Volume 6, Number 1

TURFAX™

January–February 1998

of the International Sports Turf Institute, Inc.

The International Newsletter about Current Developments in Turfgrass

IN THIS ISSUE

Turfgrass Winter Stresses

by

Dr. James B Beard

Winterkill is a general term that encompasses all stresses that may damage turfgrasses during the winter period. It is important to properly diagnose the specific cause of winter injury in order to implement the appropriate practices that will minimize a potential reoccurrence in future winters. Seven types of winter stress are summarized in the accompanying table. Low temperature kill and winter desiccation are the most common winter stress problems. The low temperature pathogens that cause snow mold diseases are additional major winterkill problems and will not be discussed in this particular article.

Low Temperature Kill. Both cool- and warm-season turfgrass species are subject to severe injury caused by low temperature kill. **The extent of injury relates to the size of ice crystal formation within the plant tissues,** which results in mechanical damage to the living portions of cells. **The higher the water content or hydration level in the tissue, the greater the potential for low temperature kill.** Thus, any soil management or cultural practice—such as a low cutting height, high nitrogen nutrition level, low potassium level and/or impaired drainage—that increases the crown hydration level during the autumn hardening period will result in increased proneness to low temperature kill. Contrary to recent widely published reports, it is essential to understand that **high crown hydration is not a cause of winterkill, but rather a precondition** that contributes to increased proneness to lethal injury.

Chilling injury of warm-season species occurs at temperatures of 54 to 60°F (12–16°C), and should not be confused with low temperature kill, which occurs at temperatures well below 32°F (0°C). Chilling stress results in autumn low temperature discoloration of the shoots of warm-season turfgrass species, but does not kill the meristematic tissues of the crowns and the nodes on lateral stems.

Cold Hardening. Turfgrasses have a natural ability to cold harden during the autumn decline in temperature that occurs prior to freezing, which is **at temperatures between 35 and 45°F (2–7°C) for cool-season turfgrasses.** Basically, cold hardening involves physiological adjustments within the plant that maximize the ability of the plant to survive low temperature stress. Two key physiological processes during this event involve the accumulation of carbohydrates, which in turn result in exosmosis, or the outward movement of water from the tissues. The more low temperature hardy species, such as creeping bentgrass and rough bluegrass, have the capability to decrease their tissue water content from 85% to the 65 to 70% range during cold hardening. Accordingly, one should **select cultural practices during this cold hardening period that promote increased carbohydrate accumulation.** These include an elevated cutting height and a moderate to low nitrogen fertilization program. Cold hardened turfgrasses typically have enlarged stem and crown diameters in the autumn due to the accumulation of carbohydrates.

Continued on page 2

FEATURE ARTICLE

The New Generation of Fungicides of Microbial Origin

Peter H. Dernoeden

By now, most golf course superintendents in the U.S. have applied or at least heard of the new fungicide Heritage®. What most people may not realize is that Heritage represents a new generation of fungicides, whose active ingredient was derived from a microbe. Use of natural products as fungicides, however, is not entirely new in the turfgrass market. Cycloheximide, which was sold under the trade name of Acti-dione®, was used in the 1960s and '70s on turf to control dollar spot, leaf spot and other diseases. Cycloheximide was a by-product in the production of the antibiotic streptomycin. Streptomycin was derived from the bacterium *Streptomyces griseus*. Cycloheximide was expensive to produce and could be phytotoxic to turf, thus its registration was withdrawn in 1981.

Fungicides of microbial origin can be produced by fermentation (i.e., growing large quantities of a desired microbe in an aerated vat) or the antifungal properties of the microbe can be identified and synthesized in the laboratory. Regardless of how the products are produced, they must undergo the same U.S. Environmental Protection Agency registration rigor that is required for all other pesticides.

