Compilation of Summaries of Short Winter Articles

Submitted by CHRIS HOFF
Precision Turf & Chemical, Inc.

Physiology, Plant Stress, Winter Injury: Summaries

Survivability of Anoxia Under Ice and Impermeable Covers (2008)

By Darryl Asher, Todd Paquette and Jim Ross

Previous research conducted at the Prairie Turfgrass Research Centre (Olds, Alberta, Canada) showed that there was a rapid loss of relative hardiness of annual bluegrass plants between 45 and 60 days under continual ice cover (Tompkins, Ross and Moroz, 2004), while plants in non-iced conditions lost hardiness very slowly. The fact that air cannot be replenished under ice cover, or an impermeable covering of any sort, was thought to be a factor contributing to the injury. Research conducted in Quebec found that under an impermeable cover oxygen was depleted and carbon dioxide increased (Rochette et al, 2006). This increase was attributed to use by the plants and to low temperature microbes. When oxygen is completely depleted, the condition is known as anoxia.

In earlier research, Beard (1965) had similar results and found that injury to annual bluegrass occurred 75 days after continual ice cover. However, it seems that creeping bentgrass is affected much less and in our research was still alive after 120 days of continual ice cover. Other researchers found that differential sensitivity to conditions of anoxia was common amongst various plant species (Bertrand et al, 2001).

So what happens to annual bluegrass between 45 and 60 days when air cannot be replenished?

It seems that under conditions of anoxia a rapid depletion of stored foods occurs. We know that these stored foods act as an anti-freeze agent for plants so when they are completely depleted the plants have lost their ability to resist freezing. And, of course, once they freeze irreversible cell damage occurs and plants die.

At this point, we think that when oxygen is fully depleted rapid utilization of food reserves occurs, which in turn causes a rapid loss of hardiness (between 45 and 60 days). Once food reserves are depleted, the plant begins to utilize energy that is provided by a process called glycolysis. However, the energy produced is not sufficient to sustain the plant. This deficit also leads to the induction of fermentation metabolism and to an increase in the production of potentially phytotoxic metabolites such as ethanol, lactic acid and carbon dioxide (Rochette et al, 2009).

So it appears that injury results from either a toxic build-up of these gases or from a complete depletion of food reserves. In the Quebec study, high levels of carbon dioxide did not produce mortality, so that may be an indication that the depletion of food reserves is the reason for the injury.

Mitigation of Anoxia Under Ice and Impermeable Covers on Annual Bluegrass Putting Greens (2008)

By Darrell Tompkins, Philippe Rochette and Jim Ross

Winter damage to annual bluegrass putting greens caused by a lack of oxygen under ice or impermeable winter covers is an important problem in cold climates. The objective of this trial was to evaluate various covering systems that would increase oxygen levels and, in turn, prevent damage associated with anoxia (lack of oxygen). Impermeable winter covers, some with an insulating air layer, were compared against ice cover and snow cover only treatments. Additional treatments to examine air replenishment under the covers were also evaluated.

Oxygen content under the various treatments remained constant for the first 75 days of the trial. However by day 90, there was a significant reduction in oxygen levels for the ice only and the ice, impermeable cover, no air layer treatments. In addition, the ice only treatment was significantly lower than the ice, impermeable cover, no air layer treatment. Air replenishment did not appear to have an impact on oxygen concentration.

Carbon dioxide levels were lowest for the no ice, no cover treatment. On day 90, the highest levels were for the ice, snow cover only and ice, impermeable cover, no air layer treatments. There seemed to be some improvement in carbon dioxide levels with the Enkamat and bubble wrap treatments.

Ice, snow cover only treatments were dead in both years of the study.

As data for turf quality and relative hardiness levels were not yet completed for this trial, it is preliminary in nature.

Strategies for Removing Ice from Annual Bluegrass Golf Greens (2005)

By Darrell Tompkins, Jim Ross and M. A. Anderson

Ice cover on annual bluegrass (Poa annua L.) putting greens often causes damage in the cold climates of North America during long winters. The objective of this study was to evaluate various ice removal strategies for use on annual bluegrass putting greens. In addition, the various products were evaluated for turf injury (damage caused by the product). An initial screening study was conducted in order to choose the best treatments for the field study. Selection of treatments was based on effectiveness and turf injury caused by the products.

