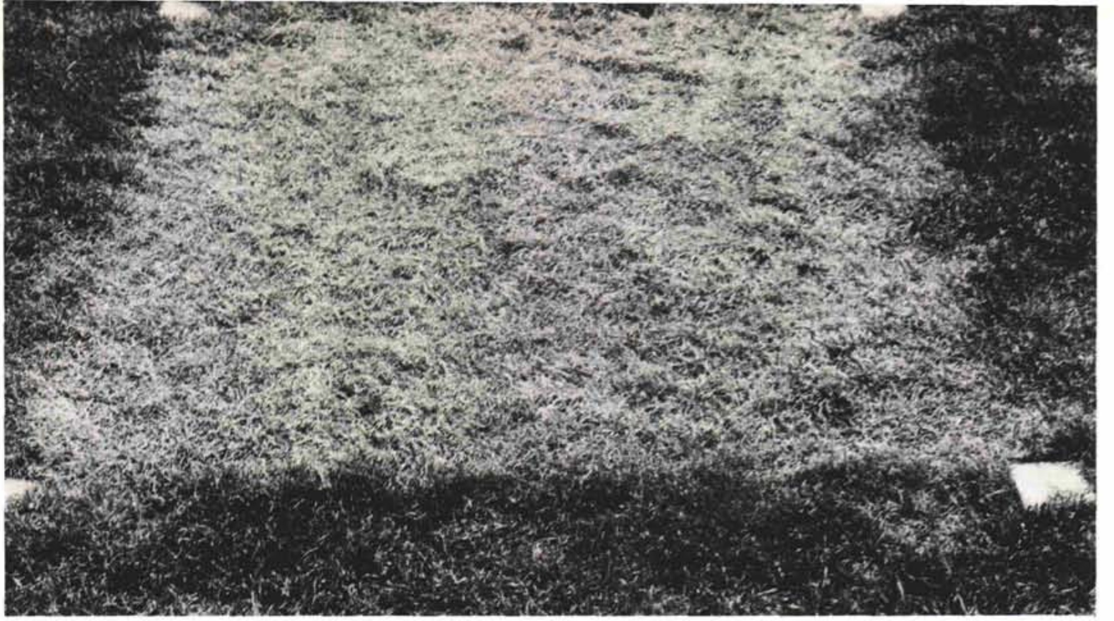


Complete kill of the leaves, crowns, and rhizomes of a Kentucky bluegrass turf resulting from a 160-pound man shuffling uniformly over the wet, slushy area just prior to a severe freeze to below 20°F.

Ten Years of Research on Winter Injury on Golf Courses: Causes and Prevention

by **DR. JAMES B. BEARD,** Michigan State University

Winter injury of turf is difficult to understand because it results from the interaction of a number of environmental, soil, and cultural factors. Before a golf course superintendent can initiate the appropriate cultural program to prevent winter injury, he must determine the particular type or types of winter injury that occur most frequently at various locations on the golf course. This involves a study of the particular symptoms, including time of occurrence, soil type, topography, drainage characteristics, traffic patterns, and the probability of environmental stress. Such information is assembled over a period of years, and a specific program is established on the golf course in order to minimize the probability of winter injury.

CAUSES OF WINTER INJURY

The four major types of turfgrass winter injury that most commonly occur are presented in Table 1, along with the symptoms and causes of injury. This information has been assembled over a 10-year period of extensive research at Michigan State University. The major types of winter injury are:

Desiccation
Direct low temperature kill
Low temperature diseases
Traffic effects.

Note that ice sheet damage caused by oxygen suffocation or toxic gas accumulations underneath an ice cover are not listed. Detailed investigations at Michigan State University indicate that this type of winter injury rarely occurs. This is in contrast to the many articles by individuals indicating that this is a serious problem. Unfortunately, these earlier writers had essentially no information on which to base their comments other than data from research with alfalfa. The winter injury most commonly associated with extended periods of ice coverage occurs during freezing or thawing periods when standing water increases the crown tissue hydration and subsequent injury of the turfgrass plants when temperatures drop rapidly below 20°F.

Table 1. Types, symptoms, and causes of winter injury that most commonly occur on golf course turf

