Winter Injury Causes Problems on Annual Bluegrass Greens

By Darrell K. Tompkins

For many golf courses with creeping bentgrass greens, annual bluegrass invasion is a major weed problem. Consequently, older turf is often overtaken. When this happens, maintenance, rather than eradication, becomes the major consideration. Unfortunately, winter damage to annual bluegrass greens is a significant problem in cold climate areas.

Winter damage to annual bluegrass greens can be due to a number of factors including reduced levels of cold hardiness compared to creeping bentgrass, early dehardening in the spring, reduced cold hardiness associated with crown hydration and mortality under ice cover. This article will examine the manner in which each of these factors can contribute to winter injury in annual bluegrass.

Cold hardiness levels

During the warmer summer months, plants have little ability to tolerate cold temperatures, and temperatures of 24.8 degrees Fahrenheit may be cold enough to cause plant mortality. In preparation for the colder temperatures of winter, plants undergo a number of changes. This process is called cold hardening.

A number of factors can induce cold hardening including low temperature, shorter day length, reduced soil and plant moisture and plant nutrition (Gusta et al., 1983). Typically, temperatures near freezing are more effective in promoting rapid hardening (Gusta and Fowler, 1979), and a period of below-freezing temperatures may be required to achieve the full level of cold hardiness (Gusta and Fowler, 1977).

Cold hardiness levels can fluctuate from year to year, and soil temperature during the hardening period plays a critical role in determining the hardiness level (Tompkins et al, 2000). Upon exposure to conditions that induce hardening, plants will achieve their maximum levels of cold hardiness at the start of the winter (Gusta and Fowler, 1979). This hardiness level will gradually decrease throughout the winter. Therefore, a plant that can tolerate temperatures of –4 degrees Fahrenheit in December may only be able to tolerate temperatures of 17.6 degrees Fahrenheit in April (Tompkins et al., 2000).

Cold hardiness levels can vary widely for different grass species (Gusta et al., 1980).

Crown hydration predisposes the plant to freezing injury because of a loss of cold hardiness.

For example, creeping bentgrass has a much greater ability to cold harden than does annual bluegrass. In Alberta in the western Canadian prairies, creeping bentgrass can cold harden to levels of at least –40 degrees Fahrenheit, while annual bluegrass can cold harden to –5.8 degrees Fahrenheit (Tompkins et al., 2000). Biotypes of annual bluegrass found in other regions may have less ability to cold harden.

As plants cold harden, there is an associated decline in moisture levels in the crown tissue. One difference between creeping bentgrass and annual bluegrass is that creeping bentgrass plants have a lower percent moisture in the crown tissues at levels of maximum cold hardiness.

Dehardening and winter Injury

Dehardening is the process that occurs when temperatures warm, and plants lose their ability to tolerate cold temperatures. During the later part of winter, plants undergo a series of thawing and freezing cycles. A plant loses some of its cold tolerance each successive time it is exposed to warmer temperatures.

Dehardening occurs much more rapidly than hardening (Gay and Eagles, 1991). Once cold hardiness is lost, it may be possible to partially re-induce cold hardiness, but this

level will never be the same as the initial cold hardiness level (Tompkins, et al., 2000) because the plant has fewer energy reserves to draw on.

While annual bluegrass is not able to attain the same level of cold hardiness as creeping bentgrass, an additional problem is that annual bluegrass can deharden earlier in the spring, making it more susceptible to a late spring frost. For example, in a two-year study conducted at the Prairie Turfgrass Research Centre in Olds, Alberta, the average cold hardiness level in mid-March for annual bluegrass was 8.6 degrees Fahrenheit compared to –20.2 degrees Fahrenheit for creeping bentgrass (Tompkins, et al., 2000).

However, with the advent of much warmer temperatures in April, the cold hardiness differences between species rapidly disappeared. By mid-April, the cold hardiness level was around 14 degrees Fahrenheit for both species.

One way to protect greens from winter injury in the late winter is to maintain a snow cover as long as possible. First, the snow protects plants from low temperatures, preventing injury. Second, as the air temperature warms, the presence of cover can maintain the plants in a dormant state, which helps prolong cold hardiness. This extension of the dormant period may only last for a few days as the snow rapidly melts once daytime temperatures warm, but this may be enough to provide protection from cold nighttime temperatures during this transition period.