Azoxystrobin. Heritage® represents a new class of chemistry referred to generically as beta-methoxy-acrylates. The origin of the first identified compound (i.e., strobilurin A) was a fungus from the mushroom family named *Strobilurus tenacellus*. The common chemical name for Heritage® is azoxystrobin. The strobilurin-based compound was stabilized by adding molecules to the structure to ensure that it was not rapidly broken-down by solar radiation. Because the original compound was slightly changed in the laboratory, azoxystrobin is best described as a synthesized analog of a natural substance.

Heritage® can be taken up by roots and move via the xylem throughout the plant. When sprayed on leaves, it penetrates and moves through the leaf, where some molecules enter the xylem and move upward in the plant from the point of uptake. Because Heritage® only moves upward from the site of uptake, **it is not truly systemic and therefore it is best described as being an acropetal penetrant.** The fungicide provides disease control by interfering with respiration of sensitive fungal pathogens. It blocks electron transfer in the cytochrome bc complex and thus it is single site specific. That is, it only blocks one biochemical event, which means that **the probability for resistance to occur increases greatly** when compared to compounds with multi-site activity.

Heritage® is remarkably broad spectrum and is one of the few turf fungicides with a diverse target list, which includes both root and foliar pathogens as well as *Pythium* diseases. It's demonstrated target strengths include brown patch (and other *Rhizoctonia* diseases such as yellow patch and zoysia patch), summer patch, take-all patch, anthracnose, red thread, and *Helminthosporium* leaf spot. There is not a great deal of evidence, however, that it is as strongly effective against snow molds or *Pythium* diseases as it is against the aforementioned diseases. **Heritage's® greatest known weakness is dollar spot.** It

Continued on page 5

Turfgrass Winter Stresses

Continued from page 1

Low Temperature Stress Tolerance. Both turfgrass species and cultivars vary greatly in low temperature hardiness. Therefore on sites subject to periodic low temperature stress, **it is important to select cold hardy cultivars as well as species.** Among the cool-season turfgrass species the perennial ryegrasses (*Lolium perenne*), tall fescues (*Festuca arundinacea*), and annual bluegrasses (*Poa annua*) are typically prone to low temperature kill. In contrast, rough bluegrass (*Poa trivialis*) and creeping bentgrasses (*Agrostis stolonifera*) are excellent in low temperature stress tolerance, followed by the Kentucky bluegrasses (*Poa pratensis*).

Among the warm-season turfgrasses Japanese zoysiagrass (*Zoysia japonica*) is the best low temperature hardy species, followed by the dactylon bermudagrasses (*Cynodon dactylon*) and seashore paspalum (*Paspalum vaginatum*). Carpetgrass (*Axonopus* spp.), St. Augustinegrass (*Stenotaphrum secundatum*), and bahiagrass (*Paspalum notatum*) are very poor in low temperature tolerance. **In both the bermudagrasses and the zoysiagrasses, the vegetatively propagated cultivars as a group tend to be more low temperature tolerant.**

Symptoms, Causes, and Prevention of Turfgrass Winter Kill.