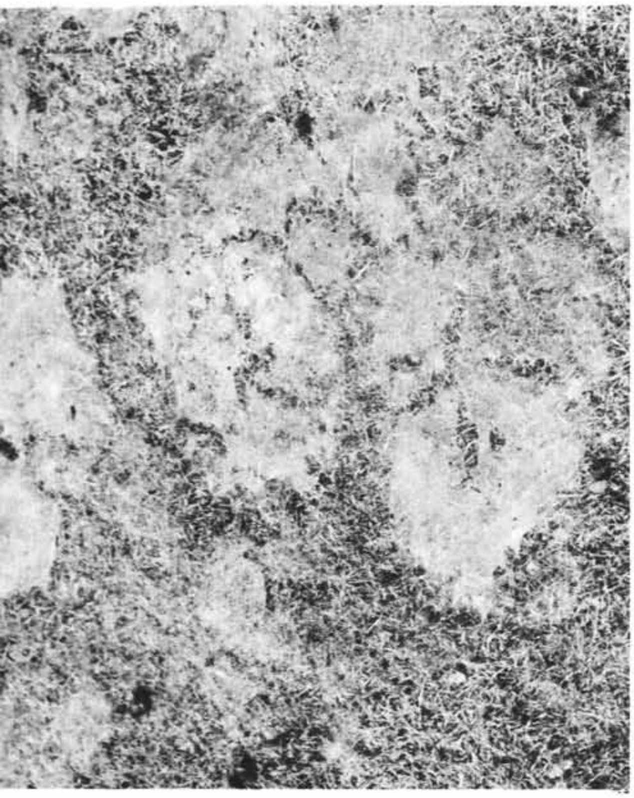
Type of winter injury	Symptoms	Cause of injury	
		External forces	Internal plant effects
A. **Desiccation:**			
(1) Atmospheric	Leaves turn distinctly white but remain erect; occurs most commonly on higher locations that are more exposed to drying winds; can range from small irregular patches to extensive kill of large areas.	A drying atmospheric environment including high winds and low relative humidity; in addition, soil water absorption is reduced at low temperatures or may be inoperative because the soil is frozen.	Desiccation of the plant causes shrinkage and collapse of the protoplasm that results in mechanical damage and death.
(2) Soil	Leaves turn distinctly white and are semi-erect; the tissues including the crown are very dry; commonly occurs in a more extensive pattern over the turf than does atmospheric desiccation.	Extended periods of soil drought due to a drying atmospheric environment and lack of precipitation or irrigation.	(Same as above)
B. **Direct low temperature kill**	Leaves initially appear water-soaked, turning whitish-brown and progressing to a dark brown; the leaves are limp and tend to lay as a mat over the soil; a distinct, putrid odor is frequently evident; occurs most commonly in poorly drained areas such as soil depressions; frequently appear as large, irregular patches.	A rapid decrease in temperature, particularly the adjacent soil temperature; kill most commonly occurs at soil temperatures below 20°F during the late winter—early spring freezing and thawing periods; may be associated with thawing of an ice cover that occurs from underneath.	Large ice crystals form within the plant tissues causing mechanical destruction of the frozen, brittle protoplasm; the higher the water content of the tissue, the larger the ice crystals and the more severe the kill.
C. **Low temperature diseases:**			
(1) *Fusarium* patch (pink snow mold)	Pink mycelium on leaves; 1 to 2 inch, tan, circular patches; or white mycelial mass on leaves, white to pink circular patches up to 2 feet in diameter.	*Fusarium nivale;* favored by turfgrass temperatures of 32 to 40°F and moist conditions.	Parasitic action.

(2) Spring dead spot	Appears in the spring as irregular, circular dead spots of up to 3 feet in diameter; shoots, rhizomes, stolons, and roots within the spot will be killed; affected spots commonly re-occur in the same location each year and may gradually enlarge.	Causal organism has not been identified; favored by turfgrass temperatures below 50°F and wet conditions.	Unknown
(3) *Typhula* blight (gray snow mold)	Light gray mycelium on leaves, especially at the margins of the advancing ring; whitish-gray, slimy, circular patches of up to 2 feet in diameter; brown sclerotia are embedded in the leaves and crowns, ranging up to 1/8 inch in diameter.	*Typhula itoana, T. idahoenis,* or *T. ishikariensis;* favored by turfgrass temperatures of 32 to 40°F, especially under an ice cover or during its thaw.	Parasitic action.
(4) Winter crown rot	Light gray, matted mycelial growth may be evident on the leaves; irregular shaped patches initially appear yellow and gradually deteriorate to a straw color; individual patches up to 1 foot in diameter may coalesce causing damage over a large area.	Unidentified low temperature *Basidiomycte;* favored by turfgrass temperatures of 28 to 32°F., especially under a snow cover.	Injury results from hydrogen cyanide gas produced by the saprophytic fungus; subsequently the fungus invades the host plant.
D. **Traffic:**			
(1) On frozen turfgrass leaves	Erect, white to light-tan dead leaves appearing in the shape of the footprints or wheels where they have been impressed onto the turf.	Pressure of the traffic (shoes or wheels) on the rigid, frozen tissues; the problem most commonly occurs during the early morning hours.	Disruption of the frozen, brittle protoplasm that has ice crystals surrounding and extending into it.
(2) On wet, slush covered turfs	Leaves initially appear water-soaked turning whitish-brown and progressing to a dark brown; the leaves are limp and tend to lay as a mat over the soil; appears in irregular shapes associated with previous patterns of concentrated traffic; soil rutting may also be evident.	Snow cover thaws to a slushy condition causing increased hydration of the turfgrass crowns; traffic, including snowmobiles, force the wet slush into intimate contact with the turfgrass crowns; kill most commonly occurs if this event is followed by a decrease in temperature to below 20°F.	Not completely understood, but is related to the direct low temperature kill mechanism.

