

ACCLIMATION AND WINTER STRESSES

What is killing our golf greens?



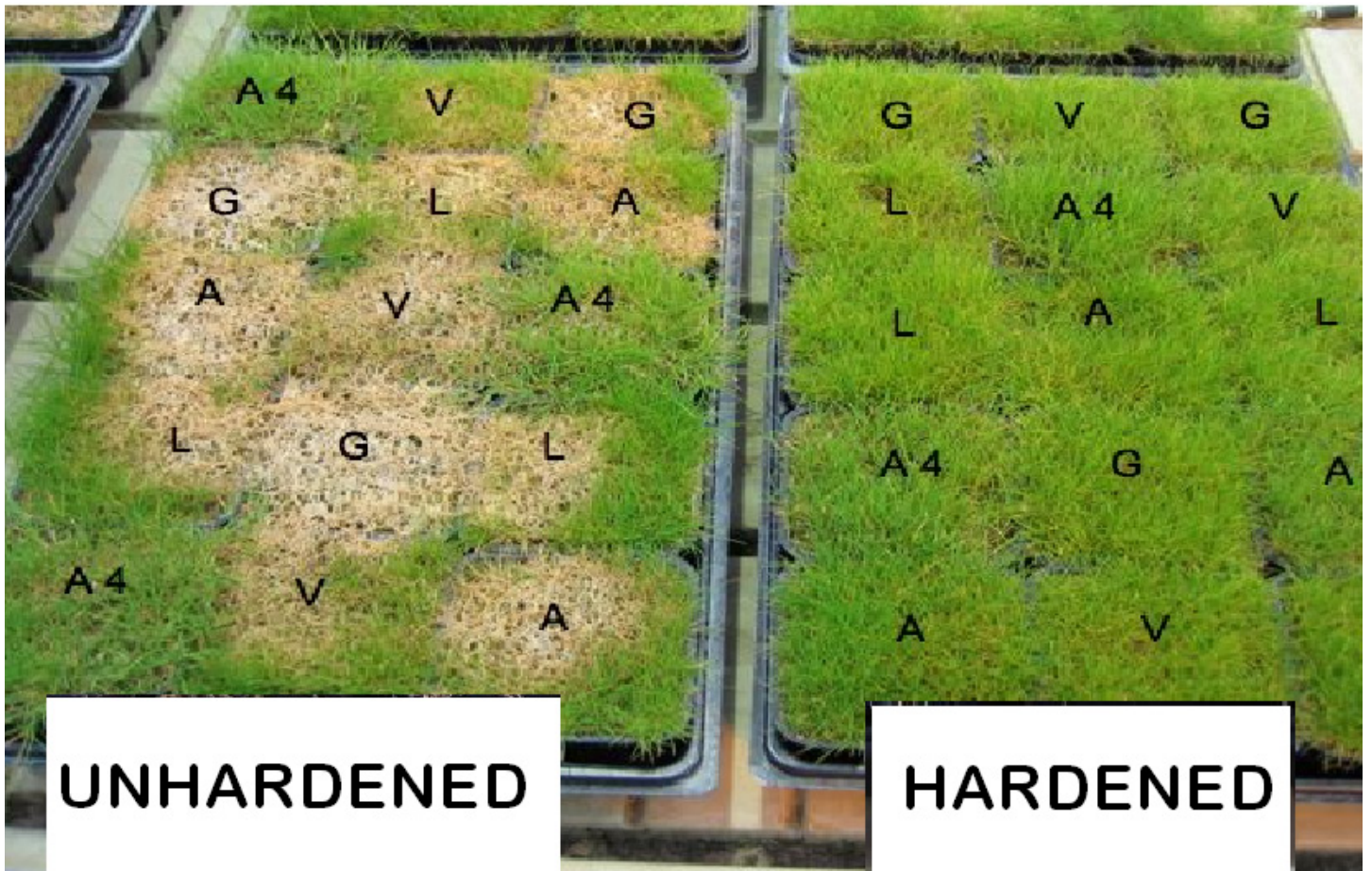
Winter stress tolerant grass

After a long winter you may notice that some grass species survive well while others are killed. This difference is mainly based on their genetic adaptation to the local winter climate and to the environment that is offered on a golf course. High cut rough will often survive while low cut fairways and greens die. Wear, cutting height, soil conditions and maintenance must be considered when winter injuries are to be analysed.

The genetics of the grass species and varieties is discussed in the fact sheet “Grass species and varieties for severe winter climates”. This text will focus on how environmental factors affect the winter stress tolerance of cold season grasses. When using the term winter we mean climatic conditions with temperatures (at least occasionally) far below zero and risk of lasting snow covers or ice formation on frozen ground.