Type of Injury	Turf Symptoms	Stress Cause(s)	Practices That Minimize Turfgrass Injury: Cultural	Practices That Minimize Turfgrass Injury: Soil	Specific Protectants
• LOW TEMPERATURE KILL below 30°F (–1°C).	Leaves initially appear water-soaked, turn tan colored and progress to dark brown; leaves limp and tend to lay as a mat over soil; distinct, putrid odor may be evident; occurs most commonly in poorly drained depessional areas as large, irregular patches.	Rapid decrease in temperature, particularly soil temperature; most commonly occurs at soil temperatures below 20°F (–7°C) during late winter/early spring freezing and mid-winter thawing periods.	Maintain a low shoot growth rate for tissue hardening such as by moderately low nitrogen (N) level and high potassium (K) level; use a high cutting height; eliminate any thatch problem; avoid excessive irrigation.	Provide rapid surface drainage by proper contours, open catch basins, and ditches; adequate subsurface drainage by drain lines, slit trenches, and dry wells; modify root zone with high-sand, cultivate turf, especially by coring when compaction is a problem.	Use winter protection cover, especially one that prevents water from reaching the turf to prevent crown hydration; enhance snow accumulation with snow fence or brush; natural organic mulches; soil warming.
• CHILLING STRESS, between 54 and 60°F (12–16°C); occurs only to warm-season turfgrasses.	Leaves of warm-season grasses turn tan to white when exposed to tissue temperatures below 60°F (16°C).	Chloroplast/chlorophyll complex disrupted, thus photosynthesis ceases and green color of leaves is lost.	Maintain moderately high nitrogen (N) level; use chill-tolerant warm-season species/cultivars.	Maintain a moist soil.	Use gibberellin within 12 hours of exposure to chilling temperatures, assuming subsequent temperatures rise above 60°F (16°C).
• TRAFFIC on frozen turfgrass leaves, at tissue temperatures below (32°F) (0°C).	Erect, white to light tan leaves appear in shape of footprints or wheel tracks where they were impressed onto the turf.	Pressure of traffic (shoes, animals, or wheels) on rigid, frozen leaves that mechanically ruptures cells; commonly occurs during early morning.	Apply a light application of water in early morning when soil is not frozen and air temperature is above freezing.	Maintain a moist soil.	Withhold or divert traffic from turfgrass areas during periods when leaf and stem tissues are frozen.
• TRAFFIC on wet slush-covered turf, followed by a rapid freeze to ~20°F (–7°C) or lower.	Leaves initially appear water-soaked, turn whitish brown and progress to dark brown; leaves limp and tend to lay as mat over soil; appear as irregular shapes associated with previous patterns of traffic.	Snow thaws to slush, causing increased hydration of grass crowns; traffic, e.g., snowmobiles and skis, forces wet slush into contact with crowns; kill occurs if followed by a decrease in temperature to ~20°F (–7°C) or lower.	Raise mowing height; maintain a high potassium (K) level and a moderately low nitrogen (N) level.	Provide rapid surface drainage by proper contours, open catch basins, and ditches; physical removal of slush may be needed.	Withhold traffic on turfgrass areas during wet, slushy conditions, especially if drastic freeze is anticipated to ~20°F (–7°C) or lower.

Type of Injury	Turf Symptoms	Stress Cause(s)	Practices That Minimize Turfgrass Injury		Specific Protectants
			Cultural	Soil	
• ICE COVER, occurs in depressional areas.	Irregularly shaped, tan patches corresponding to sites where ice cover persisted; infrequent occurrence, with annual bluegrass (*Poa annua*) being most prone to injury.	Impermeable ice layer causes buildup of gases to toxic levels; most likely to kill annual bluegrass after 60 to 75 days ice coverage; while creeping bentgrass and Kentucky bluegrass may survive 150 days coverage.	Maintain a moderately low nitrogen (N) level and high potassium (K) level; mechanically remove upper ice cover from annual bluegrass after 60 to 75 days.	Provide surface drainage by proper contours, catch basins and ditches; subsurface drainage by drain lines, modifying with a high-sand mix, slit trenches, and dry wells; cultivate by coring.	Apply black charcoal or fertilizer at temperatures above 32°F (0°C) to absorb radiant energy that thaws ice; may use a continuous polyethylene cover on greens to prevent crown hydration.
• HEAVY INJURY, most commonly occurs on newly emerged seedlings.	Young seedlings, including crowns and roots, lifted out of soil; roots broken and plants turn tan.	Repeated freezing and thawing of ice layers on surface of wet soils lifts seedlings out of soil, and they are killed by desiccation.	Avoid late planting dates in the autumn; encourage deep rooting.	Provide surface drainage by proper contours, catch basins and ditches; subsurface drainage by drain lines, modifying with a high-sand mix, slit trenches, and dry wells; cultivate by coring.	Apply straw mulch to seeding planted late in autumn; enhance snow accumulation by use of snow fence or brush; roll-in heaved seedlings at time of first thaw.
• WINTER DESICCATION, typically occurs in locations and times when a snow cover is absent.	Leaves turn distinctly white, but remain erect; meristems very dry and brittle; occurs most commonly on high locations exposed to drying winds; can range from small irregular patches to extensive kill of large areas.	Lethal plant water stress caused by a dry environment, including high winds and low humidity; extended periods of soil drought due to lack or precipitation or snow; or soil water absorption reduced or may be inoperative because soil is frozen.	Maintain moderately low nitrogen (N) level; eliminate any thatch problem; irrigate during the winter as needed by tank/truck when temperature is above freezing, especially for greens and tees.	Do not core in late autumn and then leave the holes open.	Use a winter protection cover, or certain geotextiles; 4–6 mil polyethylene cover; late-season topdressing at 0.4 yd^3/1,000 ft^2; natural organic mulches; or enhance snow accumulation with snow fence or brush.

