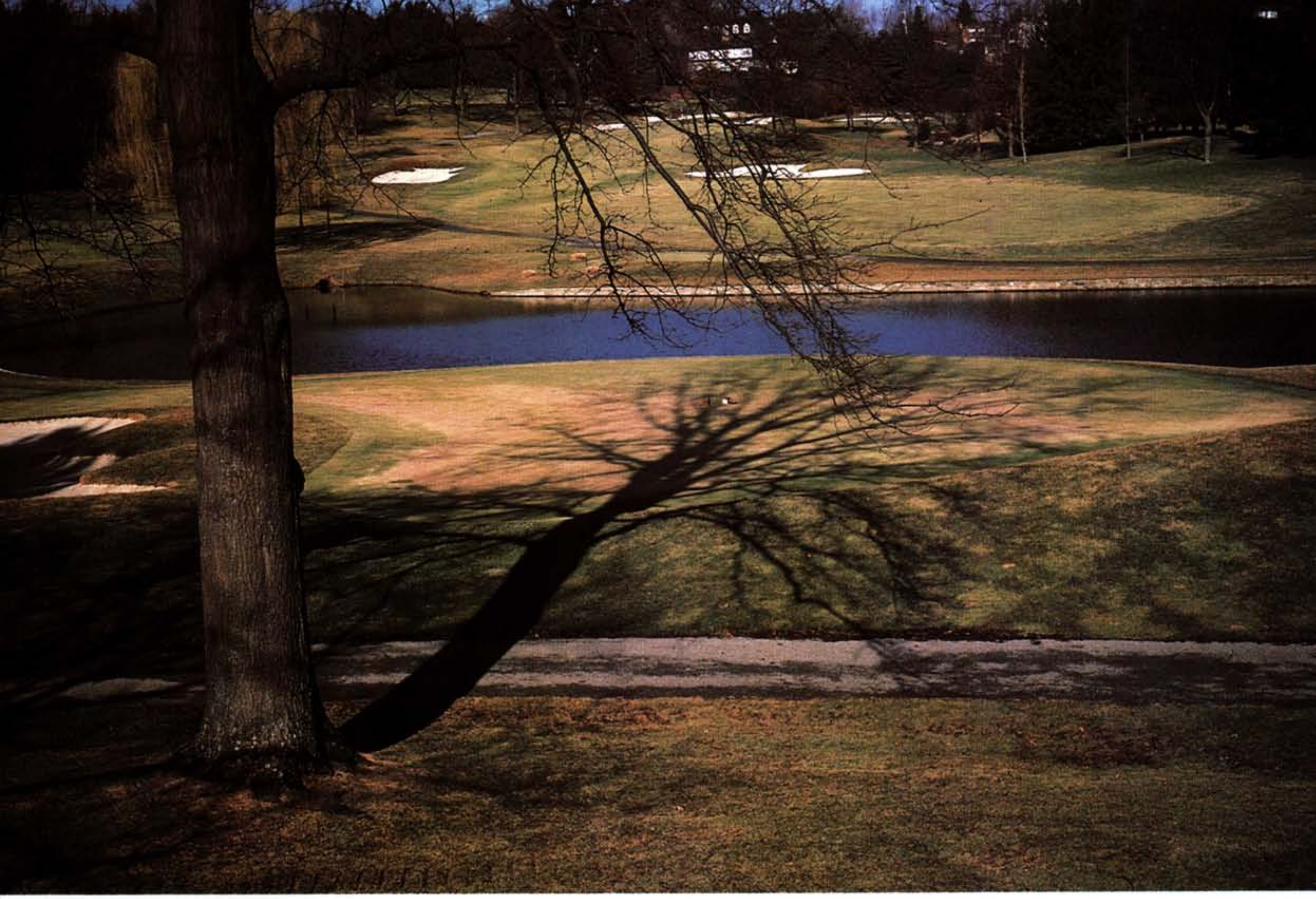

WINTER DAMAGE

Control the variables that can minimize the potential for winter turf loss.

BY KEITH HAPP

It is no coincidence that winter damage is more severe in the more shady areas of greens. To minimize the potential for future damage, remove limiting factors. Removing the tree would be a good starting point.

Thanks to research and advancements in turfgrass management, golf course maintenance has been impacted by the introduction of various technologies that have enabled turf managers to maintain higher quality conditions than in the past. While technology offers a degree of control, complete control over all of the variables associated with golf course preparation is not possible. This is particularly true when it comes to various aspects of winter injury on northern golf turf. On occasion, Mother Nature lets us know exactly how much, or should I say how little control we have. Over the last decade, numerous areas within the northern tier of states have suffered great turf loss due to direct low-temperature kill, crown hydration damage, wind desiccation, and, in some rare instances, suffocation.