Results of the five separate field tests showed that where there was ice removal turf was not improved with the use of covering materials. As far as the individual treatments were concerned, the Landscape and Alaskan ice melters had the greatest effect on reducing ice hardness, increasing ice melt and reducing the ice bond. The methanol was not as effective as either of the granular ice melters in the three tested parameters. The radiant heat producing materials, black sand and Milorganite, appeared to be more effective when light intensities were greater in the late winter study. It also appeared that full sun improved their performance.

This field trial was conducted over a three-year period to attempt to determine turf injury as a result of the various products. Turf injury was measured as percent area damage. There were no differences in turf injury when considering the covering materials. On one occasion Alaskan Ice Melter caused greater injury than any of the other treatments. Landscape Ice Melter also had significantly more injury than the other treatments. Methanol, Milorganite and black sand had injury that was similar to the untreated control.

Relative hardiness levels were measured in year three to determine whether the different ice melting strategies negatively impacted hardiness levels. The early winter test of year three showed that there

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were no differences in relative hardiness levels and the plant grew on normally after the freeze test, which might indicate that there was no damage from the treatments.

The Effect of the Plant Growth Regulator Primo on Winter Hardiness Levels (2004)

By Jim Ross, M. A. Anderson and Darrell Tompkins

Turfgrass growth under winter covers in early winter and spring is thought to be a problem for overwintering putting green turf in cold climates. Considerable growth reduction in the spring under a winter cover was observed following a single fall application of Primo MAXX at an Alberta golf course. As a result, this trial was established in order to determine the effect of the growth regulator, Primo MAXX, on fall hardening and spring dehardening of annual bluegrass (Poa annua).

An initial pilot study was conducted during the winter of 2003-04 where a single application of Primo Maxx was applied at three different rates in the late fall to an annual bluegrass (Petersen's creeping bluegrass) putting green located at the Prairie Turfgrass Research Centre in Olds, Alberta. Individual treatments were then subjected to various dehardening temperatures for various periods of time. After a freeze test, plants were re-grown and their relative hardiness levels were assessed. Due to an equipment failure during the secondary hardening stage results of the trial were inconclusive.

In year two of the study there were also no significant treatment differences when evaluating fall relative hardiness levels. Application rates and timing of Primo MAXX were evaluated in this study. For all treatments, the LT50 values for the plants were -19oC.

Spring hardiness levels will also be determined in order to evaluate the product for its effect on slowing the loss of hardiness as a result of temperature increases in the spring.

Strategies for Removing Ice from Annual Bluegrass Golf Greens (2004)

By Darrell Tompkins, Jim Ross and M. A. Anderson

Ice cover on annual bluegrass (Poa annua L.) putting greens often causes damage in the cold climates of North America during long winters. The objective of this study was to evaluate various ice removal strategies for use on annual bluegrass putting greens. In addition, the various products were evaluated for their phytotoxicity (damage caused by the product) to the turf. An initial screening study was conducted in order to choose the best treatments for the field study. Selection of treatments was based on effectiveness (efficacy) and phytotoxicity of the products. Results of the three separate field tests showed that there was no benefit to covering the turf. As far as the individual treatments were concerned, the Landscape and Alaskan ice melters and the methanol softened the ice more than the other treatments. The two granular ice melters melted the ice the best and were best at reducing the bond between the ice and the turf surface. However, in year one these two products also produced some toxicity, while the other treatments did not.

Wear Tolerant Grasses for Use on Sports Fields in a Cold Climate (2003)

By Darrell Tompkins, M. A. Anderson and Jim Ross

This trial was established in order to determine the wear and cold tolerance of various grasses for use on sports fields in the Prairie Provinces of Canada. An initial screening of 48 different grasses to determine their cold tolerance was conducted in a controlled environment during the winter of 2002-03. From this, 21 grasses were chosen for the field study component of this trial. In addition, Poa supina, a Poa supina and Touchdown Kentucky bluegrass mix, and the City of Calgary standard sports field mix were added to the treatment list. Cultivars of perennial ryegrass and tall fescue established more rapidly than did the Kentucky bluegrass cultivars, the Poa supina, the Poa supina/Kentucky bluegrass mix and the City of Calgary standard sports field mix. The perennial ryegrass cultivars that established most quickly were Fiesta 3 and Pick RC2, while Grande and SR8600 tall fescue were equal to the two perennial ryegrasses. On the second rating date, Touchdown Kentucky bluegrass, all four perennial ryegrasses and all six tall fescue were the top rated grasses for establishment.

