USE OF IMPERMEABLE COVERS

for better winter survival of golf course putting greens

Photo: James Bentley

Summary

Properly installed impermeable covers can be recommended as an efficient way to prevent damage from ice and melting water, desiccation and other types of abiotic (physical) winter stresses on golf course putting greens. Annual bluegrass (*Poa annua*) greens will normally benefit the most from such covers, but recent experiences have shown improved turfgrass quality and earlier opening in spring even on courses with creeping bentgrass (*Agrostis stolonifera*) greens.

Special types of durable and impermeable covers can be tailor-made for each individual green, but the high quality plastic foils used for greenhouses and in the building industry (thickness minimum 115 my) are fully acceptable and a more flexible and cheaper solution. More important than cover type is that the covers are installed at the right time after the turf has hardened off, the root zone is not soaked with water and the soil temperature close to freezing.

Under Nordic conditions, this will normally be some time in November, shortly before snowfall and/or severe frost. Important preparations for coverage are deep aeration, at least two (preferably three) fungicide applications, and the installation of collars that prevent melting water from seeping in under the covers. The tarps normally used in spring should be laid out under the impermeable covers, with a ventilation system installed between the two layers.

It is recommended to put out temperature sensors to monitor conditions under the covers. As part of STERF's project ICE-BREAKER, we are also testing O_2 and CO_2 sensors for the same purpose. The risk for development of anoxic conditions under the covers increases with organic matter concentration in the thatch/mat layer and is generally higher on soil-based than on sand-based greens, and higher with annual bluegrass than with the more winter-hardy species commonly seeded on putting greens. Two years coverage at Haga, Asker, Bærum and Holtsmark GC suggest that sand-based putting greens will tolerate up to 140 days under impermeable covers provided no water seepage and regular aeration under the covers.

In conclusion, the use of impermeable covers is not a quick fix on putting greens suffering from problems such as poor drainage or inadequate thatch control. The efforts with impermeable covers will not pay back every year, but we think it is a good insurance.

Two years positive results at Haga, Bærum, Asker and Holtsmark GC have been confirmed by Swedish greenkeepers who have tried impermeable covers for many years and who estimate better winter survival in four out of five years.

Introduction

The use of impermeable covers on golf course putting greens dates back at least to the 1960s (Watson 1968). In that early report, it was argued that plastic covers would be effective in preventing desiccation, but it was also warned against increasing temperatures under the covers in spring.

A couple of decades later, the emphasis had shifted to protection against low freezing temperatures, especially on annual bluegrass (*Poa annua*) greens (Dionne 2000). In her report, golf courses without a stable snow cover were advised to use some kind of insulating material under the plastic. Nowadays, we focus mostly on impermeable covers as a protection against ice and water damage, and this advantage will probably become even more important in future as global warming causes more unstable winters.

This fact sheet is based on published reports and experiences with impermeable covers in STERF-funded projects during the last decade (e.g. Rannikko & Pettersson 2010, Waalen et al. 2017) Particular attention will be paid to our experiences from Haga, Bærum, Asker and Holtsmark golf courses, all situated 10-30 km southwest of Oslo. On these courses, we have being using impermeable covers successfully for two winters after experiencing severe ice and water damage during the 2017-18 winter season.

Photo 1. *Covering greens as Asker GC in November 2019. Photo: James Bentley*

Impermeable cover types

Impermeable covers keep water out and prevent gas diffusion. Brand names such as 'Green Jacket', 'Ice Shield' and 'Cover Tech' are examples of products marked particularly for use on golf course putting greens and tees. They all have a clear of translucent whitish color that allow light penetration. Most of them consist of one or more layers of impermeable platric (polypropylene or polyethylene) that has been reinforced with fabric to make the covers more persistent against wear and tear. As an alternative to plastic, the fabric can be treated with some sort of water-proof impregnation on both sides. The sheets can be tailor-made to the size and shape of each green. While some of us consider this as an advantage, it also means less flexibility because the covers cannot replace each other should one of them be injured or one of the greens be reshaped. The custom-made covers are usually rather expensive, but they come with a warranty for up to ten year use on the same green.

A cheaper but usually fully acceptable solution is to buy transparent plastic foil as used in the building industry or for plastic greenhouses. The sheets should be sufficiently wide to cover even the widest green, including 1-2 m surrounds on each side, in one piece. Thicker plastic sheets will usually be more persistent for repeated use over several years, but they are also heavier to handle and require more space for storage during summer.

Before the 2019-20 winter season, Bærum, Asker and Holtsmark GC purchased 27 m wide plastic sheets with a thickness of 115 my from the Swedish company SLIP AB for a price of NOK 5 per m^2. Haga GC ordered 'Green Jacket' covers from Canada for a price of NOK 25 per m^2.

Grass species and covering strategy

Photo 2. *Perfect winter survival after coverage of ocreeping bentgrass putting green at Holtsmark GC, April 2020. Photo: Trygve S. Aamlid*

General information about the tolerance of turfgrass species to various types of winter stress can be found in STERF's fact sheet 'Grass species and varieties for severe winter climates' (www.sterf.org).

