

Ice Injury

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Intermittent ice formation on golf greens and fairways is a common event in the northern United States. However, over the last few years ice formation has increasingly been singled out as the cause or strongly associated with winter injury. Ice injury can occur either directly from continuous cover or as part of freeze injury (low temperature kill).

Continuous Ice Cover Injury

The first type of ice injury is the direct result of a continuous ice cover. In the early to mid-1980s Jim Beard conducted controlled laboratory study where he looked at the survival rate of three cool season turfgrasses under a continuous ice cover and two turfgrasses under field conditions. He found that creeping bentgrass could survive 120 days of continuous ice cover; however, annual bluegrass (*Poa annua*) loss occurred after 60 days with substantial loss around 75 days. In a Canadian field study annual bluegrass and creeping bentgrass turf was subjected to 45 days of continuous ice cover and then the ice as removed. Seventy-five days after initiating the study and 30 days after removing the ice cover creeping bentgrass still maintained its cold hardiness, while annual bluegrass was dead. It would appear from this study that annual bluegrass under a continuous ice cover will survive for about 45 days.

The reasons commonly proposed for ice injury are the build-up of toxic gases and/or the development of anoxic conditions, and the loss of cold hardiness. It appears that carbon dioxide accumulation under ice cover is a major contributor to the death of herbaceous plants. Intermittent thawing helped eliminate the carbon dioxide buildup and injury to the plants in this study did not occur.

The loss of cold hardiness under ice cover occurs and varies among turfgrass species. Under continuous ice cover annual bluegrass loses its cold hardiness, while creeping bentgrass is not affected. The loss of cold hardiness in annual bluegrass is likely due to the anoxic (lack of oxygen) conditions that develop under an ice cover.

Ice in Association with Freeze Injury

In most of the Midwest and Northeast, a continuous ice cover exceeding 45 days is unlikely. The winter weather pattern is generally broken with intermittent periods of thawing and melts the ice. Where "Ice injury" plays a more likely role is a component of freeze injury. In this role the freezing of water that would occur with a rapid drop of temperature in or around the growing point during or after dehardening of annual bluegrass.

The critical precursor to freeze injury is the loss of cold hardiness through dehardening and subsequent rehydration of the annual bluegrass crown region. Continuous ice covers as previously mentioned contribute to the decline in cold hardiness. However, the most important factor regulating dehardening is temperature. In annual bluegrass the dehardening process can occur quickly when soil temperatures exceed 46°F for 48 hours.

What cultural practices can be instituted to minimize ice injury and/or freeze injury? A thorough discussion is found in the 2004 November /December issue of the USGA Green Section *Record* in an article entitled "Winter Damage" by Keith Happ, which is worth reading. A management program for reducing ice or freeze injury should center on:

1) Produce a health plant going into the winter. A weak annual blue-

grass plant with low carbohydrate storage is not going to tolerate ice cover or be resistant to freeze injury as a healthy plant. Shaded areas are more prone to freeze injury than sunny areas, probably due to the carbohydrate status of annual bluegrass.

2) Eliminate poorly drained areas. Annual bluegrass growing in areas where water accumulates is at high risk to rapid freezing during freeze-thaw cycles.

In conclusion, winter injury is normally a combination of several factors, one of which is ice cover. A continuous ice cover alone in the Midwest is not a likely event. However, freeze/thaw cycles in late winter can create a situation where excessive water in and around annual bluegrass crowns can create freeze injury from the ice formed from the freezing of water.

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