The Effect of the Plant Growth Regulator Primo on Winter Hardiness Levels (2003)

By Jim Ross, M. A. Anderson and Darrell Tompkins

Considerable growth reduction in the spring under a putting green winter cover was observed at an Alberta golf course, which prompted the development of this trial. As a result, the objective was to determine the effect of the growth regulator, Primo MAXX, on fall hardening and spring dehardening of annual bluegrass (Poa annua).

Strategies for Removing Ice from Annual Bluegrass Golf Greens (2003)

By Darrell Tompkins, Jim Ross and M. A. Anderson

Ice cover on annual bluegrass (Poa annua L.) putting greens often causes damage in the cold climates of North America during long winters. The objective of this study is to evaluate various ice removal strategies for use on annual bluegrass putting greens. In addition, the various products were evaluated for their phytotoxicity (damage caused by the product) to the turf. An initial screening study was conducted in order to choose the best treatments for the field study. Selection of treatments was based on effectiveness (efficacy) and phytotoxitity of the products. Results of the field study that was conducted in March 2004, are preliminary in nature. The clear polyethylene and the no cover treatments appeared to be superior to the black polyethylene cover. As far as the individual treatments were concerned, the two ice melters, Landscape and Alaskan, appeared to soften the ice more rapidly than the other treatments.

Evaluation of Winter Covers for Prevention of Freezing Injury on Putting Greens (2001)

By Jim Ross

This trial was initiated in the early winter of 2000 to determine the insulating value of various winter covers and whether there was an effect on winter injury, spring colour and plant hardiness levels. Nine golf green winter covers were compared against an uncovered control. Covers were installed on greens at four golf courses throughout Alberta. Temperatures were collected twice a month from November to the end of February and then three times per week in March and April to determine the effect of the covers on temperatures at the crown level of the plants. Colour rating, area cover and plants hardiness levels were also conducted in April.

The two sites at Innisfail and Edmonton were severely damaged from winter injury as these golf courses were without snow cover for most of the winter. Winter injury was as a result of freezing injury and dessication. Those covers that prevented less than 50% winter injury at Edmonton and Innisfail were Gridlock #2, TurfPro #1, and TurfPro #3. Those best covers that prevented winter injury at Calgary and Red Deer were TurfPro #3, and Gridlock #3 and #4.

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Those covers that insulated the greens from low temperatures in winter were Gridlock #3 and #4, and TurfPro #1 and #2. Those that showed the least insulation properties during low temperatures were the uncovered control, Albarrie #1, Gridlock #1 and #2, and TurfPro #3. Those covers that insulated against warm temperatures and kept the turf cool in the spring evaluations were Albarrie #1, Nilex #1, and TurfPro #1. Those that showed poor insulation properties and heated the turf were Gridlock #3, TurfPro #2 and #3.

There was the greatest retention of winter hardiness for annual bluegrass under the Albarrie #1, Gridlock #4 and TurfPro #3 covers. For creeping bentgrass the best hardiness levels were the uncovered control, TurfPro #3 and Albarrie #1. Those that showed the least hardiness for annual bluegrass were TurfPro #2 and Gridlock #3. Those that showed the least hardiness for creeping bentgrass were Gridlock #1, #2 and #4and TurfPro #2.

Control of Winter Injury Caused by Ice Cover on Annual Bluegrass and Creeping Bentgrass (2000)

By Darrell Tompkins, Jim Ross and D. L. Moroz

A lab study compared the effect of ice cover and ice encasement with a control treatment (no ice) on annual bluegrass (Poa annua) and creeping bentgrass (Agrostis palustris) plants. Generally, snow covered plants maintained cold hardiness much longer than plants that were ice encased. Cold hardiness levels for the ice covered plants were intermediate between the other two treatments. This effect was much more pronounced for annual bluegrass than for creeping bentgrass. For annual bluegrass, after 60 days, cold hardiness levels were: -180 C for snow covered plants, -100 C for ice covered plants and -20 C for ice-encased plants. By 90 days, ice encased plants were dead. By 120 days, the ice-covered plants were dead. For creeping bentgrass, the same trend occurred, but the loss of cold hardiness was greatly delayed. Therefore, at 150 days the snow covered plants had a cold hardiness level of -20 C compared to -180 C for the ice encased plants.