An important message is that annual bluegrass is more susceptible to all kinds of abiotic (physical) winter damages (ice encasement, melting water, desiccation, freezing injury etc.) than the species commonly seeded on putting greens such as creeping bentgrass (*Agrostis stolonifera*), velvet bentgrass (*A.canina*), colonial bentgrass (*A. capillaris*), Chewings fescue (*Festuca rubra* ssp. *commutata*) and slender creeping red fescue (*F. rubra* ssp. *littoralis*).

It may therefore not be surprising that annual bluegrass is usually regarded as the turfgrass species that will benefit the most from impermeable covers. However, despite the fact that creeping bentgrass is considered as one of our most winter-tolerant species, we have also seen earlier green-up and enhanced turfgrass quality after coverage of creeping bentgrass greens (Photo 2).

When to put out the covers?

The right timing to out impermeable covers is when the grass has stopped growing and hardened off for a couple of weeks at temperatures ranging from 0°C to 8°C. Under Nordic conditions, this usually occurs some time in November depending on latitude, altitude and distance from the coast. Ideally, there ought to be some sunny and chilly days with mild night frosts leading up to coverage. In contrast, a rainy period causing the thatch/may layer and root zone to be soaked with water is not a good starting point for coverage.

Experienced greenkeepers follow the long-term weather forecast and have the workforce needed (staff and/or golf course members) to cover 18+ greens in a day or two once the forecast says heavy frost and/or snow fall in a few days. To accomplish this, it is important that necessary preparations have been made in advance.

Photo 3. *Distinct line between covered and uncovered turf in foregreen at Asker GC, 23 April 2020. Photo: Trygve S. Aamlid.*

Photo 4. *An important preparation is to dig plastic collars into the higher surrounds outside the green. In this case, the spring tarp and the impermeable cover can be fastened under the collar to prevent melting water from seeping in under the covers. Photo: Mads Thers.*

Preparations

For the most part, winter preparations of greens that are going to be covered are the same as for uncovered greens. These include topdressing according to turfgrass growth rate and frequent inputs of a complete fertilizer at small and decreasing rates until the weekly average air temperature drops to 3-4 °C (More information and an autumn fertilizer calculator in STERF's 'Turfgrass Winter Stress Management Handbook' at www.sterf.org).

Some greenkeepers practise heavy topdressing before coverage in autumn, but it is hard to understand the rationale for this if there is no traffic on the greens during winter and the shoot apices are going to be protected by impermeable covers anyway. Turfgrass thatch control should be a year-round commitment, not an all-out effort in autumn.

Greenkeepers who use a growth regulator program (e.g. Primo MAXX) should continue applications well into October as this will enhance hardening by allocating sugar from photosynthesis to carbohydrate reserves rather than to growth. In annual bluegrass, it may also be a good idea to increase mowing height by up to 50 % from late September, on the condition that the greens are protected by fungicide applications before coverage.

Since impermeable covers prevent gas diffusion between the rootzone and the atmosphere, it is important that the rootzone is decompacted and filled with oxygen before the winter. Deep aeration with Vertidrain or similar before coverage is therefore recommended.

Most importantly, it is essential to have greens protected with fungicides before coverage. Before snow cover, and particularly if the soil in not yet frozen, the impermeable cover can be expected to trap water (e.g. from soil respiration) and lead to condensation and a humid environment causing a higher disease pressure than on uncovered greens (e.g. Koch 2017).

In the late winter this situation may perhaps be revered as low oxygen concentrations may limit the activity of the winter-active pathogens *Microdochium nivale* (causing microdochium patch) and *Typhula* sp. (causing gray and speckled snow mold) under the plastic sheets. The latter effect is, however, too risky to count on, so the take-home message is that impermeable covers increase the need for fungicide applications before winter.

As for uncovered greens, we recommend the application of a product containing at least one systemic fungicide (e.g. Delaro 325 EC with the active compounds prothioconazole and trifloxystrobin) or Instrata Elise (with the systemic compound difenoconazole) when the grass is still growing in early October. This first application will usually reduce the disease pressure by 60-70 %, which is not sufficient if you are going to put out covers. Three to four weeks later, after mowing has been discontinued for the season, the first application therefore has to be followed by a second application of a predominantly contact fungicide, e.g. Medallion TL (active compound fludioxonil).

Furthermore, if the coverage is postponed to late November or early December due to mild weather, there should be a second application of the contact fungicide before the covers are installed.

Finally, a very important preparation 1-2 weeks before expected coverage (and before the soil freezes) is to dig trenches and install plastic collars on the higher areas surrounding the putting greens to prevent melting water from seeping in under the covers (Photo 4). This is a critical precaution because seepage under the covers will inevitably lead to dead grass in the lower areas on the green. Moreover, installation of the collars 1-2 m outside the green will secure winter survival even on the nearest foregreen and not interfere with the final preparation before coverage (e.g. deep aeration or last fungicide application). Doing this in advance will greatly increase the chances of having all greens covered under good conditions before the first heavy snow fall or severe frost.