Summary

- Winter injuries can be caused by several strains. Winter-active fungi cause snow moulds, water and ice suffocate the turf and frost, wind and low temperatures desiccate the plants.
- Acclimation is an internal process that makes the grass plants more resistant to winter stresses. Shade from trees will reduce the grass’ acclimation, and cutting trees is one of the few actions a golf course superintendent can take to make the plants more winter stress resistant.
- Golf course architects are to some degree responsible for the microclimate on the greens. Good surface water runoff is important. The choice of grass species and varieties has considerable impact on the winter survival of the golf course turf.



All plants were inoculated with *Microdochium nivale*. The bent grass pots to the left were not acclimated and most of them were attacked with snow mould. The acclimated plants to the right resist the disease because they have been through a period with light and low temperatures. Photo: Katarina Gundsø Jensen.

Acclimation

Some plants are not able to survive freezing temperatures at all. Potatoes and the popular garden flower dahlia are examples. Cold season grasses can, with only few exceptions, survive the winter, but their ability to tolerate winter stresses are influenced by environmental factors. To be able to resist freezing temperatures the plants must be acclimated (=hardened).

During the acclimation grasses undergo major changes at all levels from molecular level to the whole plant level. Visually we observe that the grass plant stops growing, but the photosynthesis continues. The sugar from this process is not used for growth but stored in the crowns and stems as long chained sugar molecules called fructans. The cells are reconstructed to allow quick water movements through the membranes, and special proteins are produced to inhibit formation

of big ice crystals inside the cells. The acclimation also increases the plant's resistance to disease and other winter stress. All details about acclimation are not yet fully understood, but the effects of good and bad acclimation are demonstrated in many plant experiments.

The acclimation is initiated by the environment. Local ecotypes from Northern Scandinavia are affected by day length and will be acclimated when the days get shorter. Turf grass cultivars that are developed for an international market are less influenced by day length, and this makes low temperature the most important factor. There is, however, a relation between light, day temperature and night temperature. To prevent acclimation caused by cold summer nights the plants will only acclimate when not only the night temperatures, but also the day temperatures are low.

The plants will be well acclimated when they grow in full daylight and experience daily mean temperatures around 5°C for a couple of weeks.

Several experiments in the laboratory also confirm that acclimation temperatures below zero, e.g. (-3 - 0°C) towards the end of the acclimation phase improve the freezing tolerance compared to acclimation at only plus degrees.

In nature the acclimation take longer time and temperature fluctuates a lot. Naturally acclimated plants usually have better winter tolerance than what is reported from experiments under controlled conditions in the lab.

Turf managers may have reason to be concerned if the autumn brings cloudy, mild weather followed by a rapid drop of temperature.



A test green was established with Norwegian varieties and international fescue /bent varieties. In December 2003 the Norwegian had a less attractive colour, but the snow mould resistance was excellent. No fungicides were applied. (Pictures taken in opposite directions!)

Winter stresses

There are a number of defined stresses that may harm the turf and also have the potential to kill the grass plants.

Wear

When plants do not grow they will not be able to repair damages from wear. Winter play can wear out the turf. The cell disruption from wear is exacerbated if internal ice crystals have formed in the grass cells.

Starvation

In the far north the days are short and shade long during the winter season. In cloudy and mild weather the sugar consumption may exceed the production from photosynthesis and this slowly makes the plants weaker. Long lasting thick snow cover also blocks light radiation, but since the temperature is kept constantly around 0°C the respiration rate is low. Lasting, dry, insulating snow cover is offering the optimal conditions for winter survival.

Winter diseases

Several fungi are able to grow and attack grass plants at low temperatures. Long lasting snow cover on non-frozen soil is supposed to be the optimal conditions for snow moulds. When the soil is frozen the temperature is slightly below zero, and this reduces the activity of the pathogens.



A man walking on the green on October 18th caused purple and injured turf on March 30th. Snow mould also caused winter injury. Photo: A.Kvalbein

In the Nordic countries the fungus *Microdochium nivale* (microdochium patch/pink snow mould) causes more trouble for turf growers than any other snow mould. This fungus does not require any snow cover and will attack the grass plants even in the growing season under chilly and moist conditions. New data show that golf courses in the southern and coastal areas of Scandinavia have more snow mould problems than the inland courses with long lasting snow covers.

There are at least three other economic important snow moulds in the Nordic countries: grey snow mould caused by *Typhula incarnata*, speckled snow mould caused by *Typhula ishikariensis* and sclerotinia snow mould caused by *Sclerotinia borealis*. In contrast to microdochium patch they are dependent on snow cover and the distribution of these snow moulds are limited to the regions where snow cover lasts for 2-6 months.

