

What Goes on Under Ice?

by Jim Ross



Solid ice sheet following an early winter rain.

After searching for over 10 years, I think I finally found an explanation for injury and why it occurs under ice cover on annual bluegrass putting greens. I think that this explanation can also apply to injury that occurs under impermeable winter covers that have a heavy snow accumulation.

It seems that under conditions of ice or impermeable winter covers air cannot be replenished and toxic gases cannot be vented to the atmosphere. Research conducted by Dr. James Beard back in the 1960's mentioned toxic gas accumulation as a possible explanation for mortality under ice covers, but his research did not specifically measure the possible toxins.



Ice Injury on Bentgrass

However, a scientific paper that was written in an obscure journal, the Icelandic Agricultural Scientific Journal, discusses a number of factors that contribute to injury under ice cover and presumably impermeable winter covers (Andrews and Pomeroy, 1989).

Under these conditions the plants and microbes that are active in the soil utilize oxygen (O₂) and carbohydrates. The by-products of this use are carbon dioxide (CO₂), ethanol and lactic acid. It seems that for every part of carbohydrate that is utilized two parts of ethanol and two parts of CO₂ are generated. The ethanol does not appear to be toxic but rather enhances the toxicity of the CO₂ and the lactic acid does not appear to have any effect.

Some of the other factors discussed in this paper were:

1. Species tolerance to ice cover and anerobic (lack of air) conditions. It seems that certain species of grass uses more O₂ than others and this would explain why annual bluegrass is more susceptible to this type of injury than is creeping bentgrass.
2. Physiological state of the plants. The cold hardiness and food reserve levels affect the plant's tolerance to ice cover and anerobic conditions. If plants are not fully hardened, they will not withstand these conditions as readily.
3. Nature of the impermeability. The density of the ice sheets affects permeability and air flow i.e. a dense ice sheet does not allow for intake of air or exhaust of CO₂. An air gap under the ice or winter cover may allow for survival.
4. Soil moisture levels prior to freezing. The paper mentions that moisture levels greater than 40% will create the most severe injury. Presumably this means that CO₂ cannot be absorbed in the soil.

A few years ago when I attended a conference in Rhode Island, they wondered why injury could occur with much shorter duration of ice cover than what we typically experience. This certainly could relate to their reduced cold hardiness levels or increased O₂ use. Warm temperatures would not allow sufficient time for the plants to fully harden or the O₂ use might be greater due to warmer soil temperatures.



Solid ice sheet on Annual Bluegrass



Spring Ice Damage

In 1985, when I was Superintendent at the Stony Plain Golf Course, we had a rainfall event which turned into permanent snow cover on October 16. A swale on the 5th green accumulated 10" of ice, yet when we removed it on March 10th there was no injury to the creeping bentgrass and it recovered normally. The fact that the grass was creeping bentgrass and the permeability of the ice sheet may have been the factors involved.

I recently spoke to Dr. Philippe Rochette, who is cooperating on our current ice injury project, and he mentioned that the golf club that he is a member at in Montreal had suffered considerable winter injury last year. They had installed 2" perforated pipes under impermeable winter covers in order to vent the greens. However, in the spring the only undamaged turf was within 6" of the pipe. It would seem that the impermeable covers combined with the heavy snow created anerobic conditions and CO₂ build-up probably caused the injury. Venting must allow for the free exchange of gases before it will be successful.