Table 2. Practices available to minimize winter injury on golf course turf

Type of winter injury	Practices that minimize injury: Turfgrass cultural	Practices that minimize injury: Soil management	Specific protectants	Turfgrass species most commonly affected
A. **Desiccation:**				
(1) Atmosphere	Moderate nitrogen nutritional levels. Elimination of any thatch problem.	Do not core in late fall and leave the holes open.	Conwed Winter Protection Blanket Polyethylene (4-6 mil) Saran Shade Cloth (94%) Topdressing (0.4 yd^3 / 1,000 sq. ft.) Windbreaks such as snow fence, brush, or ornamental tree and shrub plantings. Natural organic mulches.	Annual bluegrass
(2) Soil	Moderate nitrogen nutritional levels. Irrigation or hauling of water to critical turfgrass areas.	(Same as above)	(Same as above)	Annual bluegrass
B. **Direct low temperature kill**	Moderate nitrogen nutritional levels. High potassium nutritional levels. Higher cutting heights. Elimination of any thatch problem. Avoidance of excessive irrigation.	Rapid surface drainage by proper contours, open catch basins, and ditches. Adequate subsurface drainage by drain tile, soil modification with coarse textured materials, slit trenches, and dry wells. Cultivation, especially coring and slicing, when compaction is a problem.	Conwed Winter Protection Cover Soil Retention Mat Enhancing a snow cover with snow fence or brush. Natural organic mulches such as straw. Soil warming by electricity.	Bermudagrass Annual bluegrass Red fescue

C. **Low temperature diseases:**				
(1) *Fusarium* patch	Moderate nitrogen nutritional levels. High potassium and iron nutritional levels. Moderate to low cutting heights. Elimination of any thatch problem.	Avoiding neutral to alkaline soil pH's	Cadmiums Benomyl Daconil Mercuries	Annual bluegrass Bentgrass
(2) Spring dead spot	Avoid excessive winter irrigation. Elimination of any thatch problem.	Provide good surface and subsurface drainage. Cultivate when compaction is a problem.	Nabam, time the applications to be present when soil temperatures are below 50°F and the soil is water saturated.	Bermudagrass
(3) *Typhula* blight	Moderate nitrogen nutritional levels. Moderate to low cutting heights. Elimination of any thatch problem.	Provide good surface and subsurface drainage. Cultivate when compaction is a problem.	Cadmiums Chloroneb Mercuries	Annual bluegrass Bentgrass
(4) Winter crown rot	Elimination of any thatch problem.		Mercuric chloride (2 applications)	Annual bluegrass Bentgrass
D. **Traffic:**				
(1) On frozen turfgrass leaves	Apply a light application of water in early morning; this is most effective when the soil is not frozen and the air temperatures are above freezing.		Withhold or divert traffic from turfgrass areas during periods when the leaf and stem tissues are frozen.	
(2) On wet, slush covered turf			Withhold traffic on turfgrass areas during wet, slushy conditions, especially if a drastic freeze is anticipated.	Annual bluegrass



White mycelium of the Typhula *species occurring in numerous irregular circular patches on an annual bluegrass fairway.*

PREVENTING WINTER INJURY

Cultural steps can be taken to minimize the potential for injury in the future once the cause or causes of winter injury on specific turfgrass areas on the golf course have been established. The first prerequisite in minimizing all types of winter injury is a healthy turf with adequate carbohydrate reserves and recuperative potential. This phase of winter injury prevention is accomplished during the normal growing season, particularly in the late summer—early fall period. Practices to prevent or at least minimize the potential for turfgrass winter injury can be divided into cultural practices, soil management, and specific winter protectants.

The specific practices utilized in each of these categories are summarized in Table 2. It should be noted that a number of them apply to more than one type of winter injury. In some cases, the practice that is effective in preventing one type of winter injury will actually increase the probability of damage from another type. For example, snow covers or winter protection covers used to prevent winter desiccation will also maintain temperatures near 32°F which will enhance the probability of snow mold disease activity. This means that when such a practice is in use, steps should also be taken to apply a preventive snow mold fungicide application to the turfgrass area prior to installing the winter protection cover.

From a cultural standpoint, the proper control of plant and soil water relations is the most critical factor affecting all phases of turfgrass winter injury. Techniques to adjust the soil-water status must be achieved during the summer period.

Finally, it is quite obvious that selection and planting of the appropriate turfgrass species and cultivar can be critical in minimizing the degree of turfgrass injury that may occur. Annual bluegrass is very prone to all types of winter injury. The bentgrasses are considerably less susceptible to injury, and also have a greater recuperative potential from existing vegetative plant parts.

IN SUMMARY: This article gives a brief summary of a great deal of research conducted at Michigan State University over the past 10 years. Portions of it were supported by the U.S.G.A. Green Section Research and Education Fund.

THE AUTHOR

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