A related field study compared the effects of: snow cover, snow removed in February, ice cover and ice removed in February for annual bluegrass and creeping bentgrass plants. Annual bluegrass plants that had been ice covered had very little cold hardiness after 60 days and were dead by 5 days. Creeping bentgrass plants in all treatments could tolerate temperatures below -280 C after 90 days.

Evaluation of Winter Covers for Prevention of Freezing Injury on Putting Greens (2000)

By Jim Ross

This trial was initiated to determine the insulating value of various winter covers and whether there was an effect on spring colour and plant hardiness levels.

Four golf green winter covers were compared against an uncovered control. The four covers were Evergreen permeable cover, Typarâ permeable cover, RPEâ Type 4 impermeable cover and an impermeable insulated turf blanket. Covers of 12 foot by 24 foot dimensions were installed on greens at four golf courses throughout Alberta.

Temperatures were collected twice a month from November to the end of February and then three times per week in March and April to determine the effect of the covers on temperatures at the crown level of the plants. Colour rating and plants hardiness levels were also conducted in April.

The insulated turf blanket showed the least fluctuations in temperatures while the RPEâ Type 4 cover showed the greatest heating. The insulated turf blanket and the RPEâ Type 4 cover had the highest colour ratings.

There was the greatest retention of hardiness levels under the insulated turf blanket when measured on April 10. The RPEâ Type 4 cover had the least amount of hardiness. Hardiness levels were measured for the Innisfail site only.

Control of Winter Injury Caused by Ice Cover on Poa annua and Agrostis palustris (1999)

By Darrell Tompkins, J.B. Ross and D. L. Moroz

A lab study was set up to compare the effect of ice cover and ice encasement with a control treatment (no ice, snow cover only) on Poa annua (annual bluegrass) and Agrostis palustris (creeping bentgrass) plants. Generally, snow covered plants maintained cold hardiness much longer than plants that were ice encased while hardiness levels of plants treated with an ice cover were intermediate between these levels. This effect was much more pronounced for Poa annua than for Agrostis palustris. For Poa annua, at 60 days, cold hardiness levels were: -180 C for snow covered plants, -100 C for ice covered plants and -20 C for ice encased plants. By 90 days, ice encased plants were dead. By 120 days, the ice covered plants were dead. For Agrostis palustris, the same trend occurred, but the effect was delayed in time. Therefore, at 150 days the snow covered plants had a cold hardiness level of -20 C compared to -180 C for the ice encased plants.

A related field study comparing the effects of snow cover, snow removal in February, ice cover and ice removal in February for Poa annua and Agrostis palustris plants was also set up. In 1999, Poa annua plants that had been ice covered were dead after 60 days. Agrostis palustris plants in all treatments were able to tolerate temperatures below -200 C after 90 days.

The Use of Synthetic Covers on the Overwintering of Poa annua and Agrostis palustris Golf Greens (1999)

By C. E. Miluch and Jim Ross

A golf green cover trial was established late in the fall of 1999 at four different golf courses. One replication was established at Edmonton Country Club, Red Deer Golf and Country Club, Innisfail Golf Club and Riverbend Golf Club in Red Deer. The treatments included an uncovered control, Hinsperger Woven Permeable, LP Typar Permeable Geotextile, RPE Type 4 Impermeable and an Insulated Blanket. Temperatures under the cover and depth of snow on the trial were monitored through the winter period. LT50 values under each of the covers will be determined, as well as colour and overall turfgrass quality in the spring of 2000.

Control of Winter Injury Caused by Ice Cover on Poa annua and Agrostis palustris (1998)

By Darrell Tompkins, Jim Ross and D. L. Moroz

A lab study compared the effect of ice cover and ice encasement with a control treatment (no ice) on Poa annua and Agrostis palustris plants. There were no significant differences between the ice cover and ice encasement treatments. Poa annua plants were dead after only 60 days covered with ice. In contrast, Agrostis palustris plants had LT50 values of -260 C after 90 days of ice cover and -160 C after 120 days of ice cover.

A related field study compared the effects of snow cover, snow removed in February, ice cover and ice removed in February for Poa annua and Agrostis palustris plants. Poa annua plants that had been ice covered were mostly dead by late February, a period of about 40 days. Agrostis palustris plants in all treatments could tolerate temperatures below -200 C into April. However, plants from plots where the snow and ice were removed had reduced levels of cold hardiness.