Crown hydration

Crown hydration is the process whereby cells in the crown tissue take up water. The crown tissue is a meristematic region in the grass plant that has the ability to produce new growth in the spring.

The problem with crown hydration is that it predisposes the plant to freezing injury because of a loss of cold hardiness. It is a problem in poorly drained areas where water collects and is a particular problem in the spring, when temperatures fluctuate rapidly. When temperatures drop suddenly, cells within the critical crown tissue are susceptible to damage.

During the early spring, plants can deharden considerably before there are any visual signs of growth. This loss of hardiness is associated with an increase in the percentage of crown moisture. In addition, there is a strong correlation between increased crown hydration and increased soil temperature (Tompkins, et al., 2000). Therefore, prolonging the period of dormancy through the use of an insulating cover can delay the increase in crown hydration, which helps to maintain cold hardiness.

In some years, fluctuating temperatures can cause snow to melt and refreeze. Melted water can percolate through the snow to the soil surface where it refreezes, producing a layer of ice on the soil surface (McKersie and Lesham, 1994). Ice can also form when freezing rain occurs on frozen soils. The density of the ice cover can vary depending on whether the rainfall occurs in the presence or absence of snow. Greater damage may occur when plants are encased in ice as compared to ice cover only (Andrews and Pomeroy, 1975; Beard, 1964).

The relationship between tolerance to ice cover (or encasement) and cold hardiness has not been clearly established. Some reports indicate a correlation between the two factors, and other reports indicate that the two factors are not correlated (McKersie and Hunt, 1987; Andrews and Pomeroy, 1989; Gudleifsson et al., 1986). In addition, flooding as the ice melts may reduce cold hardiness as a result of crown hydration (Gao et al., 1983).

As plants cold harden, there is an associated decline in moisture levels in the crown tissues.

The Prairie Turfgrass Research Centre recently completed a two-year study that examined the effect of snow and ice cover on annual bluegrass and creeping bentgrass. Snow and ice covers were established on annual bluegrass and creeping bentgrass greens and maintained for 90 days. At 15-day intervals, plants were sampled, and cold-hardiness levels were determined.

Ice cover had a much more dramatic impact on the loss of cold hardiness (and eventual plant mortality) for annual bluegrass than for creeping bentgrass. For example, by 60 days the ice-covered annual bluegrass

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plants had a cold hardiness level of only 21.2 degrees Fahrenheit and were dead by day 75. In contrast, the ice covered creeping bentgrass plants had a cold hardiness level of –32.8 degrees Fahrenheit at day 60 and –20.2 degrees Fahrenheit at day 90. These results compare favorably with previous research by Beard, who reported significant damage to annual bluegrass when ice covers were present for longer than 75 days (Beard, 1964) while creeping bentgrass was able to survive periods of 120 days under ice cover without damage (Beard, 1965).

Annual bluegrass is much less tolerant than creeping bentgrass of cold temperatures.

Annual bluegrass and creeping bentgrass plants that were snow covered only maintained cold hardiness throughout the 90-day period. At 90 days, annual bluegrass had a cold hardiness level of 6.8 degrees Fahrenheit (compared to –7.6 degrees Fahrenheit at the start of the experiment) and creeping bentgrass had a cold hardiness level of –20.2 degrees Fahrenheit (compared to –43.6 degrees Fahrenheit at the start of the experiment).

The study also examined the effects when ice was removed after 45 days. It would appear that ice removal after 45 days was too late to improve survival of the annual bluegrass, as there was no improvement in cold hardiness in the annual bluegrass plants at 60 days. By 75 days, they were dead. Therefore, much earlier removal of ice would be most appropriate for annual bluegrass, while creeping bentgrass may not warrant ice removal at all.

Summary

Annual bluegrass is much less tolerant than creeping bentgrass of cold temperatures and is particularly susceptible to injury when covered by ice for a prolonged period. Maintaining dormancy by retaining a snow cover is one way to prolong the period of acceptable cold hardiness for annual bluegrass greens.

Current research at the Prairie Turfgrass Research Centre is focusing on strategies to remove ice and minimize damage as well as exploring the effectiveness of winter covers to protect greens.

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