TURFAX™
Introductory offer: $69.95 + shipping and handling
6 issues/year
Available by mail and/or fax
Ann Arbor Press
121 South Main Street
P.O. Box 310
Chelsea, MI 48118
Telephone: 800-858-5299
Fax: 313-475-8852
Email: turfax@aol.com

Type of Injury	Turf Symptoms	Stress Cause(s)	Practices That Minimize Turfgrass Injury		Specific Protectants
			Cultural	Soil	
• ICE COVER, occurs in depressional areas.	Irregularly shaped, tan patches corresponding to sites where ice cover persisted; infrequent occurrence, with annual bluegrass (*Poa annua*) being most prone to injury.	Impermeable ice layer causes buildup of gases to toxic levels; most likely to kill annual bluegrass after 60 to 75 days ice coverage; while creeping bentgrass and Kentucky bluegrass may survive 150 days coverage.	Maintain a moderately low nitrogen (N) level and high potassium (K) level; mechanically remove upper ice cover from annual bluegrass after 60 to 75 days.	Provide surface drainage by proper contours, catch basins and ditches; subsurface drainage by drain lines, modifying with a high-sand mix, slit trenches, and dry wells; cultivate by coring.	Apply black charcoal or fertilizer at temperatures above 32°F (0°C) to absorb radiant energy that thaws ice; may use a continuous polyethylene cover on greens to prevent crown hydration.
• HEAVY INJURY, most commonly occurs on newly emerged seedlings.	Young seedlings, including crowns and roots, lifted out of soil; roots broken and plants turn tan.	Repeated freezing and thawing of ice layers on surface of wet soils lifts seedlings out of soil, and they are killed by desiccation.	Avoid late planting dates in the autumn; encourage deep rooting.	Provide surface drainage by proper contours, catch basins and ditches; subsurface drainage by drain lines, modifying with a high-sand mix, slit trenches, and dry wells; cultivate by coring.	Apply straw mulch to seeding planted late in autumn; enhance snow accumulation by use of snow fence or brush; roll-in heaved seedlings at time of first thaw.
• WINTER DESICCATION, typically occurs in locations and times when a snow cover is absent.	Leaves turn distinctly white, but remain erect; meristems very dry and brittle; occurs most commonly on high locations exposed to drying winds; can range from small irregular patches to extensive kill of large areas.	Lethal plant water stress caused by a dry environment, including high winds and low humidity; extended periods of soil drought due to lack or precipitation or snow; or soil water absorption reduced or may be inoperative because soil is frozen.	Maintain moderately low nitrogen (N) level; eliminate any thatch problem; irrigate during the winter as needed by tank/truck when temperature is above freezing, especially for greens and tees.	Do not core in late autumn and then leave the holes open.	Use a winter protection cover, or certain geotextiles; 4–6 mil polyethylene cover; late-season topdressing at 0.4 $yd^3/1{,}000\ ft^2$; natural organic mulches; or enhance snow accumulation with snow fence or brush.

TURFAX™
Introductory offer: $69.95 + shipping and handling
6 issues/year
Available by mail and/or fax

Ann Arbor Press
121 South Main Street
P.O. Box 310
Chelsea, MI 48118
Telephone: 800-858-5299
Fax: 313-475-8852
Email: turfax@aol.com