Although there are several agronomic strategies that can be utilized to prepare for the onset of winter weather, control is not completely in the hands of the superintendent. Turf managers can control only certain aspects of turf health. Fertility strategies can be adjusted, cultural programs can be implemented in a timely fashion, plant protectants can be applied, drainage infrastructure can be enhanced, surface drainage patterns can be altered, and, most important, the growing environment can be improved by addressing limiting factors such as shade and airflow restrictions. This article will discuss some of the strategies that are being utilized to minimize the potential for turf loss during severe winter weather.

THE HARDENING PROCESS

Plants withstand freezing in the cells of crown tissue by increasing concentrations of carbohydrates and other nutrient solutes within these cells as the plant hardens in the fall and early winter (Tompkins, 1995). To completely harden, turfgrass plants must freeze for a period of at least one month. This hardening process is reversed in the spring when stored energy (carbohydrates) is rapidly used. The plant dehardens (i.e., defrosts) and becomes very susceptible to low-temperature injury if the contents of cells are again exposed to low-temperature stress. If crown cells freeze after dehardening, severe damage can result. Research studies have revealed how susceptible unhardened biotypes of *Poa annua* can be to temperature fluctuations. Unhardened biotypes only tolerated temperatures of 23° to 28° F, while completely hardened biotypes exhibited tolerance of -13° to -25° F (Tompkins et al., 1995). As a comparison, researchers have reported that creeping bentgrass exhibits maximum hardiness levels of -40° F.

Biotypes of *Poa annua* can rapidly deharden when subjected to temperatures of 45° F for 48 hours (Tompkins, Budar, and Ross, 1996). In many portions of the Mid-Atlantic Region, these temperature fluctuations can and often do occur frequently within a short period of time. For example, during the prime hardening period of the early winter of 2003/2004, the Pittsburgh area experienced a temperature of 61° F on January 3, only to be followed by subzero temperatures seven days later. Under these conditions even the most proactive measures employed prior to the temperature swings can go for naught. The question is, what can turf managers do to improve the potential for the turf surviving severe weather conditions, particularly fluctuations in temperature resulting in rapid freeze and thaw cycles?

MOWING HEIGHT

Turf managers, with the help of the Green Committee, have developed course setup guidelines for maintenance and course preparation. Major components of course setup are the mowing procedures used throughout the property in general, and for the greens in particular. There are many factors that affect putting green performance, and all too often golfers focus on mowing heights to achieve the desired playing effect. Mowing height is critical to the plant's ability to prepare for winter weather. Excessive close mowing late in the year severely compromises the turf's natural defense mechanisms going into winter. Maximizing energy production via photosynthesis is essential to the hardening process. Surface area of the leaf is an important part of the equation. Energy is stored first in the leaves and then transported to the roots for use as winter reserves.

As a first step, set limits as to how the greens will be prepared during the period of plant hardening. For example, pick a date and stop mowing the turf. Use other techniques to prepare for bonus golf late in the year. Rolling could be used rather than regular mowing practices. If mowing has to be implemented, then raise the height of cut slightly until mowing can be completely halted before winter weather prevents any play. Even though it may be late in the season, make sure the mowers are sharp so that additional cutting does not bruise or tear the turf during the critical hardening process. It is no coincidence that turf on the collars often avoids crown hydration damage when grass on the green surface is severely damaged.

FERTILIZATION

Adequate fertilization plays a key role in preparing the turf for winter. Researchers have examined the fertility needs of turf prior to winter weather and have found that elevated levels of potassium and phosphorus are key components to surviving cold-temperature stress (Roberts, 1993; Johansson, 1994). There are a number of different materials that can be utilized to enhance winter hardiness, and it begins with nitrogen fertilization, which is the catalyst for nutrient uptake.

Studies have shown that carbohydrate reserves increase from fall fertilization. For example, researchers at Cornell University revealed the importance of nitrogen to the uptake of potassium (Woods, 2004). Additionally, Roberts (1993) reported that 30% less damage occurred on research plots treated with a 1:2 nitrogen-to-potassium regime. The least tolerant plots were those treated with nitrogen only.