Desiccation

The combination of radiation, wind and frozen soil can dry out the grass leaves. Frost heave can also tear off the grass root and increase the risk of desiccation even when the soil has thawed. Growing grass is vulnerable to drought and irrigation may be started too late in spring.

Suffocation and intoxication

Ice encasement creates multiple stresses for the turf. Limited access to oxygen inhibits normal respiration and the plants exploit the sugar reserves through anaerobic metabolism. This biochemical process is far less efficient than respiration and the sugar reserves are rapidly depleted. Some of the chemicals produced under anaerobic conditions are toxic to plants, especially hydrogen sulphide (H₂S), which is produced by some soil bacteria. Newly established greens and greens with good thatch control usually survive ice encasement better than old greens with less air-filled soil pores. There is also big difference among the grass species in their tolerance to survive ice encasement.

For details, see the fact sheet "When to break the ice".

Photo bleaching

It is often observed that the turf looks green when appearing from under the snow, but it turns brown after a few days. Most people blame the wind and call it desiccation, but it is more likely that the sunlight radiation in spring is too strong for the grass leaves that were formed under low light conditions in the autumn



The "mould" from pink snow mould is only visible a few hours when the snow melts. Photo: W. Waalen.



Grey snow mould on a green in the middle of Norway, April 2010. Photo: T. Espevig



Typical ice injury on the low part of a green. Photo: A. Kvalbein

and have been protected by the snow. Rapid change in light intensity is problematic for plants. The green leaves intercept light energy, but too much is harmful. Luckily the crowns are well protected in the sleeves. If the grass is not starved, it

will be able to recover, but the setback causes disappointments to greenkeepers and players. Some grasses will develop a purple colour which functions as a sun shield and protects the leaves.

Interactions

The stresses above may occur in combinations. Wear and desiccation, starvation and snow mould are examples of stresses that occur at the same time.

It is also normal that one stress is followed by another. Ice encasement can cause energy depletion and when the ice is cracked or melts, the sun radiation can destroy the leaves. Without intact leaves the plant may die.

The acclimation status of the plant is very important. Normally the winter acclimation status increases in the autumn and reaches a maximum stress tolerance in January. Plants are de-acclimated when the temperatures rise and carbohydrate reserves are depleted. Plants that have started to grow are therefore very vulnerable to winter stress. Snowfall in spring may cause more snow mould patches than after a lasting snow cover in the winter.

Generally there is a negative relation between winter growth and winter hardiness. Thus, grass species that are eager to start growing during winter, like annual meadow grass and ryegrass, are less winter hardy than other grasses.



Variety trial SCANGREEN at Landvik. Outbreak of microdochium patch after short snowfall in April 2008. Photo: T. Espevig.

How can we improve the grass' winter stress resistance?

It is very important that golf course architects pay attention to the risks for winter damages when planning new golf courses. Turf grass microclimates can to a certain extent be manipulated, and it is especially important to avoid low spots where surface water may accumulate. Selection of turf grass species and varieties is another critical decision for the long-term winter survival of the golf course. These conditions are usually determined when a course manager is hired. Reseeding with more winter stress tolerant cultivars into well-established turf is challenging. You can, however, improve the acclimation conditions considerably by removing trees that shade the turf. Light is an important factor for good acclimation. This also means that winter protective covers should not be installed too early.

So far we have focused on the plants themselves, but some winter injuries depend on the soil/plant system.

Suffocation occurs when there is no oxygen available for respiration. Under an ice cover or a protective plastic cover the soil or root zone mix may contain sufficient air



to keep the plants alive throughout the winter. Construction with good root zone material, well working drainage followed by appropriate thatch control are crucial for good winter survival in districts where ice encasement occurs.

This Poa dominated Finnish golf course had no chance to come alive after the winter. Could the situation have been different if the trees were cut down when the course was established and seeded with perennial grasses? Long shade from trees reduce the acclimation of the turf. Photo: A.Kvalbein



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Read more

STERF's Research and Development Program within Turf Grass winter stress management (www.sterf.org)



STERF (Scandinavian Turfgrass and Environment Research Foundation) is the Nordic golf federations' joint research body. STERF supplies new knowledge that is essential for modern golf course management, knowledge that is of practical benefit and ready for use, for example directly on golf courses or in dialogue with the authorities and the public and in a credible environmental protection work. STERF is currently regarded as one of Europe's most important centres for research on the construction and upkeep of golf courses. STERF has decided to prioritise R&D within the following thematic platforms: Integrated pest management, Multifunctional golf facilities, Sustainable water management and Winter stress management. **More information can be found at www.sterf.org**



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