Spring tarps underneath the impermeable covers?

We recommend to put out the permeable tarp normally used in spring (e.g. 'Evergreen', 'Wondermesh' or 'Agryl' fiber tarp) as an undercover under the impermeable covers. The spring tarps may have a small insulating effect, and they will prevent the plastic from freezing to the surface in direct contact with the grass.

For the greenkeepers, it may also be an advantage to have the spring tarps installed before the winter already as they will most probably be needed for protection against freezing temperatures or desiccating winds once the impermeable covers have been removed in spring.

Monitoring gas composition under impermeable covers

Dry air contains 20.95 % oxygen (O_2) and 0.04 % (400 ppm) carbondioxide (CO_2; currently increasing by 3-9 ppm per year). The major component is nitrogen (N2; 78.09 %)

Under the impermeable covers, the relative humidity is 100% and the water molecules also occupy some of the space, so the sum of CO_2 and O_2 is about 15%.

Despite the fact that aerobic respiration yields one molecule of CO_2 for every molecule of O_2 consumed, the increase in CO_2 concentration under covers is usually less than the decrease in O_2 concentration. This is partly because of anaerobic processes converting CO_2 to methane (CH4) and partly because some of the CO_2 is trapped in soil water since CO_2 is eighty times more soluble than O_2 in water.

In the new STERF project ICE-BREAKER we are using not only temperature sensors, but also O_2 and CO_2 sensors as a decision support tool for when to ventilate under the covers during winter and when to remove the covers in spring. Tentatively, the thresholds for when to aerate will be set to less than 10 % O_2 or more than 5 % CO_2.

O_2 and CO_2 concentrations and the need for ventilation

Both plants and soil microorganisms respire and thus contribute to oxygen deprivation and CO_2 accumulation under impermeable covers. The respiration rate is closely related to temperature and is usually significant even around 0°C, the temperature normally found at ground level under impermeable covers overlain by snow. Since a rise in temperature will cause an exponential increase in respiration, it is a good idea to install sensors that monitor temperature at turfgrass crown level under the covers.

Besides temperature, soil organic matter is the most important factor governing microbial activity and thus respiration under the covers. Thus, the risk for harmful gas concentrations to build up is usually higher on old push-up greens than on new sand-based green, and higher on greens with a high organic matter in the thatch/mat layer (e.g. Rochette et al. 2005). As an insurance against oxygen deprivation and accumulation of CO_2 and toxic gases, it is recommended to install a ventilation system between the permeable spring tarp and the impermeable plastic cover.

This system can be made up of perforated drainage pipes, interconnected and with an average distance of 4-5 m between the pipes. Alternatively, manufacturers of impermeable turf covers often offer perforated plastic tubes that inflate upon air pressure, e.g. when connected to a leaf blower. Advantages of these flat tubes are that they are less voluminous during storage and do not create 'bumps' on the green that can create problems if there is a need to remove snow from the covered green in early spring. On the other hand, there is always a risk that the flat tubes will not inflate should there be a heavy layer of ice above the covers. In such cases, the extra oxygen reservoir in the fixed drainage pipes may perhaps be an insurance, although the weight of the ice can make it difficult to have the air distributed uniformly across the green surface even with such pipes.

Regardless of system, it is important that the outlet of the ventilation system is connected to a firm pole that stands up and is easy to find even after a heavy snow storm.

When to remove the plastic in spring?

As mentioned already, it is important to avoid temperature increase under the covers in spring. Greens in full sunlight and facing to the south will usually need to have the covers removed earlier than shaded greens or greens facing to the north. During the winter 2019-20, some greenkeepers removed the impermeable covers very early due to an exceptionally mild winter with a complete snow melt in February already. In this case it was important to have the spring tarps in place as a protection should cold nights come back.

In a more normal winter, the impermeable covers can usually stay on the greens until natural snow melt in March or April. It is, however, important to monitor the condition under the covers at least weekly

Photo 5. *Snow removal above the impermeable cover may be necessary should toxic gases start to accumulate. Photo: Mads Thers*

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to avoid anaerobic conditions. If you have a feeling that your ventilation system does not work, it may be safer to clear the snow and/or to put out some charcoal or other black material to melt the snow and, more importantly, the ice underneath it.

Experiences from the four Norwegian golf courses during the past two winters suggest that USGA-spec. and California greens with a good thatch control program can tolerate impermeable covers for up to 140 days provided ventilation every 3-4 weeks. This is the case even with annual bluegrass as the predominant grass species. Should anoxic conditions occur (O_2 concentration less than 1 % and/or CO_2 concentrations higher than 10 %), the maximum tolerance than can be expected is around 25 days in annual bluegrass and around 45 days in creeping bentgrass (Aamlid et al. 2009).

Read more

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STERF 2020. Layout: Karin Schmidt.