Treating in a controlled fashion with readily available nitrogen sources provides the opportunity to stimulate the desired level of growth without compromising root growth. All too often, large quantities of fertilizer applied late in the season create a lush turf that is very susceptible to winter damage as well as disease. All fertilization programs utilized late in the season should be focused on supporting the turf's ability to prepare itself for cold-temperature stress. That is, fertilization should be performed to stimulate and support carbohydrate storage. These reserves are critical to the hardening process. They can be maximized by using readily available nutrient sources that offer a predictable response.

TREE MANAGEMENT

In the fall, autumn days get shorter and temperatures decrease. These changes in environmental conditions provide a signal to turfgrass that winter is approaching. To allow the turf to use available nutrients, other essential factors must be considered. First and foremost, adequate sunlight must be provided. Availability of light is essential to photosynthesis during the hardening process (Johansson, 1994). Without sunlight, photosynthesis is restricted, resulting in lower carbohydrate production, and this reduces storage within the root structures. Additionally, shade plays a significant role in winter freeze-and-thaw cycles, particularly severe cold-temperature stress. It is no coincidence that greens that suffer the most during winter weather are located in shadier sites. During the winter months when the sun is lower in the southern sky, radiant energy is spread over a much wider area. The impact of shade is then magnified during freeze-and-thaw cycles.

Evaluate all areas of the course, particularly green complexes, for sunlight exposure, maximizing sunlight on the east and southern borders of these sites. Trees should accent and highlight the course, not interfere with proper course maintenance.

DRAINAGE

The importance of having adequate surface drainage characteristics during the winter cannot be overstated! Surface drainage becomes all the more important when rapid fluctuations in temperature occur. Water can collect in low-lying areas and freeze rapidly, resulting in crown hydration damage and/or direct low-temperature kill. It is not uncommon to see poor surface drainage characteristics near the interface of the collar and the putting green surface. Many turf managers are modifying these areas of their greens to help minimize the potential for any further winter damage.

A sod cutter is utilized to strip the area adjacent to the putting green that is in effect creating a dam or dyke, not allowing the water to escape. The sod is removed and the subsoils are shaved with a sod cutter. When positive water flow is

Follow the trail of draining water. Improving drainage to minimize standing water improves the chances of survival.

On this *Poa annua* green, triplex ring was a positive in this one instance. The traffic pattern resulted in less thatch in the wheel tracks and the turf was not lost to desiccation injury.

established, the sod is replaced. These types of projects are normally conducted late in the fall or during early winter. The sod will heal quite rapidly and playability can be restored before the next season. This type of minor change is not noticeable for daily play. However, during periods of rain or during periods of freeze and thaw, the changes can be significant.

Turf managers have also utilized intercept drains on the high side of a green that is prone to damage from runoff during precipitation or melting snow. Intercept drains, including drop inlets (DIs), can be strategically placed to capture rainfall or melting snow and ice. The position of these DIs is critical. During the winter months when soils are frozen, open stone intercept drains may not adequately accept runoff water. The excess then flows over the green, increasing the potential for crown hydration damage. The best method of positioning these DIs involves spending time on the course during a rain event. Watch the flow of the water and chart areas where additional drainage infrastructure is needed.

AERATION AND TOPDRESSING

Accumulations of excessive thatch will reduce the turf's ability to survive severe winter weather. Plant crowns and other structures elevated from the soil/thatch interface are not buffered as well from temperature extremes. Excessive thatch (more than an inch) is prone to desiccation when located in a windy area and also is prone to direct low-temperature damage when located in low-lying portions of the surface. Thatch that becomes saturated during thawing events is very prone to crown hydration damage. To a large degree this variable can be controlled with core cultivation and topdressing treatments.

There has been a resurgence of using late-season topdressing treatments. For years turf managers have practiced heavy late-season topdressing that provides an added degree of insulation against cold-temperature stress. The theory has been that crowns will be protected from desiccation and will also enjoy improved free drainage near the active growing point of the plant. Problems occur when sand is aggressively dragged or brushed into the canopy of the turf. The best possible scenario exists when treatments are performed in a light and frequent manner. Natural precipitation events then work the sand into the profile. Eliminating dragging manages a stress variable associated with the hardening process. As topdressing accumulates, a more resilient surface can result. Footprinting is often much less noticeable due to the fact that the topdressing is providing a firmer surface upon which to play. Still, the critical issue is topdressing at a rate that matches the growth of the turf and protects the active growing points of the plant.

To a large degree, preparing for winter weather hinges on the support of the Green Committee. We know that routine topdressing treatments provide an element of protection, insulation, and improved free drainage in the upper portion of the soil structure. However, this strategy must be balanced between trying to protect the turf and still providing an acceptable playing condition if weather allows the course to be used late in the season. Frankly, the first question to pose is whether or not bonus golf should take precedence over trying to prepare the course, in fact to protect it from potential severe weather. All too often, focus is placed on putting green performance at a time of year when excessive conditioning could easily predispose the turf to severe damage.

Recently, turfgrass managers have been experimenting with black topdressing sand to aid in controlling the temperature near the surface of the turf. The theory is to maintain growth by stimulating higher temperatures near the soil surface. This controlled plant growth can result in greater storage of carbohydrates, and thus more reserves for greater tolerance of cold-temperature stress (Hamilton, 2003).

TURF COVERS

When it comes to controlling winter damage, questions are always posed regarding the use of geotextile covers. Research has indicated that the use of these tools can be beneficial if desiccation is the primary concern. These covers will help to minimize water loss from turf that is frozen and may even provide much faster growth response in the spring when the covers are removed.

For information regarding the use of covers, refer to the September/October 2000 issue of the *Green Section Record* ("Winter Protection of Annual Bluegrass Golf Greens"). In most instances, these geotextile covers and other green blankets will protect the turf from certain cold-temperature stresses, but the turf cannot be protected from all of the conditions that can be presented. Crown hydration damage has occurred underneath geotextile covers even when the most laborious precautions have been taken.

TO REMOVE OR NOT TO REMOVE?

A question often posed is whether or not to remove snow cover on an ongoing basis during the winter. Research is clear on this one point. One way to protect greens from injury in the late winter is to maintain snow cover as long as possible. The snow insulates the turf from air temperatures that may warm the soil and induce a reduction in cold tolerance. Basically, the snow cover helps to maintain a dormant state, which prolongs the tolerance to cold-temperature stress. If snow melts rapidly, then the extent of the protection may only last a few days during the nighttime hours. However, this may still be enough to prevent major damage. Naturally, the surfaces need to be inspected to determine if ice accumulation is occurring.

Ice accumulation is another story. The turf can survive under ice, but it is the initial phases of freezing that impact survival. If the plant has hardened, soils have frozen, and a gradual reduction in temperature has occurred, then the potential for damage is reduced. The worst-case scenario occurs when the soil is not frozen, there is rainfall, and the temperature plunges. Damage may then be unavoidable.

Removal of ice has become much more feasible with the introduction of black topdressing sand. This material has offered a high degree of control during certain types of winter weather. Research has indicated that treatments of between 70 and 100 lbs. of actual product per 1,000 sq. ft. can rapidly melt significant accumulations of ice (Hamilton, 2003). Often, treatments performed in the middle of winter can melt through 2 to 4 inches of ice in a 24-hour period. As the snow and ice melt, the runoff must have a place to go. This reemphasizes the need for adequate drainage capacity to move the water away from the turf.

CONCLUSION

There are several factors that help induce natural cold hardening. Low temperature, shorter day length, and reduced soil and plant moisture are prime examples, but these factors are uncontrollable.

Low-temperature hardiness can fluctuate from season to season, and soil temperature plays an important role in determining the degree of hardiness the plant can reach. If factors are favorable, plants will achieve the maximum levels of cold hardiness at the start of winter. However, a plant that can tolerate temperatures of below 0° F in December may only be able to tolerate temperatures slightly below 20° F in early April. It is possible for the turf to experience improved cold hardiness, but the level never reaches the initial cold hardiness established prior to winter. Simply put, as the winter season progresses, there are fewer energy reserves within the plant to draw on to tolerate the colder weather.

Golf tees can be impacted by winterkill as well. Attention to traffic stress, compaction, and proper agronomic procedures are equally critical issues.

Black topdressing sand was used to rapidly melt snow and ice on this putting green surface. Using 75 to 100 lbs. of product per 1,000 sq. ft. removes significant ice accumulation in 24 hours.

Research indicates that fall applications of black sand can increase soil temperatures. This may help turf better tolerate winter freeze-and-thaw cycles.

This further emphasizes the need to fertilize in an appropriate manner and at the proper time in the fall and early winter to maximize the natural stress mechanisms of the turf. The hardening process is of great importance for grasses to survive the winter. Planning to control as many factors as possible will help improve the chances for turf survival, no matter what weather conditions may be presented. While weather is a difficult factor to calculate into management regimes, the need for communication is not. Don't stop communicating to golfers the importance of what needs to take place during a time of year when preparation is everything.

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